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Primary and Secondary Processing of a Waking Subliminal Stimulus in REM- and Non-REM-Sleep

- Empirical Investigation of a Psychoanalytic Concept -

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Was von Menschen nicht gewusst,
Oder nicht bedacht,
Durch das Labyrinth der Brust
Wandelt in der Nacht.

(Johann Wolfgang von Goethe)

Zusammenfassung

Die hier vorgestellte Studie befasst sich mit einer der Grundannahmen der psychoanalytischen Theorie: der Existenz zweier verschiedener Arten mentaler Prozesse, genannt *Primär-* und *Sekundärprozess*. Gemäß Freud findet sich der Sekundärprozess in unserem wachen bewussten Denken und Erleben wieder, welches vorwiegend rational und logisch ausgerichtet ist. Demgegenüber beschreibt der Primärprozess eine eher irrationale Form des Denkens. Er umfasst Mechanismen wie Verdichtung, Verschiebung und Symbolisierung, die sich vor allem in unbewussten Prozessen wiederfinden, wie sie beispielsweise Träumen, Fehlleistungen oder Phantasien zugrunde liegen.
Im Jahre 1917 machte Pötzl erstmals die Entdeckung, dass nicht registrierte Teile eines unterhalb der Wahrnehmungsschwelle präsentierten Reizes in den nachfolgenden Träumen auftauchen. Allerdings stellte er dabei fest, dass diese Teile vor ihrem Wiederauftreten bedeutsame Transformationen und Entstellungen durchgemacht haben. Interessanterweise erinnern diese Transformationen stark an die Mechanismen des Primärprozesses (z.B. Verdichtung, Verschiebung und Symbolisierung). Somit scheint diese Entdeckung Freud's Hypothese, dass Träume nach den Prinzipien des Primärprozesses organisiert sind, zu bestätigen.

In der vorliegenden Studie wenden wir die Methode der subliminalen Stimulation auf den Schlafzyklus an, um unbewusste Prozesse während des Schlafes zu untersuchen. Ziel dieser Studie ist es heraus zu finden, ob sich diese Prozesse im REM- und non-REM-Schlaf unterscheiden und ob sich diese Unterschiede dem Freudschen Konzept vom Primär- und Sekundärprozess zuordnen lassen. Bislang gibt es nur eine einzige Studie, die die Effekte eines im Wachzustand subliminal präsentierten Stimulus auf die gedanklichen Abläufe im REM- und non-REM-Schlaf untersucht (Shevrin and Fisher, 1967). Wir möchten diese frühen Ergebnisse replizieren und erweitern, indem wir zusätzliche Stimuli verwenden und darüber hinaus neurophysiologische Daten erheben und analysieren. Unsere Haupthypothese lautet, dass im REM-Schlaf, in dem meist bizarre, phantasievolle und irreale Träume erlebt werden, der Primärprozess der vorherrschende Denkmodus ist. Der non-REM-Schlaf auf der anderen Seite, der eher kürzere, weniger bizarre, sondern vermehrt gedankenartige Träume hervorbringt, ist vermutlich vermehrt durch sekundärprozesshafte Abläufe charakterisiert.

Um diese Hypothese zu untersuchen, wurde 20 Probanden vor dem Schlafengehen ein visueller Stimulus subliminal dargeboten. Dabei handelte es sich um einen speziellen Rebus-Stimulus, der es aufgrund seiner Doppeldeutigkeit möglich macht, sowohl primär- als auch sekundärprozesshafte Abläufe zu untersuchen. Die Probanden wurden im Verlauf der Nacht insgesamt sechsmal geweckt (dreimal aus dem REM-Schlaf und dreimal aus dem non-REM-Schlaf Stadium 2) und nach jeder Weckung aufgefordert, verschiedene Aufgaben zu erfüllen (einen Traumbericht abliefern, vier Minuten frei assoziieren, sowie das erste in den Sinn kommende Bild aufmalen). Vor allem die Analyse der freien Assoziationen zeigte, dass die mentalen Abläufe im non-REM-Schlaf wie erwartet durch den Sekundärprozess charakterisiert sind. Assoziationen nach REM-Schlaf Weckungen hingegen ließen starke primärprozesshafte Einflüsse erkennen. Diese Ergebnisse zeigen eine deutliche Übereinstimmung mit denen der Originalstudie (Shevrin and Fisher, 1967).
Um diese Ergebnisse zu erweitern, verwendeten wir außerdem die geometrischen GeoCat-Stimuli von Brakel et al. (Brakel et al., 2000, 2002; Brakel and Shevrin, 2005). Diese geometrischen Figuren bestehen aus verschiedenen Items, die hinsichtlich spezifischer Gemeinsamkeiten untereinander beurteilt werden müssen und auf diese Weise ebenfalls primär- und sekundärprozesshaftes Denken untersuchen. Wie erwartet, zeigte sich nach Weckungen aus dem non-REM-Schlaf die erwartete Dominanz von Entscheidungen auf Basis des Sekundärprozesses. Die erwartete Dominanz von primärprozesshaften Entscheidungen nach REM-Schlaf Weckungen konnte hingegen nicht gezeigt werden.
Darüber hinaus wurden die elektrophysiologischen Daten der REM- und non-REM-Schlafphasen analysiert, die den jeweiligen Weckungen voraus gingen. Auf diese Weise sollte untersucht werden, ob Veränderungen innerhalb der Power im Alpha- und Theta-Frequenzband mit Veränderungen im primär- und sekundärprozesshaften Denken assoziiert sind. Obwohl vorherige Studien gezeigt haben, dass erhöhte Alpha-Aktivität mit Kreativität und Originalität assoziiert ist, konnte die erwartete Beziehung zwischen Alpha Power und dem Primärprozess nicht bestätigt werden. Erhöhte Theta-Aktivität auf der anderen Seite, welche mit höheren kognitiven Funktionen assoziiert ist, korrelierte gemäß der Hypothese mit sekundärprozesshaften Antworten. Allerdings handelt es sich hierbei um sehr vorläufige und exploratorische Ergebnisse.

Zusammenfassend liefert die Studie vor allem anhand des subliminal präsentieren Rebus-Stimulus wichtige empirische Belege für die These, dass die gedanklichen Abläufe im REM-Schlaf primärprozesshaft organisiert sind, während im non-REM-Schlaf sekundärprozesshafte Abläufe vorherrschen. Mögliche Gründe dafür, dass dieser Effekt nicht auch unter Verwendung der GeoCat-Items demonstriert werden konnte, sowie eine mögliche Beziehung zwischen elektrophysiologischen Markern und primär- bzw. sekundärprozesshaften Denkprozessen werden diskutiert.

Die Bedeutung dieser Studie liegt darin, dass sie einen wichtigen Beitrag zur empirischen Validierung eines der psychoanalytischen Kernkonzepte liefert. Dies ist vor allem aktuell bedeutsam, da die Psychoanalyse heute mehr denn je gefordert ist, empirische Belege für ihre theoretischen Konstrukte zu liefern, um ihre Glaubwürdigkeit weiterhin aufrecht erhalten zu können.

Summary

The presented study deals with one of the fundamental psychoanalytic assumptions: the existence of two different ways of mental functioning called *primary* and *secondary process*. In Freudian theory, the secondary process dominates our conscious, awake, and alert way of thinking and functioning which is mostly rational and logical. The primary process, however, describes a more irrational way of thinking and comprises mechanisms like condensation, displacement, and symbolization. These mechanisms can mainly be found in unconscious processes underlying dreams, slips of the tongue, fantasies, and symptoms.
In 1917, Pötzl discovered that unnoticed parts of a visual stimulus presented below the perception threshold appeared in the subject's following dreams. However, these parts had undergone significant transformations and distortions before their reoccurrence. Interestingly, these transformations closely resemble the mechanisms of the primary process (e.g. condensation, displacement, symbolization). This finding seemed to support Freud's hypothesis that dreams are organized along primary process lines.
In our study, we apply the subliminal method to the sleep-dream cycle to study unconscious thought processes during sleep. We aim at finding out whether these processes differentiate REM- and non-REM-sleep and match the Freudian idea of primary and secondary process thinking. So far, only one single study has investigated the effects of a waking subliminal stimulus on REM- and non-REM-sleep mentation (Shevrin and Fisher, 1967). We wish to replicate these early findings and extend them by using additional stimuli and by recording neurophysiological measurements. Our main hypothesis is that during REM-sleep, when most bizarre, fanciful, and irrational dreams occur, the primary process is the dominant mode of mental functioning. Non-REM-sleep, however, when dreams are mainly characterized as thought-like, is supposed to be characterized by secondary process mechanisms.

To investigate our main hypothesis, 20 subjects were presented a visual stimulus subliminally before retiring to bed. A special rebus stimulus able to elicit different levels of associations was applied to allow for tracking primary and secondary process influences. Being awakened three times from REM-sleep and three times from non-REM-sleep (stage 2), subjects were asked to perform several tasks (give a dream report, have four minutes of free association, and draw the first image coming to mind). As revealed by the free associations (which are supposed to be most capable of catching the ongoing process underlying the preceding sleep stage), non-REM-sleep mentation is indeed marked by secondary process mechanisms. Associations following REM-sleep awakenings, on the other side, revealed strong primary process influences. These findings are in great accordance with the results of the original study (Shevrin and Fisher, 1967).

To extend these findings, we used the geometrical *GeoCat* stimuli of Brakel et al. (Brakel et al., 2000, 2002; Brakel and Shevrin, 2005). These geometrical items ask for two different kinds of similarity choices which index either primary or secondary process thinking. Again, awakenings from non-REM-sleep showed the expected predominance of secondary process choices. The hypothesized predominance for primary process choices after REM-sleep awakenings, however, could not be demonstrated.

Finally, the electrophysiological data preceding the respective awakenings from REM- and non-REM-sleep was analyzed to investigate whether power changes in the alpha and theta frequency band are related to changes in primary and secondary process thinking. Although previous studies have shown that increased alpha power is associated with creativity and originality, the hypothesized relationship between alpha power and primary process thinking could not be observed. Increased theta power, on the other hand, as an index for higher cognitive functioning, seems indeed to be correlated with secondary process answers, although these findings are preliminary.

Summarizing, the current study demonstrates that the same subliminal stimulus can be processed during sleep in significantly different ways. It was thus possible to provide experimental evidence that mentation during non-REM-sleep is organized along secondary process lines, while REM-sleep mentation is characterized by primary process mechanisms. Reasons for the failure to demonstrate the same effect using the GeoCat items, as well as a possible relationship between electrophysiological markers and primary and secondary thinking, are discussed. The importance of this study lies within the fact that it contributes to the experimental validation of one of the psychoanalytical core concepts. This is especially important because psychoanalysis is now being challenged more than ever to provide empirical evidence for its theoretical constructs to maintain and to increase its credibility.

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1. Introduction

1.1 Psychoanalysis - empirical science or hermeneutic discipline?

According to Freud, the term “psychoanalysis” comprises three aspects: a scientific theoretic construct (psychoanalytic theory), a method for the investigation of unconscious processes (psychoanalytic method), and a technique for the therapeutic treatment of psychic disorders (psychoanalytic therapy). However, especially the question as to whether psychoanalysis can be regarded as empirical science has never been as hotly debated as it is today, “at a time when so many voices are calling more loudly than ever for the total rejection of psychoanalysis - as a therapy, as a science, and as a movement” (Holt, 2009, p.86). Although psychoanalysis has always had to face strong objections and manifold criticism since its emergence at the beginning of the 20th century, its scientific status has been especially under attack since the actual “decade of the brain” produced such a flood of experimental findings. Confronted with this flood of putative hard facts produced within the field of neurosciences, psychoanalysts are being explicitly challenged to underpin the state of psychoanalysis as an empirical science.

Indeed, psychoanalysis is, above all, a clinical method for the treatment of patients suffering from psychological disorders and clearly derives from a clinical and not an experimental tradition. Nevertheless, it comprises a wide range of expansive theories embracing elements of the human being like mental disorders, symptom formation, hallucinosis, development, dreams, slips of the tongue, emotions, motivation, affect, humor, religion, culture, and much more. But despite its large, all-engulfing and far-reaching impact on all these different aspects of human life, the few clinical case studies psychoanalytic theory is mainly based upon are highly anecdotal in nature. Psychoanalysis, it seems, is and always has been far better at generating hypotheses than at systematically validating them. Experimental setups, clearly formulated hypotheses, controlled observations, and statistically significant findings are largely missing. Hence, psychoanalysis has undoubtedly missed the opportunity to “develop a systematic, investigative, research-oriented dimension to its science” (Shevrin, 2000, p.34). Shevrin goes on and summarizes the dilemma of psychoanalysis:

> [I]t has remained with a few significant exceptions a clinical science, its major interest and investment devoted to the treatment of patients and the training of clinicians. If it has a research interest, it is in research aimed at proving the effectiveness of psychoanalytic treatment and in studying the nature of the analytic process. (Shevrin, 2000, p.34-35)

The apparent distrust of empirical research might be explained by the fear of many psychoanalysts that experimental testing leads to an oversimplification and reductionism of psychoanalytic theory. An empirical approach is assumed not to take the complexity of clinical phenomena into account, and to disregard the dynamic processes taking place unconsciously between analyst and patient. Furthermore, experimental psychoanalytic research is supposed to miss "the deeper aspects of oedipal and pre-oedipal, sexual and aggressive fantasy life and conflicts" (Kernberg, 2006, p.902). Another reason for the apparent failure to put psychoanalytic assumptions to testable experimentation is the lack of an immediate use for the analytic practice. On the other hand, clinical evidence and anecdotal case studies do not satisfactorily fulfill contemporary scientific standards or, as Westen puts it, the "recognition that "I had a patient once" is not the firmest of epistemological foundations" (Westen, 1998, p.334). This, however, has led to the "insularity and anti-intellectualism" (Kandel, 1998, p.467-468) characteristic especially of psychoanalysis in the past 50 years.
Accordingly, critics like Grünbaum (1984; 2001; 2006), Crews (1986; 1996), or Macmillan (1991) claim that Freudian theories clearly lack "any observational basis, being drawn entirely from nonempirical sources" (Holt, 2009, p.86). Very harshly, Crews downgrades psychoanalysis to "a faith like any other" and states that "Freudianism has become (...) the paradigmatic example of doctrine that compels irrational loyalty" (Crews, 1986, p.12). Similarly, Grünbaum speaks about the "biblical deference" (Grünbaum, 2001, p.106) of most psychoanalysts. Westen made a similar observation and states that for years "many in the psychoanalytic community have treated psychoanalysis as a religion and have been more interested in protecting than testing psychoanalytic dogma" (Westen, 1998, p.334). It is widely criticized that the central presuppositions of psychoanalysis are largely taken for granted, and emphasized that it is indispensable that these assumptions are put to the test. By doing so, the famous critique by Popper (1963) that Freud's psychoanalytic theory is a non-falsifiable pseudoscience could be answered. Hence, empirical research investigating the basic principles underlying psychoanalytic theory is very much needed, so that the theory itself can be exposed to falsification. These basic principles of psychoanalysis are:

1. *The existence of a psychological unconscious:* Unconscious processes exist; thoughts, feelings, and motives can occur entirely unconsciously. Furthermore, these unconscious processes have a strong influence on conscious processes.

2. *The role of free associations:* By applying the method of free association, which is one of the most important techniques in psychoanalytic treatment, unconscious elements are supposed to be revealed.

3. *The existence of two different modes of mental functioning - primary and secondary process:* Conscious and unconscious processes differ with regard to their prevailing mental organization. While unconscious processes are dominated by primary process thinking, conscious processes are largely organized along secondary process lines.

However, designing experiments based on the theory which is put to test, runs the risk of circularity. Brakel accordingly claims:

> The findings of a method cannot provide evidence for its own assumptions. (...) Thus, postulates or assumptions must gain support from findings outside the methods that presuppose those same assumptions. (Brakel, 1994, p.41)

Hence, the challenge psychoanalysis has to answer is to search for independent evidence-based support for its fundamental propositions (Popper, 1963; Grünbaum, 1984; Edelson, 1990; Shevrin, 1995; Shevrin et al., 1996). Following this challenge, more and more contemporary psychoanalysts plead for more scientific research within the field of psychoanalysis (e.g. Schachter, 2005; Meissner, 2006; Jiménez, 2007; Wallerstein, 2009; Chiesa, 2010).[1] Furthermore, the call for an interchange between psychoanalysis and neighbouring disciplines, such as cognitive psychology, social psychology, or neuropsychology, gets louder. Especially the connection between psychoanalysis and neuroscience has become very popular recently - with good reason. Despite its wealth of significant and meaningful findings, neuroscience (as well as cognitive psychology) lacks a global and comprehensive theory which "explains more than the immediate set of findings at hand, and one that can generate an explanation of findings at a conceptual and phenomenological distance from the original ground on which the theory was based" (Shevrin, 2000, p.34). What is handled as theory within neuroscience or cognitive psychology is often not much more than an empirical generalization of several findings, rather than a true theory. As described above, psychoanalysis faces the opposite dilemma. However, according to the often-cited statement of Nobel-prize winner Kandel, "psychoanalysis still represents the most coherent and intellectually satisfying view of the mind" (Kandel, 1999, p.505), but - one might wish to add - a view without empirical support or scientific foundation. Hence, the convergence of both disciplines promises to be a very fruitful endeavour and has been pursued by leading specialists in both fields, such as Kandel (1998; 1999), Panksepp (1998), Shevrin (Shevrin and Fritzler, 1968a; Shevrin et al., 1971,

[1] It is important to note, however, that mainly during the 50s a lot of psychoanalytically oriented research was conducted especially in the United States (see chapter 1.2.3 and 1.3).

1996), Solms (Solms and Saling, 1986; Solms, 1997, 1998), Kernberg (2006), and many more. It is important not to lose sight of the fact that this was exactly what Freud, being originally trained as a neurologist, had in mind. At the time he started to immerse himself into the implication of unconscious mental processes, he intended to sketch a neural model of behavior as a basis for a scientific psychology. However, since brain sciences at that time were still very immature, he abandoned his idea of a neural model and turned towards a purely psychological, mentalistic conceptualization of the mind and the psyche. Still, he never doubted that one day the neural basis for his concepts would be found:

> Das Lehrgebäude der Psychoanalyse, das wir geschaffen haben, ist in Wirklichkeit ein Überbau, der irgendeinmal auf sein organisches Fundament aufgesetzt werden soll.[2] (Freud, 1917, p.377)

Summarizing, psychoanalysis is very much in need of opening itself to an empirical approach and to other disciplines if it wants to "regain its intellectual energy" (Kandel, 1999, p.506) and strengthen its scientific status. With our work, we wish to contribute to the independent experimental validation of one of the fundamental psychoanalytic presuppositions, namely the existence of two different modes of thinking: primary and secondary process thinking.

1.2 The Freudian concept of primary and secondary process thinking

As early as in his ***Entwurf einer Psychologie*** (1895), Freud described what has been appraised as "epoch-making distinction" (Klein, 1967, p.130) and Freud's "most fundamental contribution to psychology" (Jones, 1953, p.389): the distinction between the two principles of mental functioning - the primary and the secondary process.

As Freud hypothesized, the so-called *primary process* is developmentally earlier in both, ontogeny and phylogeny (Freud, 1900). This "more primitive form" of thinking (Holt, 2009, p.3) is ruled by the pleasure principle. Excitation seeks immediate discharge to establish an "identity of perception"[3], i.e. something that is perceived as being identical with the experience of satisfaction. It strives for wish fulfillment and the gratification of drives and needs by the shortest path - either motorical or hallucinatory. The primary process is further marked by freely displaceable cathexes and free transferences of intensities from one idea to another. Repeated transformations and displacements of this kind lead to condensations of intensities.

[2](Engl.: The theoretical structure of psychoanalysis that we have created is in truth a superstructure, which will one day have to be set upon its organic foundation.)

[3]("Wahrnehmungsidentität" (Freud, 1900, p.571))

Thus, the "intensity of an entire train of thought may ultimately be concentrated in a single conceptual unit"[4]. These mechanisms of condensation (i.e. two or more different elements are combined to form a new one) and displacement (i.e. intensity attached to one specific idea is displaced onto another, less frightening one), as well as symbolization, substitution, compromise-formation, "omnipotence of thought, pars pro toto" (Rapaport, 1951, p.694), and "superficial associations"[5] characterize primary process thinking. It is hallucinatory, unrealistic, not time-bound, and irrational. The primary process prevails in the unconscious (see below). Therefore, not only the mental activity of young children (until the age of about seven; see Burstein, 1959; Brakel et al., 2002) operates under primary process principles. It also prevails in all different kinds of phenomena which reveal close relationships to unconscious processes such as neurotic and psychotic symptoms, slips of the tongue and other parapraxes, jokes, transference manifestation, fantasies and free associations, as well as altered states of consciousness (e.g. sleep, dreams, hypnosis).
The "more sophisticated" (Holt, 2009, p.3) *secondary process* develops in the course of life and functions to inhibit and control the primary process. It comprises the more mature mode of mental functioning and can be found in our awake and conscious thinking and in experiences which are ruled by the reality principle. It aims at establishing an "identity of thought"[6]. Impulses and instinctual urges do not need to be satisfied immediately, since the secondary process is "attuned to the efficient attainment of goals in reality with the delayed gratification of impulses that is necessary" (Holt, 2009, p.3). It is an ordered and goal-directed thought-process - mostly logical, rational, non-hallucinatory, self-correcting, and realistic. However, it is important to note, as Gill points out, that "there is no such thing as "pure" primary process. Even a product involving condensation and displacement must be a compromise-formation expressing the functioning of both primary and secondary processes" (Gill, 1967, p.288). Similarly, Rapaport claims that there is no "sharp dichotomy" between these two modes of mental functioning, but rather a "continuous transition" (Rapaport, 1951, p.709). He also refers to the different states of consciousness from the most vigilant waking state to the deepest sleep stage, as well as those special states of consciousness induced by medication, drugs, hypnosis or meditation and claims that "as one descends levels of consciousness, thinking is increasingly taken over by symbolic, transformative, dreamlike ways of processing information" (Holt, 2009, p.33), that is by primary process thinking.

Table 1.1 summarizes Freud's major propositions about his theory of primary and secondary process thinking taken from ***Die Traumdeutung*** (1900) and the ***Formulierungen über die zwei Prinzipien des psychischen Geschens*** (1911).

[4] ("[Die] Intensität eines ganzen Gedankenzugs [kann] schließlich in einem einzigen Vorstellungselement gesammelt sein." (Freud, 1900, p.565))
[5] ("oberflächliche Assoziationen"(Freud, 1900, p.567))
[6] ("Denkidentität" (Freud, 1900, p.571))

Primary Process	**Secondary Process**
- genetically older, present from the first - residue of an early developmental stage when it was the only kind of mental process - regressive	- later, more adult - unfolds during the course of life and inhibits and overlays primary process only quite late
- the only process admitted in the unconscious	- the process resulting from inhibitions imposed by the (pre)conscious
- ruled by the pleasure principle - entirely disregards reality testing - wards off displeasure by repression	- ruled by the reality principle - uses and respects reality testing - impartial passing of judgment (true/false)
- aims at identity of perception (hallucinatory ideation, phantasizing) - wish fulfillment by the shortest path - seeks immediate gratification by any available means	- aims at identity of thought (more abstract, non-hallucinatory thinking) - detouring to gratification through reality - seeks ultimate gratification by roundabout route through reality
- mostly unconscious and non-verbal - occurs only if an unconscious wish, derived from infancy and in a state of repression, is transferred to it	- mostly conscious and verbal
- cathecting (drive-)energy is free and easily capable of discharge, by condensation and displacement	- cathecting energy is bound, most of it kept in a state of quiescence - discharge inhibited by means of hypercathexes

Table 1.1: Freud's major propositions about primary and secondary process thinking (adapted and modified from Holt, 2009)

1.2.1 The primary process and the unconscious

The demonstration of the existence of the unconscious and of its huge impact on our mental life is without doubt one of Freud's major contributions. Although he might not have been the one to *discover* the unconscious (see James, 1890), he was surely the one to stress its importance and to investigate it in more detail.

Following his earlier topographic model, "the mental apparatus"[7] consists of a system called *preconscious* (Pcs.) and a system named *unconscious* (Ucs.). Preconscious contents are not conscious yet, but principally capable of consciousness, e.g. when they achieve a certain intensity or are considered with sufficient attention (Freud, 1912, 1915). Unconscious contents, however, although they strongly influence ourselves, our actions, affect, and thoughts, do not have access to consciousness. They need to pass the system Pcs. first, but a censorship is interconnected between Ucs. and Pcs. If access to consciousness is refused by the censorship, those unconscious contents are repressed and stay unconscious (Freud, 1900).[8] Thus, the censorship functions to protect ourselves from a breakthrough of unconscious wishes and drives. It helps to control our waking life and our voluntary conscious actions and can, therefore, be seen as the "guardian of our mental health"[9]. If unconscious contents do get access to consciousness through the preconscious, they have to undergo various changes and modifications like condensation, displacement, and symbolization until they cannot be recognized anymore as such. This happens in dreams for example (see chapter 1.2.2), or in psychotic patients whose censorship is overwhelmed by the unconscious excitation which may result in hallucinatory regression. Following Freud, the third system *consciousness* (Cs.) holds the function of the sense organ or perception-system. He assumed that the transition from Pcs. to Cs. is also guarded by a censorship (Freud, 1900, 1915). Instead of the "once so all-powerful and over-shadowing all else"[10] consciousness, he declared the unconscious as the "general basis of psychic life"[11] and the true psychic reality. According to his hypothesis, the unconscious is the large circle which includes the smaller circle of the conscious. Everything has a preliminary unconscious stage as Freud claims repeatedly:

> [A]lles Bewußte hat eine unbewußte Vorstufe.[12] (Freud, 1900, p.580)

and later

[7] ("der seelische Apparat" (Freud, 1900, p.513))
[8] According to Freud the unconscious thought is barred from consciousness by active forces, such as defence and resistance (Freud, 1912).
[9] ("Wächter unser geistigen Gesundheit" (Freud, 1900, p.540))
[10] ("einst allmächtigen, alles andere verdeckende" (Freud, 1900, p.583))
[11] ("allgemeine Basis des psychischen Lebens" (Freud, 1900, p.580))
[12] (Engl.: Everything conscious has a preliminary unconscious stage.)

> Das Unbewußte ist eine regelmäßige und unvermeidliche Phase in den Vorgängen, die unsere psychische Tätigkeit begründen; jeder psychische Akt beginnt als unbewußter und kann entweder so bleiben oder sich weiterentwickelnd zum Bewußtsein fortschreiten, je nachdem, ob er auf Widerstand trifft oder nicht.[13] (Freud, 1915, p.33-34; see also chapter 1.2.3)

In his metapsychological writing ***Das Unbewußte*** (1915), Freud described the nature of the systems Ucs. and Pcs. in more detail. According to this, the unconscious consists of drive representations which seek discharge of their cathexis. It is organized along primary process lines (see above) and encompasses the respective mechanisms (condensation, displacement, etc.). In this system, there is no doubt, no negation, no temporal order, no regards for reality; everything is subject to the pleasure principle. Repressed contents are part of the unconscious, and this repressed unconscious is named the *dynamic unconscious* which cannot become conscious - no matter how intense or effective it is. As stated by Shevrin, this dynamic unconscious "refers to the motivated inhibition of experience and to such defenses as repression, isolation, and so forth" (Shevrin, 1992, p.136). Preconscious contents, on the contrary, follow the laws of the secondary process and are subject to the reality principle. Discharge of chathexed ideas is inhibited and displacement and condensation hardly appear.[14]

One has to keep in mind, however, that the assumption of the existence of an unconscious had been strongly refuted over and over again. In 1890, even before Freud's detailed description of unconscious processes, William James found ten arguments against the mere existence of an unconscious (James, 1890). Freud himself answered objections of this kind and stated in ***Das Unbewußte*** (1915): "Our right to assume the existence of something mental that is unconscious, and to employ that assumption for the purpose of scientific work, is disputed in many quarters. To this we can apply that our assumption of the unconscious is *necessary* and *legitimate*."[15] But the objections did not stop. Especially in the 1950s, the scientific field was strongly dominated by advocates of behaviorism who believed only in observable and measurable behavior, which can be fragmented into stimulus and response. All intrapsychic and cognitive processes, which could not be measured objectively, had been refused and declared

[13] (Engl.: The unconscious is a regular and inevitable phase in the processes constituting our psychic activity; every psychic act begins as an unconscious one, and it may either remain so or go on developing into consciousness, depending on whether it encounters resistance or not.)

[14] In 1923 Freud replaced the former topographic model by the new structural model in which he divided the psychic apparatus into the three subsystems *id, ego*, and *super ego*. The substantives *unconscious, preconscious*, and *consciousness* were changed into adjectives. Later, in his ***Abriß der Psychoanalyse*** (1940), he clearly assigned the unconscious and the primary process to the *id*.

[15] ("Die Berechtigung, ein unbewußtes Seelisches anzunehmen und mit dieser Annahme wissenschaftlich zu arbeiten, wird uns von vielen Seiten bestritten. Wir können dagegen anführen, daß die Annahme des Unbewußten *notwendig* und *legitim* ist." (Freud, 1915, p.125))

esoteric and unscientific. Consequently, the unconscious was considered only as a psychoanalytic myth and even consciousness itself was rejected as being a proper subject for scientific investigation. Nevertheless, in the 1970s, with the turn of behaviorism towards cognition, more and more studies of cognitive psychologist - starting with Marcel (1975; 1983a; 1983b) - actually supported the idea of unconscious processes.[16] Subsequently, it is nowadays widely accepted - even within cognitive psychology and neuroscience - that unconscious processes do exist. Learning and memory can be implicit, perception can be subliminal, affect can be non-conscious. However, we are dealing with two different concepts: the psychoanalytic *dynamic unconscious* and the so-called *cognitive unconscious* (Kihlstrom, 1987) which rather corresponds to the psychoanalytic preconscious. More specifically, "the dynamic unconscious is a mental structure that is the seat of instincts, drives, and motivations and is subject to irrational mentation; whereas the cognitive unconscious refers to a type of indispensable, but rational, mental processing that occurs out of awareness, is automatic, and is not under conscious control" (Klein Villa, 2006, p.156). Or as Eagle points out:

> [I]n Freudian theory, unconscious mental processes always reveal their links to drive gratification and are characterized by such primary process features as irrationality, illogicality, symbolization, condensation, displacement, and so on. By contrast, the unconscious mental processes of cognitive psychology are anything but irrational and illogical. (. . .) [T]hese processes are intelligent, logical, and problem-solving. (Eagle, 1987, p.159)

1.2.2 The primary process and dreams

In ***Die Traumdeutung*** (1900), Freud presented his extensive and ingenious theory of dreaming. According to this, every dream is "the (disguised) fulfillment of a (suppressed, repressed) wish"[17]. Hence, the incitement of each dream is a day residue - mostly indifferent, quickly perceived registrations - which conjoins with an unconscious infantile wish. The excitation strives to become conscious by passing the preconscious. As described above, this way is blocked during the day by the censorship. At night, however, this censorship is weakened and the unconscious drive is able to gain access to consciousness. Since the gate to motility is blocked during the night (see chapter 1.5), excitation cannot result in motor action. It needs to take a regressive path and ends up in hallucinatory wish fulfillment.[18] However, the unconscious wish undergoes various changes and modifications on its way before it appears in the dream. It is disguised and distorted by defensive necessities by means of the so-called dream

[16] Most of these studies used the method of subliminal stimulation which will be described in more detail in chapter 1.3.

[17] ("die (verkleidete) Erfüllung eines (unterdrückten, verdrängten) Wunsches" (Freud, 1900, p.175))

[18] Patients with so-called REM-sleep behavioral disorder show a lack of the characteristic muscle atonia during REM-sleep and, therefore, act out their dreams (e.g. Schenck and Mahowald, 2002; Mahowald and Schenck, 2005; Eiser, 2005).

work. In chapter VII of ***Die Traumdeutung*** (1900), Freud introduced the mechanisms of condensation, displacement, symbolization, and compromise-formation as essential tools of the dream work to achieve distortion. At the end of chapter VII, these mechanisms are summarized under the term *primary process.* Interestingly enough for the purpose of the study described here, condensation in dreams is most obvious when it concerns words or names. According to Freud's theory, names are treatened as objects and are combined, condensed and concentrated in new, often bizarre and funny word creations (Freud, 1900). These verbal transformations can also be found in the language of schizophrenics (see Robbins, 2002, 2004), as well as in little children who also treat words as objects and invent artificial languages. This special feature of dream work will be used to trace back primary process mechanisms in dream mentation in this study, as described below.
Thus, as Freud hypothesized, we can assume "two psychic forces (tendencies, systems)"[19] in dream formation: one of which is the unconscious wish underlying the dream, and the other the censorship which enforces disguise. Hence, he distinguished the latent dream thoughts from the manifest dream content - the former describing the unconscious repressed wish instigating the dream, and the latter resulting from the defensive distortions of the former. As Freud put it: "Traumgedanken und Trauminhalt liegen vor uns wie zwei Darstellungen desselben Inhaltes in zwei verschiedenen Sprachen"[20] (Freud, 1900, p.280). Dream work functions to convert the reasonable, latent dream thoughts into the often bizarre and incomprehensible pictorial language of the manifest dream content. Freud warns that the symbols of this language must not be read according to their values as pictures, but according to their meaning as symbols. The dream is a picture-puzzle, a *rebus* and must be read this way. Free associations, which are thought to provide linkages to underlying unconscious causes, are used to trace the way back from the manifest dream content to the latent dream thoughts. The dreamer is supposed to say whatever comes to mind about the manifest content, without constraints or censorship, to advance to the underlying unconscious thoughts and causes (Freud, 1900). This method has proved to be a helpful tool in the detection of unconscious ideas and processes (see chapter 1.2.3).

Summarizing, dreams are determined by unconscious and repressed wishes which need to connect with day residues to result in the manifest dream. Therefore, Freud declared the dream as being the "Via regia" (Freud, 1900, p.577) to the unconscious. Dreams result from the disguising mechanisms of dream work and represent the regression to a former, more primitive, infantile way of thinking - the primary process. According to Freud (1911), dreams are therefore particularly suitable for investigating the nature of primary process thinking in more detail, since they are the remains of the supremacy of this principle and evidence of its

[19] ("zwei psychische Mächte (Strömungen, Systeme)" (Freud, 1900, p.160))
[20] (Engl.: Dream thoughts and dream content present themselves as two descriptions of the same content in two different languages.)

power.

1.2.3 The experimental investigation of the primary process

The experimental investigation of the primary process and dreaming started more or less accidentally in 1917 with the Viennese sensory physiologist Pötzl. Using the method of subliminal stimulation (for a more detailed review of this method see chapter 1.3), he found that parts of a stimulus presented below the perception threshold appeared in the manifest content of the subsequent dreams. Since this was only the case for those parts formerly unregistered, he postulated the *law of exclusion*, describing the "relationship of mutual exclusion (...) between the consciously experienced percepts and the unconsciously experienced ones which emerged in dreams" (Pötzl, 1917, p.50). He further observed that those parts of the stimulus appearing in the dream had undergone significant transformations and distortions before their reoccurrence. Most interestingly, those transforming and disguising mechanisms closely resembled the mechanisms Freud had described as manifestation of the primary process and dream work, i.e. condensation, displacement, symbolic transformation, etc. (see chapter 1.2).[21] Even earlier in 1907, Urbantschitsch had demonstrated that unnoticed registrations appear in subsequent eidetic images but undergo various changes beforehand, such as fragmentation, rotations, displacements and condensations. However, the implications of these observations for psychoanalysis were largely ignored for a long time and a replication of Pötzl's original findings was not attempted, although later investigators made use of his method of subliminal stimulation (e.g. Allers and Teler, 1924; Malamud and Linder, 1931).

It was not until the beginning of the 1950s when Fisher, a psychoanalyst himself, built on these previous findings by trying to replicate and integrate them into psychoanalysis. In his remarkable studies, he could indeed confirm Pötzl's results by showing that unregistered parts of a subliminally presented stimulus did appear in the following dreams (e.g.Fisher, 1954, 1957; Fisher and Paul, 1959; Paul and Fisher, 1959). Remarkably, the delayed appearance of these preconscious percepts was as long as five to six days (Fisher, 1956). Furthermore, he demonstrated that "these unnoticed elements were influenced by unconscious wishes and subjected to primary-process transformations" (Fisher, 1960a, p.21), such as displacement, fragmentation, condensation, symbolic transformation, composite formation, as well as to spatial dislocation, reversals, and rotations. Luborsky and Shevrin confirmed Pötzl's findings, as well (Luborsky and Shevrin, 1956; Shevrin and Luborsky, 1958). They also made the important observation, as did Fisher (Fisher, 1954, 1959, 1960b), that also *consciously* registered parts of the

[21] As Pötzl was originally interested in visual perception in pathological brain conditions it was in fact not his aim to provide experimental evidence of the Freudian dream theory in the first place. Nevertheless, his observations were praised by Freud in a footnote of the 1919 edition of ***Die Traumdeutung***.

subliminally presented stimulus were incorporated into subsequent dreams. Therefore, they suggested a modification of Pötzl's *law of exclusion* to the effect that the dream is a better - but not the exclusive - vehicle for the unintentional occurrence of subliminal registrations, while intentional recall in the waking state is more efficient in recovering consciously registered parts of the stimulus. However, in contrast to these consciously registered parts, the subliminally registered percepts seem to be related to "more deeply repressed material" (Fisher, 1954, p.78). Investigating more carefully the different fates a stimulus undergoes after subliminal and supraliminal exposure, Fisher summarized:

> It was shown that the subliminal stimulus is drawn into the drive organization of memories, subjected to primary-process transformations, and appears in the manifest content of the dream in image form. These manifest images are related to the repressed, drive-oriented, wish-fulfilling aspect of the dreams. The supraliminal stimulus, on the other hand, appears to activate preconscious trains of secondary-process thought, direct derivates of the stimulus emerging in the dream in verbal, conceptual form. (Fisher, 1960a, p.23)

Because unnoticed parts of a subliminal stimulus also appear in distorted ways within free imagery and associations immediately following stimulus presentation (which was already described by Allers and Teler (1924), Luborsky and Shevrin (1956), and Shevrin and Luborsky (1958)), Fisher assumed that primary process transformation and distortion of subliminal percepts begin right after exposure (Fisher, 1954, 1956, 1957).[22] Hence, he suggested a modification of Freud's dream theory since something like dream work is apparently already active during the day. It begins at the moment the stimulus is flashed and is continued during the night. Furthermore, the concept of day residues needed to be extended to include not only *conscious* percepts, but also *preconscious* subliminal registrations. One could thus assume that many of the manifest dream images in fact derive from subliminal daytime percepts which have already made contact with repressed wishes. Consequently, Fisher proposed a model of perception in which every stimulus - subliminal or supraliminal - first registers preconsciously. In a second step this preconscious percept connects with pre-existing memory traces and results in recognition. Afterwards, it can undergo three different fates: (1) it enters consciousness immediately showing no or little primary process transformations which is usually the case for all non-conflictual supraliminal stimuli; (2) it remains in the preconscious ready to become conscious as soon as provided with sufficient attention, as is the case for neutral subliminal stimuli; (3) it is drawn from the initial preconscious phase into the dynamic unconscious, as is the case for stimuli which have made contact with repressed memories, like

[22] At the same time, this was empirical evidence for the often doubted retrieval capacity of free associations. This is an important aspect, since free associations are still one of he main tools in investigating the unconscious in psychoanalytic practice (see chapter 4.1.1).

all conflictual sub- and supraliminal stimuli. These preconscious percepts connected with unconscious repressed wishes provide the day residues underlying dream formation, and appear indirectly in distorted and disguised ways within the dream. Hence, "[t]he raw material of dreaming (...) is already present during the day and the dream itself arises when there is a second activation of the unconscious wish during sleep" (Shevrin, 1986, p.387).
In this model, the preconscious plays an important role and is seen as "port of entry for external stimuli where they can be immediately shunted into consciousness or be drawn into repression of the dynamic unconscious" (Shevrin, 2003, p.4). Thus, consciousness is regarded as a later optional stage which only occurs for a small part of the percepts and depends on stimulus factors (brightness, loudness, etc.), state factors (level of activation, sleep stage, etc.), and motivational factors (emotional content, avoidance of anxiety, conflict, etc.; see Shevrin and Dickman, 1980).[23] Similar to Freud's hypothesis about the development of primary and secondary process thinking, Fisher further declares this preconscious perception as being an ontogenetically earlier, more primitive stage of perception which is controlled by drives, wishes, and primary process mechanisms. It is inhibited by maturation of the ego and replaced by a more reality-oriented secondary process mode of perception (Fisher, 1954).

For a closer investigation of the primary process mechanisms of condensation and displacement in responses to subliminal stimulation, Shevrin and Luborsky (1961) designed a special stimulus - a *rebus stimulus* composed of the pictures of a *tie* and a *knee*. This stimulus can be read on a semantic, conceptual secondary process level and lead to associations and ideas related meaningfully to the pictured objects *tie* and *knee* (conceptual effect). A more primary process way of reading this stimulus, however, would result in words incorporating the clangs of the pictured objects, such as *ti*tle or pen*ny* which are related to the objects by sound, but not by meaning (clang effect). Finally, another primary process way of reading this picture-puzzle would lead to the phonic condensation of the sounds and, therefore, to the totally new rebus word *tiny*, or related associations and ideas (rebus effect). Such a rebus stimulus is based on Freud's assumption expressed in ***Die Traumdeutung*** (1900) that the pictographic symbols of the manifest dream, which result from the distorting mechanisms of condensation and displacement, and the unconscious processes underlying dream formation, are rebus-like (see chapter 1.2.2). In his ***Die Psychopathologie des Alltagslebens*** (1901b), he expanded this idea by claiming that not only dreams but also other unconscious formations, like symptoms, slips of the tongue, etc. can be read as rebuses. At the same time, this goes back to Freud's early neurological-based work ***Zur Auffassug der Aphasien*** (1891) in which he identified two levels of linguistic processing as being crucial in the understanding of the unconscious processing of language. The *semantic* level refers to the word *meaning* which means

[23] This matches the findings of the much-noticed experiments of Libet who demonstrated a neural delay of ca. 500 milliseconds preceding conscious experience of any event. He drew from this observation the very same conclusion that all mental events begin unconsciously (Libet et al., 1967; Libet, 1992, 1993).

words are treated as having a referential function for concepts or objects. The *perceptual* level refers to the word *presentation* which means words are treated as concrete entities based on their phonemic, graphemic, motoric, and kinesthetic properties.[24] The main advantage of using a subliminal rebus stimulus is that it is a reliable and objective method not only to study its recovery under certain circumstances, but also to track its primary and secondary process influences by means of certain predictable transformations (conceptual, clang, rebus). It is thus possible to determine the respective dominant mode of thinking and investigate the primary process mechanisms of condensation and displacement. Indeed, after flashing the *tiny* rebus subliminally, a clang effect was found in the subsequent ranking of words including the rebus word, clang-related words, as well as unrelated words, and in the description of waking images. Hence, a primary process transformation, as Freud identified in the formation of *dreams* (see chapter 1.2.2) and Fisher in subliminally presented *visual stimuli* (see above), also occurs for the *names* of those briefly flashed objects. This fits the observation of Freud's that the mechanisms of condensation and displacement can be best seen when they handle words and names: the names of these objects were treated as concrete phonemic patterns losing their referential function and resulting in novel words totally unrelated to their original meanings.

Likewise, using a *penny* rebus, consisting of the picture of a *pen* and a *knee*, primary process clang and rebus effects were shown within free associations after subliminal, but not after supraliminal exposure (Shevrin and Luborsky, 1961). Thus, the rebus technique turned out to be a helpful tool in investigating the conditions under which "the change from a conceptual to a sensorial ordering of thought takes place - the conditions, that is, under which secondary-process thinking gives way to primary-process thinking" (Shevrin and Luborsky, 1961, p.486-487).[25]

In 1967, Shevrin and Fisher went one important step further in the investigation of the primary process and dreams by combining the method of subliminal stimulation with the newly discovered sleep-dream cycle (see chapter 1.5). Thus, they were not only able to explore primary process transformations of a subliminal stimulus in dreams, but also to compare dreams from REM-(rapid eye movement) sleep and non-REM-sleep by awakening the subjects from the respective sleep stage. They flashed the penny stimulus for 6 ms (milliseconds) imme-

[24] These two different aspects of language finally resulted in the concept of primary and secondary process thinking. Hence, this dual process theory of language can be seen as the basis for Freud's later conceptualization of the two different principles of mental functioning.

[25] The hypothesis inherent in the rebus findings just described, and in Freud's ***Zur Auffassung der Aphasien*** (1891), that is "a distinct role for the perceptual aspects of words in the unconscious" (Klein Villa et al., 2006, p.118) was more recently tested by Klein Villa et al. (2006) (see also Bazan, 2007). Using a priming paradigm with a subliminal or supraliminal palindrome word as prime and two target alternatives, they provided evidence for Freud's hypothesis that word meaning and word presentation are functionally distinct when processed unconsciously. Recent preliminary data confirm this first finding (Bazan et al., 2010).

diately before the subject's retiring to bed. During the night, the subjects were awakened from REM- and non-REM-sleep and asked to fulfill several tasks (give a dream report, have four minutes of free association, and draw an image). It was hypothesized that REM-sleep, in which most dreams occur and which are described as more bizarre (see chapter 1.5), is characterized by a more primary process mode of thinking. This hypothesis was confirmed by more *penny* related words within the free associations after REM-sleep awakenings (rebus effect). Non-REM-sleep awakenings, however, were followed by significantly more *pen* and *knee* associates (conceptual effect; Shevrin and Fisher, 1967). This was a remarkable finding since it suggests that REM- and non-REM-sleep can be distinguished on the basis of their respective thought processes which parallel the Freudian concept of primary and secondary process thinking. Although there have been some (but only quite rare) attempts to investigate the effects of subliminal effects on dreams beyond the above mentioned pioneering studies of Pötzl, Fisher and Shevrin (Kaser, 1986; Leuschner and Hau, 1992; Leuschner, 1994; Schredl, 1999; Leuschner et al., 2000), the Shevrin and Fisher study is still the only one to investigate the *primary and secondary processing* of a waking subliminal stimulus in REM- and non-REM-sleep. However, the results have never been replicated, although they bear such central assumptions about dreams, unconscious processes, and primary and secondary process thinking. To make up for this major omission, the study presented here aims to replicate and extend this original study. By this, we hope to find supportive evidence for the original findings which clearly demonstrate a predominance of primary process thinking during REM-sleep, while non-REM-sleep seems to be organized along secondary process lines.

Summarizing the vast amount of studies investigating primary process thinking by means of subliminal stimulation, one can state that altered states of consciousness, such as dreams (Fisher, 1954, 1956, 1957; Luborsky and Shevrin, 1956; Shevrin and Luborsky, 1958), hallucinations (Pötzl, 1915; Fisher, 1959), and hypnosis (Shevrin and Stross, 1962; Stross and Shevrin, 1965, 1968) are especially conducive to the emergence of subliminal effects and primary process operations. Also certain kinds of responses facilitate the occurrence of the phenomenon, such as free imagery (Allers and Teler, 1924; Luborsky and Shevrin, 1956; Fisher, 1956; Fisher and Paul, 1959; Fiss et al., 1963), drawings (Giddan, 1967; Leuschner, 1994), free associations (Urbantschitsch, 1918; Shevrin and Luborsky, 1958; Haber and Erdelyi, 1967; Shevrin and Fritzler, 1968b; Stross and Shevrin, 1968; Leuschner and Hau, 1992), or Rorschach responses (Silverman and Silverman, 1964).[26] Generally, a supine position of the subject in a darkened room seems to enhance the recovery of subliminal effects in comparison with a upright-light condition (Fisher and Paul, 1959). This fits to the finding of Shevrin

[26]Next to the question of whether unconsciously registered elements do appear in subsequent dreams, fantasies, and images, the method of subliminal perception was also successfully used to investigate the responses to subliminal stimulation in relation to repression as a defense mechanism (e.g. Fritzler et al., 1970; Shevrin et al., 1969, 1996; Shevrin, 2000; Shevrin et al., 2002).

and Luborsky that significantly more elements of a subliminally exposed stimulus appeared in dreams and images than in intentional recall (Shevrin and Luborsky, 1958). Snodgrass et al. (1993) similarly found evidence that subjects performed better when told to guess the subliminally presented stimulus by just letting the words pop into their minds, instead of trying hard to do so. All in all, as Dixon states, a "state of effortless relaxation on the part of the subject" (Dixon, 1971, p.111) seems to be the essential condition for a subliminal effect to appear. This might be due to the fact that "when certain ego functions controlling the higher discriminative visual perceptive processes are interfered with (. . .) the more primitive, primary mode of visual perception manifests itself" (Fisher, 1960a, p.34) and, therefore, subliminal effects are facilitated. This is confirmed by studies which found that subjects with a high capacity for *regression in the service of the ego* (Kris, 1952), who are more able to adopt a passive, non-critical, regressive, and receptive position, and who can temporarily refrain from secondary process control, show stronger subliminal effects (Eagle, 1959; Fisher, 1960a).

However, not all the studies dealing with primary process thinking used the method of subliminal stimulation, nor did they necessarily focus on one of the conditions (sleep, hypnosis, etc.), or methodologies (free associations, dreams, images, etc.) mentioned above. Extensive research had been done on the relationship between primary process organization and creativity (e.g. Kris, 1952; Pine and Holt, 1960; Domino, 1976; Suler, 1980; Martindale and Dailey, 1996; Russ, 1988, 2001). These studies suggest that access to primary process thinking - and therefore the capability of controlled regression, loose associations, free floating energy, and novel combinations of images and ideas - is strongly connected with creativity.
Holt developed a scoring manual designed to score primary process markers in Rorschach responses (Holt, 1956; Holt and Havel, 1960; Holt, 1977, 2002) which was also used to score dream reports (Levin and Harrison, 1976), Thematic Apperception Test (TAT) stories (Eagle, 1964; Horowitz, 1965), psychotherapy transcripts (Bugas, 1986), and other free verbalizations (Goldberger, 1961). Fromm (1969) even used it to score the paintings of the Dutch painter Hieronymus Bosch. Similarly, Martindale and Dailey developed a computerized scoring system (the Regressive Imagery Dictionary) to analyze the amount of primary process content in any given text (Martindale, 1975, 1990). The validity of this scoring system has been proved in several studies, confirming the hypotheses that primary process contents are more prominent in children (West et al., 1985), psychopathology (West and Martindale, 1988), and altered states of consciousness induced either by drugs or medication (Martindale and Fischer, 1977; West et al., 1983) or by hypnosis (Comeau and Farthing, 1985, cited by Holt, 2009). Furthermore, Auld et al. (1968) constructed a 7-point rating scale for the scoring of primary process thinking in dreams.

Another set of evidence, supporting the central psychoanalytic assumption of the existence of primary and secondary process thinking as two distinct modes of mental functioning, was provided by Brakel and colleagues (Brakel et al., 2000, 2002; Brakel and Shevrin, 2005) and their so-called *GeoCat*-experiments (= geometrical categorization). In these ingenious studies, using neutral geometrical items as stimuli, they provided experimental evidence outside the clinical practice and independent of the psychoanalytic environment for this particular assumption. The notion of independent evidence is an important factor since it answers the objection made by critics of psychoanalysis who call for the use of extraclinical methods in the investigation of psychoanalytical constructs (e.g. Popper, 1963; Grünbaum, 1984; see chapter 1.1).[27] Their aim was to test the hypothesis that these two distinct thought systems have two different organizing and categorizing principles as one formal aspect in which primary and secondary process thinking differ from each other. While primary process organization is supposed to focus on attributional similarity (= similarity of concrete and superficial features, special attributes, parts rather than wholes), secondary process thinking should favor categorizations made on the basis of relational similarity (= similarity of relations between parts) or configurational similarity (= similarity of the total configuration resulting from the way parts are related to each other). One can refer to several remarks leading to this hypothesis, starting with Freud. In his writing ***Über den Traum*** (1901a), he states:

> Einer einzigen unter den logischen Relationen, der der *Ähnlichkeit, Gemeinsamkeit, Übereinstimmung*, kommt der Mechanismus der Traumbildung im höchsten Ausmaße zugute. Die Traumarbeit bedient sich dieser Fälle als Stützpunkte für die Traumverdichtung, indem sie alles, was solche Übereinstimmung zeigt, zu einer *neuen Einheit* zusammenzieht.[28](Freud, 1901a, p.63)

In his ***Formulierungen über die zwei Prinzipien des psychischen Geschehens*** (1911), he describes the secondary process as thinking which "went beyond mere ideational presentations and was directed to the relations between impressions of objects".[29] Accordingly, Rapaport claims: "Where the primary process (...) holds sway (...) everything belongs with everything that shares an attribute of it" (Rapaport, 1951, p.708). Bruner similarly describes that secondary process thinking "employs categorization or conceptualization and the operations by which categories are established (...) and related one to the other to form a

[27] In fact, this also partly applies to the subliminal experiments described above, which investigate the psychoanalytic unconscious, since the method of subliminal stimulation itself does not presuppose dynamic unconscious processes. Chapter 1.4.2 describes another set of experiments, using neurophysiological methods to gain evidence for psychoanalytic core assumptions totally independently of the clinical situation.

[28] (Engl.: One of these logical relations - that of similarity, consonance, the possession of common attributes - is very highly favored by the mechanisms of dream-formation. The dream work makes use of such cases as a foundation for dream-condensation, by bringing together everything that shows an agreement of this kind into a new unity.)

[29] ("welches sich über das bloße Vorstellen erhob und sich den Relationen der Objekteindrücke zuwendete" (Freud, 1911, p.233))

system", while primary process categorization is "judged for its goodness as a story by criteria that are of a different kind" (Bruner, 1986, p.12.13).
The conceptual roots of the experiments and the stimuli used by Brakel et al. go back to the work on categorization by the cognitive psychologist Medin (e.g. Smith and Medin, 1981; Murphy and Medin, 1985; Medin et al., 1990). Using special geometric figures consisting of squares, circles, triangles, arches, etc., subjects were asked to judge which of two choices was more similar to a presented master figure - the relationally or the attributionally similar alternative (see chapter 2.2.4.1 for an example). They found that the relationally similar choice was significantly more often judged as being more similar. Brakel et al. extended this finding by taking attributional similarity judgments as an index for primary process thinking and relational responses as markers for secondary process mentation. They tested the hypothesis that unconscious similarity judgments - as opposed to the conscious ones shown by Medin et al. - would result in more attributional similarity choices, since unconscious mentation is supposed to be ruled by primary process thinking (Freud, 1900; see chapter 1.2.1). Indeed, their hypothesis was confirmed by showing that when the same stimuli were presented outside awareness by subliminal exposure, categorization was mainly attributional (Brakel et al., 2000). By this, additional important evidence was provided for (a) the existence of unconscious processes which (b) are organized along primary process lines - as opposed to the predominance of secondary process thinking in conscious mentation. Extending these experiments, it could, furthermore, be demonstrated that an indirect similarity task ("Which of the two choices do you prefer?") also results in more attributional responses when items are presented subliminally than a direct task does ("Which of the two choices is more similar?") (Brakel, 2004). Brakel et al. could likewise confirm the hypothesis that the thinking of young children is characterized by primary process thinking while secondary process thinking only develops in the course of the life span (Freud, 1900, see chapter 1.2). While preschoolers made significantly more attributional similarity choices, this changed at the age of about seven when a shift to more relationally based similarity judgments, as an index of secondary process thinking, was observable. This predominance of relational responses then remains stable throughout life (Brakel et al., 2002). Furthermore, they demonstrated that people with increased state anxiety, which is supposed to be related to unconscious conflict (Freud, 1926), shift toward primary process thinking - as expressed in their predominance of attributional responses (Brakel and Shevrin, 2005).

Summarizing, whenever psychoanalytic theory predicts a shift towards primary process thinking, Brakel and colleagues found a predominance of attributional similarity choices in their GeoCat-experiments. Using their geometrical figures, they could confirm three implications of Freud's theory of primary process thinking: (a) unconscious processes are ruled along primary process lines (Brakel et al., 2000) and in indirect tasks, where unconscious influences are larger, primary process thinking predominates (Brakel, 2004), (b) primary process thinking is developmentally earlier (Brakel et al., 2002), and (c) anxiety states, often related to unconscious conflicts, favor regression on primary process thinking (Brakel, 2004). These important findings were supplemented by Bazan et al. (2007) who found, by means of the same geometrical figures, that schizophrenic patients in an acute psychotic state tend to more attributional choices as evidence for the predominance of primary process thinking in schizophrenia. Lacking so far is the application of the GeoCat figures to the sleep-dream cycle. Since this would complement the set of findings mentioned above, we want to examine in our study whether the predominance of categorization by attribute is also detectable after REM-sleep awakenings, where the primary process mode is supposed to be dominant. Correspondingly, one would expect to get more relational similarity judgments after being awakened from non-REM-sleep, which is supposed to be ruled by the secondary process.

1.3 The method of subliminal stimulation

The term *subliminal* derives from the Latin words *sub* (Engl.: under) and *limen* (Engl.: threshold). Following a definition by Merikle "subliminal perception occurs whenever stimuli presented below the threshold or limen for awareness are found to influence thoughts, feelings, or actions" (Merikle, 2000, p.497). Intuitively the idea that perception occurs without any awareness of perceiving, contradicts the common idea that perception implies consciousness. For that reason, the question of whether stimuli might be perceived and acted upon without the subject having any awareness of the stimulus has always been a question of interest and it has produced a considerable amount of research, discussion, and controversy.

The experimental investigation of subliminal perception started more than 120 years ago with Pierce and Jastrow (1884) and Sidis (1898). However, these early studies are only of historical interest and had little impact on the further development of the method of subliminal stimulation. This changed with Pötzl who was the first to explore the recovery of unconscious registered elements in dreams and images (Pötzl, 1917; see chapter 1.2.3). For the subliminal presentation of the stimulus, he used a tachistoscope (Greek for *tachistos* (Engl.: very rapid) and *skopein* (Engl.: to view)). This apparatus allows a very brief presentation of a visual stimulus down to one millisecond. It either works with a high-speed shutter and continuous illumination, or with special lamps able to produce such short light flashes (Benschop, 1998). Despite their theoretical impact, Pötzl's findings were mainly anecdotal and lacked systematic control and methodological rigor. Nevertheless, the method of subliminal stimulation began to arouse the interest of other researchers, starting in the early 1950s with Charles Fisher (e.g. Fisher, 1954, 1956, 1957; Fisher and Paul, 1959; Fisher, 1960b; see chapter 1.2.3). Following Fisher, more and more likewise psychoanalytically oriented researchers adapted the

subliminal method (e.g. Dixon, 1956, 1958a,b; Luborsky and Shevrin, 1956; Klein et al., 1958; Klein, 1959; Eagle, 1959; Smith et al., 1959; Paul and Fisher, 1959; Shevrin and Luborsky, 1958, 1961; Shevrin and Stross, 1962; Shevrin and Fisher, 1967; Stross and Shevrin, 1968; Shevrin et al., 1969; Pine and Holt, 1960; Spence, 1961; Spence and Holland, 1962; Fiss et al., 1963; Giddan, 1967; Haber and Erdelyi, 1967; Silverman and Silverman, 1964; Silverman, 1983).[30] They used this method for the investigation of unconscious processes (including the preconscious and the dynamic unconscious) and studied states and concepts of psychoanalytical interest, such as conflict, affect, repression, dreams, hallucinations, free association, and primary process thinking (see chapter 1.2.3). The results of these experiments demonstrated that despite the very brief stimulus presentation, highly accurate registration takes place, so the subliminal presented stimulus is registered in an almost photographic way. Summarizing, it is mainly due to this revolutionary method that one of the major assumptions of psychoanalytic theory - the existence of unconscious psychological processes (see chapter 1.1) - is no longer doubted. Hence, its importance for psychoanalysis cannot be overestimated.
However, the history of subliminal experiments has always been a history of strong criticism and heated controversies, ranging from "slight unease to downright hostility" (Dixon, 1971, p.223). Although Fisher and his successors introduced some substantial modifications to account for some of the methodological weaknesses of the Pötzl study (e.g. by using suitable controls, complex scoring systems, blind judges, etc.), methodological limitations remained. This was emphasized by the behaviorists Goldiamond (1958) and Eriksen (1959, 1960) who criticized the methodology of these early psychoanalytically-based subliminal studies - especially with regard to inconsistent modes of stimulus presentation, different exposure times, and rarely mentioned luminance levels. Furthermore, it was never exhaustively determined how much of the flashed stimulus was actually consciously registered (see below).

As described in chapter 1.2.1, in the late 1970s subliminal research was largely taken over by cognitive psychologists (Wickens, 1972; Marcel, 1975, 1983a,b; Kunst-Wilson and Zajonc, 1980; McCauley et al., 1980; Fowler et al., 1981; Balota, 1983) to study "preattentive, preconscious aspects of perception" (Shevrin et al., 1996, p.4) and preconscious cognition. Mainly by means of priming experiments they could, for instance, demonstrate the influence of subliminal primes on subsequent decision tasks. Most of these priming studies relied on backward *pattern masking* which means the subliminal stimulus is *masked* by a second, immediately following stimulus consisting of a random pattern of letters, numbers, or figures. This is a substantial difference from the Pötzl-based experiments described above which used so-called *energy masking*, in which the subliminal stimulus is followed by a blank slide of much brighter intensity than the masked stimulus (Turvey, 1973).
However, objections against the subliminal method remained. Even though extensive research

[30] For a more extensive review see Dixon, 1971 and Dixon, 1981.

in this field demonstrated that people do in fact perceive stimuli and act on them without being consciously aware of them, questions like "Are the subliminal effects truly unconscious or maybe due to some residual consciousness?" are still a matter of controversial discussion. In addition, Kouider and Dehaene identify the following aspects:

> Indeed, this topic has faced some of the most complex problems of experimental psychology, not only technically (e.g. How to present stimuli that are invisible but still processed?), but also methodologically (e.g. How to demonstrate an absence of conscious perception?), theoretically (e.g. Should we trust introspective subjective measures or rather rely on objective measures?) and epistemologically (e.g. Why do so many subliminal perception experiments fail to be replicated?). Such difficulties, among others, are the reasons why the topic of perception without awareness has taken so long to achieve respectability. (Kouider and Dehaene, 2007, p.857)

1.3.1 Subjective and objective threshold approaches

All experiments trying to demonstrate unconscious perception go back to the so-called *dissociation paradigm* (Erdelyi, 1985, 1986) in which performance on two different tasks is compared: one (usually direct) to measure conscious perception, and one (usually indirect) to measure unconscious perception. The dissociation paradigm holds that unconscious perception can be demonstrated when the direct measure of conscious awareness yields null sensitivity (e.g. the subject indicates no conscious awareness of the stimulus), while effects on the indirect measure can still be found (e.g. significant effects in a priming task demonstrate that the stimulus was nevertheless perceived). The direct measure to index conscious perception usually relies on some sort of perceptual discrimination task (e.g. identification or detection) in which the subject is asked to discriminate between alternative stimuli, or to choose between presence or absence of a certain stimulus. This forced-choice discrimination measure is based on the *signal detection theory* (SDT; Green and Swets, 1966) which defines consciousness or awareness as discrimination ability.

Early studies in subliminal research mainly relied on the subject's self-reports of whether they had been consciously aware of the flashed stimulus or not. In the studies of Fisher, for instance (see chapter 1.2.3), subliminality was established after the actual experiment following a classical psychophysiological approach. Therefore, the stimulus was first exposed for the defined duration of 10 ms (the duration used during the experiment) and the subject was asked to report what he saw (mostly only a flash of light). Stimulus duration was then increased until the subject first reported seeing something (the detection threshold), and then further increased until he reported being able to identify the stimulus (the identification threshold). It was concluded, that there was no conscious awareness of the stimulus below the detection threshold. But of course these self-reports were far from being consistent and objective, and have, therefore, been strongly criticized (e.g.Eriksen, 1960). In the often-cited Marcel studies on semantic priming, for instance, subjects reported that they did not perceive the masked stimuli at all (Marcel, 1980, 1983a,b). As demonstrated by Cheesman and Merikle (1984), however, they were able to discriminate the masked stimuli better than chance (more than 50 % correct guesses), when forced to chose out of several alternatives which stimulus might have been the one presented before. Following this observation, Cheesman and Merikle (1984, 1985) distinguished between two different threshold measures: the *subjective* and the *objective threshold*.

Studies based on the *subjective threshold* rely on the subjects' self-reports about whether or not they were consciously aware of the flashed stimulus. Stimulus intensity is arranged such that subjects report not being able to detect anything and not having any conscious experience of the stimulus. However, when forced to choose out of several alternatives, their choices are above chance, although they feel they are only guessing. This could be due to the subject's conservative response criterion for consciousness because, as Merikle (1984) points out, it is difficult to know which criterion the subject applies when reporting conscious experience. Thus, "denials of awareness may reflect very low confidence rather than a complete absence of awareness" (Snodgrass and Shevrin, 2006, p.4) and alternative weak conscious perception explanations cannot entirely be ruled out (the so-called SDT criterion artifact critique).[31] Following Eriksen's critique (1959), Cheesman and Merikle summarize the controversial aspect of the subjective threshold method:

> Since the subjective approach simply defines awareness in terms of observers' self-reports of their conscious experiences, this approach transfers the responsibility for operationally defining awareness from the investigator to the observer, and any experimenter who uses this approach is, in effect, asking each observer to provide his or her own definition of awareness. (Cheesman and Merikle, 1985, p.314)

Thus, self-reports about the presence or absence of conscious awareness can vary considerably between subjects, depending on their individual criterion for accepting something as being conscious.

In contrast, stimulus presentation at the *objective threshold* is arranged such that above chance discrimination in a direct forced-choice discrimination task is ruled out. Thus, the criterion artifact concern of the subjective threshold approaches is avoided. Since the subject does not report any awareness of the stimulus *plus* is not able to discriminate between the presence or absence of a stimulus, a complete absence of conscious perception is assumed. This measure requires even weaker stimulus intensities as compared to the subjective threshold approach and

[31] As Dixon comments, people might "prefer to appear insensitive rather than hallucinated" (Dixon, 1971, p.230).

thus represents a more conservative estimate - and, presumably, the most stringent criterion for subliminality. Cheesman and Merikle state:

> [A]n objective approach based on forced choice decisions among stimulus states has the obvious advantage of providing a method for assessing perceptual sensitivity independent of an observer's biases in a particular situation. Thus, the objective approach places the responsibility for defining awareness clearly with the experimenter, as the experimenter has a method for distinguishing response patterns attributable to biased responding from those due to true perceptual sensitivity. (Cheesman and Merikle, 1985, p.314)

As described above, this forced-choice discrimination method is based on the signal detection theory. In this procedure, an equal number of stimulus and non-stimulus cards are flashed in random order and subjects have to state after each exposure whether they detected something or nothing. Afterwards, *d'* as measure of conscious perception (sensitivity to discriminate between stimulus and no-stimulus) is calculated by comparing the number of correct guesses (hits) with the number of incorrect guesses (false alarms; see chapter 2.3.1 for more details). In terms of the SDT, *d'* at the objective threshold is at chance ($d' = 0$; null sensitivity) which means the subject cannot detect a difference between stimulus and no-stimulus. At the subjective threshold, however, detection is above chance ($d' > 0$). This means, some degree of phenomenal awareness is still possible at the subjective but not at the objective threshold which exhaustively excludes any conscious perception. This refers to a central requirement of the dissociation paradigm that null sensitivity in the conscious perception measure, when equated with awareness, provides an *exhaustive* index of *all* relevant conscious experience (Reingold and Merikle, 1988). If this is not the case, putatively unconscious processes can still be explained by some residual conscious influences. However, if the applied measure of conscious awareness is at the same time an exhaustive measure of *unconscious* processes, then establishing null sensitivity would eliminate all evidence for both conscious and unconscious perceptual processes. Hence, exhaustiveness alone is not sufficient to provide convincing evidence for unconscious perception. Instead, an exhaustive measure that *exclusively* measures conscious perceptual information would be desirable. But, according to Merikle and Reingold (1992), no such measure exists. Neither the method of the subjects' introspective reports, nor the behavioral measures indexing the subjects' ability to discriminate between stimuli yielded convincing findings, since one could always doubt whether the selected measure did indeed guarantee a complete absence of all conscious (and only conscious) registration - or rather implied "weak, residual conscious perception (...) responsible for [the] putatively unconscious effects" (Snodgrass, 2004, p.110). For this reason, sceptics like Holender (1986) and Holender and Duscherer (2004) still doubt the influence of unconscious perceptual processes on affective and cognitive reactions.

1.3.2 Criticism

Indeed, as Cheesman and Merikle (1984, 1985) have shown, none of the studies on subliminal perception mentioned above, such as the cognitive priming experiments, could guarantee that the presented stimuli were indeed undetectable, as can be measured by a forced-choice procedure. They concluded that the stimulus presentation of these studies was at the subjective, rather than at the objective threshold level[32] and ascribed the positive findings of Marcel and others to the fact that subjects have apparently been conscious of more than they reported (which is in accord with Holender's critique (1986)). Hence, following Cheesman and Merikle, "any conclusions favoring unconscious word recognition based on the results of these studies are completely unwarranted" (Cheesman and Merikle, 1985, p.315). In their opinion, only the demonstration of perceptual processes occurring at the objective threshold, at which the observer fails at discriminating between stimulus and no-stimulus condition, would count as true evidence for perception without awareness. In their own experiments, however, Cheesman and Merikle (1984, 1985) found no evidence for priming without awareness under objective threshold conditions, and stated consequently that "no evidence for unconscious priming will ever be found when precautions are taken to measure detection thresholds accurately". They further stated that "perception without awareness is a bogus phenomenon since (. . .) evidence supporting the phenomenon disappears when appropriate threshold procedures are used" (Cheesman and Merikle, 1985, p.333).[33]
Nevertheless, Cheesman and Merikle still accept perception without awareness as a real phenomenon, as long as awareness is defined in terms of a subjective threshold. However, "if the objective detection threshold is assumed to be the appropriate definition of awareness, then the only possible conclusion is that perception without awareness does not occur" (Cheesman and Merikle, 1985, p.334). Dagenbach et al. (1989), as well as Kemp-Wheeler and Hill (1988), however, found convincing evidence for unconscious perception at the objective threshold - as did Groeger (1984), Kunst-Wilson and Zajonc (1980), Snodgrass et al. (1993), Van Selst and Merikle (1993), Bernat et al. (2001a), Klein Villa et al. (2006), and Shevrin et al. (1992) in their more recent investigations. Hence, whether the subjective or the objective threshold is the better method to assess perception without awareness (see Merikle and Reingold, 1998; Reingold and Merikle, 1990 for a summary of this controversy), as well as how to rule out alternative weak conscious perception explanations, is still hotly debated.
This debate is accentuated by the fact that whether acceptable evidence for perception without awareness is obtained, or not, apparently depends on the respective definition of awareness. Similarly, Snodgrass points out that the subjective and the objective approach do not even share the same underlying assumptions concerning the role of unconscious influences. In his

[32] This is also true for the stimuli of the studies ran by Fisher and his associates (see chapter 1.2.3).

[33] Snodgrass et al. (2004a), however, emphasized that this study was actually run under objective *identification* threshold, instead of objective *detection* threshold conditions (see below).

excellent summary of this dilemma he states:

> (...) [R]ecalling the canonical subjective threshold effect (i.e. direct discrimination remains above chance even when awareness is denied), subjective models must postulate (...) that this elevated direct performance indeed reflects unconscious influences. If so, utilizing objective methods, which require chance direct performance, should seriously reduce or outright eliminate not only conscious but unconscious influences as well. With this in mind, objective methods must apparently assume that direct discrimination tasks somehow tap only conscious perceptual influences (...). On the other hand, if reliable objective threshold effects are obtainable (e.g. on indirect tasks such as priming), this would apparently confirm that direct tasks are indeed insensitive to unconscious influences. If so, this would in turn imply that subjective threshold effects on direct tasks are actually due to conscious influences, and hence, that subjective methods are invalid. In short, it seems that subjective and objective methods are not just more or less stringent, but actually imply mutually incompatible models - and hence, cannot be both valid.[34] (Snodgrass, 2009, p.509)

Comparing subjective with objective threshold effects reveals further substantial differences. More specifically, inhibitory, as well as facilitative processes can be demonstrated at the objective threshold (see also chapter 4.5). This is, however, not true at the subjective threshold where effects are usually only facilitatory (e.g. Shevrin et al., 1996; Bernat et al., 2001b). One could thus assume that subliminal effects at the objective threshold occur at a deeper unconscious level, as compared to the subjective threshold effects.[35]

1.3.3 Responses to criticism

Responding to the difficulties of demonstrating true unconscious perceptual processes, Merikle and colleagues suggest abandoning the question "Do unconscious perceptual processes exist?" in favor of the question "How does unconscious perception differ from conscious perception?". Since the former could not be answered unequivocally because alternative explanations of the findings are always possible, the latter should provide evidence that perception without awareness occurs. They cite various studies using this so-called process-dissociation method to demonstrate qualitatively different effects of conscious and unconscious perception (see

[34] Snodgrass and Shevrin further propose that "objective threshold approaches index phenomenal awareness, and that subjective threshold approaches index an additional form of consciousness - namely higher-order reflective awareness. In this framework, objective threshold methods index phenomenally unconscious perception, whereas subjective threshold methods index phenomenally conscious but reflectively unconscious perception." (Snodgrass and Shevrin, 2006, p.32).

[35] This assumption gains further support by the findings of Shevrin et al. (1992, 1996) which demonstrated subliminal activation of unconscious conflict at the objective detection threshold.

Merikle and Daneman, 1998 for review). They claim, "[n]ot only do these qualitative differences show how conscious and unconscious perception differ, but they also provide stronger evidence for the existence of unconscious perception than was ever obtained in experiments designed to demonstrate unconscious perception directly" (Merikle and Daneman, 1998, p.16).[36] Furthermore, with regard to the subjective vs. objective threshold measures debate mentioned above, they established their *subjective threshold model* (Cheesman and Merikle, 1984, 1986; Reingold and Merikle, 1988, 1990; Merikle et al., 1995, 2001). They claim subjective threshold effects (stimulus conditions under which the subject claims not to perceive anything, but still performs above chance in a forced-choice discrimination task) to be truly unconscious and, consequently, deny objective threshold effects.

This model was questioned by Snodgrass and his colleagues who propose the so-called *objective threshold/strategic (non-monotonic) model* (Snodgrass, 2002; Snodgrass et al., 2004a,b; Bernat et al., 2001b), and hold that reliable unconscious perception at the objective threshold does exist. They stress the importance of distinguishing between the *objective detection threshold* (ODT; discrimination of the presence or absence of a stimulus), which is below the *objective identification threshold* (OIT; discrimination of one stimulus from another), which is in turn below the *subjective identification threshold* (SIT; correct identification of the stimulus) (Snodgrass, 2004). If one follows the conscious-perception-only model (Reingold and Merikle, 1988, 1990; Holender and Duscherer, 2004) which functions on a hierarchical strength/complexity continuum (the greater the stimulus intensity, the stronger/more complex the effects), the effects should be strongest at the SIT, where more conscious information is available, and weakest - respectively absent - at the ODT. However, unconscious effects are demonstrably strong and reliable under ODT conditions (Groeger, 1984; Shevrin et al., 1992; Snodgrass et al., 1993; Van Selst and Merikle, 1993; Bernat et al., 2001a; Klein Villa et al., 2006). At the longer OIT, however, those effects are mostly absent (e.g. Dagenbach et al., 1989; Cheesman and Merikle, 1984) but observable again under SIT circumstances. Since ODT conditions require weaker stimulus intensity than OIT, this finding remarkably contradicts the strength/complexity continuum. It suggest rather that conscious and unconscious perceptual influences are functionally exclusive, which means conscious perceptual influences override unconscious ones when both are present (Snodgrass, 2004; Snodgrass et al., 2004a). Snodgrass et al. summarize:

> At the ODT, conscious perception is completely absent, allowing higher level unconscious perceptual influences to manifest freely. In the ODT-OIT region, these slightly stronger

[36] This interpretation, however, was criticized by Snodgrass et al. (e.g. 2004a). Instead of interpreting the qualitative differences found in those studies as evidence for conscious and unconscious perceptual processes, they could rather be seen as representing two different aspects of conscious processes (conscious perception and metacognitive decision processes).

stimuli are consciously detectable although not yet identifiable. This lower level conscious perception nonetheless overrides higher level [i.a. identification-dependent] unconscious perceptual influences, producing the negative portion of the curve. Beyond the OIT, conscious perception is strong enough by itself to drive higher level effects, and the curve becomes positive. (Snodgrass et al., 2004a, p.862)

Thus, this non-monotonic relationship between the conscious and the unconscious perception indexes strongly speaks against alternative weak conscious perception explanations and provides convincing evidence for true unconscious perception at the ODT (Snodgrass et al., 2004b,a). Table 1.2 summarizes the assumptions and predictions of the model suggested by Snodgrass et al. (2004a) with regard to the performance on direct (detection and identification) and indirect (e.g. semantic priming) tasks.

	Performance Measures and Underlying Processes		
	Detection	*Identification*	*Indirect (e.g. semantic priming)*
Objective Detection Threshold (ODT)	Chance performance: no conscious detection	Chance performance: no conscious identification	Above chance performance: unconscious semantic activation
Objective Identification Threshold (OIT)	Above chance performance: conscious detection	Chance performance: no conscious identification	Chance performance: conscious detection overriding unconscious semantic activation
Subjective Identification Threshold (SIT)	Above chance performance: conscious detection	Above chance performance: conscious identification	Above chance performance: driven exclusively by conscious perceptual inputs
Supraliminal	Above chance performance: conscious detection	Above chance performance: conscious identification	Above chance performance: driven exclusively by conscious perceptual inputs

Table 1.2: Assumptions of the objective threshold/strategic (non-monotonic) model by Snodgrass et al. (2004a; adapted from Reingold (2004))

Summarizing, the results of the subjective threshold models which increase monotonically with stimulus intensity - as predicted by the conscious-perception-only model (see above) - are much more in need to rule out possible conscious perception explanations. Furthermore, they need to answer the critique, based on a SDT-perspective, that stimuli are in fact conscious but below the subject's criterion for consciousness (the criterion artifact; e.g. Macmillan, 1986). Objective threshold approaches, however, and especially the ODT, represent the most stringent criterion for subliminality and are assumed to exclude all conscious influences without affecting unconscious ones. However, since objective detection thresholds are quite difficult to obtain, the amount of studies at the ODT is relatively small.[37] Nevertheless, for all the reasons described above, we attach great importance in our own study to establish stimulus conditions at the ODT to ensure that stimulus presentation in our experiment entirely rules out conscious awareness (see chapter 3.1.1).

1.4 The electroencephalogram

In 1929, Berger developed the electroencephalogram (EEG) to record the brain's electric activity. The measurement of the electrical signals of the brain allows a person's experiences and behavior to be related to his or her brain activity. By this means, it becomes possible to draw conclusions concerning the underlying mechanisms of information processing. One of the advantages of the EEG is its high temporal sensitivity, since very fast information processing within several milliseconds can be measured. Furthermore, it is a non-invasive method and brain signals can be recorded from the scalp with very little effort.

The EEG measures voltage differences between multiple electrodes which are attached to the scalp. This voltage develops initially with a neurotransmitter which is released at the apical dendrites of a cortical pyramidal cell. Depending on the respective neurotransmitter and receptors, either an excitatory or an inhibitory post-synaptic potential results. The excitatory post-synaptic potential (EPSP) is characterized by a net negativity around the apical dendrites outside the cell. The inhibitory post-synaptic potential (IPSP), however, is characterized by a net positivity around the cell body which is due to the current flow which leaves the soma (Luck, 2005). By this, a small dipole is generated (negative pole at the apical dendrite and positive pole at the soma). Summing up large numbers of these electric dipoles ($>$ 10000), which result from the synchronized activity of many parallel pyramidal cells, leads to an electric field which is strong enough to be measured on the scalp. Thus, the recorded signal is based on the temporal and spatial summation of excitatory and inhibitory post-potentials

[37] This is due to the mechanical constraints of computer screens which are mostly used in contemporary subliminal research. The refresh rate of even a 140 Hz monitor allows no shorter presentation time than 7 ms (17 ms with normal monitors). Thus, one needs to rely on backward masking procedures to mask the subliminal stimulus.

of large assemblies of cortical pyramidal cells (Zschocke, 1995; Kirschstein, 2008).
The electrical activity of the EEG can be divided into *spontaneous* activity (e.g. alpha or sleep rhythms), *evoked potentials* (EPs), and *event-related potentials* (ERPs). EPs are triggered by internal or external stimulation. ERPs occur before, during, or after a sensoric, motoric, or psychic event. In contrast to EPs, ERPs are also marked by cognitive processes. By averaging numerous EPs or ERPs, the random EEG fluctuations can be eliminated and the evoked or event-related potential becomes visible. The ERP consist of different positive and negative components which represent different sensory, motor, or cognitive processes (Luck, 2005).
The spontaneous EEG maps the basic activity of the brain - the continuously measurable voltage fluctuations, mostly independently of external stimulation. It consists of a composition of oscillations of various frequencies which prevail in dependence of the respective state of consciousness and activity. The spontaneous EEG activity of a healthy person in relaxed wakefulness with closed eyes, for instance, is strongly characterized by so-called alpha-waves (8-13 Hz) which generally have higher voltages over occipital areas. As soon as the person focuses on some kind of external stimulus, however, these alpha-waves are blocked and replaced by high frequency beta (15-30 Hz). All in all, five frequency bands can be distinguished which are displayed in table 1.3.

	Frequency (Hz)
gamma (γ)	28 - 48
beta (β)	15 - 30
alpha (α)	8 - 13
theta (θ)	4 - 7
delta (δ)	0.5 - 4

Table 1.3: EEG frequency bands

More and more researchers nowadays follow the approach of Basar and his co-workers who claim that brain functions are represented by oscillatory activity in one (or more) of the frequency bands described above (Basar, 2006). They analyze spontaneous, evoked, or induced brain activity with regard to its frequency components. They consider the complex integrative brain activity as the superposition of different oscillatory components which are generated in different subsystems of the brain (Basar, 1980, 1990, 1998, 1999). Presumably, only the interaction of these selectively distributed delta-, theta-, alpha-, beta-, and gamma-oscillatory networks can account for the dynamic processes of the brain. Thus, oscillations (neuronal rhythms as characteristic features of neural activity) are seen as possible communication mechanisms between cortical cell assemblies. Starting from the distributed selective generators, different brain regions begin to oscillate in synchrony within the respective frequency of the generator and are thus able to communicate, to interact, and therefore, to produce higher cognitive functions. Hence, according to this approach, the electrocortical signals are not only analyzed within the time domain, but also regarding their composition of frequencies using frequency filtering of the EEG signal. In a next step they can be correlated with psychological variables to better understand the basis of processes like attention, memory, learning, etc. Numerous investigations have shown that delta-, theta-, alpha-, beta-, and gamma-oscillations can be seen as functional correlates for sensory and cognitive processes (see Basar et al., 1999a,b, 2001 for review). It must be emphasized, however, that it is not possible to assign one specific function to one specific oscillatory activity. Each frequency range has multiple functional correlates, and only the functionally interacting and superposition of several oscillatory components allows complex and integrative brain functioning. Or as Basar et al. put it: "On one hand, spontaneous and event-related oscillations are correlated with several brain functions; on the other hand, brain functions are related to a superposition of oscillatory responses." (Basar et al., 1999b, p.63)

In the following chapter, we will focus on the functional correlates of alpha and theta oscillatory activity since these frequencies might be of special importance in the investigation of primary and secondary process thinking, as described below.

1.4.1 The role of alpha and theta

The functional role of alpha as the dominant frequency in the human EEG has undergone significant changes. Formerly, alpha synchronization was interpreted as a passive idling rhythm (e.g. Adrian and Matthews, 1934; Pfurtscheller, 1992; see Pfurtscheller et al., 1996 for review). This interpretation was based on the observation that spontaneous alpha oscillations are most prominent in states of physical relaxation, like relaxed wakefulness with closed eyes or sleep onset. They are blocked, however, when eyes are opened and under conditions of mental effort (see below). Today, alpha is no longer regarded as pure noise or an idling phenomenon. On the contrary, the spontaneous alpha rhythm is supposed to "facilitate, *overall*, association mechanisms in the brain" and to "serve as *a communication signal "par excellence"* between different structures" (Basar et al., 1999b, p.60). Alpha thus seems to represent an important functional and universal code which facilitates sensory-cognitive communication.
Evoked alpha oscillations have been related to early sensory stimulus processing (Schürmann et al., 1997; Williamson et al., 1997; Basar, 1998). Furthermore, various functional correlates have been found for event-related alpha oscillations. For example, alpha suppression has been demonstrated in response to various perceptual, motor, and cognitive tasks (Klimesch et al., 1990; Pfurtscheller and Klimesch, 1991; see Klimesch, 1999 for review). Interestingly, internal tasks, such as visual imagination or mental arithmetic tasks, lead to an *increase* in alpha frequency (Hadley, 1941; Klinger et al., 1973; Ray and Cole, 1985; Cooper et al., 2003, 2006). This was interpreted as the inhibition of sensory input while attention is turned toward inter-

nal processing. This alpha-inhibition hypothesis was taken further by Klimesch (Klimesch, 1996; Klimesch et al., 2007) and Pfurtscheller (2003) who proposed alpha synchronization as an active inhibition mechanism of task irrelevant processes and cortical areas. Hence, a suppression of alpha activity (alpha desynchonization) is regarded as reflecting a state of high excitability and cortical activation (Steriade et al., 1990; Pfurtscheller and Klimesch, 1991), whereas an increase in alpha activity (alpha synchronization) is assumed to be the functional correlate of cortical inhibition (Klimesch et al., 2007).[38] These findings suggest, "that alpha activity is not a simple index of cortical idling, but that it is a measure of active processing necessary for internally driven mental operations" (Cooper et al., 2003, p.66).

Furthermore, alpha power (defined as the maximal amplitude in the alpha frequency band) seems to be correlated with originality and creativity which has been related to primary process thinking (see chapter 1.2.3). Fink and Neubauer (2006) recently demonstrated that creative problem solving of a verbal creativity task is accompanied by lower levels of cortical activation, as revealed by a marked increase in alpha power. As the authors point out, this task-related synchronization of alpha activity "presumably reflecting a reduced state of active information processing in the underlying neuronal networks (. . .), stands in clear contrast to the phenomenon of alpha desynchronization that is usually observed during performance of conventional cognitive tasks" (Fink and Neubauer, 2006, p.51-52). Similarly, Martindale and his co-workers demonstrated that creative subjects are less cortically aroused while performing a creativity task, as compared to less creative individuals (Martindale and Hines, 1975; Martindale and Hasenfus, 1978; Martindale et al., 1984). They concluded that lower levels of cortical arousal favor creative thinking and, hence, that primary process cognition is related to low cortical activation as well.

Finally, alpha activity seems to be a distinctive feature of REM-sleep EEG (Roth et al., 1999). However, only very few studies deal with its spectral features and topographic distribution (e.g. Zeitlhofer et al., 1993; Cantero et al., 1999; Cantero and Atienza, 2000; Cantero et al., 2000). Esposito et al. (2004) demonstrated that lower alpha power was associated with increased recall of sleep mentation. With regard to the negative relationship between alpha power and cortical activation (see above), they suggest that a decrease in alpha activity might reflect cognitive elaboration taking place just before awakening.

Because of the apparent association between alpha activity and creativity and originality, one could hypothesize that alpha is likewise related to primary process thinking. Hence, we would expect to find a positive correlation between alpha power during REM-sleep and the rebus effect as an index for primary process thinking and creativity. This very exploratory

[38] Palva and Palva (2007), however, claim that this inhibition hypothesis falls too short. They refer to an increase in alpha oscillations during the maintenance of information during working memory tasks, and suggest a more active role of alpha in working memory processes, which might be interpreted in terms of attentional control processes (Herrmann and Knight, 2001).

hypothesis is based on the suggestion of Klimesch that a "decrease in alpha during parts of the REM-sleep can be interpreted in terms of an event-related suppression or desynchronization of the kind that can be observed during an alert subject performing some type of task" (Klimesch, 1999, p.180). Accordingly, an *increase* in alpha power during REM-sleep could be interpreted in terms of an event-related *synchronization*. Therefore, an increase in alpha power during REM-sleep could be related to an increase in creative primary process thinking on the rebus level.

Activity in the theta frequency band is closely associated with higher level cognitive functions. For instance, event-related theta oscillations have been related to cognitive processing (Basar et al., 1999a; Sakowitz et al., 2000; Basar-Eroglu and Demiralp, 2001), information integration (Schmiedt et al., 2005), encoding of new information (e.g. Klimesch, 1996) - as well as to anticipation, signal detection, and selective attention (Basar-Eroglu et al., 1992). While long-term (semantic) memory tasks lead to a desynchronization in the alpha band (Klimesch, 1996), short-term (episodic) and working memory processes lead to a synchronization in the theta band - as reflected in an increase in band power (Klimesch et al., 1994; Klimesch, 1996, 1999). Furthermore, theta power increases with increasing task demands (Basar et al., 1999b). Basar (1999) summarizes that event-related theta oscillations are highly correlated with mechanisms of associative learning and attention, as well as retrieval.
Spontaneous theta rhythms are rarely observed in the spontaneous EEG of a waking, alert subject. However, they are prominent during sleep. As demonstrated by Armitage (1995), REM-sleep shows more power in the theta frequency band than in any other frequency. The same is true for non-REM-sleep stage 2.

As mentioned above, we assume alpha power to be related to a more primary process way of mental functioning. Hence, we expect a positive correlation between alpha power, which has been associated to creativity and originality, and the rebus effect. On the other hand, theta activity which has been related to higher cognitive performance might be associated to a secondary process way of thinking, comprising reflective conscious thought. Although this is a rather speculative hypothesis, we wish to explore whether theta power might indeed be positively correlated with the conceptual effect which implies mental functioning on a more rational, logical level.

1.4.2 Brain correlates of unconscious perceptual processes and primary process thinking

Next to their various other applications within scientific research, EEG measures were also used to support the existence of unconscious processes and subliminal perception and - although very rarely - to investigate primary and secondary process thinking. Implementing brain responses in the study of subliminal perception was meant to answer the objections made by critics who called for objective evidence for the existence of unconscious processes (see chapter 1.1). Using event-related potentials as non-psychological markers for unconscious processes thus leads to the required independent support.

In the 1960s, being far ahead of their time, Shevrin and associates investigated the electrical brain activity in relationship to subliminal perception and other psychological and especially psychoanalytical relevant concepts like unconscious attention, primary- and secondary process thinking, and repressiveness (for a summary of these experiments see Shevrin, 1973).
Shevrin and Fritzler (1968b) were the first to study subliminal visual evoked potentials. They collected average evoked responses (AERs) during the sub- and supraliminal presentation of the penny-stimulus (see chapter 1.2.3) and a dummy control stimulus matched in size, shape and colour but lacking the specific content of the penny rebus. After each block of stimulus presentation, subjects were asked to give two minutes of free association. Interestingly, Shevrin and Fritzler found that the B-C amplitude of the average evoked potential, which is nowadays called the P200 (a positive going amplitude occurring about 200 ms poststimulus), was significantly greater for the rebus stimulus than for the dummy control in the subliminal condition as well as in the supraliminal condition. Hence, the AER is able to discriminate between a subliminally presented penny rebus stimulus and a dummy control - a finding which was confirmed by further studies of Shevrin and his co-workers (Shevrin and Fritzler, 1968a; Shevrin et al., 1969, 1971). Furthermore, the P200 was significantly correlated with the incidence of conceptual free associations, while rebus and clang associations were correlated with AER alpha. Thus, a high amplitude of the evoked response P200 is associated with a secondary process subliminal effect, while bursts of alpha occurring ca. 1.5 s poststimulus are associated with a primary process subliminal effect. It was assumed that the "high incidence of alpha may be coordinate with a state which favors fantasy, loose thought connections, and in general, thinking of an illogical rather than a logical type" (Shevrin and Fritzler, 1968b, p.298). This is in great accordance with the more recent findings concerning the role of alpha and its relation to internal processes and creativity described in chapter 1.4.1. Hence, increased alpha activity might be related to more creative, unrealistic associations, as in the case of rebus and clang associates. For this reason we expect alpha power in our study to be positively related to the rebus effect as an index for primary process thinking.
These findings cannot be overestimated since they present evidence for brain correlates of Freud's theoretical constructs of primary and secondary process thinking. It needs to be emphasized that these studies were conducted at a time when the combination of psychoanalysis and neurosciences was not at all as "en vogue", as it is now. Nor was psychoanalysis as much in need of presenting objective empirical evidence for its constructs as it is today (see chapter

1.1). This underscores even more the importance and the farsightedness of these early studies.

Summarizing, Shevrin and his co-workers could demonstrate in a number of studies (e.g. Shevrin and Fritzler, 1968b; Shevrin, 1973; Shevrin et al., 1992; Shevrin, 2001) that event-related potentials are also measurable after the subliminal presentation of certain stimuli and can thus be seen as markers for unconscious processes. It was further shown that these "subliminal ERPs" have a similar component structure (although smaller in amplitude) to conventional supraliminal ones (Bernat et al., 2001a). Finally, by means of subliminal ERPs, it was possible to demonstrate that (a) a P300 component can be obtained by subliminal stimuli in an oddball paradigm (Bernat et al., 2001b), (b) aversive conditioning can be established without conscious awareness (Wong et al., 1997, 2004), and (c) affective valence is registered unconsciously (Bernat et al., 2001a).[39]
In addition to the investigation of descriptively unconscious processes by studying electrocortical effects in relation to subliminal verbal effects (as described above), Shevrin and his associates also applied the method of event-related potentials combined with subliminal stimulation to investigate the dynamic unconscious and related aspects like repression, defense, unconscious conflict, affect, and motivation (Fritzler et al., 1970; Shevrin et al., 1969, 1996; Shevrin, 2000; Shevrin et al., 2002).

1.5 Sleep and dreams

The development of the electroencephalogram by Berger in 1929 (see chapter 1.4) marks the starting point of modern sleep research. With the EEG it was not only possible to investigate the electrophysiological brain activity during wakefulness, but also during sleep. Loomis et al. (1937) were the first to describe the characteristics of the human sleep EEG. The discovery of rapid-eye-movement-sleep (REM-sleep), in 1953 by Aserinsky and Kleitman, marked another important milestone in the history of sleep research. Following the current classification developed by Rechtschaffen and Kales (1968), five different sleep stages are distinguished on the basis of their specific electrophysiological characteristics - four stages of so-called non-REM- and one stage of REM-sleep (see table 1.4).[40]

[39] Quite a few more studies exist dealing with ERPs to subthreshold stimuli (e.g. Kiefer, 2002; Kiss and Eimer, 2008). However, most of them can be criticized on methodological grounds, since either subliminal conditions were not described in full detail (e.g. Brandeis and Lehmann, 1986; Naccache et al., 2005), or were not sufficient enough to ensure true subliminality at the objective threshold (see chapter 1.3.1) (e.g. Kostandov and Arzumanov, 1986; Devrim et al., 1997; Brazdil et al., 1998, 2001).

[40] These original rules for a standardized scoring of sleep stages have recently been worked over by the American Academy of Sleep Medicine (Iber et al., 2007). According to these revised rules, the four stages of non-REM-sleep are subsumed under only three stages. However, at the time the experiments of the study described here were run, the original rules from 1968 were still applied.

Sleep stage	**Frequency [Hz]**	**Amplitude [mV]**	**Type**	**Characteristics**
1 (non-REM)	4-8	50-100	alpha, theta	- transition from wake to sleep - very light sleep - slow eye movements
2 (non-REM)	6-15	50-150	theta, sleep spindles, K-complex	- some slow eye movements - sleep spindles (short rhythmic waveform clusters of 12-14 Hz) - K-complexes (sharp negative wave followed by slower positive component)
3 (non-REM)	2-4	100-150	delta, theta	- slow wave sleep (SWS) - little or no eye movements - 20-50 % delta waves
4 (non-REM)	0.2-2	200-200	delta, theta	- slow wave sleep (SWS) - little or no eye movements - more than 50 % delta waves
5 (REM)	>12	5-50	beta, alpha	- dream sleep / paradoxical sleep - rapid eye movements - desynchronisation of the EEG (similar to wakefulness) - PGO-waves

Table 1.4: Characteristics of the different sleep stages

During the night we pass these five stages in a cyclic pattern. One sleep cycle, which starts with stage 1 non-REM-sleep, goes down all the way to stage 4 and then up again to finally end in REM-sleep, lasts about 90 minutes. While slow wave sleep mainly occurs during the first part of the night, REM-sleep phases get longer in the course of the night (see figure 1.1).

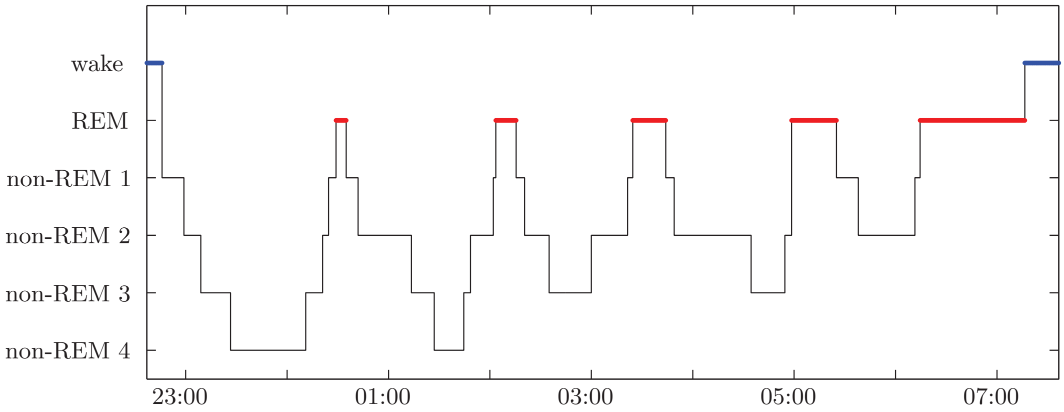

Figure 1.1: Schematic depiction of a healthy sleep architecture throughout an entire night

In contrast to the synchronized, large amplitude EEG during slow wave sleep, the electrophysiological pattern during REM-sleep shows a desynchronized and highly activated brain. Along with this increased activation and the occurrence of rapid eye movements, REM-sleep is characterized by several neurophysiological parameters, such as enhanced heart beat, accelerated breathing frequency, genital erection, and at the same time paralysis of all other muscles. Struck by the remarkable paradox between a highly activated brain and a person that is sound asleep, Aserinsky and Kleitman (1955) assumed that REM-sleep represents the external manifestation of the subjective experience of dreaming. This assumption was supported by the observation that REM-sleep awakenings result in 70-95 % of the cases in a dream report, while this is only true for 5-10 % of non-REM-sleep awakenings (e.g. Dement and Kleitman, 1957; Wolpert and Trosman, 1958; Kales et al., 1967). Accordingly, REM-sleep was believed to be the neurophysiological equivalent of dreaming and researchers hoped to solve the mystery of dreaming by investigating the neural correlates of REM-sleep.
Jouvet (1962) was the first who demonstrated in cat experiments that pontine brain stem mechanisms control REM-sleep. Almost ten years later, Hobson and McCarley identified specific assemblies of neurons located in the pons and their respective neurotransmitters as being responsible for switching on and off REM-sleep. This alternate interaction is described in their *model of reciprocal interaction* (Hobson and McCarley, 1971; Hobson et al., 1975; Hobson and McCarley, 1977). While cholinergic neurons in the formatio reticularis initiate REM-sleep, aminergic neurons in the raphé nucleus and nucleus locus coeruleus, producing serotonine and noradrenaline, inhibit the activity of the cholinergic REM-on neurons and switch off REM-sleep again. Hence, Hobson and McCarley claim in their *activation-synthesis-model* (1977), which has been developed further into the *activation-input-mode model* (AIM) (Hobson et al., 2000), that dreams result from the effort of the cortex to give meaning to this chaotic activation arising from the brain stem. Accordingly, dreams are only an epiphenomenon of

REM-sleep; they are meaningless, and especially lack any motivational or emotional driving forces as was claimed by Freud.
Over time, more and more studies have proved that the amount of non-REM dreams was apparently underestimated (e.g. Foulkes, 1962; see also review of Nielsen (1999) who found an average REM dream report rate of 81.8 ± 8.7 % compared to an average non-REM dream report rate of 42.5 ± 21.0 %). But even though Hobson et al. included this observation in their AIM model (2000), the assumption of dreams being controlled by pontine brain stem mechanisms reflected the scientific consensus for a long period of time. It was more than 20 years later when Solms proved it to be wrong and demonstrated that REM-sleep and dreams are actually dissociable states which are controlled by different brain mechanisms. In his extensive research with lesioned patients, he showed that damages in the brain stem, which lead to a cessation of REM-sleep, do not necessarily affect dreaming. On the other hand, lesions in distinct forebrain structures, which completely spare the brain stem, cause a total loss of dreaming while REM-sleep still occurs. He concluded that "forebrain structures are essential for dreaming whereas brainstem structures are not" (Solms, 1995, p.54). Subsequently, Solms identified a whole network of highly specific brain areas involved in the dream process (Solms, 1997, 2000; Kaplan-Solms and Solms, 2003). He demonstrated that dreaming is especially controlled by dopaminergic forebrain mechanisms involving the ventral tegmental area component of the dopaminergic mesolimbic reward circuits (Solms, 2000).[41]

As mentioned above, dreams apparently do not only appear during REM-, but also during non-REM-sleep. However, there are qualitative and quantitative differences between REM- and non-REM-sleep dreams. While REM-sleep dreams are mostly longer (e.g. Foulkes and Rechtschaffen, 1964; Antrobus, 1983; Stickgold et al., 1994), more bizarre (e.g. Fiss et al., 1966; Porte and Hobson, 1987; Zepelin, 1989), more vivid, visual, emotional, and less related to waking reality (e.g. Foulkes, 1962; Rechtschaffen et al., 1963; Cavallero et al., 1992), non-REM-sleep mentation is usually shorter, less imaginative, bizarre and emotional, more thought-like, and consists mostly of single thoughts or ideas often related to waking life (e.g. Foulkes, 1962; Rechtschaffen et al., 1963).[42] These remarkable differences in REM- and non-REM-sleep mentation are probably due to the differences in the physiology of these two stages which were demonstrated in the 1990s by a number of positron emission tomography (PET) imaging studies. Non-REM-sleep is characterized by a relatively global cerebral deactivation (decrease of energy metabolism throughout the basal forebrain, thalamus, pontine brain stem,

[41] These circuits belong to the so-called *seeking system* (Panksepp, 1998) because they are involved in goal-seeking and appetitive driven behaviors. Therefore, this observation could be used to revive Freud's theory of dreams as wish fulfillment (see chapter 1.2.2).

[42] Despite these differences, there are some non-REM-sleep dreams which are very similar to REM-sleep dreams in their intensity and sometimes even indistinguishable from REM dreams (Monroe et al., 1965). These are mainly found at sleep onset (Foulkes and Vogel, 1965) or at the end of the night (Kondo et al., 1989).

as well as orbitofrontal and anterior cingulate cortices), whereas activity in the visual and auditory cortices remains preserved (Braun et al., 1997; Maquet et al., 1997; Hofle et al., 1997). This possibly reveals "the cortical substrate of dream-like imagery" during non-REM-sleep (Hofle et al., 1997, p.4803). In contrast, there is a widespread activation of brain areas during REM-sleep (e.g. basal forebrain areas such as anterior hypothalamus, caudal orbital cortex, and ventral regions of the striatum, all regions of the brainstem, as well as limbic and paralimbic regions such as the amygdala, the hippocampal formation, parahippocampal gyri, anterior insula, and the anterior cingulate cortices), which even exceeds the level of activation prominent during wakefulness (Maquet et al., 1996; Braun et al., 1997; Nofzinger et al., 1997). At the same time prefrontal (dorsolateral, orbital, and opercular) cortices are dramatically deactivated (Maquet et al., 1996; Braun et al., 1997; Madsen et al., 1996). Interestingly, these cortices are normally responsible for the "highest order processing of neural information, integrating sensory, cognitive and limbic information, organizing meaningful, temporally sequenced behavioural responses and subserving working memory" (Braun et al., 1997, p.1188). The deactivation of these areas might account for the bizarre, hallucinatory, irrational, and disorientated, but highly emotional nature of REM-sleep imagery and cognition (Kahn et al., 1997).[43] Concluding, following Nofzinger et al., their findings "of limbic and paralimbic activation (. . .) and increased metabolism during REM-sleep, as well as global, regionally non-selective cortical deactivation and decreased metabolism during non-REM-sleep, are generally supportive of the traditional notion that more story-like affect-laden dreams are more attributable to the REM-sleep, than non-REM-sleep behavioural state" (Nofzinger et al., 1997, p.199).

Alongside these state-dependent activations of specific brain areas, the three states of consciousness (wake, non-REM-sleep, REM-sleep) also differ with respect to their neurochemical influences. During wakefulness, the cortex is activated by brain stem ascending cholinergic influences (Moruzzi and Magoun, 1949) - and at the same time inhibited by aminergic ascending neurons releasing dopamine, noradrenaline, serotonine, and histamine. This interplay of activation and inhibition allows our rational and logical waking thinking. Both influences decrease during non-REM-sleep. During REM-sleep, however, the cortex is widely activated again (see above), but simultaneously strongly disinhibited since all aminergic neurons stop firing, except for the dopaminergic ones.[44] This sustained release of dopamine in the absence of serotonergic and noradrenergic inhibition is hypothesized to account for the bizarre and illogical characteristics of REM-sleep mentation, which strikingly resemble the cognitive activity of psychotic patients (Gottesmann, 2000).

[43] However, results are partly contradictory since Nofzinger et al., 1997 found an *increase* in cerebral blood flow in the prefrontal cortices during REM-sleep.

[44] This is in strong accordance with Solms' observation that dreaming ceases completely when the dopaminergic circuits are impaired (Solms, 2000).

EEG studies showed that REM- and non-REM-sleep can also be distinguished on the basis of gamma activity. This very fast frequency (30-50 Hz) is assumed to be correlated with cognitive processing (see Basar-Eroglu et al., 1996 for review) and is prominent in wakefulness and during REM-sleep.[45] However, the occurrence of gamma oscillations is greatly reduced during non-REM-sleep (Llinás and Ribary, 1993; Steriade, 1997; Kahn et al., 1997). Together with the sensorimotor blockade, this could contribute to the "emotional, hallucinatory, illogical, amnestic and disorientated cognition that typifies REM-sleep dreaming" (Hobson et al., 1998, p.242). Hence, gamma activity might be the neural substrate of the equally diverse, but qualitatively different cognitive processes during wakefulness and REM-sleep, while the absence of this gamma activity during non-REM-sleep could explain the absence of these kinds of cognitive processes.

Apart from their discrete underlying neurophysiological mechanisms and dominating neurotransmitters, differences in REM- and non-REM-sleep mentation show remarkable references to what Freud described as the differences between primary and secondary process thinking (see chapter 1.2). The primarily bizarre, imaginative, illogical, and irrational nature of most REM-sleep imagery with its manifold condensations, displacements, and transformations strongly corresponds to Freud's primary process. Non-REM-sleep mentation, however, which is more rational and reasonable, is closer to our waking thinking and what Freud named the secondary process. This is in accord with observations even of non-psychoanalysts such as Gottesman who points out that the "thought-like activity [of non-REM-sleep] somewhat corresponds to Freud's *secondary process* which sustains waking psychological controlled activity" (Gottesmann, 2000, p.2). Even earlier, Rechtschaffen et al. stated that non-REM-sleep mentation "has more of the secondary process characteristics (. . .) than does REM-sleep mentation" (Rechtschaffen et al., 1963, p.546). Hence, dream content could possibly, instead of being determined by a certain *state* (REM- vs. non-REM-sleep), be rather the result of a certain underlying *process* (primary vs. secondary process). But can REM- and non-REM-sleep indeed be distinguished on the basis of the respectively prevailing kind of mental organization paralleling the Freudian concept of primary and secondary process thinking? As described in chapter 1.2.3, there has been one study which tried to answer this particular question (Shevrin and Fisher, 1967). However, despite its encouraging results, there has been no further supportive evidence so far. With our study we wish to replicate these important findings. Thus, one of our main hypotheses is the assumption that the mental activity during REM-sleep - in which more bizarre and imaginative dreams occur - has more characteristics of the primary process, while during non-REM-sleep - in which dreams are more thought-like - more secondary process operations take place (see chapter 1.6).

[45] As opposed to during wakefulness, gamma activity during REM-sleep is marked by a lack of reset by sensory input. This observation corresponds with the fact that attention during REM-sleep is turned away from external sensory inputs toward internal inputs and memories (Llinás and Ribary, 1993).

1.6 Aims and scopes

With this study we hope to be able to make a contribution to the experimental validation of the psychoanalytical construct of primary and secondary process thinking. Especially with the ongoing rapid developments and manifold discoveries in the field of brain research and neuroscience, the more than centenarian psychoanalytic theories are being evermore criticized as hypothetical and untenable. Psychoanalysis is challenged to present not only clinical, but also experimental evidence for its hypotheses (see chapter 1.1). This project ties in with this endeavor by trying to take a look at the Freudian theory from an experimental and neurophysiological point of view.
Although there have been numerous studies dealing with primary and secondary process thinking (see chapter 1.2.3), the question whether this theory can be transferred to the sleep-dream-cycle has been largely ignored. This is even more remarkable since Freud explicitly linked his famous theory of dream formation and dream work to the mechanisms of the primary process (see chapter 1.2.2). Hence, we wish to make up for this failure, and apply the Freudian concept of primary and secondary process thinking on the sleep-dream cycle. We aim at demonstrating that REM- and non-REM-sleep can be distinguished on the basis of their prevailing thought processes, paralleling primary and secondary process thinking. So far, only one single study (Shevrin and Fisher, 1967) has attempted to test this hypothesis - with success. Shevrin and Fisher were able to demonstrate that a visual stimulus presented subliminally during wakefulness was processed in a more primary process way during REM-sleep, while non-REM-sleep enhanced a more secondary process way of stimulus processing. However, this striking finding has not been replicated ever since, although it touches on so many important aspects relevant to psychoanalysis. With our study we want to make up for this major omission and wish to investigate the following main hypothesis and the accompanying sub-hypotheses:

- REM- and non-REM-sleep differ with respect to their prevailing way of mental functioning. These differences match the Freudian concept of primary and secondary process thinking. While REM-sleep follows the rules of the primary process, non-REM-sleep mentation is organized along more secondary process lines.

To investigate this hypothesis we follow three different approaches. Firstly, we want to replicate the original findings of Shevrin and Fisher (1967) by presenting a subliminal rebus stimulus and investigate its primary and secondary processing during REM- and non-REM-sleep (see chapter 3.3). We expect to find the following:

◇ The subliminally presented rebus stimulus is processed differently during REM- and non-REM-sleep. While REM-sleep mentation is marked by more primary process transformations on the clang and rebus level, non-REM-sleep reveals more secondary process transformations on the conceptual level.

Secondly, we want to extend these findings by using additionally stimuli (the so-called GeoCat-stimuli of Brakel (2004)) which have proven useful in the investigation of primary and secondary process thinking (see chapter 3.4). Here we wish to demonstrate that:

◇ REM-sleep awakenings result in more attributional similarity judgments of the GeoCat items as an index for primary process thinking, while more relational similarity judgments as an index for secondary process thinking are given after awakenings from non-REM-sleep.

Lastly, we will look for neurophysiological correlates of these two modes of thinking as additional independent evidence for primary and secondary process thinking. Since this is a largely unexplored field, our results will be mainly preliminary and exploratory. Nevertheless, we want to analyze the neurophysiological data in more detail (see chapter 3.5) and try to investigate the following hypothesis:

◇ Neurophysiological measures can be used as independent evidence for these different modes of mental functioning during REM- and non-REM-sleep. While increased alpha power is expected to be associated with primary process effects, we expect theta power to be correlated with secondary process thinking.

2. Method

2.1 Subjects

The experimental group consisted of 20 university students (5 male, 15 female) who were recruited by postings on the university campus. Subjects ranged in age from 20 to 35 (mean age 23.6 ± 3.2 years) and met the following inclusion criteria:

- no diagnosed sleep disorder
- no history of neurological or psychiatric illness
- no current medication
- no drug abuse (see appendix A)

Except for one subject who was born in Poland but moved to Germany at the age of three, and another subject who was born in Kazakhstan but had a German grandmother and moved to Germany when she was seven years old, all subjects were German native speakers. All had normal or corrected to normal visus and 14 to 19.5 years of education (16.2 ± 1.4 years). Reported sleep efficiency (total sleep time / time in bed) ranged from 78-99 % (90.6 ± 6.6 %) and average total sleep time from 6-10 hours (8 ± 1.3 hours). 90 % rated their sleep quality as "good" (50 %) or "very good" (40 %). This was reflected in the mean total score of 3.8 (± 1.9) in the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989), which assesses the subjective sleep quality of the preceding four weeks (the cut-off score for the PSQI is 5, a score higher than 10 reveals severely disturbed sleep). With respect to dream recall frequency, 45 % indicated remembering their dreams "several times a week", and 40 % chose "about once a week". The remaining 15 % remembered their dreams "twice or three times a month" (10 %), or "less than once in a month" (5 %). Participants received 70 € when they completed the study.

2.2 Study design

2.2.1 Initial contact

Interested subjects were informed extensively in a first informal meeting about the experimental procedure, the measurement method, data protection, and data storage (see appendix B).[46] They were assured of having the right to quit the study at any point without giving any reason. After they had rated their dream recall frequency on a seven-point scale (Schredl, 2002), they were asked to fill in the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) to assess their individual sleeping habits and to measure the subjective sleep quality of the previous four weeks. Those subjects who did not show impaired sleep quality and met the inclusion criteria described above were included in the study. They gave written informed consent (see appendix C) and were scheduled for the experiments. Each subject had to spend four nights in the neurological sleep laboratory of the Klinikum Bremen-Ost (one baseline night and three experimental nights) each with an interval of 5-7 days. They were asked to keep a sleep log between sessions in which they wrote down when they went to sleep, when they got up, how many times they woke up and if they had used any kind of drugs or alcohol.

2.2.2 Baseline night and data acquisition

All participants were firstly studied during a baseline night. By this, the subject could get used to the environment of the lab and to sleeping with the electrodes. At the same time a healthy sleep cycle could be assured and sleep disorders of any kind ruled out (i.e. obstructive sleep apnea syndrome, periodic limb movement disorder, somnambulism, REM-sleep behavioral disorder, etc.). The subject arrived at the sleep lab in the evening, at around 9 PM. After changing for the night, electrodes and additional measuring devices were placed. Polysomnographic recording included four scalp electrodes (C3, C4, O1, O2) with contralateral mastoid references. EEG was measured monopolar with Ag-AgCl electrodes which were attached with a conducting paste and fixed on the scalp with collodion following the international 10-20 electrode placement system (Jasper, 1958). The grounding electrode was placed on the forehead. For the detection of REM-sleep, bipolar electrooculogram (EOG) from left and right epicanthus lateralis was recorded to measure eye movements and bipolar submental electromyography (EMG) to measure muscle tone. Figure 2.1 shows the usual polysomnographic setup.

The following filter settings were used: EEG: sensitivity 7 muV/mm, low frequency filter (LFF) 0.5 Hz, high frequency filter (HFF) 70 Hz; EOG: sensitivity 20 muV/mm, LFF 0.5 Hz, HFF 30 Hz, and EMG: sensitivity 10 muV/mm, LFF 10 Hz, HFF 70 Hz. Impedances

[46] The study protocol was designed according to the Helsinki Declaration (1964/2004), and approved by the ethics commission of the University of Bremen on October 16th 2009.

for all electrodes were kept below 5 kOmega. All electrophysiological data was digitized with a sampling rate of 200 Hz. Visual scoring of wakefulness and sleep stages was done following the standardized rules of Rechtschaffen and Kales (1968), using 30 s epochs for scoring. Data was recorded using Excel-Tech (XLTEK) hard- and software.

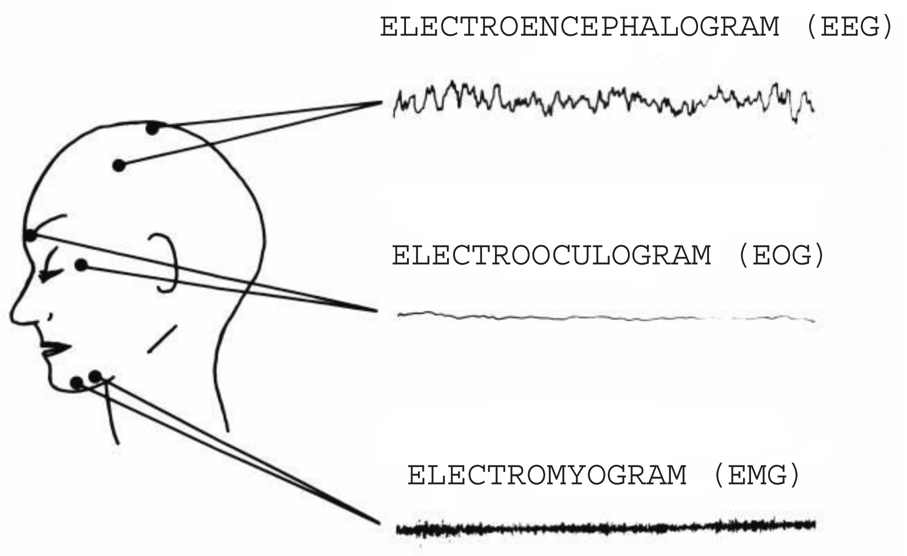

Figure 2.1: Polysomnographic setup (adapted from Borbély, 1984)

To rule out sleep disorders, the following additional measurements were used during the baseline night: anterior tibialis leg EMG, electrocardiogram (ECG), as well as measures of airflow, respiratory effort, and blood oxygen saturation. All nights were acoustically and visually recorded with a microphone and a video camera. By this, subjects could get in touch with the experimenter in the adjoining room during the whole night at any time. After putting on the electrodes and measuring devices, the subject went straight to bed and was awakened the next morning around 7 AM. After all cables had been removed, the testing was over and the subject could go home.

2.2.3 Rebus and control night

For the first and second experimental night (rebus and control night), participants again arrived in the evening in the sleep lab. In all experimental nights, leg EMG and respiratory measures could be eliminated since sleep disorders had already been ruled out during the baseline night. Instead, the EEG electrodes Fpz, Fz, Cz, Pz, and Oz were added. After putting on the electrodes, and immediately before the subject's retiring to bed, the experimental stimulus was presented.

2.2.3.1 Rebus stimulus

Like Shevrin and Fisher (1967; see chapter 1.2.3), we also use a rebus stimulus for the investigation of primary and secondary processes during sleep. Our rebus consists of the two pictured objects *Kamm* (Engl.: comb) and *Floß* (Engl.: raft; see figure 2.2). The condensation of the sounds of both objects leads to the rebus word *kampflos* (Engl.: without a struggle/fight).

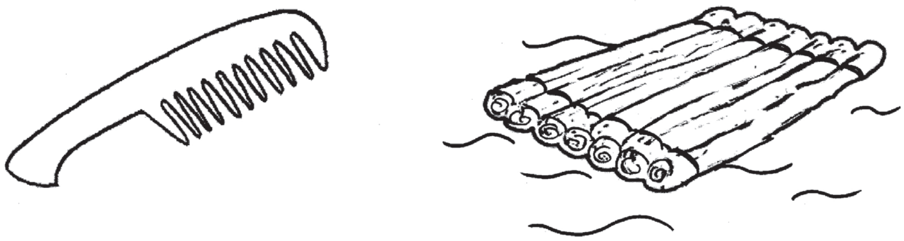

Figure 2.2: The *kampflos* rebus stimulus

This stimulus is able to evoke different levels of associations and thus allows for tracing back primary, as well as secondary process influences:

- **Associations on the conceptual level:** hair, head, water, wood, etc. (associations refer to the pictured objects comb and raft)
- **Associations on the clang level:** *Kamm*er (Engl.: broom closet), *Kam*in (Engl.: chimney), hil*flos* (Engl.: helpless), etc. (associations imply the sounds of the pictured objects)
- **Associations on the rebus level:** victory, defense, enemy, fight, etc. (associations refer to the rebus word *kampflos*)[47]

As described in chapter 1.2.3, associations on the **conceptual level** imply the characteristics of the secondary process. They are logical, rational, and conventional and refer clearly to the pictured objects *Kamm* and *Floß*. However, associations on the clang, and especially on the rebus level are characterized by more primary process operations. On the **clang level**, objects are not longer treated as real objects but as phonetic structure. On the **rebus level**, a condensation of these sounds occurs, resulting in a completely new word (*kampflos*). Thus, only a primary process reading, which combines the word presentations of the stimuli (condensation), results in associations on the rebus meaning. The main advantage of such a rebus stimulus is that it allows one to investigate the conditions under which it undergoes primary or secondary process transformations. This is possible by making concrete predictions about several transformations (conceptual, clang and rebus) that can be identified precisely

[47] Freud referred to associations of this kind as being *superficial associations* which are a characteristic of the primary process (Freud, 1900; see chapter 1.2).

and reliably.[48]
In the rebus night, this stimulus was presented subliminally before the subject's retiring to bed. To control for the experimental effect of this stimulus, we also ran a control night in which a blank slide was presented instead of the rebus stimulus. Thus, each subject was his[49] own control and a measure of base rate recovery could be provided (see Dixon, 1971). The order of the rebus and the control night was randomized and counterbalanced. Both the experimenter and the subject were blind to the respective condition.

2.2.3.2 Stimulus presentation

Rebus and control stimulus were presented by an electronical projection-tachistoscope EPT 5a which consists of two Kodak carousel-projectors (see figure 2.3) and an external control box.

Figure 2.3: The two Kodak carousel-projectors of the tachistoscope

The projectors work with special xenon high-pressure lamps. The advantage of these lamps is their very short rise and drop time of only 30 μs. In case of subliminal stimulation, where presentation times are supposed to be extremely short to avoid conscious awareness of the stimuli, this is a crucial factor. Presentation times of the EPT 5a tachistoscope can be varied from 0.1 ms to 100 s in steps of 0.1 ms. Projector 1 (P1) is switched off and flashes only during the defined presentation time ("light flash") to present the stimulus. Projector 2 (P2) is switched on and gets dark ("dark flash") during this stimulus presentation. Because of this uninterrupted cross-fading the light is continuously on and the subject does not realize when the picture is being flashed. In our experiment, stimulus presentation was characterized by

[48] Using pictures instead of words is preferable since words, being strongly overlearned, have strikingly low recognition thresholds (see Shevrin, 1973).
[49] In order to improve readability, only the masculine form is used in the text. Nevertheless, all data apply to the male *and* female participants.

the following parameters:

- presentation time: 1 ms
- number of presentations: 5
- time between each of the 5 flashes: 1 s
- luminance: 5 fl (foot lamberts)
- size of projection screen: 100 x 66 cm
- size of the stimulus on the screen: the picture of the *Kamm* and the *Floß* covers a square of the size 24 x 6 cm
- distance from subject to screen: 2.35 m[50]

Working with this duration and luminance has proven to assure working at the objective detection threshold (ODT), described in chapter 1.3.3 (Shevrin et al., 1992; Van Selst and Merikle, 1993; Bernat et al., 2001a,b; Klein Villa et al., 2006; Snodgrass and Shevrin, 2006; Snodgrass, 2009). Furthermore, Wong et al. (1994) demonstrated that the individual thresholds of a group of subjects were on average at 2.35 ms, ranging from 2 to 4 ms. Hence, the 1 ms exposure time used in this study is indeed below most individual thresholds. In this respect we differ from the original study of Shevrin and Fisher (1967) who used presentation times of 6 ms, and were thus most probably working at the subjective detection threshold (see chapter 4.1 for a discussion of this point).

The subject was asked to sit down in front of the screen and look at the fixation cross at the center of the screen. He was told that he would soon be asked to respond to a stimulus which was probably not seen but still present. This was done to avoid the subject feeling too awkward by responding to something he did not see. By saying “Ready!” just before flashing the stimulus, the subject was warned and knew when to focus on the fixation cross and not to blink his eyes. Either the rebus stimulus or a blank control slide was flashed, immediately followed by the reappearance of the fixation cross.[51] Afterwards, the subject stated whether he had seen anything. Then he was asked to describe the first picture which came to mind and to make a drawing of it while describing it a second time. After this, the subject was asked to free associate for four minutes. Immediately afterwards, the subject went to bed and the light was switched off.

[50] See chapter 3.1 for the results of the pretestings which were run to test the characteristics of the tachistoscope and to assure subliminality.

[51] Since luminance levels for all the slides (rebus stimulus, blank slide, fixation cross) were set at 5 fl, this method differs from the energy masking method employed in earlier subliminal studies (see chapter 1.3). However, it is in accord with more recent subliminal studies working at the ODT (e.g. Bernat et al., 2001a,b).

2.2.3.3 Tasks

During the night, the subject was awakened several times. Our aim was to get three REM- and three non-REM-sleep (stage 2) awakenings.[52] We did not use the first sleep cycle but the second, third, and fourth since they are more stable and last longer. The first awakening was a non-REM awakening immediately following the first sleep cycle, and the last one was a REM awakening early in the morning. To assure a stable non-REM period, we waited for 15 minutes of uninterrupted stage 2 sleep before waking the subject up. Since especially the REM periods of the earlier sleep cycles are shorter and less stable, the REM awakenings were all five minutes into their respective periods of uninterrupted REM-sleep. Figure 2.4 exemplarily shows the order of the nocturnal awakenings in the rebus night which also pertains for the control night.

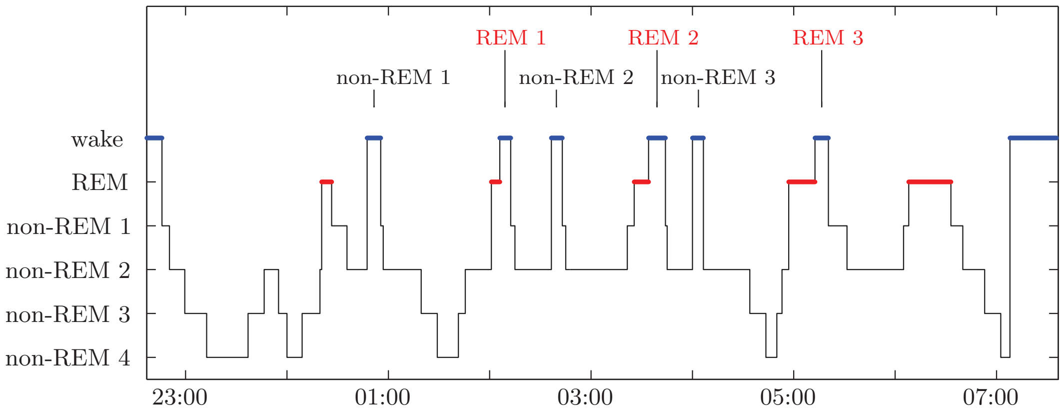

Figure 2.4: Order of the nocturnal awakenings in the rebus night

After waking the subject up by knocking on the door the experimenter entered the room and sat down next to the subject's bed. After each awakening the subject was asked to perform the following tasks (verbal answers were tape recorded):

1. *A verbal dream report and a drawing of it*
   Immediately upon awakening the experimenter asked "What was happening before I awakened you?"[53] and added "Please recall what was happening in as much detail and as elaborately as possible. Allow enough time to avoid forgetting something". Because the

[52] This is in accordance with the original study of Shevrin and Fisher (1967). Furthermore, almost all non-REM-sleep dream reports described in the literature are obtained from stage 2 sleep, since stage 2 makes up the major part of non-REM-sleep and is equally distributed throughout the night (see Antrobus, 1991).

[53] This formulation proved to result in more dream reports than the question "What were you dreaming before I awakened you?" (Foulkes, 1962). Since non-REM-sleep mentation is often less dream- but more thought-like (see chapter 1.5), it might, therefore, sometimes not be identified as a dream by the dreamer himself.

experimenter was blind to the respective condition (rebus or control), she could feel free to ask the subject to clarify details of the dream in order to get as detailed a report as possible. Afterwards, the subject was asked to make a drawing of what he had reported and to describe it at the same time. This was meant to elicit a greater amplification of the dream content.

2. *Four minutes of free associations*
After this, the subject was asked to close his eyes and to say all the individual words that came to mind for the following four minutes. The instruction was: "Please tell me all of the individual words that come to your mind in the next few minutes. Let your mind roam as far as it wants to - no matter how related or unrelated, no matter how silly or non-sensical the words may seem. It is particularly important that you say all of the words that come to your mind. You can do this best by making yourself as relaxed as possible so that the words just come up by themselves. Just let it happen, and say the words as they come to you. It would help if you would close your eyes - so please close them now and let them remain closed until I tell you to open them. I will tell you when to start and when to stop again."

3. *A description and drawing of the first picture that came to mind*
Finally, the subject was asked to describe the first picture that came to mind, and to make a drawing of it while describing it for a second time.

Besides the dream reports, free associations and images were used because former studies have shown that both are useful in recovering subliminal material (e.g. Luborsky and Shevrin, 1956; Fisher, 1956; Fisher and Paul, 1959; Stross and Shevrin, 1968; Shevrin and Fritzler, 1968b; see chapter 1.2.3). Furthermore, as Holt points out, primary and secondary process are hypothetical constructs which can hardly be observed directly. Hence, we must "content ourselves with thought products, in some of which we can detect signs (...) that have been produced by primary and/or secondary processes" (Holt, 2002, p.461). In our opinion, the dream report is clearly the end product of the underlying thought process, be it primary or secondary process-like. With the methods of free associations and free imagery, however, we hope to be closer to the process itself.
The next morning the subject was again awakened around 7 AM and released from the cables.

2.2.3.4 Detection experiment and debriefing

To assure that the stimulus was indeed presented subliminally, we ran a forced-choice detection experiment (based on signal detection theory; see chapter 1.3.1) the morning after the second experimental night. Therefore, we flashed 32 cards with the rebus stimulus and 32 blank cards under the experimental conditions described in chapter 2.2.3.2, in a randomized

order. By this, one of the basic criteria for establishing subliminality called for by Merikle (1982), that is to obtain a sufficient number of threshold-determining responses, is fulfilled. Participants were told that either a slide with a picture or a blank slide would be flashed five times for 1 ms in quick succession, and that there would be an equal number of trials of each kind in random order. They were asked to state after each presentation whether they had seen "something" or "nothing" and to keep their responses approximately equally divided between these two choices. This answers another basic criteria for establishing subliminality, that is to eliminate response bias. Only by answering "yes" and "no", even in the absence of a stimulus, is it possible to precisely determine the objective threshold. To meet the conditions of the objective detection threshold (ODT), subjects must not be able to detect a difference between the rebus and the blank. If they see "something" - even if they cannot identify it as a comb or a raft - they are no longer at the ODT. Thus, if discrimination between stimulus and no stimulus conditions is $d' = 0$ (see chapter 1.3.1), detection is at chance and subliminality is guaranteed.
After the detection experiment there was a debriefing in which the rebus stimulus was projected on the screen and subjects were asked the following questions:

1. What is this?
2. What are your first five associations to each of the pictures (*Kamm* and *Floß*)?
3. Do these items have any association to one of your dreams during the last two nights here in the sleep lab?
4. Are there more ideas you have about these two items?
5. If this was a rebus, what would it mean?
6. What are your first five associations to the rebus word (*kampflos*)?
7. Does this word have any association with one of your dreams during the last two nights here in the sleep lab?

2.2.4 GeoCat night

In this last experimental night, the same electrodes as in the rebus and the control night were used (see chapter 2.2.3). However, there was no subliminal stimulation and subjects went straight to bed after all the cables had been fixed. As in the rebus and control night, we aimed at getting three REM- and three non-REM-sleep awakenings - starting with a non-REM-sleep awakening after the first sleep cycle and ending with a REM-sleep awakening early in the morning. For the first four awakenings (two REM and two non-REM awakenings) we used the classic GeoCat stimuli of Brakel (2004), while during the last two awakenings (one REM and one non-REM awakening) the scalar GeoCat items of Brakel (unpublished scale, described in Vanheule et al., (under review)) were administered. Figure 2.5 shows the procedure and the awakenings of this experimental night.

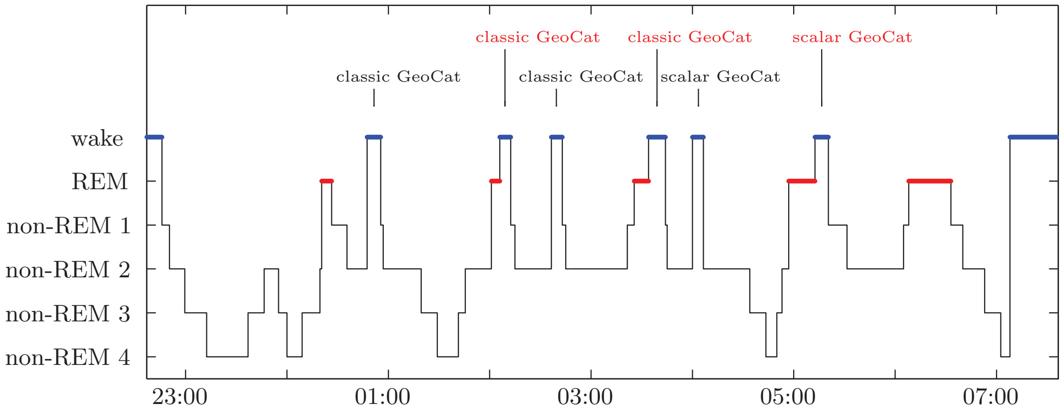

Figure 2.5: Order of the nocturnal awakenings in the GeoCat night

2.2.4.1 GeoCat stimuli

The classic GeoCat stimuli comprise four lists, each with six items. Every item consists of three geometric figures - a master figure at top center and two different similarity choices below: one relational similarity choice (different features but identical spatial organization) and one attributional similarity choice (identical features but different spatial organization; Brakel, 2004; see figure 2.6).[54] The figures are counterbalanced for position and item bias. This means an attributional choice in one item functions as relational choice in another item with a different master figure, and vice versa (list 1 and 2). Furthermore, the position of both choices (left/right) was reversed (version A and B; Brakel, 2004; Brakel and Shevrin, 2005; see appendix D for all four lists).

Besides the classic GeoCat stimuli, we also used the 24 scalar GeoCat items which comprise the same geometric figures as the classic GeoCat items. One scalar GeoCat item consists of two figures and instead of giving categorical similarity judgments, subjects were asked to indicate on a scale ranging from 1 to 5 how similar these two figures were (see appendix E for an example). The scalar GeoCat items were created by taking the 12 classic GeoCat master

[54]Good internal validity and internal consistency of these items was demonstrated by Vanheule et al., (under review).

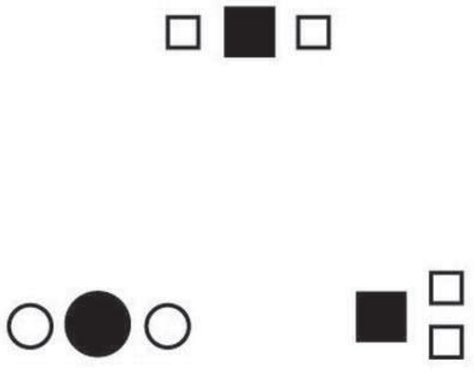

Figure 2.6: Exemplary version of one classic GeoCat item consisting of a master figure on top and two alternatives (relational left and attributional right) underneath (Brakel, 2004)

figures and putting them in paired opposition with the relational and the attributional alternatives of the corresponding classic GeoCat item. Hence, twelve items assess attributional and twelve relational similarity judgment. Figure 2.7 shows an example of two attributionally similar items.

Figure 2.7: Exemplary version of one scalar GeoCat item showing two attributionally similar items

2.2.4.2 Tasks

Immediately after the first four awakenings (two non-REM- and two REM-sleep awakenings), the subject was presented with a pen and paper version of one of the classic GeoCat lists. The order of the different lists was randomized. On each of the four sheets was a visual analog scale on which the subject had to state his respective state of anxiety ranging from 1 ("calm") to 10 ("very anxious"). The instruction below told the subject to make a spontaneous choice about which of the two alternatives (attributional and relational) was more similar to the respective master figure (see appendix D). The attributional choice - which is based on part-for-whole categorization - is an index for primary process thinking, whereas relational similarity judgments are thought to reflect more secondary process thinking.
After the last two awakenings (one non-REM- and one REM-sleep awakening), the subjects were presented with the 24 items of scalar GeoCat. Instead of categorical similarity judgments, subjects were asked to rate the similarity of all 12 pairs of attributionally similar items and

12 pairs of relationally similar items on a visual analog scale ranging from 1 (“different”) to 5 (“identical”). Each pair was presented on a separate sheet with the visual analog scale below the items and the question “How similar are these two figures?” (see appendix E). The order of the 24 items was randomized for each awakening and for each subject. The morning after this last experimental night, subjects had to redo the four classic GeoCat lists and the 24 scalar GeoCat items in a fully awake condition. The order of the four classic lists and the 24 scalar items was again randomized.

2.2.4.3 Personality measures

Finally, subjects were asked to fill in the following personality questionnaires: the State and Trait Anxiety Inventory (STAI; Laux et al., 1981) which consists of two scales to measure state anxiety as a temporary emotional state, as well as trait anxiety as a relatively stable personality feature. The NEO-Five-Factor-Inventory (NEO-FFI; Borkenau and Ostendorf, 1993) which is designed to measure five domains of personality: *neuroticism, extraversion, openness to experience, agreeableness*, and *conscientiousness*. Additionally, two scales to measure social desirability were administered. Firstly, the German version of the Balanced Inventory of Desirable Responding (BIDR; Paulhus, 1998) by Musch et al. (2002) which consists of two scales measuring self-deceptive enhancement and impression management. Secondly, the Social Desirability Scale (SDS-16) by Stöber (1999) which mainly measures impression management.

2.3 Data analysis

2.3.1 Stimulus detectability

As described in chapter 2.2.3.4, we presented 32 rebus (stimulus YES) and 32 blank (stimulus NO) cards in the detection experiment in randomized order for 1 ms. After each presentation, the subject had to state whether he saw “something” (response YES) or “nothing” (response NO). Table 2.1 shows the resulting possibilities:

	response YES	**response NO**
stimulus YES	hit	miss
stimulus NO	false alarm	correct rejection

Table 2.1: Possible answer categories in the detection experiment

For the analysis of the detection experiment, *d'* as an index for conscious perception (discrimination between stimulus and no stimulus condition; see chapter 1.3.1) is calculated. Technically, *d'* is defined as the normalized distance between the means of the underlying stimulus and no-stimulus distributions (Macmillan, 1986). Hence, the following formula is applied (Macmillan and Creelman, 1991):

$$d' = \mathrm{z(H)} - \mathrm{z(F)}$$

where “H” is the hit rate (proportion of YES trials to which subject responded YES) and “F” the number of false alarms (proportion of NO trials to which subject responded YES). As already mentioned, *d'* at the objective detection threshold is supposed to be zero - more specifically it is supposed to be not significantly different from zero. Hence, the H0 hypothesis that $d' = 0$ is tested with a one-sample t-test. In case of a non-significant result, the H0 hypothesis can be accepted and it is clearly demonstrated that detection is indeed at chance.

2.3.2 Rebus night

2.3.2.1 Free associations

For the scoring of the rebus and conceptual associates obtained from our experimental subjects during the night, we need an objective reference. Therefore, we collected normative word association data to the rebus word (*kampflos*) and its components (*Kamm* and *Floß*) from a large group of people (reference group: N = 510). A catalogue was compiled which was then used as a basic scoring measure (see appendix F). It was obtained from 403 women (79 %) and 107 men (21 %) aged 18-35, like the experimental group. Mean age was 24 ± 3 years and all of them were German native speakers. They were filling in an online questionnaire (see appendix G) which was distributed via the internet. In this questionnaire they were asked to give some personal information and five associates to a list of pictures (including a picture of a comb and a raft) and words (including the rebus word and its component parts). By these means, we obtained extensive lists of associates for the key words, on the basis of which we could judge the appearance of stimulus-related words within the associates given by our subjects after each awakening. Although we obtained five associations to both pictures and words, we decided to take the first given associates to the words (*Kamm, Floß*, and *kampflos*) as reference, since this is more in accord with the original procedure applied by Shevrin and Fisher (1967). This association catalogue was also used to score dream reports and image descriptions. As Shevrin (1973) has shown, scoring on the basis of such association norms is possible with a degree of reliability limited only by scoring error which is usually less than 3 %. Hence, this method allows a very objective and reliable scoring. In our case, this was even more enhanced by the fact that the rater was blind to the respective condition (rebus or control) and state (wake, non-REM, or REM). In the following, the scoring of the free

associations is described in more detail to illustrate the basic procedure. This procedure is largely adopted from the scoring rules of Shevrin and Stross (1964) which were also used in the original study by Shevrin and Fisher (1967). The same rules are applied to the scoring of dream reports and image descriptions but, for the sake of simplicity, the free association scoring is described representatively.
After the transcription of the associations, which had been tape recorded during the experimental sessions, the actual scoring begins. Each word is taken one at a time in the subject's production and looked for on the alphabetized list of the association catalogue. When a word is found to match it is assigned to the respective category:

1. pure associate to *Kamm*
2. embedded associate unchanged in meaning to *Kamm*
3. embedded associate changed in meaning to *Kamm*
4. clang associate to *Kamm*
5. pure associate to *Floß*
6. embedded associate unchanged in meaning to *Floß*
7. embedded associate changed in meaning to *Floß*
8. clang associate to *Floß*
9. pure associate to *kampflos*
10. embedded associate unchanged in meaning to *kampflos*
11. embedded associate changed in meaning to *kampflos*

Pure associates are only exact associates as shown in the basic association catalogue, and their grammatical variants (singular, plural, possessive forms of nouns, different tenses of verbs, participles, gerunds, imperative and superlative forms of adjectives, adverbs, etc.) - e.g. *frei* (Engl.: free) and *Freiheit* (Engl.: freedom). **Embedded associates unchanged in meaning** refer to those associates which occur in compound words without any significant change in meaning (e.g. *Schiff* (Engl.: ship) and *Schiffbruch* (Engl.: shipwreck)). This rule is applied both ways: to words in the association catalogue and words in the subject's productions. **Embedded associates changed in meaning** imply all associates which occur in compound words but have undergone a significant change in meaning (e.g. *Baum* (Engl.: tree) and *baumeln* (Engl.: to dangle)). Hence, it is more the sound than the actual meaning of the word that is involved in some other word. Finally, the **clang** category is scored when the phonemes of the key rebus words appear as a clang within the subject's verbalizations (e.g. *Kamm*er (Engl.: chamber) or hil*flos* (Engl.: helpless)).[55] It is the clang sound, not the spelling that counts. Because of the low incidence of words containing *kamm*- and *flos*-clangs and our wish to get as full a measure of the clang response as possible (and since the three consonants determine and differentiate the syllable sufficiently), we decided to score *k_mm* and *fl_s* with whatever single sounded vowels or diphtongs appear between the anchoring consonants as clangs (e.g. *Kummer* (Engl.: grief) or *Keim* (Engl.: seed)).[56] Reliability for the clang scoring is very high, since no judgments are involved in identifying these clang associates. In accord with the original study (Shevrin and Fisher, 1967) the clang effect, which implies the characteristics of the primary process, is measured independently of the rebus and conceptual effect (see below).

Each of these categories - depending on whether it is assigned to *Kamm-, Floß-*, or *kampflos*-associates - describes either more primary process (PP) or secondary process (SP) thinking (see table 2.2).

	pure	**embedded unchanged in meaning**	**embedded changed in meaning**
Kamm	1 (SP)	2 (SP)	3 (PP)
Floß	5 (SP)	6 (SP)	7 (PP)
kampflos	9 (PP)	10 (PP)	11 (PP)

Table 2.2: Possible scoring categories for *Kamm-, Floß-*, and *kampflos*-related words and their respective relation to primary process (PP) or secondary process (SP) thinking

Associations on the *conceptual level* (**pure** and **embedded unchanged in meaning** associates to *Kamm* and *Floß*; category 1, 2, 5, 6) reflect a secondary mental process which depends entirely on the semantic/dictionary meaning of the word - not on its sound or any change in meaning. Associations on the *rebus level* (**pure** and **embedded unchanged in meaning** associates to *kampflos*; category 9, 10) reflect the primary mental process, which has already occurred unconsciously when the words *Kamm* and *Floß* are treated as sounds and combined to form a new word (*kampflos*). Furthermore, the **embedded changed in meaning** categories (3, 7, 11), in which words are also treated as concrete phonemic patterns (and not with respect to their referential function), indicate primary process thinking as well and, therefore, also enter the calculations of the rebus effect.

Hence, following our second hypothesis (see chapter 1.6), we expect to find a stronger rebus effect as indicator for primary process thinking in associations (and dream reports and image

[55] Since clang associates to *kampflos* are highly unlikely (to our knowledge no word exists which contains the sound *kampflos*), only the sounds *kamm* and *flos* are scored.

[56] This procedure is also in accordance with the scoring rules of Shevrin and Stross (1964) which were used in the original study by Shevrin and Fisher (1967).

descriptions) following REM-sleep awakenings. After non-REM-sleep awakenings, however, more secondary process-like answers and associations on the conceptual level are expected.

After all associations are assigned a number between 1 and 11 (or 0 in case of no matching category), all secondary process associations (category 1, 2, 5, 6) and all primary process related associations (category 3, 7, 9, 10, 11) are summed up within each awakening. These scores are then corrected for the total number of words in that respective awakening and for the total amount of awakenings in that respective sleep stage (non-REM or REM). To depict the experimental effect of the subliminal rebus stimulus, difference scores are calculated by subtracting the respective sum scores of the control condition from those of the rebus condition. Thus, each subject gets three difference scores (wake, non-REM, and REM). Out of these scores a rank order is built. In order to compare the scores of these three states, a Friedman two-way analysis is performed on the difference scores. Additionally, a Wilcoxon signed rank test is applied to check the differences between two stages each.

2.3.2.2 Dream reports

Before scoring the dream reports with the procedure described above, the reports must be prepared appropriately. According to the guidelines of Schredl and Erlacher (2003a), all parts of the report not directly belonging to the dream (i.e. all remarks going beyond the actual dream content) need to be removed. Introductory remarks (e.g. "I was dreaming that ..." or "I only remember that ..."), as well as closing words (e.g. "... and then I woke up" or "That's all I remember!") are deleted. The same is true for comments on the dream content (e.g. "I once experienced a very similar situation." or "That's the friend I met the other day.").
Along with the scoring on the conceptual-, rebus-, or clang-level, dream reports are also rated according to their degree of bizarreness and their closeness to reality.[57] One could assume that an increased prevalence of primary process mentation is related to increased bizarreness. Hence, we would expect a positive correlation between dream bizarreness and the rebus effect. Bizarreness is measured with the bizarreness scale of Schredl and Erlacher (2003b). Events, characters, objects, feelings, or actions are scored as bizarre when they are highly improbable or impossible, and match one of the following categories:

1. Incongruity
    - something inconsistent with waking life (e.g. a talking dog)
    - discrepancy from physical laws (e.g. traveling in time)
    - mismatching features (e.g. experiencing something sad, but feeling happy)

[57] We wish to thank Franc Paul for the bizarreness and reality scoring of all dream reports.

2. Discontinuity
    - changes of features: elements suddenly appear, disappear, or change shape (e.g. a friend changes into an animal)
    - impossible or very improbably alterations in familiar settings (e.g. a sphinx in the living room)
3. Uncertainty
    - undetermined elements, explicitly vagueness (e.g. an unknown, undefined object)

Mean numbers of bizarre elements per dream are calculated. Differences between stages are tested using Wilcoxon test for related samples. For a correlation between dream bizarreness and the rebus effect, difference bizarreness scores are built by subtracting the bizarreness score of the control condition from the one of the rebus condition. Spearman rank order correlation is applied to check for correlations between the experimental effect and dream bizarreness.
A 4-point scale (1 = realistic to 4 = several bizarre associations) is applied to judge the closeness to reality of the dream content. To obtain individual dream content measures, medians across each subject's reported dreams per stage and condition are calculated. Wilcoxon signed rank test is used to test differences in closeness to reality between stages. Again, Spearman's correlation is applied to check for correlations between the rebus effect and closeness to reality.

2.3.2.3 Images

As with the free associations and dreams reports, image descriptions after non-REM- and REM-sleep awakenings were scored following the rules described in chapter 2.3.2.1. Additionally, picture drawings were checked for any resemblances to the subliminally presented pictures of the *Kamm* and the *Floß*.

2.3.3 GeoCat night

For the evaluation of the *classic GeoCat* data, attributional and relational answers on each list (maximum two from non-REM-sleep awakenings, two from REM-sleep awakenings, and four from the fully awake condition) are counted. A continuous score is devised for each list (relational minus attributional choices; see Brakel and Shevrin, 2005). This score ranges from 6 (all relational), through 0 (relational equal to attributional) to -6 (all attributional). In the next step, average scores are calculated for each subject. Therefore, scores of the non-REM, REM, and wake lists are summed up and divided by the number of awakenings (for the non-REM and REM lists), respective by four (for the wake lists). For a statistical test of mean differences between stages (non-REM, REM, wake), a 1-factor ANOVA for repeated measures on the factor stage is run. Post-hoc analysis is carried out by applying t-test for related samples. As described in chapter 2.2.4.2, subjects are asked to rate their state of anxiety on every classic GeoCat lists. Mean anxiety scores are calculated for every sleep stage and for the waking state.

To build up a score reflecting the strength of similarity judgment for each of the *scalar GeoCat* items, it is measured how many centimeters and millimeters subjects marked the line (range 1-5 cm) below the respective scalar item. Total scores for both attributional and relational judgments are obtained by calculating the mean scale score for the 12 attributionally and the 12 relationally similar items for every subject and every stage (non-REM, REM, wake). The resulting score ranging from 1 (different) to 5 (identical) reflects how similar the items were judged to be. Repeated measurement ANOVA with the factor item (2 levels: attributional and relational) and the factor stage (3 levels: non-REM, REM, wake) is calculated. For the post-hoc evaluation of differences between items and stages, a t-test for related samples is applied. To be able to correlate the attributional scalar similarity score with the rebus effect (both are hypothesized to measure primary process thinking), we need to subtract the scalar non-REM score from the scalar REM score. This is necessary to get a controlled scalar measure which can thus be correlated with the already controlled rebus effect (rebus night minus control night). Spearman rank order correlation is applied to check for these correlations between the controlled scalar measure and the rebus effect.

2.3.4 EEG data

Electrophysiological data sets from the rebus and the control night are analyzed in more detail to investigate a possible relationship between alpha and theta power and primary and secondary process thinking, as well as dream bizarreness (see chapter 1.4.2 and 1.6).
After recording all night sleep EEG data using Excel-Tech (XLTEK) hard- and software (see chapter 2.2.2), sequences of interest (five minutes of non-REM-sleep stage 2 and five minutes of REM-sleep before the respective awakenings) are cut out and converted from XLTEK format to European Data format (EDF). Data is then imported into Matlab (Mathworks, version 7.0) software package for further analysis. Each of the five minutes sequences of continuous data is visually inspected for artifact-free 20 sec epochs (i.e. without movement-, eye- or muscle-artefacts).[58] These epochs are subdivided into the single frequency bands by using digital filtering. Therefore, the non-relevant components are put back to zero and the filtered signal results after an inverse Fourier transformation. Thus, the respective oscillations curves

[58] Ten epochs of two seconds of EEG or 20 seconds of continuously EEG have proven to satisfy both stationarity and stability for power analysis. Furthermore, this time span is short enough to prevent statistical parameters from changing during the epoch (Cohen, 1977; Möcks and Gasser, 1984; Corsi-Cabrera et al., 2000, 2006).

in the delta-, theta-, alpha-, beta-, and gamma-frequency can be obtained. In our further analyses, we will focus on the theta (4-7 Hz) and alpha (8-13 Hz) band. Alpha and theta spectral power (defined as maximal amplitudes in the alpha/theta frequency band) for all nine electrode positions is calculated. To diminish the number of factors included in statistical analyses, and to enhance statistical power, we subsumed the nine electrode positions under the following three areas: frontal (= fpz + fz), central (= c3 + c4 + cz), and occipital (= o3 + o4 + oz). Probably due to the sleeping position, the pz electrode displayed strong disturbances in most subjects and was therefore excluded from further analyses. Finally, average power values are derived for all awakenings (non-REM and REM) in the respective condition (rebus and control). These power scores are correlated with the rebus and conceptual subliminal effect and dream bizarreness using Pearson correlation coefficient for normally distributed data or Spearman rank order correlation test for non-normally distributed variables.

2.3.5 Statistical analyses

Statistical analyses are run using SPSS (Statistical Package for Social Science) for Windows (version 11.5). Non-parametric one-sample Kolmogorov-Smirnov test is used to check for normality of continuous variables. In case of normal distribution, parametric statistical analyses are justified. General linear model (GLM) repeated measures analyses of variance (ANOVA) are performed to check for mean differences of more than two variables and to investigate statistical main and interaction effects. Mauchly test for sphericitiy is used to test violation of sphericitiy. In case of a significant Mauchly test, Greenhouse Geiser corrected scores are used for further analysis. Post-hoc comparisons between two variables are run using t-tests for related samples. Here, Levene-test is used to check homogeneity of variances. Correlations between two or more normally distributed interval scaled variables are run using Pearson correlation coefficient.

In case of a non-Gaussian distribution of the data, or ordinal scaled variables, non-parametric tests are applied. Friedman rank analysis of variance is performed as a non-parametric equivalent to the repeated measure ANOVA mentioned above. Wilcoxon signed rank test is used for the non-parametric comparison of two related samples. Spearman rank order correlation is applied in case of at least one ordinal scaled variable or non-normally distributed data.

Differences are considered significant at $p < 0.05$. Two-tailed tests are used if not stated otherwise.

3. Results

3.1 Pretestings

3.1.1 Establishing subliminality

Clearly, one of the major requirements of this study is the guarantee of true subliminality. Therefore, it is indisputable to test in advance that the experimental conditions meet the conditions of the objective detection threshold (ODT) - the most stringent criterion for subliminality (see chapter 1.3.3). Thus, it is necessary to demonstrate that:

- the defined presentation time of the tachistoscope is indeed exactly 1 ms,
- the required luminance is indeed 5 fl,
- stimulus presentation under these conditions is indeed subliminal as can be demonstrated by a forced-choice detection experiment with a number of subjects prior to the actual experiments.

3.1.1.1 Presentation time and luminance

To make sure that the declared presentation time of the tachistoscope is exactly 1 ms and that the light intensity is constant during this time interval, some pretestings were necessary. We tested the characteristics of the xenon lamps with a photo cell connected to a digital oscilloscope. The photo cell converts the light intensity of the xenon lamps into voltages that can be measured very accurately with the digital oscilloscope. The screen shots of the oscilloscope can then be transferred to a PC.
In the first experiment we measured the temporal behavior of the light flashes of projector 1 (P1). In figure 3.1(a) the average light intensity of 25 flashes is plotted over time. After 0.005 ms, the average flash has already reached its maximum value. The switch-off time of the xenon lamp is slightly longer but the complete signal has already diminished after about 0.05 ms after switching off the pulse. 96.2 ± 0.4 % of the integrated signal lies within the desired

time interval (thick line in figure 3.1(a)), and thus proves that an ideal pulse (1 ms light flash with constant intensity) is indeed achievable with those xenon lamps. The overshoots of the signal at switching on and off is probably caused by the non-ideal response of the photo cell, due to the fast switching. The negative intensities at switching-off prove that it cannot be an effect of the xenon lamp itself (negative light intensities are not possible and must, therefore, be an artifact of the measuring device). Thus, the real temporal behavior of the xenon lamps probably resembles the ideal pulse even better than represented in the figure.

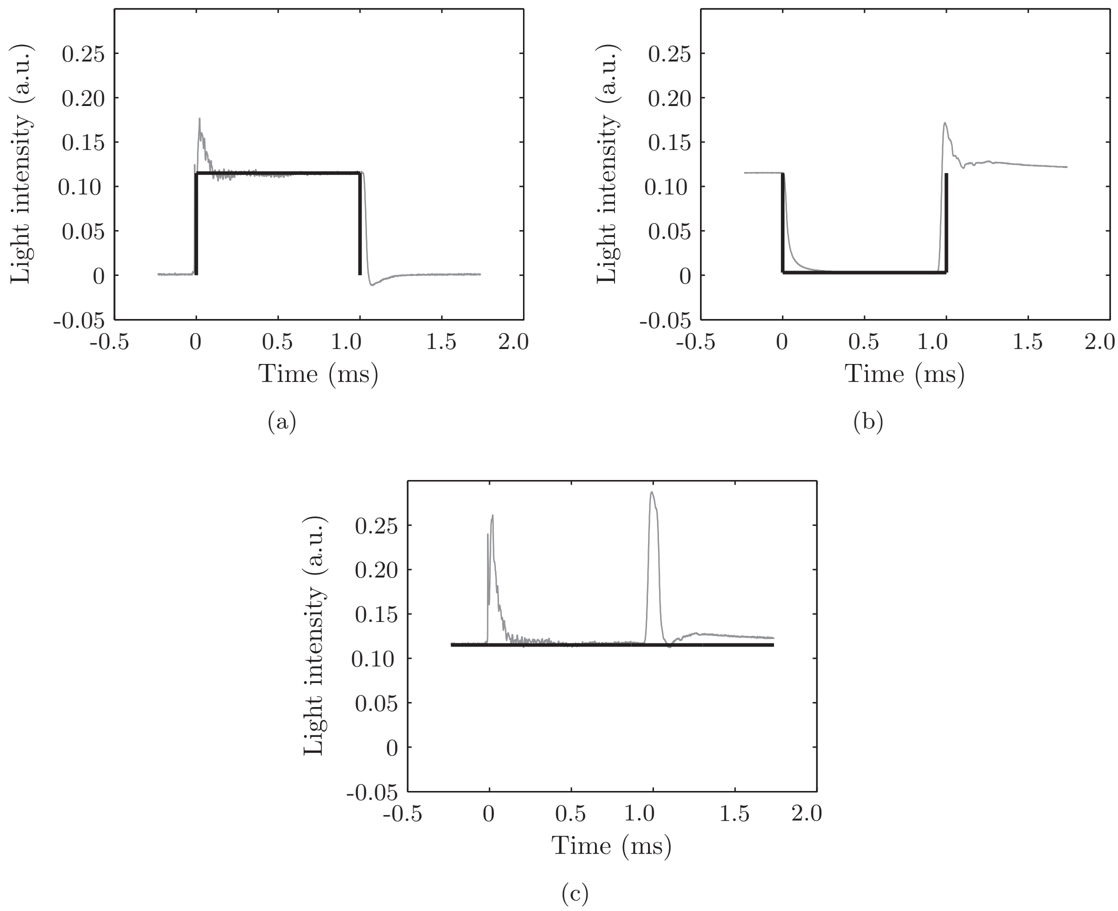

Figure 3.1: (a) Average intensity of 25 *light flashes* of P1; (b) average intensity of 25 *dark flashes* of P2; (c) uninterrupted cross-fading of P1 and P2 (thin lines represent the measured signals, thick lines represent the ideal pulses)

In the same way as for the light flash, the temporal behavior of the “dark flash” of projector 2 (P2) was measured. The drop and rise times are not as good as for the light flash of P1. However, since P2 is only used to “mask” the light flash of P1 (to ensure an uninterrupted

cross-fading) and no stimulus is presented, the rise and drop times are less critical. In figure 3.1(b), the average of 25 dark flashes are plotted over time. Although the rise and drop times are longer than for the light flash, still 92.7 $\pm$ 1.1 % of the integrated signal of the dark pulse lies within the desired time interval (thick line in figure 3.1(b)).
In figure 3.1(c), the uninterrupted cross-fading is analyzed by measuring the light intensity of the complete stimulus presentation (average of 25 light flashes together with 25 dark flashes). The figure shows that the light intensity remains constant over time, except for short time intervals at the beginning and the end of the stimulus presentation. However, these overshoots are due to measuring artifacts of the photo cell, as described above. These results prove that the tachistoscope used in this experiment meets the required criteria, and is well suitable for the use of subliminal stimulation.

As described in chapter 2.2.3.2, studies working at the ODT mainly rely on presentation times of 1 ms and luminance of 5 fl. Luminance is defined as the brightness reflected from the screen, not the brightness of the projector itself (the so-called ansi-lumen). Hence, the ansi-lumen, the size of the stimulus, and the gain-factor of the screen constitute the actual luminance. By using a lux meter and varying the distance between the screen and the projectors, it was found that a distance of 2.35 m was necessary to achieve the required luminance of 5 fl.

3.1.1.2 Stimulus detectability

Presentation time and luminance are the crucial factors in determining subliminality. However, further characteristics like size and contrast of the drawings, the distance between the subject and the screen, etc. also play an important role. Size, contrast, and distance, as well as some characteristics of the pictures themselves had to be modified several times (see chapter 3.1.2) and a number of pretestings were necessary to determine the ideal conditions. To assure that the conditions applied in this study actually meet the criterions of the ODT so that the stimulus is not perceived consciously, we ran a detection experiment with a sample of eight people beforehand.[59] Applying the formula of Macmillan and Creelman (1991), we received a mean d' of -0.12 $\pm$ 0.31 (-0.48 min, 0.40 max). To test the H0 hypothesis that d' = 0, we ran a one-sample t-test which showed a non-significant result (T(7) = -1.068; p = 0.321). Thus, we could assume that the conditions of our experiment and the nature of the pictures indeed assure subliminality. This detection experiment was run again with each of the experimental subjects as described in chapter 2.2.3.4 and 3.3.4.

[59]The procedure of the detection experiment is identical to the one described in chapter 2.2.3.4.

3.1.2 Suitability of the rebus stimulus

The challenges in developing a German rebus stimulus were manifold because it has to fulfill several requirements: firstly, the two pictured objects resulting in the rebus word have to be easily illustratable; secondly, they need to be inconclusively identifiable; thirdly, these two objects should not be associated with each other; and lastly, the resulting rebus word must not have any contentual connection to the two pictured objects.

The first requirement was fulfilled since both objects, the comb and the raft, can be pictured without problems. However, for the reading on the rebus level, an unambiguous identification of these pictured objects is indispensable (second requirement). To ensure the unambiguity of the objects, we presented the picture of the comb and the raft to several people (N = 74), and asked them to identify the objects. While the comb was identified very easily (100 %), it turned out that this was not the case for the raft which was only identified correctly by 55 % of the people. The remaining 45 % identified the picture of the raft as sausages, airbed, heater, or panpipes. Therefore, a number of modifications were necessary to increase the unambiguity of the picture. In a second testing, both the comb and the raft were identified correctly by 100 % of the sample (N = 54).[60] Hence, we could be fairly sure that the pictured objects would be identified correctly - even under subliminal conditions.
By analyzing the associations in the basic association catalogue given by the reference group (see chapter 2.3.2.1), it was possible to check that *Kamm* and *Floß* are not associated with each other (third requirement; see appendix F for the association lists). The forth requirement can be answered in the same way by checking the associates given by the reference group to *kampflos* (see appendix F) for the occurrence of the word *Kamm* or *Floß*. As expected, neither *Kamm*, nor *Floß* appears as an associate to *kampflos*. Hence, one could conclude that our rebus fulfills all the requirements mentioned above.

3.2 Baseline night

Since the experimental procedure involved six awakenings (see chapter 2.2), it is very important that all participants have a normal sleep architecture. Hence, a healthy sleep of our subjects is another basic requirement. As can be seen in table 3.1, which displays the major sleep parameters of the baseline night, the average total sleep time (TST) was 7 h 27 min ± 58 min. All subjects fell asleep quite quickly (mean sleep onset after 9.9 ± 4.2 min) and displayed good sleep efficiency (90.9 ± 5.7 %; a sleep efficiency above 85 % describes a “healthy” sleep). Although three subjects showed increased periodic limb movements (PLMs) during the night and displayed a PLM index above the cut off point of 5, their sleep architecture was

[60] See appendix H for the original and the modified versions of the comb and the raft picture.

unaffected in every case. Thus, these subjects could still be included in the study. One male subject exhibited an apnea/hypopnea index of 5. Exceeding the cut off point of 5 would hint at an underlying obstructive sleep apnea syndrome (OSA). However, the subject showed no arousals or oxygen desaturations accompanying the hypopneas and, therefore, the criteria for an obstructive sleep apnea syndrome were not fulfilled (American Sleep Disorder Association, 1990). Overall mean oxygen saturation was very good (97.4 ± 1.8 %), as can be expected in young healthy subjects. Table 3.1 displays all sleep parameters of the baseline night. Summarizing these parameters, all subjects showed a healthy sleep cycle during the baseline night and could therefore be included in the study and scheduled for the three experimental nights.

Time in bed (TIB) (total time from "light off" in the evening until "light on" in the morning)	492.7 ± 46.0 min
Sleep period time (SPT) (time interval from sleep onset until the last occurrence of a sleep stage before awakening)	478.6 ± 46.2 min
Total sleep time (TST) (addition of all sleep stages without stage "wake")	447.0 ± 58.2 min
Sleep efficiency (percentage proportion between all sleep stages without stage "wake" to TIB)	90.9 ± 5.7 %
Sleep latency S1 (time interval from "light off" until first epoch stage 1; sleep onset)	9.9 ± 4.2 min
Periodic leg movement (PLM) index (number of PLMs per hour)	4.1 ± 10.9
Number of awakenings	15.6 ± 4.6
Time awake after falling asleep (total time within SPT spending awake)	30.1 ± 24.6 min
Apnea/hypopnea index (AHI) (number of apneas/hypopneas per hour)	0.4 ± 1.2
Oxygen saturation	97.4 ± 1.8 %

Table 3.1: Sleep parameters of the baseline night (mean ± standard deviation)

3.3 Rebus and control night

With the results of the rebus and the control night, we hope to find supporting evidence for the findings of the Shevrin and Fisher study (1967), and hence, for our main hypothesis that REM-sleep is characterized by primary process thinking, while non-REM-sleep is characterized by more secondary process mentation. Therefore, we expect to find a stronger rebus effect after REM-sleep awakenings, and a stronger conceptual effect after awakenings from non-REM-sleep (see hypothesis 2 in chapter 1.6). Our aim was to gain three non-REM-(stage 2) and three REM-sleep awakenings every night (see chapter 2.2.3.3), which means 240 awakenings in total for the rebus and control night (120 non-REM and 120 REM awakenings). However, due to the unpredictable individual sleep behaviors, and the sometimes quite long time intervals needed to fall back asleep again, we "only" managed to get 226 awakenings in total - 115 non-REM-sleep awakenings and 111 awakenings from REM-sleep. Table 3.2 displays the amount of non-REM- and REM-sleep awakenings in the rebus and the control night.

	rebus night	**control night**	**total**
non-REM	58	57	115
REM	57	54	111
total	115	111	226

Table 3.2: Number of non-REM and REM awakenings in the rebus and control night

3.3.1 Free associations

After each of the 226 awakenings, subjects gave four minutes of free associations. Taking rebus and control night and all non-REM- and REM-sleep awakenings together, we obtained 1555 associations in the waking state, 3187 after awakenings from non-REM-sleep and 3195 after REM-sleep awakenings - which results in 7937 scorable associations in total. Figure 3.2 displays the total amount of wake, non-REM, and REM associations in the rebus and the control night. The number of associations does not vary a lot within stages between rebus and control night. Although there is a slight predominance of associations given in the rebus night, this difference is statistically not significant.
However, the varying number of non-REM-sleep and REM-sleep awakenings (see above) must be taken into account to make the sleep stages comparable to each other and to the presleep waking state. Furthermore, it is important to note that the amount of words given during the four minutes of free association varies a lot between subjects. Table 3.3 shows the average number of associations for wake, non-REM-, and REM-sleep (corrected for the number of awakenings).

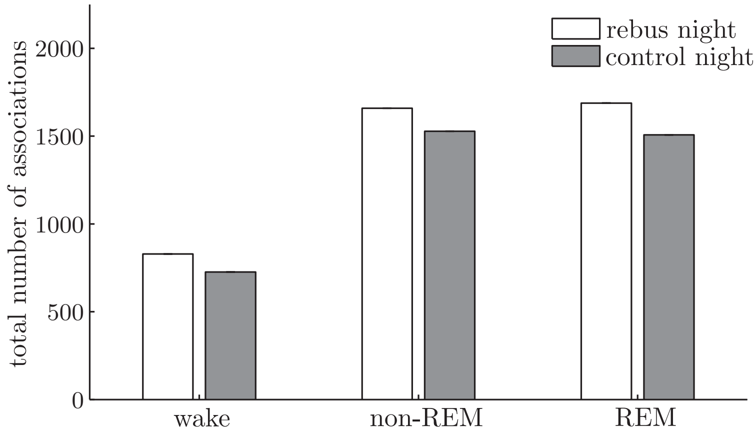

Figure 3.2: Total number of wake, non-REM, and REM associations in the rebus and control night

	rebus night	**control night**
wake	41 ± 19	36 ± 24
non-REM	28 ± 18	27 ± 16
REM	30 ± 15	27 ± 16

Table 3.3: Average number of wake, non-REM, and REM associations per subject in the rebus and control night (means ± standard deviation)

All associations are scored following the rules described in chapter 2.3.2.1 (the so-called normative scoring). The amount of *Kamm*- and *Floß*-related words (conceptual effect as an index for secondary process thinking) is higher in the presleep waking state and - as expected - in non-REM-sleep, as compared to REM-sleep. Moreover, the amount of *Kamm* and *Floß*-related associations is higher in the rebus night (when the subliminal rebus stimulus was presented), as compared to the control night (when only a blank control stimulus was presented). In contrast, the differences between the amount of *kampflos* associates (rebus effect as an index for primary process thinking) across stages and conditions do not vary a lot (see figure 3.3).

To depict the experimental effect and to be able to compare the conceptual effect (*Kamm* and *Floß*) and the rebus effect (*kampflos*) with each other, difference scores are built by subtracting the scores of the control condition from those of the rebus condition. A positive score (and a higher mean rank) indicates a stronger experimental effect in the rebus than in the control condition, while a negative score indicates the reverse (see table 3.4 and table 3.5).

To compare all three stages (wake, non-REM, REM) a Friedman two-way analysis of vari-

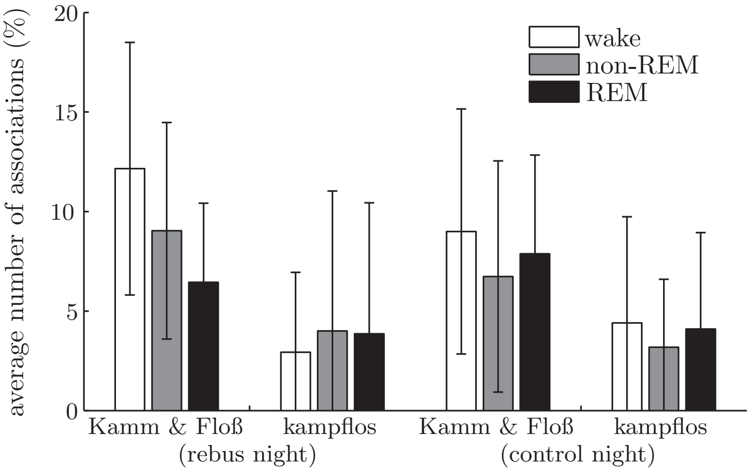

Figure 3.3: Average number of *Kamm & Floß* and *kampflos* associations in both conditions (rebus and control) and all stages (wake, non-REM, REM) (normative scoring)

subject	**wake**	*rank*	**non-REM**	*rank*	**REM**	*rank*
1	-3.12	2	4.17	3	-4.17	1
2	0.53	3	-2.91	1	-1.15	2
3	5.01	2	7.21	3	-1.29	1
4	-4.76	1	9.65	3	-0.97	2
5	1.86	3	-7.14	1	-3.43	2
6	1.25	3	-1.04	2	-3.08	1
7	8.33	2	9.38	3	0.00	1
8	8.50	3	5.09	2	2.09	1
9	4.04	2	6.15	3	-3.33	1
10	2.50	2	9.44	3	-4.59	1
11	0.00	2	2.39	3	-3.69	1
12	3.23	2	4.07	3	-0.52	1
13	1.10	3	-1.88	1	-1.49	2
14	7.01	3	-5.82	1	-5.74	2
16	6.98	3	-2.54	1	-0.34	2
17	5.00	3	4.53	2	-3.60	1
18	-4.31	1	1.32	2	3.84	3
19	16.00	3	0.00	1	7.99	2
20	6.28	2	15.13	3	-0.83	1
21	-2.31	3	-11.28	1	-4.37	2
mean rank		**2.40**		**2.10**		**1.50**

Table 3.4: Differences scores and ranks for the conceptual effect (free associations; normative scoring) in all stages (wake, non-REM, REM)

ance is performed on these difference scores. For the **conceptual effect** the difference is significant ($\chi^2 = 8.4$; $p = 0.015$). The individual group comparisons based on the Wilcoxon signed rank test for paired samples reveals, as hypothesized, a stronger conceptual effect in

subject	**wake**	*rank*	**non-REM**	*rank*	**REM**	*rank*
1	-4.19	1	19.40	3	19.25	2
2	-4.17	1	2.62	3	-0.50	2
3	-0.10	2	-0.49	1	0.05	3
4	2.86	3	-2.02	1	2.25	2
5	4.02	3	1.39	2	-0.35	1
6	-13.33	1	-0.64	2	-0.09	3
7	0.00	1.5	2.36	3	0.00	1.5
8	5.50	3	-0.31	2	-2.82	1
9	0.00	1	0.78	2	0.90	3
10	1.63	3	0.00	2	-0.95	1
11	4.17	3	-7.26	2	-15.46	1
12	-10.53	1	0.00	3	-4.63	2
13	-9.52	1	-8.29	2	-5.57	3
14	0.11	3	-1.52	1	-1.19	2
16	4.48	3	3.37	2	-3.89	1
17	2.50	3	-6.33	1	-1.61	2
18	0.00	2	0.00	2	0.00	2
19	-3.05	1	16.23	3	11.03	2
20	-5.56	1	0.00	3	-1.11	2
21	-4.17	1	-3.03	2	0.00	3
mean rank		**1.93**		**2.10**		**1.98**

Table 3.5: Differences scores and ranks for the rebus effect (free associations; normative scoring) in all stages (wake, non-REM, REM)

non-REM-sleep than in REM-sleep ($p = 0.033$). In the presleep waking stage, the effect is even stronger compared to REM-sleep ($p = 0.002$). The difference between wake and non-REM-sleep is not significant. With regard to the rebus effect, the differences between stages as revealed by the Friedman test are not significant. Also, as can be seen in table 3.5, against our hypothesis, a tendency for a stronger rebus effect can be found in non-REM- rather than REM-sleep (higher mean rank for non-REM than for REM). These results are pictured in figure 3.4. While there is a clear predominance of the conceptual effect in the presleep waking state and in non-REM-sleep, the pattern is not as clear for the rebus effect and scores remain non-significant.

What can account for the fact that we do find the expected conceptual effect in non-REM-sleep, but no rebus effect in REM-sleep? Presumably, one major reason is the rebus word *kampflos* itself and its abstract and somehow paradox nature. It contains something (*Kampf* (Engl.: fight)) but at the same time negates it (kampf*los* (Engl.: *without* a fight)). Furthermore, the words *Kampf* or *kampflos* might tap into something sensitive and/or emotional and, therefore, have very different unconscious effects, as compared to the much more neu-

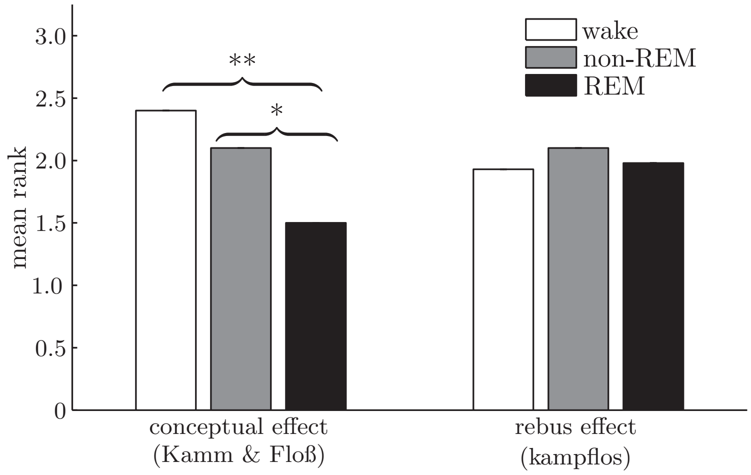

Figure 3.4: Experimental conceptual and rebus subliminal effect (free associations; normative scoring) as function of stage ($* \ p < 0.05$ and $** \ p < 0.01$)

tral *penny* rebus word used in the original study (Shevrin and Fisher, 1967).[61] In contrast to *penny*, the *kampflos* rebus word can lead to very different, subjective, and confused associative activations, maybe even marked by a personal history. It also strongly depends on whether one focuses on the *Kampf*-aspect and thus associates rather negative-toned words like "war", "blood", or "enemy" - or whether one concentrates more on the positive part (*without* a fight) and thus gives associates like "peace", "harmony", or "friendship". Hence, the *kampflos* stimulus allows a very wide range of different and very individual associations. This hypothesis is confirmed by the associates prevalent in the basic association catalogue (see chapter 2.3.2.1 and appendix F). While all 510 people of the reference group gave only 47 different associates to *Kamm* and 74 associates to *Floß*, the amount of different *kampflos* associates is much larger (114). Furthermore, a closer look at the associates themselves reveals that people associate quite different words, feelings, and ideas to *kampflos* as opposed to *Kamm* and *Floß*. More specifically, while associates given to *Kamm* and *Floß* can be put in more or less one single category (e.g. "personal hygiene" for *Kamm* and "summery adventure" for *Floß*), this is not possible for the *kampflos* associates since they seem much more diverse (e.g. *Friede* (Engl.: peace), *erschöpft* (Engl.: exhausted), *Hund* (Engl.: dog), *klug* (Engl.: clever), *Rom* (Engl.: Rome)). Apparently there are no such prototypes of associations to *kampflos*, as there are to *Kamm* or *Floß*. Hence, it would be important to know the very individual associations of each subject to the word *kampflos*, and score all associations of that single subject again, while taking the individual associates as reference for the *kampflos* scoring. In fact this was possible, since we asked all subjects after the second experimental night in a debriefing to give five associations to the *kampflos* stimulus (see chapter 2.2.3.4). Thus, we were able to

[61] One could even assume whether the word *Kampf* touches thoughts, ideas, and associations buried deep inside the collective German unconscious, and thus has an even more sensitive meaning.

redo the *kampflos* scoring on the basis of the individual rebus associates.
Indeed, following the same rules as described in chapter 2.3.2.1, but using only the individual debriefing associations for the scoring on the *kampflos* level (the so-called individual scoring), leads to a quite different pattern (see figure 3.5). Although the total amount of *kampflos*-related associations is much smaller, as compared to the normative scoring (since we only have the five individual debriefing associates as reference), there is a recognizable increase in *kampflos* associates, as compared to *Kamm* and *Floß* associates during REM-sleep in the rebus night. Hence, the individual nature of the rebus stimulus might indeed play a crucial role.

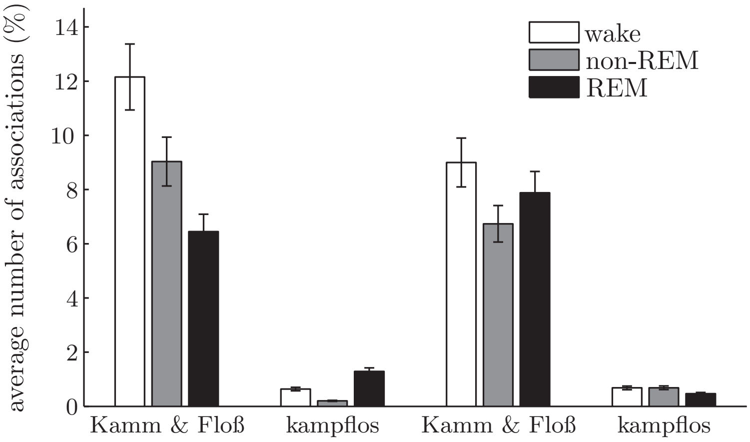

Figure 3.5: Average number of *Kamm* & *Floß* (normative scoring) and *kampflos* (individual scoring) associations in both conditions (rebus and control) and all stages (wake, non-REM, REM)

To check for the experimental effect, difference scores are built again as described above. As expected, the rebus effect becomes much stronger. Individual group comparisons based on the Wilcoxon test for related samples reveal a significantly stronger rebus effect in REM-, as compared to non-REM-sleep ($p = 0.013$). The difference between REM-sleep and the presleep waking state is non-significant. Figure 3.6 shows the clear predominance of the rebus effect in REM-sleep, as compared to the presleep waking state and non-REM-sleep.

Out of the total amount of 7937 associations, only 24 associates (0.3 %) were clang associates. Because of this small amount, we abstained from scoring the clang associates as further indication for primary process mentation.

3.3.2 Dream reports

After 162 of the total amount of 226 awakenings (115 non-REM- and 111 REM-sleep awakenings; see table 3.2 above), we were able to obtain dream reports - 62 from non-REM-sleep

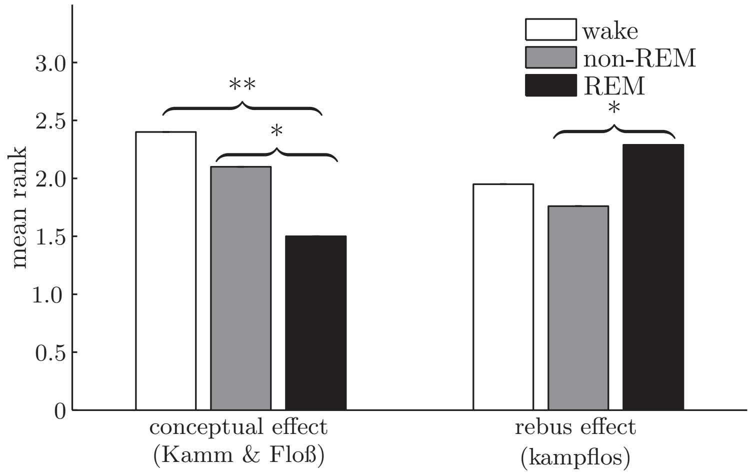

Figure 3.6: Experimental conceptual (normative scoring) and rebus (individual scoring) subliminal effect as function of stage ($*\ p < 0.05$ and $**\ p < 0.01$)

stage 2 (54 % of all non-REM awakenings), and 100 from REM-sleep (90 % of all REM awakenings). Half of the non-REM dream reports (31) and of the REM reports (50) were obtained during the rebus night and the other half during the control night. This proportion of non-REM and REM dreams is typical, and reflects the numbers described in the literature (e.g. Nielsen, 1999; see chapter 1.5). More importantly, these percentages resemble the ones from the original study of Shevrin and Fisher (1967) who obtained 60 % non-REM-sleep dream reports and 90 % REM-sleep dream reports. The length of the dream reports varies considerably between stages and subjects. Consistent with the literature (see chapter 1.5), REM-sleep dream reports are much longer as compared to non-REM reports (rebus condition: $p = 0.002$; control condition: $p = 0.049$). Table 3.6 displays the average number of words for non-REM and REM dream reports in the rebus and the control night.

	rebus night	**control night**
non-REM	24 ± 14	52 ± 101
REM	94 ± 75	89 ± 60

Table 3.6: Average number of words for non-REM and REM dream reports in the rebus and control night (means ± standard deviation)

Following the procedure described above (see chapter 2.3.2.1), the normative scoring of the dream reports yields no significant differences. Neither the expected conceptual effect (predominance of *Kamm*- and *Floß*-related words in non-REM dream reports), nor the rebus effect (higher incidence of *kampflos* associations in REM dream reports) can be observed. Although the conceptual effect is slightly higher during non-REM-sleep, this difference remains

non-significant. The same is true for the rebus effect which is also - contrary to our hypothesis - slightly stronger in non-REM- than in REM-sleep.
Rescoring the dream reports with the individual debriefing associates to *kampflos* increases the occurrence of *kampflos*-related words within REM-sleep dream reports (see figure 3.7). But although we do find the right tendency (stronger conceptual effect in non-REM reports and stronger rebus effect in REM reports), these differences remain non-significant (conceptual effect: $p = 0.477$; rebus effect: $p = 0.123$).

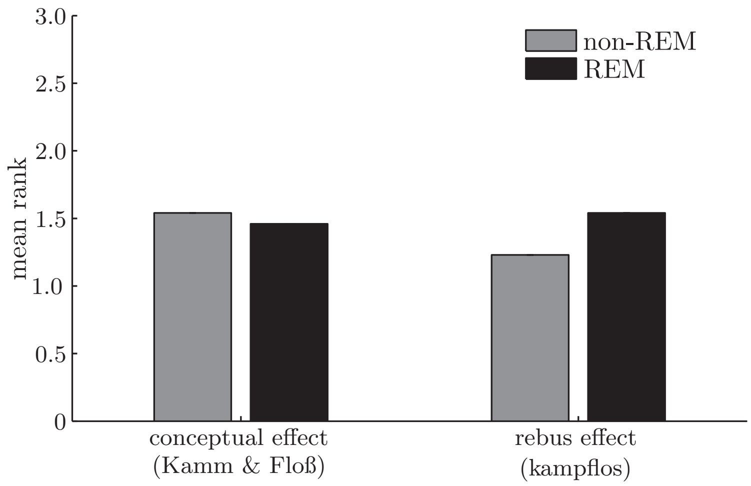

Figure 3.7: Experimental conceptual (normative scoring) and rebus (individual scoring) effect in non-REM and REM dream reports

Again clangs were not scored since out of the total amount of words from all dream reports (11598), only 16 (0.14 %) contained clang associations to *Kamm* or *Floß*.

Additionally to the scoring on the conceptual-, rebus-, and clang-level, dream reports were scored with respect to their degree of bizarreness and their closeness to reality (see chapter 2.3.2.2). All in all, 11 (6.79 %) out of 162 dreams contained bizarre elements. This putatively low incidence matches the observation that laboratory dreams usually comprise less bizarre elements than everyday dreams (e.g. Cipolli et al., 1993). On the other hand, it has been questioned whether dream bizarreness in general might be overestimated (see chapter 4.1.2). Table 3.7 shows the mean number of bizarre elements in non-REM and REM dreams in the rebus and control night. While REM dreams during the rebus night contain significantly more bizarre elements as compared to non-REM dreams ($p = 0.041$), this difference remains non-significant during the control night.

The same pattern is reflected in the closeness to reality of non-REM and REM dream reports in the rebus and control night (see table 3.8). While non-REM dream reports in the rebus

	non-REM	REM	p[1]
rebus night	0	0.17 ± 0.33	0.041
control night	0.09 ± 0.27	0.08 ± 0.21	n.s.

Table 3.7: Number of bizarre elements per dream in the rebus and control night (means ± standard deviation)
[1]Wilcoxon test for related samples

night are significantly closer to reality than REM-sleep reports (1 = realistic; 4 = several bizarre associations), this difference is non-significant for the control night.

	non-REM	REM	p[1]
rebus night	1.20 ± 0.30	1.81 ± 0.44	0.001
control night	1.42 ± 0.59	1.72 ± 0.50	n.s.

Table 3.8: Closeness to reality in non-REM and REM dreams in the rebus and control night (median ± variance)
[1]Wilcoxon test for related samples

The correlation between dream bizarreness, as well as closeness to reality and the rebus effect (individual scoring) is non-significant. Hence, there seems to be no relationship between the degree of bizarreness and the subliminal rebus effect during REM-sleep.

3.3.3 Images

After 113 of the 226 awakenings (115 non-REM- and 111 REM-sleep awakenings; see table 3.2 above), subjects were able to describe an image coming to mind immediately after the four minutes of free associations. 54 of these images were obtained after non-REM-sleep (47 % of all non-REM awakenings; 31 in the rebus night and 23 in the control night) and 59 after awakenings from REM-sleep (53 % of all REM awakenings; 28 in the rebus night and 31 in the control night). The length of image descriptions varies considerably between subjects. Table 3.9 shows the average number of words for non-REM and REM image descriptions in the rebus and the control night.

Neither the normative nor the individual scoring lead to any demonstrable conceptual or rebus effect. While the amount of *Kamm*- and *Floß*-related words in non-REM and REM image descriptions for the normative scoring is identical, the individual scoring does lead to a slight increase in *kampflos* associations within the REM descriptions - however, without any significant effect ($p = 0.180$) (see figure 3.8).

	rebus night	control night
non-REM	49 ± 50	38 ± 31
REM	48 ± 31	43 ± 44

Table 3.9: Average number of words for non-REM and REM image descriptions in the rebus and control night (means ± standard deviation)

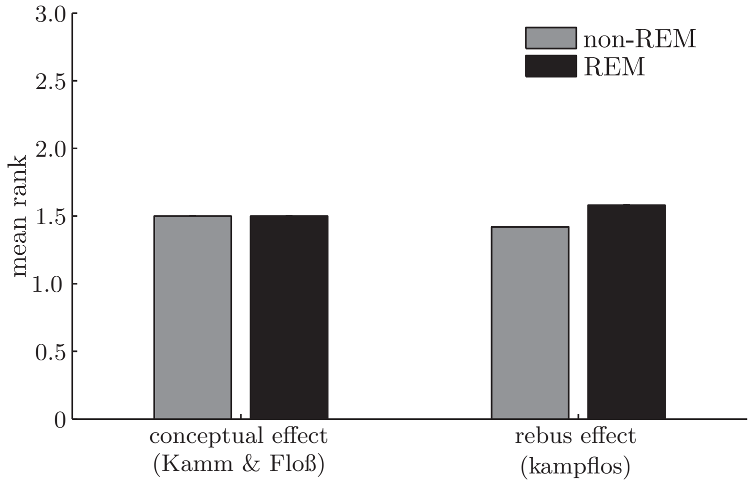

Figure 3.8: Experimental conceptual (normative scoring) and rebus (individual scoring) effect in non-REM and REM image descriptions

Although the majority of clangs appeared, as one would expect, within images descriptions obtained after REM awakenings in the rebus night, the total amount of clangs (14 out of 5201 words) was again too small to be scored.

3.3.4 Detection experiment

As described in chapter 2.2.3.4, we ran a detection experiment with each individual subject (N = 20) the morning after the second experimental night. The so-called criterion c, which reflects main response bias, is minimal (mean $c = 0.02 \pm 0.13$). This indicates that subjects indeed distributed their “yes” and “no” responses equally. Hit rates range from 0.34 to 0.66 and false alarms from 0.19 to 0.63. Table 3.10 displays the *d’* of all subjects. Mean *d’* is 0.07 ± 0.37 (-0.56 min, 0.80 max). The non-significant result of the one-sample t-test confirms our H0 hypothesis that *d’* is at chance (T(19) = 0.847; $p = 0.407$). Hence, we can indeed assume that stimuli were presented at the objective detection threshold (ODT) for every single subject, and that there was no conscious awareness of the stimuli during the experiment.

Snodgrass et al. (1993) point out that the sample characteristics are regarded as more important as the individual performance levels. Hence, “[n]o evidence for conscious perception

in the sample exists if the performance distribution is normal with a mean around chance" - as is the case in our study. Relevant with respect to individual subject performance is the question whether there are subjects within the sample whose performances depart so strong from the sample performance that they count as outliers, and must be regarded as belonging to another group - the group of *conscious perceivers*. As can be seen in figure 3.9, this is not the case with our subjects.
Summarizing, detection in our sample is clearly at chance and any conscious perception can be ruled out. This data of the individual detection experiments gives further evidence that the subliminal method used in this study effectively excludes any conscious awareness of the rebus stimulus at the defined exposure duration (1 ms) and luminance level (5 fl).

subject	d'	subject	d'
1	0.38	**11**	0.23
2	0.3	**12**	0.08
3	-0.15	**13**	-0.56
4	-0.08	**14**	0.08
5	0.49	**16**	0.72
6	-0.41	**17**	-0.46
7	-0.15	**18**	-0.15
8	0.38	**19**	0.3
9	-0.08	**20**	-0.23
10	0.8	**21**	-0.08

Table 3.10: *d'* of all subjects in the detection experiment

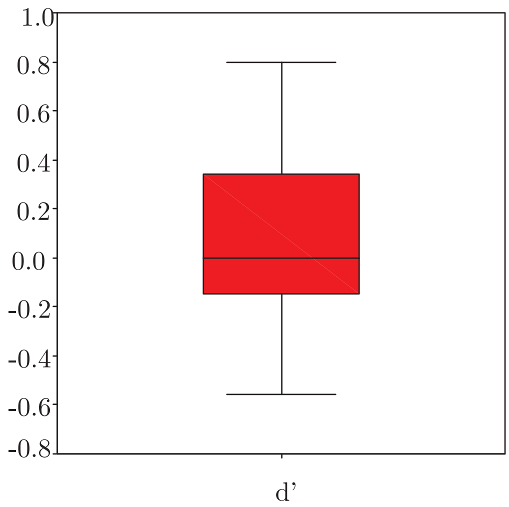

Figure 3.9: Boxplot of *d'*s

With regard to the personality measures applied after the last experimental night (see chapter 2.2.4.3), we found a significant positive correlation between *d'* and the Social Desirability Scale by Stöber (1999) (r = 0.584; $p = 0.007$) - as well as between *d'* and the subscale *self-deceptive enhancement* of the German version of the Balanced Inventory of Desirable Responding by Musch et al. (2002) (r = 0.468; $p = 0.038$). Furthermore, we observed a negative relationship between detection and state anxiety (r = -0.447; $p = 0.048$). There were no significant correlations with the subscales of the NEO-FFI.

3.3.5 Debriefing

When the picture of the *Kamm* and the *Floß* was presented supraliminally the morning after the second experimental night and after the detection experiment, all subjects expressed surprise. None of them seemed to have expected a picture like this. Asked to name the pictured objects all subjects identified the comb and the raft correctly.[62] After giving the first five associations to both comb and raft, subjects were asked whether these two objects had any connection to their dreams, their free associations or to the images they drew during the last two nights in the sleep laboratory. Although all subjects seemed rather puzzled when they were presented the stimulus, 14 out of 20 (70 %) reported a relation to their nocturnal productions when asked explicitly. Out of these 14 subjects, 93 % reported a relation to *Floß* but only 57 % to *Kamm*. While most referred to the higher incidence of *Floß*-related words and topics within the dreams or the free associations (such as nature, wood, water, rain, river, swimming), some subjects were able to give concrete examples. Subject No.4, for instance, reported the following dream after the first non-REM-sleep awakening in the rebus night:

> Wir beide waren zusammen im Auto unterwegs, hier auf dem Gelände und wir mussten irgendwie zu einem anderen Raum (...) und dann sind wir über die Straße hier gefahren und es lagen viele Äste auf dem Weg und du bist viel zu schnell gefahren (...) und wir mussten immer um die Äste drum herum fahren, die so auf der Straße lagen und dann mussten wir auf dem Rasen ein Stück lang fahren und dann wieder auf der Straße.[63]

Asked about a relationship between the presented objects and one of the dreams the subject responded:

> Dieser Traum der ersten Nacht, wo ich geträumt hab, dass wir hier beide durch den Park

[62] This was taken as further validation for the second requirement of the rebus stimulus, that is the pictures making up the rebus need to be inconclusively identifiable (see chapter 3.1.2).

[63] (Engl.: We both were in the car on our way to another room here on the hospital grounds. (...) We were driving across the street and there were many branches lying in the way. You were driving far too fast (...) and we had to go around the branches which were lying on the street and then we had to drive some part of the way on the lawn and then on the street again.)

> mit dem Auto gefahren sind. (...) Wenn ich jetzt diese Floß sehe, erinnert mich schon der Traum daran, dass (...) die Straße wirklich sehr kurvig war, was man ja irgendwie find ich mit dem Wasser verbinden kann und dann halt diese total parallel gelegenen Äste, die auf der Straße lagen, also die sehr parallel in Abständen zueinander lagen.[64]

Subject No.12 was able to relate several aspects from dream reports and free associations to the pictured objects. Notably, all of them were recorded in the rebus night. His associations to the supraliminally presented picture of the *Kamm* and the *Floß* go as follows:

> Wenn ich jetzt das Floß sehe und an diesen einen Traum denke, wo ich von ganz weit oben von so einer Plattform runter geschaut habe, dann hat beides so einen Touch von Entfernung und Einsamkeit. (...) Und wenn ich an das Fußballspiel denke (...), da fällt mir ein, dass ich bei den Spielern oft gesehen habe, dass deren Haare oft so lang waren, dass sie so ins Gesicht gefallen sind in so einzelnen Strähnen. (...) Und dann habe ich ja ein paar mal diese Figuren gezeichnet (...), die hatten ja so mehrere Schichten - wo glaub ich beim dritten mal oder so "Der Schrei" rausgekommen ist. Das erinnert mich natürlich auch so ein bischen so an's gekämmt sein. So mit den einzelnen Schichten, Strähnen .... Und dann hatte ich doch diese Sitzreihen gezeichnet. Das erinnert mich auch ein bisschen so an die Form von dem Floß (...), weil sie auch so geordnet waren.[65]

None of the subjects was able to identify the rebus level without broad hints. This is in accord with the findings of the early Shevrin studies and was interpreted to mean "that primary process thinking is not easily accessible in the usual alert, conscious, waking state" (Shevrin, 1973, p.60), and that "having been responsive to the effect was no help in achieving insight into the relationships" (Shevrin and Luborsky, 1961, p.484). Only asking whether they had any ideas about the pictured objects had no effect. When explained, however, that these objects would represent a rebus and invited to solve it, all of them were able to do so - but mostly only after being given numerous hints (e.g. "What happens if you combine both objects?"; "Try merging the sounds of the two objects."). After they had successfully solved the rebus and had given five associations to the rebus word *kampflos*, they were asked whether

[64] (Engl.: This dream from the first night when I was dreaming that we were both driving in a car through the park. (...) When I see this raft I have to think about the dream when (...) the street was really curvy which one could relate to the water. And then these totally parallel lying branches on the street, which were lying in very parallel distances from each other.)

[65] (Engl.: When I see this raft and think about that dream where I was looking down from a very high platform, then both have a touch of distance and loneliness. (...) And when I think about that football match (...) I remember that I often saw players whose hair was so long that it was falling in their face in single strands. (...) And then I was drawing these figures several times (...) which had like multiple layers - one resulted in "The Scream" I think. That also reminds me of being combed. With these single layers, strands .... And then I once drew these rows of seats. That also reminds me a bit of the shape of the raft (...) since they were also ordered that way.)

there was any relationship between this word and any of their dreams, free associations, or images during the last two nights in the sleep laboratory. 42 % of the subjects saw a connection. Subject No.6, for example, rated the positive and peaceful nature of her dreams during the rebus and control night as being associated with the *kampflos* theme. Interestingly, this subject was one of those who gave only positive and peaceful associations to the word *kampflos* (e.g. *friedvoll* (Engl.: peaceful), *schön* (Engl.: nice), *ruhig* (Engl.: calm), *besinnlich* (Engl.: contemplative), and *Klasse* (Engl.: great)). The same was true for subject No.7 who associated *Harmonie* (Engl.: harmony), *friedlich* (Engl.: peaceful), *ruhig* (Engl.: calm), *blauer Himmel* (Engl.: blue sky), and *kitschige Landschaft* (Engl.: kitschy landscape) with *kampflos*. He also described his dreams as being peaceful and as having included kitschy landscapes and blue sky. Subject No.12 described above, who drew figures similar to the famous painting "The Scream" by Edward Munch during the free imagination, associated the somehow scary atmosphere of the picture and the feeling of despair with the word *kampflos*. Finally, subject No.19 described a picture during the rebus night which was related to her summer job, in which she built a Celtic village and "lived" in this village for several weeks as part of a holiday project for children. Asked about connections between the *kampflos* stimulus and her dreams or associations, she was reminded of the Celtics who were also fighting, and of her two male colleagues who also had played the part of Celtics, but who were very defensive in their attitude and to whom she would immediately ascribe the attribute *kampflos*.

Summarizing, although none of the subjects showed any sign of recognition when the rebus stimulus was presented supraliminally and none of them was able to identify the rebus level without hints, some did indeed find relationships between either the pictures of the *Kamm* and the *Floß*, or the word *kampflos*, and their dreams, images, or associations. Hence, this can be seen as a further indication that the subliminal stimulus was processed unconsciously.

3.4 GeoCat night

In the third experimental night classic and scalar GeoCat stimuli were applied to obtain supporting evidence for our main hypothesis that REM-sleep mentation follows the rules of the primary process, while non-REM-sleep is organized along secondary process lines. According to our third hypothesis (see chapter 1.6), we expect similarity judgments after awakenings from REM-sleep to be mainly attributional (as an index for primary process thinking), while awakenings from non-REM-sleep are supposed to lead to more relational similarity judgments (as an index for secondary process thinking).

As in the rebus and the control night (see chapter 3.3), our aim was to obtain three non-

REM-(stage 2) and three REM-sleep awakenings: the first two non-REM and two REM awakenings for the classic GeoCat items, and the last non-REM and REM awakening for the scalar GeoCat items. Hence, six awakenings per subject, i.e. 120 awakenings in total (60 from non-REM- and 60 from REM-sleep) would be the optimum. As table 3.11 shows, we were able to get 110 awakenings - 56 from non-REM- and 54 from REM-sleep.

	classic GeoCat	**scalar GeoCat**	**total**
non-REM	39	17	56
REM	38	16	54
total	77	33	110

Table 3.11: Number of non-REM- and REM-sleep awakenings in the GeoCat night

3.4.1 Classic GeoCat

Average continuous scores ranging from 6 (all relational) to -6 (all attributional) across subjects show a clear predominance for relational choices for all stages (non-REM, REM, wake), as indicated by the positive mean scores in table 3.12. As can be expected from these numbers, the repeated measure ANOVA on the factor stage (3 levels: non-REM, REM, wake) revealed no differences within the similarity choices made after non-REM- and REM-sleep awakenings or in the waking state. While 85 % of the subjects chose the relational over the attributional alternative after awakenings from non-REM-sleep and in the fully awake condition the morning after (as indicated by a positive number in table 3.12), this was also the case for awakenings from REM-sleep. Hence, the expected relational dominance was found for non-REM-sleep awakenings and the waking state but also, against our hypothesis, for REM-sleep awakenings.

State of anxiety, however, did vary between stages as revealed by a significant stage effect in the repeated measure ANOVA ($F(1.496) = 7.832$; $p = 0.004$). Post-hoc t-test for related samples showed higher anxiety after non-REM awakenings than in the waking state ($T(19) = -2.990$; $p = 0.008$). After awakenings from REM-sleep, anxiety was even more increased as compared to the waking state ($T(19) = -3.047$; $p = 0.007$). The difference in anxiety after REM- and non-REM-sleep awakenings was not significant. Importantly, overall mean anxiety scores on the scale ranging from 1 (“calm”) to 10 (“very anxious”) were rather low (wake: 0.56 ± 0.94; non-REM: 1.12 ± 1.11; REM: 1.23 ± 1.12). There was no correlation between the level of anxiety and the continuous scores of the classic GeoCat list. Hence, no relationship between lower anxiety and more relational responses, or higher anxiety and more attributional responses could be found.

subject	**non-REM**	**REM**	**wake**
1	6.0	4.0	5.5
2	6.0	6.0	5.0
3	6.0	6.0	6.0
4	4.0	2.0	-3.5
5	5.0	6.0	6.0
6	3.0	1.0	4.0
7	5.0	2.0	4.0
8	4.0	3.0	0.0
9	6.0	6.0	1.0
10	-1.0	2.0	1.5
11	4.0	4.0	4.0
12	1.0	0.0	0.5
13	5.0	6.0	5.5
14	-6.0	-6.0	-6.0
16	6.0	3.0	3.0
17	-4.0	-4.0	-6.0
18	2.0	6.0	4.5
19	6.0	4.0	5.0
20	5.0	6.0	6.0
21	4.0	6.0	6.0
mean	**3.35**	**3.15**	**2.60**
stddv	**3.42**	**3.41**	**3.87**

Table 3.12: Average continuous scores of the classic GeoCat items for all subjects and all stages

3.4.2 Scalar GeoCat

The total scores for the judgments of the attributionally and the relationally similar scalar GeoCat items, ranging from 1 (different) to 5 (identical; see chapter 2.3.3) for each stage (non-REM, REM, wake), are depicted in table 3.13. Across stages, relationally similar items were judged to be more similar than attributionally similar items (non-REM: n.s.; REM: T(16) = -2.404; p = 0.030; wake: T(16) = -2.279; p = 0.037). At the same time, mean attributional similarity scores do not differ a lot between stages, neither do relational scores. Accordingly, repeated measurement ANOVA shows no effect on the factor stage (3 levels: non-REM, REM, wake).

Interestingly, correlating the controlled attributional similarity scalar score (att REM minus att non-REM; see chapter 2.3.3) with the rebus effect within the free associations (individual scoring), leads to an almost significant positive correlation (r = 0.511; p = 0.062). Hence, subjects who show a stronger rebus effect judged attributional scalar GeoCat items as being more similar. Since this finding is in the hypothesized direction (stronger attributional similarity scores correlate with a stronger rebus effect), one could even justify a one-tailed test which would result in a significant finding (r = 0.511; p = 0.031). Similarly, correlating the controlled scalar score (att REM minus att non-REM) with the likewise controlled occurrence of rebus-related associations in the experimental night (amount of rebus associations after REM minus amount of rebus associations after non-REM) leads to a significant positive correlation, using a one-tailed test (r = 0.487; p = 0.039). With regard to the relational similarity judgments these correlations are non-significant.

	att non-REM	**rel non-REM**	**att REM**	**rel REM**	**att wake**	**rel wake**
1	1.5	2.1	-	-	0.7	3.3
2	0.7	0.5	0.4	0.3	1.2	1.6
4	2.4	2.2	1.6	1.7	2.9	2.1
5	0.8	3.5	1.0	3.6	0.8	4.1
6	1.1	1.5	0.5	1.1	0.5	1.7
7	1.6	2.8	1.9	3.4	1.6	3.7
8	2.1	2.1	2.0	2.7	2.3	2.7
9	2.4	2.2	1.6	1.3	1.6	1.1
10	1.9	2.0	2.2	2.3	2.2	2.4
13	2.1	2.3	1.8	3.0	2.2	3.0
14	1.1	3.7	1.1	3.7	1.0	4.3
16	4.3	2.6	3.6	3.0	4.1	3.5
17	2.6	3.0	2.9	3.1	1.6	1.1
18	3.3	2.4	3.8	2.4	3.6	2.4
19	1.4	4.7	2.0	4.3	1.9	4.0
20	1.4	1.6	1.7	1.9	2.8	2.1
21	0.9	3.3	1.2	3.3	1.4	3.3
mean	**1.9**	**2.5**	**1.8**	**2.6**	**1.9**	**2.7**
stddv	**1.0**	**1.0**	**1.0**	**1.1**	**1.0**	**1.0**

Table 3.13: Total scores for relationally and attributionally similar scalar GeoCat items for all subjects and all stages

3.5 EEG data

As described in chapter 2.3.4, average spectral power scores in the alpha and theta frequency band for non-REM- and REM-sleep periods prior to the respective awakenings in both rebus and control night are calculated. On the basis of these scores we want to investigate our explorative hypothesis that primary process mentation is related to increased alpha power, while secondary process thinking is associated with increased power in the theta frequency band (see hypothesis number 4 in chapter 1.6).

Two separate ANOVA tests are carried out for both frequency bands (alpha and theta) with three variables per test: (1) condition (rebus, control), (2) stage (non-REM, REM), and (3) electrode position (frontal, central, occipital). The 2×2×3 ANOVA for the alpha frequency band reveals no significant changes in spectral power for the main effect of condition or stage. However, there is a significant effect for electrode position (F(1.390) = 43.779, p < 0.001). Pairwise comparisons using t-test for related samples reveals significantly higher alpha power values for frontal electrodes as compared to central ones, and for occipital electrodes as compared to central ones in both stages and conditions ($p < 0.001$). The 2×2×3 ANOVA performed on the power scores for the theta band reveals no significant main effects for condition but for stage (F(1) = 44.299, $p < 0.001$) and electrode position (F(1.228) = 57.697, p < 0.001). Interaction effects are found for stage×electrode (F(1.714) = 11.760, $p < 0.001$). Post-hoc pairwise comparisons reveal significantly higher theta power in non-REM-sleep as compared to REM-sleep for all electrodes in both conditions ($p < 0.005$). Finally, higher theta power is found for frontal electrodes as compared to central ones and for occipital electrodes, as compared to central ones in both stages and conditions ($p < 0.001$).

To be able to correlate alpha power with the rebus effect within the free associations (individual scoring), as well as theta power with the conceptual effect within the free associations (normative scoring), difference scores for spectral power values are built by subtracting the power scores from the control night from those of the rebus night. The resulting correlation between these alpha power difference scores and the rebus effect (individual scoring) during REM-sleep is non-significant. Pearson correlation coefficient displays a positive correlation, however, for theta power and the conceptual effect (normative scoring) in non-REM-sleep for the central electrodes (r = 0.655, p = 0.004). The same correlation for the rebus effect (individual scoring), on the other side, is non-significant.

The correlation between the difference scores of dream bizarreness (rebus night minus control night) and the difference scores for alpha power reveals a significant negative correlation for the frontal electrodes (r = -0.560, p = 0.019) during REM-sleep. Hence, increased alpha power during REM-sleep is related to decreased dream bizarreness. The same correlation for non-REM-sleep is non-significant.

4. Discussion

4.1 Primary and secondary process effects in the rebus night

The major aim of this study was to test the hypothesis that REM- and non-REM-sleep differ with respect to their prevailing ways of mental organization which parallel the Freudian concept of primary and secondary process thinking (see chapter 1.6). Therefore, we firstly aimed to replicate the study of Shevrin and Fisher (1967) which is the only study trying to answer this question. We hoped to obtain converging evidence to support their findings that REM-sleep is characterized by a more primary process way of thinking, while non-REM-sleep follows the mechanisms of the secondary process. Therefore, we presented a subliminal rebus stimulus prior to the subjects' retiring to bed, and analyzed their responses given after REM- and non-REM-sleep awakenings during the night. We obtained the following results:

1. A stronger conceptual effect (normative scoring) within *free associations* obtained after non-REM-sleep awakenings and a stronger rebus effect (individual scoring) within free associations obtained after REM-sleep awakenings (see chapter 3.3.1).

2. A tendency for a stronger conceptual effect (normative scoring) in *dream reports* from non-REM-sleep and a tendency for a stronger rebus effect (individual scoring) in dream reports from REM-sleep which, however, remain non-significant (see chapter 3.3.2).

3. No conceptual or rebus effect within *image descriptions* obtained after non-REM- or REM-sleep awakenings (see chapter 3.3.3).

In total, these findings match those of the original study by Shevrin and Fisher (1967) very well. Similarly, they found a conceptual effect within non-REM-sleep associations and a rebus effect within REM-sleep associations, but no effects whatsoever in dream reports and images. But to compare the results of these two studies reliably, it must be discussed beforehand in which respects both studies are indeed similar or different from each other. The simple fact that this study was run with a German rebus, for instance, makes it no exact but rather a systematic replication. Although we tried to stay as close as possible to the original procedure, we departed in some important aspects which will be discussed in the following:

- Instead of running only 10 subjects, we ran a larger sample of 20 subjects to increase statistical power.
- In the original study, the subjects were nurses who worked during the night and were thus able to sleep during the day. However, day-time sleep might differ considerably from night-time sleep. To ensure a normal sleep cycle and a stable sleep architecture, we therefore decided to run our experiments during the night - having students as subjects.
- As compared to the *penny* rebus stimulus used in the Shevrin and Fisher study, our *kampflos* rebus has some disadvantages. It is not a noun, and it is a rather abstract word. Because of its ambiguous nature, it gives rise to very individual associations (see chapter 3.3.1). Moreover, the prevalence of the word *kampflos* is presumably not as high as the prevalence of the words *Kamm* and *Floß*. Although we were well aware of these problematic aspects of the *kampflos* stimulus, the advantages still outweigh the disadvantages since this rebus nevertheless fulfills all the requirements of a suitable rebus stimulus (see chapter 3.1.2). Furthermore, a lot of time was invested in searching for the ideal German rebus. Involved in this search were several linguistic institutes of German universities, who were asked to pass on our request to their students. Additionally, a broad public was addressed by an online competition in which a prize was promised for the best rebus word (see appendix I). After this long and extensive but fruitless search for an even more suitable German rebus, we are convinced that there is no better alternative to the *kampflos* rebus.
- Because of the paradox nature of the *kampflos* stimulus which leads to very different and individual associations, as opposed to the far more unambiguous words *Kamm* and *Floß*, we had to introduce an important change in the scoring procedure. Alongside the *normative scoring*, which entirely follows the procedure of the Shevrin and Fisher study, we applied a totally new scoring procedure - the so-called *individual scoring*. By this, we were able to take the very individual *kampflos* associations given by the experimental subjects themselves into account (see chapter 3.3.1).
- Instead of a presentation time of 6 ms as in the original study, we flashed our rebus stimulus only for the duration of 1 ms. By this means, and by assuring a luminance level of 5 fl (see chapter 3.1.1.1), we could be sure of working at the objective detection threshold (ODT), which has proven to present the most stringent criterion for subliminality (see chapter 1.3.3). In this respect, we presumably differ on a very important point from the original study. However, we cannot be entirely sure whether the stimulus presentation in the Shevrin and Fisher study was at the subjective or objective threshold. Although the presentation time (6 ms) and the method of assuring subliminality (psychophysiological method of ascending

limits) rather suggest that the stimulus was presented at the subjective threshold, it remains unclear if this was in fact the case. The findings, on the other hand, which are very similar to our own findings which were clearly obtained at the ODT, strongly suggest that Shevrin and Fisher might have been working at the ODT as well.

4.1.1 Free associations

Although critics like Grünbaum (1984; 2002), Wilcocks (1994), or Webster (1995) doubt the retrieval capacity of free associations and claim that free associations are actually not free at all but influenced by suggestions from the analyst and by his personal theories, this method is still one of the most important techniques in psychoanalytical practice. Kris states: "For me, the central point in psychoanalysis is the commitment to the free association method." (Kris, 1966, p.7). By asking the patient explicitly to say everything coming to mind without restriction or hesitation, no matter how unrelated, painful, embarrassing, or silly it might seem, access to the unconscious is presumed to be facilitated. We strongly believe that this method can also be used to reveal unconscious processes in an empirical situation. Furthermore, as has been shown in early studies, free associations are especially sensitive to subliminal effects (e.g. Luborsky and Shevrin, 1956; Shevrin and Luborsky, 1958; Stross and Shevrin, 1968; see chapter 1.2.3). Correspondingly, the experimental effect found in our study was carried by the free associations, so its retrieval capacity of unconscious processes and subliminal effects could be clearly demonstrated. The fact that we were only able to demonstrate the rebus effect by using each subject's individual associations to the rebus word *kampflos* (individual scoring) gives converging evidence to the observation made by Fisher (1960b) and later Shevrin et al. (1996) that the nature and the strength of the subliminal effect depends on the subject's personal history and individual ideas and experiences.

But, besides the fact that free associations are apparently able to reveal unconscious processes, how can we assume that the associations we obtained in the *waking state* actually revealed processes which took place during the preceding *sleep stage*? Or more specifically, can we catch a process (primary or secondary process) characteristic for a certain state of consciousness (REM- or non-REM-sleep) in a totally different state of consciousness (wakefulness)? The answer is: Yes, we can! As numerous studies have shown, "the states of consciousness prevailing in sleep have a certain momentum: although to outward appearances the subject is awake as he gives his associations, they remain substantially influenced by the immediately preceding sleep stage" (Shevrin, 1973, p.62). In other words, "cognitive and physiological components of a sleep stage will "carry-over" and influence waking performance" (Nielsen, 2000, p.858). This carry-over effect of sleep mentation into the waking state was first described by Fiss et al. (1966) who used the thematic apperception test (TAT) to investigate the types of cognition that characterize REM- and non-REM-sleep. Indeed, their hypothesis that the differentiating characteristics of a certain sleep stage would persist in the following waking state could be confirmed. TAT stories following REM-sleep awakenings were qualitatively different, and more "dream-like", than stories following non-REM-sleep awakenings. Other studies have supported this carry-over effect (e.g. Lavie, 1974; Stones, 1977; Bertini et al., 1982; Lavie and Tzichnisky, 1984; Spitzer et al., 1993). Hence, it could be concluded that "qualitatively different cognitive processes are active following and, by inference, just preceding awakenings from REM- and non-REM-sleep" (Nielsen, 2000, p. 858). That makes our assumption that the free associations obtained in the waking state reflect the mental process prevailing during the preceding sleep stage justifiable.

4.1.2 Dream reports

As opposed to the free associations, the dream reports failed to show significant effects, although the expected tendency could be observed (stronger conceptual effect (normative scoring) in the dream reports obtained after non-REM-sleep awakenings, and stronger rebus effect (individual scoring) in the dream reports obtained after REM-sleep awakenings). Although it corresponds to the results of the Shevrin and Fisher study, this might be interpreted as a rather surprising finding, since Freud explicitly assigned dreams a special function as vehicles for the primary process (see chapter 1.2.2). Accordingly, he assumed that primary process transformations can frequently be observed in dreams, an assumption which is in accord with the early studies of Pötzl, Fisher and others, as described in chapter 1.2.2. Hence, one would expect the primary process rebus effect to be even stronger in the dream reports obtained after REM-sleep awakenings than within the free associations. Strikingly, the opposite is true - we found a rebus effect in REM-sleep free associations, but not in REM-sleep dream reports. However, these studies are not easily comparable. Firstly, there are important differences in stimulus presentation - our study is the only study so far dealing with primary and secondary processing of a subliminally presented stimulus in REM- and non-REM-sleep clearly working at the ODT. Secondly, earlier studies relied more on *visual* transformations of the presented stimulus reappearing in the dream report, while our study and the study of Shevrin and Fisher (1967) mainly rely on *verbal* transformations.
Besides these practical and theoretical considerations, statistical problems might account for the non-existent effect. More specifically, significance might not have been achieved because of the fact that we have 10 % absence of scorable responses in REM-sleep, and 46 % absence of scorable responses in non-REM-sleep which limits statistical analyses.

At this point, a more general note on dream research should be made since it is very often confronted with strong objections and criticisms. Hobson, for instance, who is one of the most popular opponents to the idea of dreams being a meaningful and motivated phenomenon, complains about the "methodological shortcomings and conceptual confusions" (Hobson et al., 2000, p.801) in the field of dream research. Among other things, he emphasizes the following point:

> The most profound problem in studying conscious states is the necessity of reliance on verbal reports. This method is problematic because these accounts are just *reports*, not the subject's experience of the states themselves. (Hobson et al., 2000, p.802)

Next to the danger of reducing psychological states to narrative reports, Hobson's comment touches on an important issue already mentioned in chapter 2.2.3.3 - the difference between process and product. We are interested in the investigation of a certain *process* (namely primary and secondary process). Since it is very difficult to capture these processes in their pure form, we often must content ourselves with *products* and try to draw conclusions about the underlying processes. The dream which actually occurs in the very state we are interested in (REM- or non-REM-sleep) as a visual, sensorial, and hallucinatory creation, often enough escapes from being reported in verbal form - as everybody knows from his own experience. Hence, the dream reports we obtain after REM- or non-REM-sleep awakenings are not fully congruent with what we actually experienced during sleep. It is rather the end product of what was happening during the respective stage. Presumably, it is difficult to capture the *process* of interest (primary or secondary process) within the *product* (the dream report), which might have led to the non-significant findings. By using the method of free associations, and assuming a certain carry-over effect from the preceding sleep stage on wakefulness, however, we hoped (and our results confirm our hypotheses) to get closer to the process itself (see chapter 4.1.1 above).

Although dream reports following REM-sleep awakenings in the experimental night contained more bizarre elements, and were rated as being less closer to reality as compared to non-REM-sleep dreams, the small total amount of bizarre elements still appears striking (see chapter 3.3.2). However, studies have shown that dream reports obtained in the sleep laboratory usually contain fewer bizarre elements as compared to everyday dreams (Cipolli et al., 1993). Furthermore, Schredl and Erlacher (2003b) demonstrated that external judges find significantly less bizarre elements than the dreamer himself. This leads to the question already discussed above of how well in fact the dream report reflects the actual dream experience. Besides, it can be questioned whether dream bizarreness is generally overestimated. As Leuschner (1999) points out, dreams in general are not bizarre, sensational, and colourful, but rather gray and ordinary. But since we remember a dream better the more bizarre it is (Cipolli et al., 1993), we tend to infer that most of our dreams are as bizarre and fanciful. Holt gives an excellent summary of this issue, which is very much in accord with our findings:

> We can be pretty sure that the most bizarre, "dreamlike" dreams occur in REM sleep (. . .). It is easy to lose sight of the fact, however, that the great majority of dream reports are humdrum rather than fantastic, whether they came from awakenings in the laboratory (. . .), from diaries kept on morning arisings or from other sources. According to Domhoff (2001, p.19) they are "in large measure coherent and reasonable simulations of the real world". Thus, most dream reports have little that could be coded as manifestations of the primary process. (Holt, 2009, p.76)

Presumably, the low incidence of bizarre elements accounts for the fact that we did not find a correlation between dream bizarreness and the rebus effect.

4.1.3 Images

We also failed, as did Fisher and Shevrin in their original study, to demonstrate the expected subliminal conceptual and rebus effect within image descriptions. Although the rebus effect (individual scoring) is stronger in images obtained after REM-sleep awakenings and therefore points in the expected direction, it clearly fails to be significant. However, statistical analyses for the scoring of image descriptions were even more impaired than they were for dream reports, since we had 53 % absence of scorable responses in REM-sleep and 47 % absence of scorable responses in non-REM-sleep. Furthermore, the task of drawing and describing the first picture that came to mind was the last of all the three tasks. Possibly, the subjects were already too awake after the first two tasks (dream report and four minutes of free association), so the respective prevailing mental organization from the preceding sleep stage (REM-, or non-REM-sleep) was no longer sufficiently strong enough to also show the expected effect in the image drawings and descriptions. This touches on the question of how long the carry-over effect (see chapter 4.1.1) actually lasts. This question, however, has not been exhaustively answered yet, and answers range between several minutes (e.g. Wilkinson and Stretton, 1971) and 30 minutes (e.g. Sallinen et al., 1998).
Finally, as Shevrin and Fisher (1967) state in their original study, the absence of effects within the images could be due to the fact that images are primarily visual in nature, whereas the measured effects of this experiments are largely verbal. Hence, the verbal influences investigated in this study might not be detectable in the images as a primarily visual experience.

Summarizing the findings of the rebus and control night, we were able to replicate the original findings of Shevrin and Fisher (1967) using the German *kampflos* rebus stimulus. Furthermore, these findings were put on an even more stable ground, since our results were obtained under conditions working at the objective detection threshold (ODT) which cannot be conclusively inferred from the original study. Hence, conscious perception in our experiments could be entirely ruled out, but subliminal effects nevertheless persisted. As revealed by the free associations, the same subliminal stimulus (a picture of a *Kamm* and a *Floß*) enters sleep consciousness in two significantly different ways: it is processed on the basis of its conceptual meaning (as an index of secondary process thinking) during non-REM-sleep, but on the basis of its clang combination and, therefore, on the rebus level (as an index for primary process thinking) during REM-sleep. In the course of the night, the prevailing transformations of the subliminally presented rebus stimulus change back and forth depending on the respective psychophysiological sleep state. It can thus be assumed that "we are dealing across the sleep-dream cycle with a continuum of unconscious influences rather than with qualitative differences" (Shevrin and Eiser, 2005, p.8). Thus, our main hypothesis, that REM- and non-REM-sleep differ with regard to their mental organization which parallels the Freudian concept of primary and secondary process thinking, could be confirmed. The subliminally presented stimulus is indeed processed during sleep. Furthermore, its rebus level can be read unconsciously and appears in the free associations obtained after REM-sleep awakenings, where the primary process mode of functioning is supposed to be dominant. Our findings are especially remarkable since main effects at the ODT are very rarely found (Snodgrass et al., 1993; Klein Villa et al., 2006; see also chapter 4.5 below).

4.2 Subliminal versus supraliminal stimulus exposure

Since we were able to demonstrate the expected effects using a subliminal rebus stimulus, the following question needs to be answered: "Why does the stimulus need to be presented *subliminally* to get the expected effects?". Or more precisely: "Would we find the same effects if the rebus stimulus would have been presented supraliminally, or at least for a longer duration than 1 ms?"

Fisher (1960b) was able to demonstrate that supraliminally presented stimuli are in fact incorporated into subsequent dreams as well. However, they reappear in a conceptual, secondary process way, whereas primary process transformations are only observable after subliminal exposure (see chapter 1.2.3). Similarly, Shevrin and Luborsky (1958, 1961) and Shevrin and Fritzler (1968a) found that primary process clang and rebus effects within free associations could be obtained after the subliminal presentation of the *penny* rebus, but not after supraliminal exposure. Accordingly, Dixon claimed that "not only do unperceived elements in a tachistoscopic display register and produce subsequent effects, but that these may differ considerably from those produced by the same stimulus if presented above the conscious thresh-

old" (Dixon, 1971, p.124). Apparently, an unconscious re-working of the respective stimulus - as in case of subliminal stimulation - is necessary to result in primary process transformations. Correct identification, on the other hand, might "serve to protect perception against primary process transformations" (Shevrin and Luborsky, 1961, p.487).
However, as stressed in chapter 1.3.1, it is important to distinguish between subliminal studies working at the *subjective* threshold and those working at the *objective* threshold. As Snodgrass and Shevrin (2006) point out, there is a positive relationship between subjective threshold effects and stimulus detection. Hence, the effects obtained in experiments working at the subjective threshold are greater the more the subject approaches the recognition threshold (e.g. Haase et al., 1999). At the objective detection threshold (ODT), however, effects are *negatively* correlated with stimulus intensity. Thus, unconscious effects at the ODT become even stronger when conscious perception is completely absent as reflected in *d'* (as measure for conscious perception) at or below zero (e.g. Bernat et al., 2001b; Klein Villa et al., 2006). These findings correspond with the hypothesis of Snodgrass and his co-workers that conscious perception overrides unconscious perceptual influences when both are present (see chapter 1.3.3), as in the case of subjective thresholds. Hence, as soon as any conscious perception becomes available, the correlation between the subliminal effect and stimulus detectability is no longer negative (as it is at the ODT), but becomes positive. As described in chapter 1.3.3, this negative relationship at the ODT provides very strong evidence against the hypothesis that weak residual conscious perception might account for the subliminal effect. Klein Villa et al. correspondingly found that "even the smallest amount of conscious perception at the objective detection threshold will diminish subliminal effects" (Klein Villa et al., 2006, p.133). Hence, subliminal stimulus presentation at the objective detection threshold reliably assures true unconscious perceptual processes.

One question remains: "Is the duration of stimulus exposure possibly irrelevant, since all optical impressions leave after-images on the retina - no matter how short or long the actual exposure was?" This is indeed a legitimate objection, but it misses the critical point. It is true that all subliminal stimulation initiate some kind of physiological processes - not only on the retina but within the whole central nervous system. According to Leuschner and Hau (1992), dreams and subliminal effects in general could thus be called "after-images". However, most importantly, the effects measured with the method of subliminal stimulation are based on *mental* processes. They arise simply from subjective experience. Or as Shevrin summarizes: "[The] subliminal perception lasts only as long as the brief stimulus presentation, the rest is memory and memory transformations involving processes of recognition and dynamic unconscious influences." (Shevrin, 2003, p.10).

4.3 The role of transference

Another question which needs to be answered is: "Why should the subliminal rebus stimulus, of all possible stimuli the subject registers consciously, preconsciously, and unconsciously during the day, enter the mental processing during the night?" Or: "What makes the experimental stimulus important enough to exert such a strong influence?"

Fisher, in his early subliminal studies emphasized one important aspect which, unfortunately, has been largely neglected in most subliminal research thereafter: the role of transference in the experimental situation (e.g. Fisher, 1954). Transference is defined as "a repetition of aspects of the experienced past - including one's unconscious conflicts, unconscious (wishful) fantasies, character traits, identifications, and various components of one's original object relations - in a new and often distorted version, with a new object (e.g. the psychoanalyst)" (Shevrin et al., 1996, p.25). Introducing the psychoanalytic concept of transference into the experimental situation, Fisher strongly differs from most cognitive-behavioral experiments which are designed and carried out as Shevrin puts it, "as if the subjects were tested in an interpersonal vacuum" (Shevrin, 2000, p.54). Shevrin goes on:

> The mind in most cognitive experiments (. . .) is suspended for study in a sanitized experimental booth, sound-proofed, electronically-proofed, and person-proofed. The experimental procedure is run off a computer to which the vacuum-suspended mind responds on cue. Each mind is considered to be an exemplar of all minds, and the more completely the experimental procedure is automated (rid of the experimenter's presence) and routinized, the firmer the basis for generalizing from a few minds to all minds. (Shevrin, 2000, p.54)

Very differently, Fisher focused on the relationship between the subject and the experimenter. Accordingly, he claimed that the subjects in the early Pötzl experiment might have interpreted the instructions to record their dreams as an indirect command to dream about the presented picture (Fisher, 1954). This claim is based on the psychoanalytic view of the experimental situation "as one in which the relationship between the experimenter and the subjects leads the latter to have a dream structured around several unconscious wishes activated by the total experimental situation" (Dixon, 1971, p.112). Hence, all dreams obtained within subliminal experiments are actually transference dreams. Similarly, Fisher was able to demonstrate in his experiments that subjects who had a good positive transference to the experimenter showed greater subliminal effects (Fisher, 1960b). It seems to be the transference to the experimenter which ascribes to the subliminally presented stimulus a special meaning and makes it stand out against all the other stimuli encountered during the day. Since the relationship between subject and experimenter seems to be a critical variable which influences the results obtained, Fisher explicitly attempted to establish a positive relationship and a good rapport with all his subjects.

We do not have objective criteria to describe the quality of transference between subjects and experimenter in our study. However, some inferential conclusions can be drawn from the following observations: the study reported here asked a lot of the subjects. They were willing to "sacrifice" their weekends to spend *four nights* in the sleep lab on four successive weekends. They agreed to be awakened up to *six times* per night, accepting they would be rather tired the following day. Despite these demanding requirements, all the subjects were very cooperative which cannot be explained by the rather small fringe benefit of 70 € alone. None of the subjects quit the study, although they had been explicitly informed of being allowed to do so (see chapter 2.2.1). In our opinion, this could plausibly be explained by a good transference to the experimenter. Furthermore, the nature of the study caused quite intimate situations. Subjects were sitting in their pyjamas for about one hour while the cables were attached by the experimenter. They were "observed" in a very private and unprotected state: during sleep. They were asked to give insight into very personal details: their dreams. Hence, the subjects allowed the experimenter to enter a very private sphere. Because they did so, we can assume that they fully trusted the experimenter - which again can be explained with a positive transference.
The situation described above, in which the electrodes were attached, possibly supported the development of a positive transference. This procedure, lasting about one hour, very often evoked quite personal conversations on the part of the subjects. This could be due to the setting, which has some resemblances to the classic psychoanalytic setting: the subject is sitting on a chair facing the window. The experimenter is sitting behind the subject, attaching all the cables and electrodes to the head of the subject. Hence, there is no eye contact, which we assume invited subjects to speak more freely and unrestrictedly about whatever came into their minds (even though this was not the instruction, of course, since this was not yet part of the actual experimental situation). Furthermore, although the subjects and the experimenter were quite close for a very long time, most of the time the subjects could not really *see* the experimenter: either the experimenter was sitting behind the subject (while placing and removing the electrodes), the subject was sitting in front of a screen (during stimulus presentation and detection experiment), or the subject was either sleeping, or at least in a very sleepy state. This made it even easier for the subject to project good and positive fantasies onto the experimenter.
Next to a positive transference, high social desirability could also account for the fact that subjects were so willing and cooperative. Indeed, subjects scored higher on both subscales of the German version of the Balanced Inventory of Desirable Responding (Musch et al., 2002) than compared to a reference sample of the same age (N = 220), described by Musch et al.

(subscale *self-deceptive enhancement*: 41.3 ± 8.1 vs. 39.2 ± 8.4; subscale *impression management*: 37.7 ± 8.2 vs. 31.4 ± 9.2). Presumably, one needs to be highly social desirable to be willing to participate in such a demanding study.

Of course, the point of countertransference (the conscious and unconscious wishes and fantasies on the side of the experimenter) is as important as that of transference discussed above. In our study, the experimenter had a very positive countertransference to all subjects. This seems very natural, since she was the one who formulated the hypotheses, designed the experimental setup, ran the experiments and who has a strong personal and scientific interest in the outcome of the study. Hence, there is a high risk of influencing the subjects and their behavior (not necessarily consciously) in a suggestive way to obtain the desired results. To diminish this danger, the experimenter was totally blind to the respective condition (rebus or control) during the experiments, as well as during the scoring procedure and data analysis.

4.4 The nature of the investigated unconscious processes

In our study we applied the method of subliminal stimulation to investigate unconscious processes during sleep, or more precisely to investigate how an unconsciously registered stimulus is processed during REM- and non-REM-sleep. Although we have used the Freudian concept of the unconscious as a frame of reference, it needs to be stated that we have not aimed at investigating the *dynamic* unconscious (see chapter 1.2.1). In ***Das Unbewusste*** (1915) Freud discusses the ambiguity of the word *unconscious* to the effect that there is a descriptive, a dynamic, and a systematic usage of the word. Here, we are not dealing with unconscious conflict and defensive activity related to the dynamic unconscious. Instead, we have investigated the formal shifts in thought organization from REM- to non-REM-sleep. Hence, our effects are not *dynamically*, but rather *descriptively* unconscious. However, the fact that there is a rebus effect in the free associations (applying the individual scoring rules) proves that primary process transformations, which are related to dynamic unconscious phenomena, took place. Similarly, Shevrin claims that all rebus studies investigate "a formal aspect of dynamic unconscious thought organization marked primarily by superficial associations in the form of phonetic transitions and combinations" (Shevrin et al., 1996, p.107). It follows, that this study has investigated the *descriptively* unconscious by presenting a neutral, presumably non-conflictual rebus stimulus out of conscious awareness and by demonstrating two different ways of processing principles prominent during sleep. At the same time, however, we have studied an important aspect of the *dynamic* unconscious: primary process thinking. Thus, aspects of both the descriptive and the dynamic unconscious are combined in this research.
It is important to note, however, that although we applied a rather non-conflictual stimulus (the *kampflos* rebus), dynamically unconscious processes like repression and defense still

might have been involved. This is because the *Kampf*-aspect in the *kampflos* rebus might indeed trigger something conflictual in some subjects, which then becomes subject to repression and enters the repressed unconscious. In this case, however, we would expect not the emergence but rather the inhibition of *kampflos*-related associations in the rebus night - and hence, some kind of a reverse rebus effect (more *kampflos* associations in the control than in the rebus night). Since this was not true, we can assume that acts of repression or inhibition, related to the subliminally presented *kampflos* rebus, did not occur in this study.

4.5 Stimulus detectability

As described in chapter 3.1.1 and 3.3.4, our experimental setup was explicitly designed to assure stimulus presentation at the objective detection threshold (ODT). Subliminality for all experimental subjects was determined by a detection experiment in which *d'* as an index for conscious perception was clearly at chance (see chapter 3.3.4). Our finding, that the subliminal stimulus nevertheless reappeared (after primary or secondary process transformations) within the free associations obtained after nocturnal awakenings, answers the claim of Macmillan who states:

> Above-chance recognition (i.e. identification) performance (or other evidence of activation) when detection $d' = 0$ would be, for almost everyone, persuasive evidence for unconscious perception. (Macmillan, 1986, p.39)

This claim corresponds to the signal detection theory described in chapter 1.3.1 which calls for two different tasks: one to measure conscious perception, and one to measure unconscious perception. The first task is usually a direct one (here: detection as the most sensitive conscious perception index; Snodgrass and Shevrin, 2006; Snodgrass et al., 2009), while the latter is mostly an indirect task (here: free associations, dream reports, image description). In case of true unconscious perception, the direct measure of conscious awareness is supposed to yield null sensitivity (here: $d' = 0$). Meanwhile, effects on the indirect measure are still observable (here: a significant conceptual effect (normative scoring) and a significant rebus effect (individual scoring) within the free associations). Hence, unconscious processes are present whenever an indirect measure is more sensitive than a similar direct measure to the same perceptual discrimination (Merikle and Reingold, 1992). This means the subject cannot detect the presence of a certain stimulus in a forced-choice task, but this same stimulus nevertheless influences the subject's behavior - exactly what happened in our study.

As depicted in table 3.10 in chapter 3.3.4 we did not only find positive but also negative *d'*s in our subjects. More precisely, half of the subjects had *d'*s slightly above zero (max:

0.80), while the other half had *d'*s slightly below zero (min: -0.56). But how can detection be negative? Indeed, Greenwald et al. (1995) declared the findings of negative *d'*s to be rather nonsensical and due to measurement error alone. However, as Snodgrass and Shevrin point out, "this is likely because it is often implicitly assumed that detection is exclusively sensitive to conscious perceptual influences" (Snodgrass and Shevrin, 2006, p.68). It becomes more plausible if below-chance detection is regarded as reflecting *inhibitory* (subjects give more wrong than right answers in the detection experiment), rather than *facilitatory* processes. Similarly, Erdelyi states that "inhibition is a key to subchance perception" (Erdelyi, 2004, p.85). Hence, as long as *d'* is still not significantly different from zero, a positive *d'* does not imply "better detection" but rather "more facilitation". Accordingly, a negative *d'* implies "more inhibition" rather then "worse detection". This hypothesis is supported by the fact that we found a significant negative correlation between *d'* and trait anxiety (see chapter 3.3.4). This means, inhibition of stimulus detection is related to higher anxiety. On the other hand, the significantly positive correlation between *d'* and social desirability implies that detection might be facilitated the more social desirable the subject is.
Personality measures are often implemented in subliminal experiments working at the ODT. As pointed out by Snodgrass et al. (1993), main effects at the ODT are very rarely found. Hence, personality factors are introduced to look for interaction effects with stimulus detectability (e.g. Klein Villa, 2006). As described above, stimulus detection in our experiment was negatively correlated with trait anxiety, and positively correlated with social desirability. We did not find interaction effects between the subliminal conceptual and rebus effect and detectability or personality factors - but more importantly, we found remarkably strong main effects for both the conceptual effect (normative scoring) and the rebus effect (individual scoring) within the free associations (see chapter 3.3.1).

Summarizing, we were indeed able to demonstrate the processing of a certain stimulus (the *kampflos* rebus stimulus) which has been registered totally outside of awareness. Although there are several studies dealing with subliminal stimulation and dreaming (see chapter 1.2.3), this study is, to our knowledge, the only one clearly working at the ODT and thus ruling out any conscious awareness reliably. Furthermore, next to the original study of Shevrin and Fisher (1967), it is the only one investigating primary and secondary process thinking during sleep by using a subliminal rebus stimulus. The common belief holds that consciousness is required for complex and demanding mental processes. On the contrary, we could demonstrate that highly complex and creative processes (namely the solving of the rebus picture) can occur entirely unconsciously. Moreover, in a wake and conscious state, subjects were not able to solve the rebus level of the presented picture (see chapter 3.3.5).

4.6 Primary and secondary process effects in the GeoCat night

By applying the classic and the scalar GeoCat stimuli in the third and last experimental night, we hoped to find converging evidence which would support our main hypotheses and the findings from the rebus study: that REM- and non-REM-sleep can be distinguished on the basis of their prevailing mental organization, namely primary and secondary process thinking. However, the results failed to show the expected results (see chapter 3.4). Although we found, as expected, a predominance of relational similarity judgments in the *classic* GeoCat items after awakenings from non-REM-sleep, we also found the same predominance of relational similarity judgments after awakenings from REM-sleep. Hence, the hypothesized supremacy of attributional similarity judgments after REM-sleep awakenings could not be demonstrated. With regard to the *scalar* GeoCat items, we found a similar pattern: as expected, relationally similar items were judged to be more similar than attributionally similar items after non-REM-sleep awakenings - but also, against our hypothesis, after REM-sleep awakenings. Thus, we failed again to demonstrate the hypothesized attributional effect after REM-sleep awakenings.

One could assume that differences in the nature of the tasks within the rebus night and the GeoCat night contributed to the differences within the results (expected effect in the free associations of the rebus night, but not in the classic or scalar items of the GeoCat night). While both classic and scalar GeoCat items call for a structured cognitive task (which is presumably going to wake people up), free associations do not ask the subject to focus on something particular - but to let the mind roam without cognitive demands. As described in chapter 1.2.3, previous research has shown that the GeoCat items are particularly suitable for the investigation of primary process thinking under different conditions during *wakefulness*. However, the cognitively more demanding GeoCat tasks might not be suitable for the investigation of differences in primary and secondary process thinking during *sleep*, since subjects are too much aroused by these tasks and the "carry-over" sleepiness effect, described in chapter 4.1.1, disappears too quickly.
The question of whether the order of the nocturnal awakenings might account for the fact that we did not find the expected differences within REM- and non-REM-sleep could also be discussed. As in the rebus and the control night, we aimed to get six awakenings in total - three REM-sleep awakenings and three non-REM-sleep stage 2 awakenings. As in the other two experimental nights, the first awakening always was an awakening from non-REM-sleep and the last one a REM-sleep awakening. Presumably, the relational dominated answer pattern from the very first (non-REM-sleep) awakening continued to exert its influence on the following (REM- and non-REM-sleep) awakenings when subjects were confronted with the same items again (although in a different formation as for the classic GeoCat items, or in a different order as for the scalar GeoCat items). The "carry-over" effect from the preceding

sleep stage onto mentation of the immediately following waking state does not seem to be strong enough to overcome the answer pattern known from the very first (non-REM-sleep) awakening. Thus, responses remain strongly relational when items are repeated after being first seen following a non-REM-sleep awakening.
Vanheule et al. (under review) were able to demonstrate a similar order effect within subjects who filled in both the classic and the scalar GeoCat items: participants who filled in classic GeoCat first have a higher scalar GeoCat relational similarity score, as compared to participants who first filled in scalar GeoCat. They explained this finding in terms of familiarization. The relational score on the scalar GeoCat items is assumed to require more reflective conscious thought (as an index for secondary process thinking). Hence, “it would seem that when an item that is comparable to an item one was first familiarized with in the [classic] GeoCat appears again in the [scalar] GeoCat, it is thought of as more similar” (Vanheule et al., (under review), p.9). This is not the case, however, for the attributional similarity judgments which are supposed to be less reflective (as an index for primary process thinking).

Although the expected differences in similarity judgments after REM- and non-REM-sleep awakenings could not be demonstrated, we found a positive correlation between the scalar GeoCat attributional similarity score and the rebus effect within the free associations (individual scoring; see chapter 3.4.2). Thus, the stronger the rebus effect, the more similar attributionally similar scalar GeoCat items were judged to be. This can be interpreted that both, the rebus effect and the attributional similarity scalar score, reflect a similar way of mental functioning, namely that of primary process thinking. This corresponds with the findings of Bazan et al. (personal communication). In their so-called PhonoCat priming experiments, they presented a subliminal prime (e.g. the word *door*). Afterwards subjects had to choose the word they preferred out of two alternatives: one alternative was the phonological palindrome of the prime (e.g. *road*) and the other alternative was a word without any specific relationship with the prime word (e.g. *lung*). While the phonological palindrome is supposed to show a strong attributionally similarity to the prime word and therefore to reflect primary process thinking, this is not the case for the non-related word. Interestingly, Bazan et al. were able to demonstrate a significant positive correlation between the GeoCat attributional similarity score and the PhonoCat attributional similarity choices (p = 0.003). Hence, the rebus effect, as well as geometrical *and* phonological attributional similarity scores, seem to reflect primary process thinking - each tapping this way of mental functioning in a very different manner.

Finally, we found a negative correlation between the scalar GeoCat attributional similarity score and age for non-REM-sleep (r = -0.540; p = 0.025) and wakefulness (r = -0.581; p = 0.014). The finding for REM-sleep just failed to be significant (r = -0.470; p = 0.066). Hence, the younger the subjects, the more similar the attributional similar items are judged to be. There was no correlation between the relational similarity score and age. Vanheule et al. (under review), on the contrary, found a positive correlation between relational scalar scores and age, but no correlation between attributional scalar scores and age. This seemingly contradictory finding of Vanheule and his co-workers is actually rather complementary. It supports the hypothesis that secondary process thinking (as indicated by higher relational scalar scores) predominates the older the subject is. Our results, on the other hand, support the associated hypothesis that primary process thinking (as indexed by a higher attributional scalar score) predominates the younger the subject is (see also Brakel et al., 2002).

4.7 Electrophysiological correlates of primary and secondary process thinking

As described in chapter 1.6, our last and rather explorative hypothesis was that neurophysiological measures could be used as independent evidence for primary and secondary process thinking during REM- and non-REM-sleep.
The literature about differences in alpha and theta power between REM- and non-REM-sleep yields mixed results. Benca et al. (1999) and Hadjiyannakis et al. (1997), for instance, were able to demonstrate that alpha power is lower during REM-sleep than during any other sleep stage. Our finding, on the other hand, that there is no difference in alpha spectral power between REM- and non-REM-sleep, is in accord with the findings of Armitage (1995) and Dumermuth et al. (1983) who also failed to find significant differences in alpha power across sleep stages. With regard to theta power, we found significantly higher theta power during non-REM-sleep as compared to REM-sleep. Again, this is in accordance with the findings of Armitage (1995) who described an increase in theta power during non-REM-sleep as compared to REM-sleep. On the contrary, Williamson et al. (1997) found that theta band power increases progressively from non-REM-sleep stage 4 and 3 through stage 2, REM-sleep and wakefulness.

In our very preliminary results regarding the relationship between alpha and theta activity and primary and secondary process thinking, we found no correlation between the alpha power effect and the rebus effect (as an index for primary process thinking). In view of the fact that the early studies of Shevrin and his co-workers strongly suggest a relation between power in the alpha frequency band and primary process thinking (see chapter 1.4.2), this seems surprising. However, the findings of Shevrin and associates were mainly based on event-related potentials measured during *wakefulness*. Hence, one could assume that these results cannot be readily applied to the *sleeping state*. The positive correlation between the theta power effect and the conceptual effect found within the free associations (as an index for secondary process thinking), however, was indeed significant for the central electrodes (see chapter 3.5). Thus, increased central activity in the theta frequency band seems to be associated with a stronger conceptual effect and thus with secondary process thinking on a more logical and rational level. Since activity in the theta band had been related to higher cognitive function (see chapter 1.4.1), this correlation supports the idea of secondary process thinking being the more mature mode of mental functioning reflecting ordered and goal-directed thought-processes (see chapter 1.2). The finding that the correlation between theta power and the rebus effect (individual scoring) is non-significant further supports this assumption.

Finally, we found a negative correlation between the alpha power effect and the dream bizarreness effect in the frontal electrodes during REM-sleep. Increased alpha power thus seems to be related to decreased dream bizarreness and vice versa. This finding is in accord with the hypothesis of alpha serving an inhibitory function (see chapter 1.4.1): when alpha power and therefore its inhibitory influence is increased, dreams are less bizarre. If the manifest dream content is highly bizarre, however, there is less evidence of inhibition (lower alpha power). This correlation was not found for non-REM-sleep dreams which is very likely due to the very small amount of bizarre elements observable during non-REM dreams.
Our interpretation of the negative correlation between alpha power and dream bizarreness as supporting the alpha inhibition hypothesis is very much in accord with the very recent findings of Shevrin et al. (under review). They were able to demonstrate for the first time that alpha event-related synchronization not only inhibits attentional processing of *conscious, neutral* stimuli but also *unconscious* attention to subliminal *phobic* stimuli. Hence, this finding likewise supports the idea "that alpha synchronization serves a general inhibitory function in brain processing" (Shevrin et al., (under review), p.12). Moreover, the apparent relation between inhibition (as reflected in increased alpha power) and dream bizarreness could be seen as evidence for the Freudian concept of dream censorship which functions to inhibit unacceptable contents. As our data suggests, there might indeed be some inhibitory mechanism exerting its influence onto dream content. The existence of something like a dream censor has been strongly rejected by the critics of psychoanalytic dream theory, first of all by Hobson and his associates (e.g. Hobson and McCarley, 1977; Hobson, 2000). Therefore, our observation of a close association between alpha power as inhibiting mechanism and dream bizarreness is crucial.

Summarizing, we could partly confirm our hypothesis that alpha and theta power are related to primary and secondary process thinking insofar as theta power seems indeed to be associated to secondary process thinking. Furthermore, we found a negative relation between alpha power and dream bizarreness which supports the hypothesis of alpha serving an inhibitory function and the hypothesis of the existence of a dream censorship.

4.8 Limitations

As in any other study, there are some limitations one has to keep in mind:

- One general limitation concerns the sample size of the study presented here. Although we studied twice as many subjects as in the original study, a sample size of N = 20 still limits the degree to which the results can be generalized. This especially concerns statistical analyses and leads to quite big standard variations. Furthermore, the proportion of male to female subjects (5:15) does not allow gender specific statements.
- With respect to the rebus night, the special nature of the *kampflos* rebus stimulus implies some problematic aspects as discussed in chapter 3.3 and chapter 4.1. By introducing a new way of analysis (the so-called individual scoring), it was possible to make up for these problems. Still, it would be advantageous to have a less ambiguous rebus stimulus.
- One clear limitation of the GeoCat night concerns the order of awakenings. One could assume that the expected effect (more attributional similarity choices after REM-sleep awakenings, and more relational similarity choices after non-REM-sleep awakenings) emerges if the order of awakenings is changed so that the first awakening is not always a non-REM-sleep awakening, as it was in our study. As discussed in chapter 4.6, the fact that the very first awakening was always from non-REM-sleep might account for the fact that we found a predominance of relational dominated answers not only after the following non-REM awakenings, but also after the following awakenings from REM-sleep.
- Clearly, our results regarding the correlation between the electrophysiological data and primary and secondary process thinking are very preliminary. Furthermore, the focus of our study was a replication of the original rebus study, and an extension of it with the classic and scalar GeoCat stimuli. Hence, we were more concerned with providing our subjects a sleeping environment as pleasant as possible. Otherwise, it would certainly be advisable to run the experiments in a sound- and electronically-proofed environment to gain as pure and artifact-free electrophysiological data as possible.

5. Conclusion and outlook

The present study is an important step in providing experimental validation for a psychoanalytic construct. Our goal was to investigate whether REM- and non-REM-sleep differ with regard to their prevailing form of mental organization, and whether this difference parallels the Freudian concept of primary and secondary process thinking. Our main hypothesis (see chapter 1.6) was that REM-sleep mentation follows the rules of the primary process, while non-REM-sleep mentation is characterized by secondary process thinking.
The findings from the rebus night confirmed this hypothesis by showing a rebus effect (as an index for primary process thinking) within the free associations following REM-sleep awakenings and a strong conceptual effect (as an index for secondary process thinking) within the free association obtained after non-REM-sleep awakenings. Hence, in different psychophysiological states (REM-sleep vs. non-REM-sleep), different kinds of mental organization predominate (primary vs. secondary process thinking). In other words, one could assume that the subliminally presented stimulus is processed and stored in two different memory banks. While one of these memory banks is organized along primary process lines, the other one is organized on the basis of secondary process thinking. The former is mainly drawn upon when the subject enters REM-sleep, while the latter secondary process memory bank is mainly drawn upon when the subject enters non-REM-sleep (see Shevrin, 1973). The findings from the GeoCat night, however, did not reveal these differences. While a more secondary process answer pattern could indeed be demonstrated after non-REM-sleep awakenings, the expected primary process answer pattern following REM-sleep awakenings could not be observed. However, as discussed in chapter 4.6, the nature of the GeoCat tasks, as well as the order of our awakenings, could account for this. Finally, our hypothesis that primary and secondary process thinking are related to increased power within the alpha and theta frequency band could also only be partially confirmed. While increased theta power is indeed related to the conceptual effect as an index for secondary process thinking, the expected relationship between increased alpha power and primary process thinking was not found.

Summarizing, our successful replication of the Shevrin and Fisher (1967) study demonstrates that REM- and non-REM-sleep can indeed be distinguished on the basis of their prevailing thought processes, which match the Freudian primary and secondary process. Together with the original study, the study presented here is - to our knowledge - the only one applying the psychoanalytic concept of primary and secondary process thinking on the sleep-dream cycle. By this, it provides empirical evidence for all three basic principles of psychoanalysis (see chapter 1.1):

1. *The existence of a psychological unconscious:* The hypothesis that below-conscious psychic material influences and manifests itself in various behaviors could be confirmed by demonstrating the influence of an unconsciously perceived rebus stimulus on the free associations obtained after REM- and non-REM-sleep awakenings.
2. *The role of free associations:* The relevance of the psychoanalytic method of free associations to trace back unconscious material could be supported by demonstrating the recovery of the subliminally presented rebus stimulus within free associations after REM- and non-REM-sleep awakenings.
3. *The existence of two different modes of mental functioning:* Our findings provide evidence that not only do conscious and unconscious processes differ with regard to their prevailing mental organization, but so too does REM- and non-REM-sleep mentation. While REM-sleep is characterized by primary process thinking, non-REM-sleep mentation follows the rules of the secondary process.

Since the discovery of REM-sleep was still more than three decades away, Freud was not aware of the difference between REM- and non-REM-sleep dreams (see chapter 1.5). From a contemporary point of view, however, one would conclude that Freud was referring to REM-sleep dreams when he emphasized that dreams are strongly marked by primary process transformations and mechanisms (see chapter 1.2.2). Although we were not able to confirm this hypothesis - since we did not find the expected rebus effect as a marker for primary process thinking within *dream reports* obtained after REM-sleep awakenings - our findings within the *free associations* still confirm the underlying idea: namely that REM-sleep is characterized by more primary process mentation. To strengthen the findings from the rebus study, a third study with the same experimental setup would be desirable. To overcome the problems we had with our somewhat tricky *kampflos* stimulus, another replication with a less ambiguous and less conflictual rebus might be helpful. At the same time, it would be interesting to compare male and female subjects to see whether there are gender differences in the way a subliminal stimulus is processed during sleep.

Further studies are needed to investigate our hypothesis that our failure to demonstrate the expected effect during the GeoCat night is due to the disadvantageous order of awakenings.

Hence, future studies should randomize the order of awakenings so that half of the subjects gets a REM-sleep awakening first, while the other half gets a non-REM-sleep awakening first. In this way, it would be possible to study whether the order effect (always having an awakening from non-REM-sleep first) indeed accounts for the fact that we found stronger relational similarity judgments after non-REM-sleep *and* after REM-sleep awakenings. To check our hypothesis that GeoCat might not be suitable for investigating primary and secondary process thinking during *sleep*, because its cognitive demands are going to wake people up too much, future studies might wish to change the instruction. By asking "Which figure do you like better?" or "Pick one figure following your first intuition.", one could diminish the cognitive effort and allow subjects to answer intuitively. This might more resemble the task of giving free associations, which similarly does not require any cognitive effort.

Since our results pointing at a relation between theta power and secondary process thinking are very preliminary, future research needs to focus on this relationship. Furthermore, more studies are needed to investigate the association between alpha power and primary process thinking. Although we were not able to demonstrate a correlation, the studies of Shevrin and his co-workers strongly suggest a link between increased power in the alpha frequency band and a more primary process way of mental functioning (see chapter 1.4.2). It is of great importance to replicate these early findings. However, it might be more important to concentrate on the waking state, before also trying to apply the findings to the sleeping state.

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A. Checklist

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Checkliste Erstkontakt

Datum:			
ID:			
Geschlecht:	☐ weiblich	☐ männlich	
Muttersprache deutsch	☐ ja	☐ nein	
Geburtsdatum:			
Ausbildungsjahre:			
Studienfach / Fachsemester:			
Fehlsichtigkeit:	☐ Brille	☐ Kontaktlinsen	☐ keine
Links-/Rechtshänder:	☐ links	☐ rechts	
PSQI Wert:			

Traumerinnerungshäufigkeit

Wie häufig erinnern Sie sich in der letzten Zeit (einige Monate) an Ihre Träume?

☐ fast jeden Morgen
☐ mehrmals pro Woche
☐ etwa einmal pro Woche
☐ 2-3 mal im Monat
☐ etwa einmal im Monat
☐ weniger als einmal im Monat
☐ gar nicht

Allgemeiner Gesundheitszustand (im vergangenen Jahr)
(kürzliche Krankenhausaufenthalte, schwere Erkrankungen, Unfälle, Operationen, etc.)

Allgemeine psychische Verfassung (in den letzten 6 Monaten)
(übermäßige Gefühle von Angst, Trauer, Hilflosigkeit etc.)

Internistische Erkrankungen

Neurologische Erkrankungen
(Epilepsie, Migräne, Kopfverletzungen, Bewusstseinsverluste, Meningitis, Enzephalitis)

Psychiatrische Diagnosen

Schlafbezogene Diagnosen

Regelmäßige Medikation (Indikation und Dosis)
Koffeinhaltige Getränke (welche / wie viel / wie oft / wann zuletzt) **Alkoholische Getränke** (welche / wie viel / wie oft / wann zuletzt) **Drogen** (welche / wie viel / wie oft / wann zuletzt)

Termine für die Untersuchung im Schlaflabor:

1.Nacht: _______________________Uhrzeit: __________________

2.Nacht: _______________________Uhrzeit: __________________

3.Nacht: _______________________Uhrzeit: __________________

4.Nacht: _______________________Uhrzeit: __________________

B. Information for subjects

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Probandeninformation

Liebe Probandin, lieber Proband!

Sie wurden nach Ihrer Bereitschaft gefragt, an einer wissenschaftlichen Studie zur Untersuchung der Weiterverarbeitung im Wachzustand dargebotener Stimuli in den verschiedenen Schlafstadien, sowie deren neurophysiologische Korrelate im EEG, teilzunehmen. Mit den folgenden Zeilen möchten wir Ihnen einige Auskünfte über diese Studie geben. Bitte lesen Sie die nachstehenden Informationen sorgfältig durch und wenden Sie sich bei Unklarheiten oder zusätzlichen Fragen an Frau Dipl.-Psych. J. Steinig.

Ziel der Studie

Ziel der Studie ist es, Einblicke in die geistigen und neurophysiologischen Aktivitäten während des Schlafens und des Träumens zu gewinnen, um so unser Verständnis der während des Schlafzustandes ablaufenden mentalen und physiologischen Prozesse erweitern zu können.

Ablauf der Untersuchung

Die Untersuchung besteht neben einem ersten informellen Treffen zum gegenseitigen Kennenlernen aus insgesamt 4 Nächten, die Sie im Schlaflabor des Klinikums Bremen-Ost verbringen werden. In der jeweils vorangehenden Nacht möchten wir Sie bitten, ausreichend zu schlafen und weder Alkohol noch Drogen zu konsumieren. Außerdem werden Sie gebeten, eine Woche vor dem ersten Termin, sowie zwischen den Terminen ein Schlafprotokoll zu führen, in dem Sie notieren, wann Sie jeweils zu Bett gegangen, wann Sie aufgestanden sind, etc.

Zu den Nächten finden Sie sich bitte am Abend vorher gegen 21.00Uhr (nach Absprache) im Schlaflabor ein. Dort werden vor dem Schlafengehen die nötigen Kabel angebracht (siehe Beschreibung des Messverfahrens unten).

Die erste Nacht soll Ihnen dabei helfen, sich an die Umgebung und das Schlafen mit den Elektroden zu gewöhnen, während gleichzeitig sicher gestellt werden kann, dass Sie einen gesunden Schlafzyklus haben. Sofern in dieser sogenannten Baseline-Nacht keine relevanten Schlafstörungen festgestellt werden, die Sie von der Teilnahme an der Studie ausschließen, folgen die 3 Experimental-Nächte. Der Abstand zwischen diesen Nächten beträgt jeweils eine Woche. In den

beiden ersten Experimentalnächten wird Ihnen vor dem Schlafengehen ein visueller Reiz so kurz dargeboten, dass Sie ihn nicht bewusst wahrnehmen werden. Nachts werden Sie dann insgesamt 6 mal geweckt und gebeten, verschiedene Aufgaben zu erfüllen (einen Traumbericht abliefern, das Geträumte aufmalen, 4min frei assoziieren). Dies dauert jeweils etwa 10-15min. Am Morgen nach der 2. Experimentalnacht findet ein kurzer Test statt, mit dem sicher gestellt werden soll, dass die von uns vor dem Schlafengehen dargebotenen Reize auch tatsächlich nicht wahrgenommen wurden. Außerdem werden Sie dann erfahren, welchen Reiz Ihnen vor dem Schlafengehen dargeboten wurde.
In der dritten und letzten Experimentalnacht werden Sie ebenfalls insgesamt 6 mal geweckt. Nach jeder Weckung werden Ihnen Abbildungen verschiedener geometrischer Figuren vorgelegt und Sie werden gebeten, diese hinsichtlich ihrer Ähnlichkeiten untereinander zu beurteilen. Am Morgen nach der 3. Experimentalnacht werden Sie erneut gebeten, die bereits Nachts dargebotenen geometrischen Figuren zu beurteilen.
Während der Nacht können Sie sich jederzeit über das im Raum befindliche Mikrofon oder die Videokamera bemerkbar machen und mit Frau Steinig in Kontakt treten, die im angrenzenden Überwachungsraum den Verlauf der Untersuchung die Nacht hindurch überwacht. Morgens werden Sie um 7.00Uhr geweckt und von den Kabeln befreit.

Beschreibung des Messverfahrens

Während der 4 Nächte wird ein Elektroenzephalogramm (EEG) abgeleitet. Dafür müssen an verschiedenen Stellen Elektroden platziert werden:

- 10 Elektroden auf dem Kopf zum Messen der Hirnströme (Elektroenzephalogramm)
- 2 Elektroden neben dem linken und rechten Auge zum Messen von Augenbewegungen (Elektrookulogramm)
- 2 Elektroden unter dem Kinn zum Messen des Muskeltonus (Elektromyogramm)
- 2 Elektroden hinter den Ohren als Referenz
- 1 Elektrode auf der Stirn als Erdelektrode

Die EEG-Elektroden auf dem Kopf werden mit Kollodium, einem flüssigen Klebstoff geklebt, damit sie in der Nacht nicht verrutschen. Die Elektroden bestehen aus Silber/Silberchlorid. Zur Verbesserung der Leitfähigkeit wird eine Paste verwendet, die im wesentlichen aus Wasser, Kochsalz und Verdickungsmittel besteht. Morgens wird der Kleber vollständig mit Aceton gelöst; es bleiben weder Rückstände im Haar zurück, noch gehen Haare verloren. Die übrigen Elektroden werden lediglich mit einem Pflaster auf die vorgereinigte Haut aufgeklebt. Die gesamte Prozedur ist vollkommen non-invasiv und betrifft lediglich die Hautoberfläche.
In der ersten (Baseline-)Nacht werden zusätzlich zu diesen Elektroden noch weitere Kabel angebracht, um bewegungs- oder atmungsbezogene Schlafstörungen ausschließen zu können:

- 4 Elektroden an den Unterschenkeln
- 1 Atemflusssensor, um die Atmung durch Nase und Mund zu messen, 1 Brust- und 1 Bauchbewegungsgurt, um die Brust- und Bauchatmung zu erfassen
- 1 Pulsoxymeter am Finger, um den Sauerstoffgehalt im Blut zu messen, 1 Schnarch-mikrofon unterhalb des Kehlkopfes, Lagesensor und Langzeit-EKG

Das Anbringen der entsprechenden Kabel dauert etwa 1 Stunde.

Risiken der Untersuchungen

Die EEG-Messung ist völlig gefahrlos, da es sich dabei um ein non-invasives Verfahren handelt welches keinerlei Verletzungen herbeiführt. Für das EEG werden nur solche Geräte verwendet, die den einschlägigen Sicherheitsbestimmungen genügen. Sie werden in gleicher Form auch für die tägliche klinische Routine eingesetzt. Nachteile oder Schädigungen können daraus nicht entstehen. Die mehrfachen Weckungen innerhalb der 3 Experimental-Nächte können zu einer leichten Müdigkeit oder Mattigkeit am nächsten Tag führen. Während der Baseline-Nacht werden Sie nicht geweckt werden und können somit ganz normal durchschlafen.

Freiwilligkeit der Teilnahme

Die Teilnahme an der Studie ist freiwillig. Sie können jederzeit und ohne Angabe von Gründen aus der Untersuchung ausscheiden. Wenn Sie die Studie abbrechen, hat dies keinerlei nachteilige Folgen. Für die erste absolvierte Nacht erhalten Sie als Student/in des Studiengangs Psychologie der Universität Bremen 2 Versuchspersonenstunden. Wenn Sie alle 4 Nächte absolviert haben, erhalten Sie insgesamt 10 Versuchspersonenstunden. Außerdem erhalten Sie nach der ersten absolvierten Nacht eine finanzielle Aufwandsentschädigung von 10,00€ bzw. insgesamt 70,00€ wenn Sie alle 4 Nächte absolviert haben.

Vertraulichkeit und Datenschutz

Die personenbezogenen Daten und Informationen aus der Studie werden vertraulich behandelt. Die erhobenen Daten werden in anonymisierter Form unter Einhaltung des Datenschutzes im Institut für Psychologie und Kognitionsforschung der Universität Bremen gespeichert und wissenschaftlich ausgewertet. Die für die Auswertung zuständigen Personen sind an das Datengeheimnis gemäß des Bremischen Datenschutzgesetz gebunden. Mit Ihrer Einwilligung zur Teilnahme an der Studie erklären Sie gleichzeitig, dass Sie mit der Aufzeichnung von Daten sowie deren wissenschaftlicher Auswertung und Veröffentlichung einverstanden sind.

C. Informed consent

Universität Bremen

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28359 Bremen

Telefon (0421) 218 - 7309
Fax (0421) 218 – 4600
eMail : jsteinig@uni-bremen.de

Einverständniserklärung

- Ich wurde umfassend über die Studie zur Untersuchung mentaler Prozesse während des Schlafes informiert. Hiermit erkläre ich mich einverstanden, als Proband an dieser Studie teilzunehmen und dafür insgesamt vier Nächte im Schlaflabor des Klinikums Bremen-Ost zu verbringen.

- Meine Teilnahme ist vollkommen freiwillig. Ich kann jederzeit und ohne Angabe von Gründen aus der Untersuchung ausscheiden. Wenn ich die Studie abbreche, hat dies keinerlei nachteilige Folgen. Für die erste absolvierte Nacht erhalte ich als Student/in des Studiengangs Psychologie der Universität Bremen 2 Versuchspersonenstunden. Wenn ich alle 4 Nächte absolviere erhalte ich insgesamt 10 Versuchspersonenstunden. Außerdem erhalte ich nach der ersten absolvierten Nacht eine finanzielle Aufwandsentschädigung von 10,00€ bzw. insgesamt 70,00€ wenn ich alle 4 Nächte absolviert habe.

- Ich bin darüber unterrichtet worden, dass die nächtlichen Untersuchungen im Schlaflabor sowohl akustisch über ein Mikrofon, als auch visuell über eine Videokamera kontrolliert und aufgezeichnet werden. Auf diese Weise ist es mir jederzeit möglich, während der Untersuchung mit der Versuchsleiterin Frau Dipl.-Psych. J. Steinig Kontakt aufzunehmen. Nach der Transkription und Auswertung der mündlichen Berichte wird das Video mitsamt der Tonspur wieder gelöscht.

- Ich wurde darüber aufgeklärt, dass die im Rahmen dieser Studie erhobenen Daten (Fragebögen, Schlafprotokolle, Transkription der mündliche Berichte nach den Weckungen, sowie die EEG-Daten) in anonymisierter Form im Institut für Psychologie und Kognitionsforschung der Universität Bremen gespeichert werden, so dass die Bestimmungen des Datenschutzes gewährleistet sind.

- Ich erkläre mich einverstanden, detaillierte Informationen in Bezug auf Ablauf, Inhalt und Ziel der Studie nicht an die Studierenden des Studiengangs Psychologie an der Universität Bremen weiterzugeben, da diese andernfalls von einer Teilnahme an der Studie ausgeschlossen werden müssen.

- Meine Rechte wurden mir ausführlich und verständlich erklärt.

- Ich habe eine Kopie dieser Einverständniserklärung und eine Kopie der Probandeninformation erhalten.

Ort Datum Unterschrift

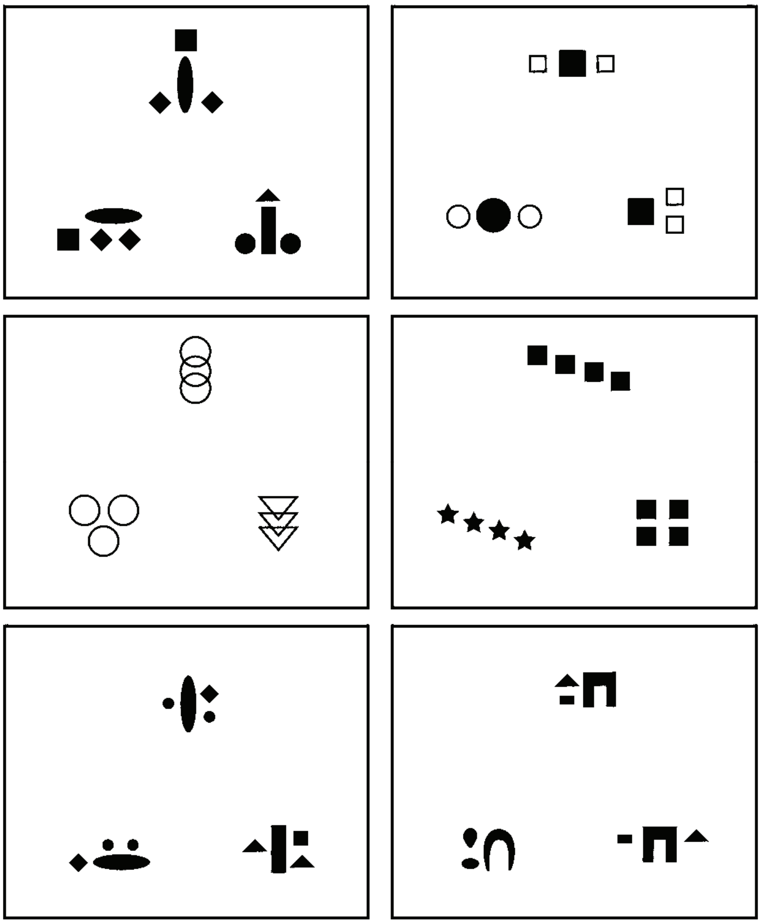
D. Classic GeoCat lists

Geocat 1A
VP:
Datum: *Weckung*: *Zeit:*

Wie ängstlich bist du in diesem Augenblick? Bitte markiere mit einem vertikalen Strich auf der folgenden Skala:

1 ├──────────┤ 10
ruhig … sehr ängstlich

Bitte schau dir die jeweils obere Figur an. Entscheide dann möglichst spontan, welche der beiden Figuren darunter der oberen am ähnlichsten ist und kreise diese Figur ein.

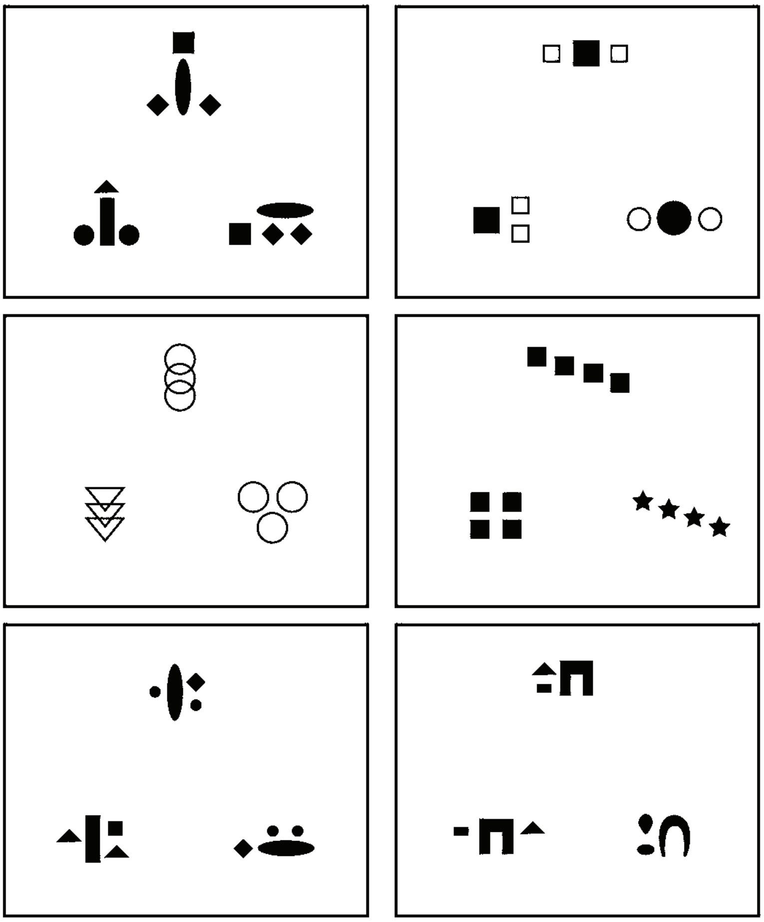


Geocat 1B
VP:
Datum: *Weckung*: *Zeit:*

Wie ängstlich bist du in diesem Augenblick? Bitte markiere mit einem vertikalen Strich auf der folgenden Skala:

1 — 10
ruhig — sehr ängstlich

Bitte schau dir die jeweils obere Figur an. Entscheide dann möglichst spontan, welche der beiden Figuren darunter der oberen am ähnlichsten ist und kreise diese Figur ein.

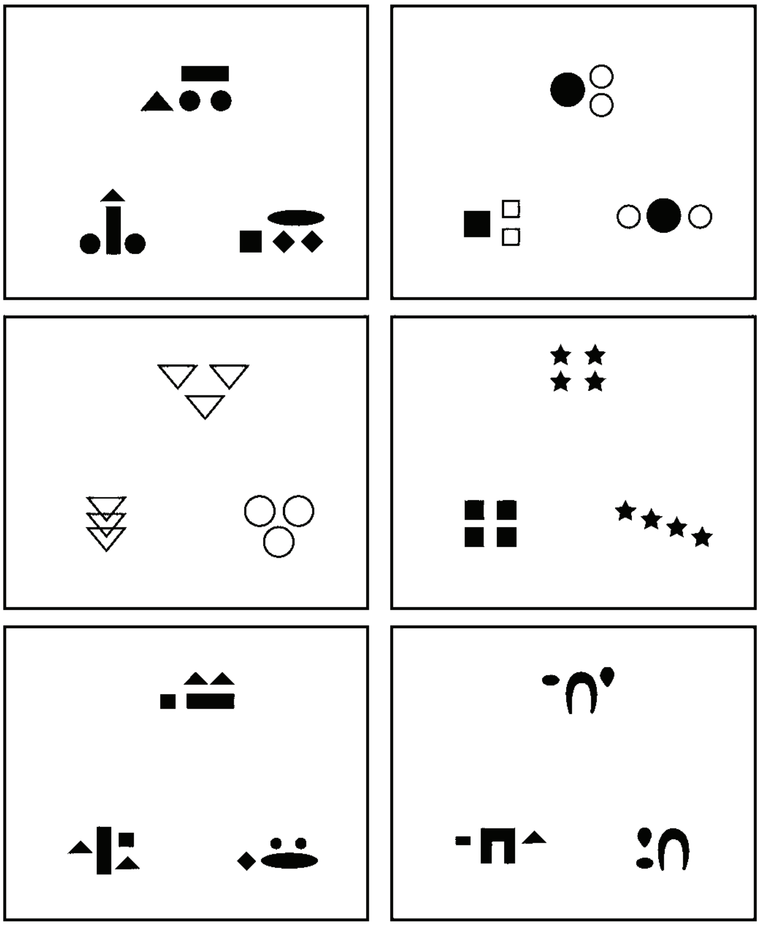


Geocat 2A
VP:
Datum: *Weckung*: *Zeit:*

Wie ängstlich bist du in diesem Augenblick? Bitte markiere mit einem vertikalen Strich auf der folgenden Skala:

1 ———————————— 10
ruhig sehr ängstlich

Bitte schau dir die jeweils obere Figur an. Entscheide dann möglichst spontan, welche der beiden Figuren darunter der oberen am ähnlichsten ist und kreise diese Figur ein.

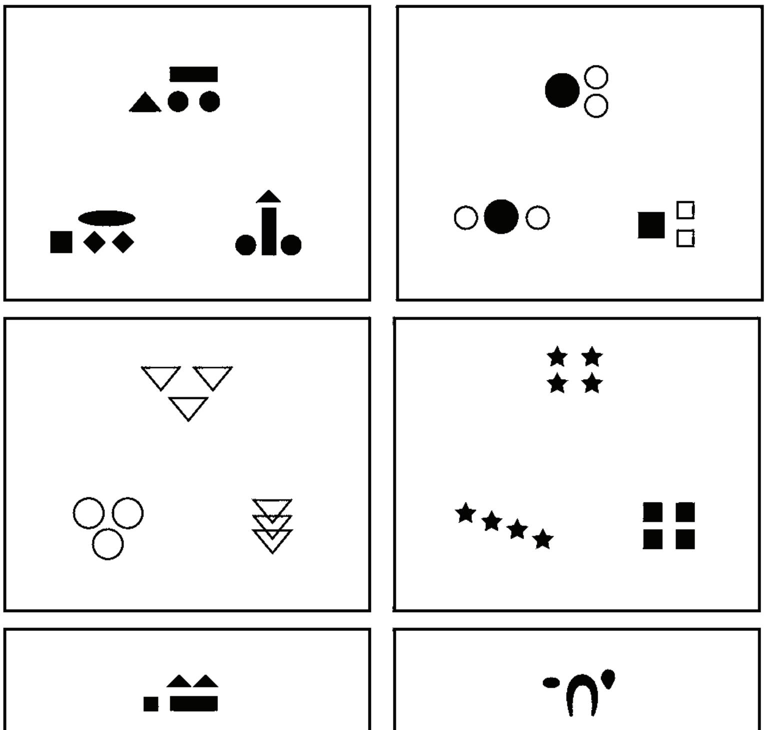


Geocat 2B
VP:
Datum: *Weckung*: *Zeit:*

Wie ängstlich bist du in diesem Augenblick? Bitte markiere mit einem vertikalen Strich auf der folgenden Skala:

1 — 10
ruhig — sehr ängstlich

Bitte schau dir die jeweils obere Figur an. Entscheide dann möglichst spontan, welche der beiden Figuren darunter der oberen am ähnlichsten ist und kreise diese Figur ein.



E. Scalar GeoCat items

WIE ÄHNLICH
sind diese 2 Figuren?

1 | **5**
verschieden | identisch

Zeichne einen vertikalen Strich auf diese Skala

(1)

F. Scoring catalogue

	Association	(%)
1	HAARE	46.84
2	BÜRSTE	17.45
3	KÄMMEN	7.06
4	FRISUR	2.55
5	ZINKEN	2.55
6	FRISÖR	2.35
7	BADEZIMMER	1.57
8	SCHERE	1.18
9	ZACKEN	1.18
10	HORN	0.78
11	ORDNUNG	0.78
12	MAMA	0.59
13	MUSIK	0.59
14	PLASTIK	0.59
15	GLATT	0.39
16	GLATZE	0.39
17	HOLZ	0.39
18	HOSENTASCHE	0.39
19	LANG	0.39
20	MANN	0.39
21	ZIEPEN	0.39
22	ALTMODISCH	0.20
23	AUFSTEHEN	0.20
24	BART	0.20

	Association	(%)
25	BLASEN	0.20
26	DÜNN	0.20
27	EITEL	0.20
28	FRAU	0.20
29	HAARPFLEGE	0.20
30	HORNKAMM	0.20
31	HÜBSCH	0.20
32	INSTRUMENT	0.20
33	KATZE	0.20
34	KLETTEN	0.20
35	LÄUSE	0.20
36	LOCKEN	0.20
37	MÄDCHEN	0.20
38	NUTZLOS	0.20
39	OPA	0.20
40	PAPA	0.20
41	PFLEGE	0.20
42	SCHNEEWITTCHEN	0.20
43	SCHÖN	0.20
44	SHAMPOO	0.20
45	SPIEGEL	0.20
46	STIEL	0.20
47	TUSSI	0.20

Table F.1: Associations to *Kamm* (Engl.: comb)

	Association	(%)
1	WASSER	31.96
2	HOLZ	13.33
3	FLUSS	9.02
4	MEER	4.51
5	ABENTEUER	3.53
6	SCHWIMMEN	2.94
7	HUCKLEBERRY FINN	1.96
8	INSEL	1.96
9	BAUMSTAMM	1.76
10	ROBINSON CRUSOE	1.76
11	RETTUNG	1.57
12	BAUM	1.37
13	EINSAM	1.37
14	FLIEHEN	0.98
15	SCHIFFBRUCH	0.98
16	TREIBEN	0.98
17	FAHREN	0.78
18	FLÖSSER	0.78
19	SEE	0.78
20	BOOT	0.59
21	FREIHEIT	0.59
22	PADDEL	0.59
23	SPASS	0.59
24	STRAND	0.59
25	URLAUB	0.59
26	BALKEN	0.39
27	BAUEN	0.39
28	GEFAHR	0.39
29	MISSISSIPPI	0.39
30	NASS	0.39
31	PFADFINDER	0.39
32	STAMM	0.39
33	TOM SAWYER	0.39
34	ÜBERLEBEN	0.39
35	UNSICHER	0.39
36	WACKELIG	0.39
37	ABHAUEN	0.20

	Association	(%)
38	ALLEINE	0.20
39	AMAZONAS	0.20
40	ANGST	0.20
41	CAST AWAY	0.20
42	ENTENTÜMPEL	0.20
43	ERREICHBAR	0.20
44	FILM	0.20
45	FLOSSFAHRT	0.20
46	FLUSSFAHRT	0.20
47	GERICAULT	0.20
48	INDIANER	0.20
49	KANU	0.20
50	KINDHEIT	0.20
51	LANGSAM	0.20
52	NATUR	0.20
53	NOAH	0.20
54	ODYSSEUS	0.20
55	PIRATEN	0.20
56	RAFTING	0.20
57	RAST	0.20
58	REISEN	0.20
59	RHEIN	0.20
60	RUDERN	0.20
61	SALZIG	0.20
62	SCHIFF	0.20
63	SCHLAUCHBOOT	0.20
64	SEENOT	0.20
65	SPIELEN	0.20
66	STABIL	0.20
67	STEG	0.20
68	STURM	0.20
69	ÜBERQUEREN	0.20
70	ÜBERSCHWEMMUNG	0.20
71	UFER	0.20
72	UNBEQUEM	0.20
73	WEIT WEG	0.20
74	WILDWASSER	0.20

Table F.2: Associations to *Floß* (Engl.: raft)

	Association	(%)		Association	(%)		Association	(%)
1	AUFGEBEN	21.76	39	AMEISE	0.20	77	NACHDENKEN	0.20
2	SCHWACH	10.2	40	ANSEHEN	0.20	78	NACHGIEBIG	0.20
3	FRIEDE	9.22	41	AUSGELAUGT	0.20	79	NIEDERGESCHLAGEN	0.20
4	ERGEBEN	8.24	42	AUSGELIEFERT	0.20	80	OHNE GEGENWEHR	0.20
5	FEIGE	5.29	43	BODEN	0.20	81	OHNE KRAFT	0.20
6	NIEDERLAGE	3.33	44	BUDDHISTEN	0.20	82	OHNE SIEGESWILLEN	0.20
7	MUTLOS	3.14	45	CHANCE	0.20	83	RITTER	0.20
8	SIEG	2.55	46	CHRISTUS	0.20	84	ROM	0.20
9	VERLIEREN	2.55	47	DEPRESSIV	0.20	85	SCHADE	0.20
10	EINFACH	0.98	48	DUELL	0.20	86	SCHLACHT	0.20
11	ERSCHÖPFT	0.98	49	DUMM	0.20	87	SCHLAFF	0.20
12	KAMPF	0.98	50	EHRGEIZ	0.20	88	SCHLAU	0.20
13	MÜDE	0.98	51	EINWILLIGEND	0.20	89	SCHLECHT	0.20
14	WEHRLOS	0.98	52	ELEFANT	0.20	90	SCHMÄCHTIG	0.20
15	GHANDI	0.78	53	ENTTÄUSCHT	0.20	91	SCHWERT	0.20
16	RESIGNIERT	0.78	54	ERLEDIGT	0.20	92	SCHWIERIG	0.20
17	ANGST	0.59	55	ERLEGEN	0.20	93	SIEGLOS	0.20
18	BOXEN	0.59	56	ERNIEDRIGUNG	0.20	94	SIEGREICH	0.20
19	ENTMUTIGT	0.59	57	FAUL	0.20	95	SOLDAT	0.20
20	FRIEDFERTIG	0.59	58	FREUNDLICH	0.20	96	STERBEN	0.20
21	KAPITULATION	0.59	59	FRIEDVOLL	0.20	97	TERRIER	0.20
22	KLUG	0.59	60	GEGENWEHR	0.20	98	TOT	0.20
23	KRAFTLOS	0.59	61	GEWALTLOS	0.20	99	TRAURIG	0.20
24	KRIEG	0.59	62	GEWALTTÄTIG	0.20	100	ÜBERRASCHEN	0.20
25	PASSIV	0.59	63	GLÜCK	0.20	101	UNBEHOLFEN	0.20
26	RUHIG	0.59	64	HILFE	0.20	102	UNENTSCHIEDEN	0.20
27	UNTERLEGEN	0.59	65	HILFLOS	0.20	103	UNERFAHREN	0.20
28	ARENA	0.39	66	HOFFNUNG	0.20	104	UNGEHEUER	0.20
29	GEWINNEN	0.39	67	IDIOTEN	0.20	105	UNREBELLISCH	0.20
30	GUT	0.39	68	KAMPFHUND	0.20	106	UNTERWÜRFIG	0.20
31	HUND	0.39	69	KAMPFKUNST	0.20	107	VERLIEBT	0.20
32	MUTIG	0.39	70	KLEIN	0.20	108	VERSTAND	0.20
33	NEIN	0.39	71	KONKURRENZ	0.20	109	WEHRHAFT	0.20
34	NIEMALS	0.39	72	KUNG FU	0.20	110	WEICHEI	0.20
35	REDEN	0.39	73	LASCH	0.20	111	WETTKAMPF	0.20
36	TRÄGE	0.39	74	LOOSER	0.20	112	WILLE	0.20
37	UNMOTIVIERT	0.39	75	LUSTLOS	0.20	113	WORT	0.20
38	VERLETZT	0.39	76	MÜHELOS	0.20	114	WORTGEWANNT	0.20

Table F.3: Associations to *kampflos* (Engl.: without a fight)

G. Online questionnaire

Liebe Studentinnen und Studenten,

vielen Dank, dass Ihr diese Seite besucht, um mir bei meinen Vorbereitungen zu meiner Promotion im Bereich Psychologie zu helfen. Der Zeitaufwand beträgt etwa 15 min. Bitte tragt zunächst die folgenden Angaben zu Eurer Person ein:

Geschlecht: männlich □ weiblich □

Geburtsjahr:

Deutsch als Muttersprache: ja □ nein □

Geburtsort:

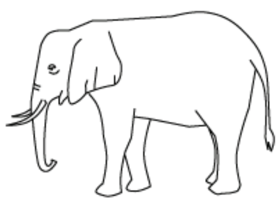
Studienfach:

Es folgt nun der erste Teil.
Bitte schaut Euch dazu die folgenden 10 Abbildungen sorgfältig an und tragt zunächst in das freie Kästchen unter der Abbildung ein, was ihr dort seht. Bitte tragt dabei immer nur jeweils ein Wort ein.
(„Was ist das?")

Anschließend notiert daneben bitte jeweils die 5 Wörter (Substantive, Adjektive, Verben – ganz egal), die Euch als erstes, ohne viel nachzudenken, spontan in den Sinn kommen, wenn Ihr das jeweilige Bild seht.
(„Assoziationen")

Wenn Ihr keine 5 Wörter eintrage, erscheint eine Fehlermeldung, also überlegt bitte, bis Euch jeweils 5 Begriffe einfallen.

Was ist das?



Assoziationen

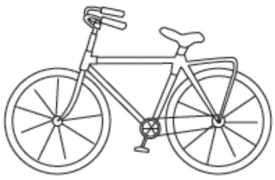
1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________

Was ist das?

Assoziationen

1. ___________________________
2. ___________________________
3. ___________________________
4. ___________________________
5. ___________________________

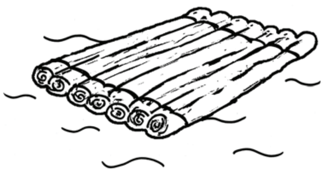
Was ist das?



Assoziationen

1. ___________________________
2. ___________________________
3. ___________________________
4. ___________________________
5. ___________________________

Was ist das?



Assoziationen

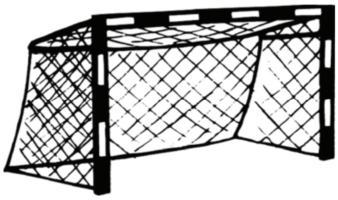
1. ___________________________
2. ___________________________
3. ___________________________
4. ___________________________
5. ___________________________

Was ist das?

Assoziationen

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

Was ist das?



Assoziationen

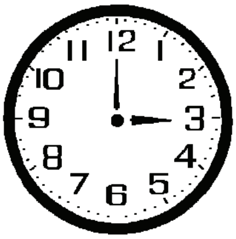
1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

Was ist das?

Assoziationen

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

Was ist das?

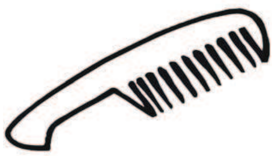


____

Assoziationen

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________

Was ist das?

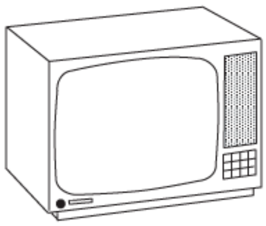


____

Assoziationen

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________

Was ist das?



____

Assoziationen

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________

Das war der erste Teil.

Im folgenden Teil sehr Ihr keine Bilder mehr, die Ihr benennen und zu denen Ihr assoziieren müsst, sondern 10 Begriffe, zu denen Ihr bitte wieder die jeweils ersten 5 Wörter aufschreibt, die Euch ohne lange nachzudenken spontan in den Sinn kommen (Substantive, Adjektive, Verben, etc.). Oben steht zuerst der Begriff und darunter habt Ihr Platz für Eure Assoziationen.

Italien

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Floß

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

schmerzhaft

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Urlaub

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Kamm

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

groß

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

sauber

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Pastor

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

kampflos

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Uhr

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Vielen herzlichen Dank für Eure Zeit und Eure Mühe,
Jana S.

H. Original and modified versions of the rebus pictures

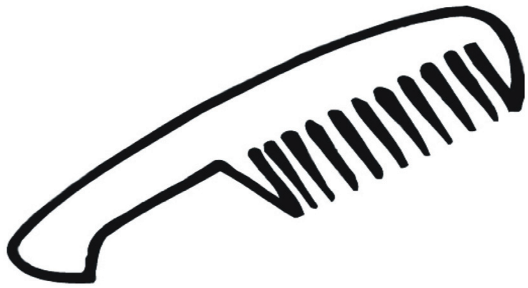


Figure H.1: original version of the comb

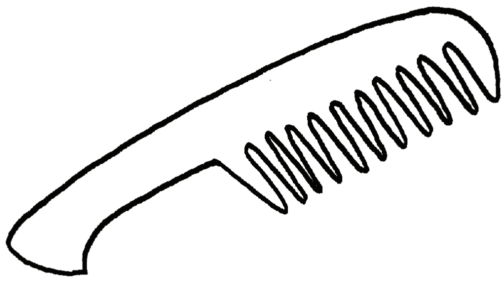


Figure H.2: modified version of the comb with more clearly visible teeth to make it easier to identify as a comb, and less strong contrast to make it more suitable for the tachistoscopic presentation

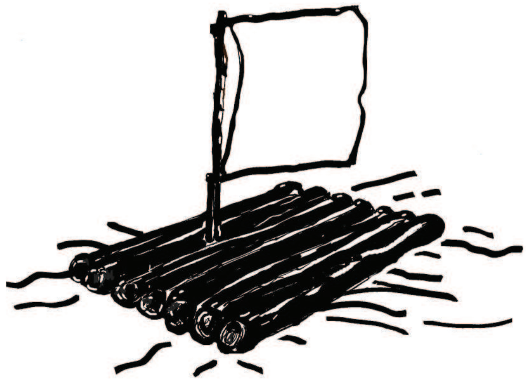


Figure H.3: original version of the raft

Figure H.4: first modified version of the raft without the flag to avoid distraction

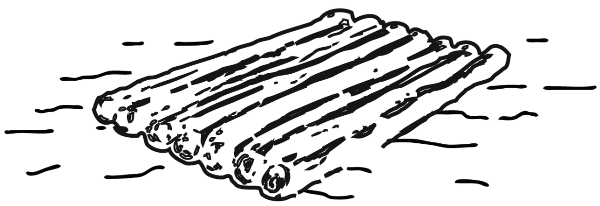


Figure H.5: second modified version of the raft with mirrored contrasts to make it less identifiable during the tachistoscopic presentation

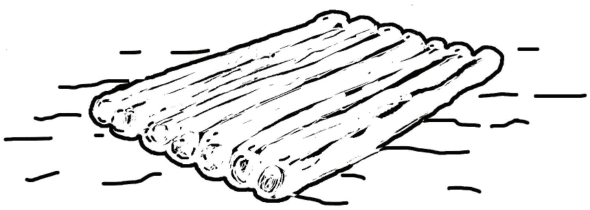


Figure H.6: third modified version of the raft with even less contrasts

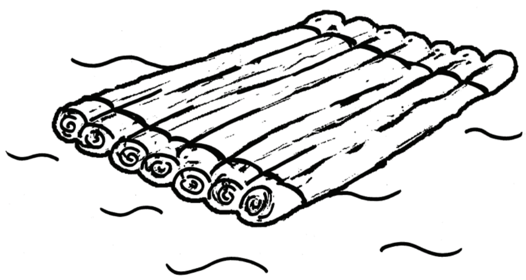


Figure H.7: forth modified version of the raft with clearer annual rings, ropes, and waves to make it easier to identify as a raft

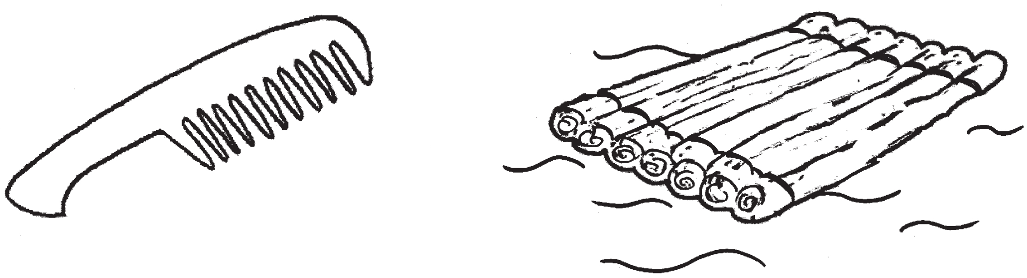


Figure H.8: final version of the comb and the raft, matched in size and contrast

I. Online rebus competition

BREMER SPRACHBLOG

INSTITUT FÜR ALLGEMEINE UND ANGEWANDTE SPRACHWISSENSCHAFT

« Spam-Update Presseschau »

Wortschmiede gesucht!

Nun haben wir also auch den ersten Wettbewerb im Blog: Gesucht wird dabei wie üblich ein Wort, nur ist es diesmal ausnahmsweise nicht das „schönste“, verwerflichste, bedrohteste oder sonstwie superlativischste seiner Art, sondern lediglich ein ganz besonders raffiniertes, klug konstruiertes, aus dem sich auch noch neue wissenschaftliche Erkenntnisse gewinnen lassen. Denn: Wissenschaftlich haben es mit der Sprache ja nicht nur Linguisten, sondern zum Beispiel auch Psychologen zu tun, und aus eben dieser Abteilung erreichte mich neulich ein ungewöhnliches Hilfegesuch, das ich an dieser Stelle – ausgebaut zu einem Wettbewerb mit handfestem Gewinn - gern weitergebe.

Hintergrund ist eine geplante Doktorarbeit am Institut für Psychologie und Kognitionsforschung an der Uni Bremen, die sich in den Worten der Verfasserin Jana Steinig

> mit unbewussten Prozessen in verschiedenen Schlafstadien befasst. Zu diesem Zweck wird den Probanden u.a. kurz vorm Schlafengehen ein visueller Reiz unterhalb der Wahrnehmungsschwelle angeboten, um durch Weckungen in den verschiedenen Schlafstadien herauszufinden, inwieweit dieser Reiz in den Trauminhalt und in das Bewusstsein der Versuchsperson Eingang gefunden hat.

Unser gesuchtes Wort kommt dabei nun wie folgt ins Spiel:

> Bei dem Reiz soll es sich um einen ganz speziellen handeln, nämlich um einen sogenannten Rebus, d.h. eine Art Bilderrätsel. Genauer gesagt handelt es sich um die bildliche Darstellung zweier Gegenstände, deren Klänge in Verbindung miteinander ein völlig neues Wort ergeben, welches mit den beiden dargebotenen Begriffen in keiner Weise assoziiert ist (z.B. englisch PEN + KNEE = PENNY, gesucht wird allerdings ein deutscher Begriff). Wichtig ist dabei nicht die korrekte Schreibweise, sondern nur, dass die Laute der beiden dargestellten Dinge zusammen ein neues Wort ergeben.

Ein deutsches Beispiel wäre somit etwa das Wort REBUS selbst, das sich in REH und BUS aufspalten lässt. Leider (bzw. interessanterweise) gibt es allerdings noch einige weitere Bedingungen, die die Sache komplizieren:

> 1. Die beiden Gegenstände, die zusammen das neue Wort - den Rebus - ergeben, müssen bildlich darstellbar sein (der Rebus selbst nicht)
> 2. Die beiden dargestellten Gegenstände müssen relativ eindeutig zu erkennen sein und möglichst auch genau das anvisierte Wort nahelegen
> 3. Alle drei Begriffe sollen in der Lage sein, vielfältige Assoziationen auszulösen
> 4. Alle drei Begriffe sollten sprachlich durch Nomina bezeichnet sein
> 5. **Nachtrag** (A.S.): Es darf kein Kompositum (zusammengesetztes Wort) sein (siehe unten).

Zur Illustration: Während der REBUS an Punkt drei scheitert (bzw. wohl kaum jemand diesen Begriff überhaupt kennt), ergibt sich etwa mit dem Kandidaten URLAUB eine Schwierigkeit in

Bedingung 2, da durch eine entsprechende Abbildung vielleicht nicht primär das Wort LAUB, sondern eher eine Bezeichnung wie BLÄTTER evoziert wird:

Die Sache ist insofern nicht ganz ohne. Dem Sieger winkt neben einer netten Anekdote über den persönlichen Eingang in die Annalen der Kognitionspsychologie ein Amazon-Gutschein im Wert von 30 Euro. Vorschläge bitte als Kommentare zu diesem Beitrag posten, den Gewinner kürt unsere Letterfee am 15. April.

[**Wichtiger Nachtrag** (A.S., 8. März 2007, 16:00 Uhr): Frau Steinig schreibt uns gerade Folgendes:

> Das sind ja schon mal ein paar schöne Einfälle. Wichtig — und das ganze erschwerend — ist aber, dass der entstehende Rebus wirklich nichts mit den beiden ursprünglichen Begriffen zu tun haben oder mit ihnen assoziiert werden darf, wie z.B. bei *Gehirnwäsche* oder *Affenzahn* der Fall. Trotzdem freue ich mich über die Vorschläge — für weitere Fragen stehe ich außerdem gerne jederzeit zu Verfügung.

Es sollen also keine Komposita (zusammengesetzten Wörter) sein, selbst dann nicht, wenn das zusammengesetzte Wort mit seinen Einzelteilen keine Bedeutungsverwandtschaft hat.]

[**Anmerkung des Sprachblog-Administratorenteams**: Posten Sie Ihre Vorschläge hier im Blog, um doppelte Vorschläge zu vermeiden und um zu dokumentieren, wann Sie Ihren Vorschlag gemacht haben. Achten Sie darauf, Ihre korrekte E-Mail-Adresse einzutragen, damit wir Sie ggf. kontaktieren können. Für die Auswahl des Gewinners/der Gewinnerin ist allein Frau Steinig verantwortlich. Der Rechtsweg ist ausgeschlossen.]

Veröffentlicht von Arne Zeschel am 7. März 2007 um 10:18 Uhr in Allgemeines.
Kommentieren | Trackback

25 Kommentare zu „Wortschmiede gesucht!"

1. **Sprachblog ib-Klartext.de | Ines Balcik, Wirtschaftslektorat - Korrektorat - Redaktion hat geschrieben:**

   […] Einen Wörterwettbewerb der kniffligen Art stellt das Bremer Sprachblog vor: Wortschmiede gesucht! Durch die Vorgaben fühlte ich mich gleich zur Wörtersuche angestachelt, andererseits überfiel mich schlagartig ein akuter Anfall völliger Fantasielosigkeit. Kein Wunder also, dass auch ein Blick auf dieses Wörterbuch mich nur auf den "Kubus" brachte. […]

   Am 7. März 2007 um 11:39 Uhr | Permalink

2. **Jens hat geschrieben:**

Ich hab ein paar Vorschläge, allerdings stellt mich keiner richtig zufrieden. Trotzdem:

Eisbein – Eis, Bein. Ein noch ziemlich durchsichtiges Kompositum, wird vermutlich noch mit den Einzelwörtern verbunden. Außerdem nicht so assoziativ.

Schachzug – Schach, Zug. Auch ein richtiges Kompositum, könnte noch mit Schach in Verbindung gebracht werden, auch wenn's zumeist ohne den Schachkontext benutzt wird.

Handlungen – Hand, Lungen. Blöderweise Plural und nicht so vielfältig assoziativ.

Ballast – Ball, Ast. Paßt vom Klang leider nicht so ganz, blöder Glottisverschluß. Wäre im Süden einfacher *g*

Orkan – Ohr, Kahn. Beim zweiten vielleicht eher ein Bild vom Fußballtorwart als von einem alten Schiff. Hat leider keine Erstbetonung.

Am 7. März 2007 um 14:02 Uhr | Permalink

3. **Traute Becker hat geschrieben:**

1. Wie sieht's mit Hechtsuppe (Hecht + Suppe) aus? Wird Punkt 3 damit ausreichend bedient?
2. Bei Gehirnwäsche (Gehirn + Wäsche) gibt's evt. Schwierigkeiten mit der Darstellung von Wäsche. Am besten noch auf der Leine.
3. Missgriff (Miss [World] + Griff)

Am 8. März 2007 um 11:08 Uhr | Permalink

4. **Ruth Scheithauer hat geschrieben:**

1. Schafgarbe = Wolltier plus Getreidebündel
2. Reißwolf = Reis (Foto von einem Teller Reiskörner?) plus Hundetier

Am 8. März 2007 um 12:26 Uhr | Permalink

5. **Sandra Zammert hat geschrieben:**

Kaffee = Kaff (Dorf) + Fee (Elfe)

Am 8. März 2007 um 12:55 Uhr | Permalink

6. **Ruth hat geschrieben:**

noch ein paar…

3. Urfaust = Uhr + Faust (Hand)
4. Affenzahn = Affen + Zahn
5. Kreisrat = Kreis (geometrische Figur) + Rad (Problem: das "Rad" wird in manchen Gegenden "Ratt" ausgesprochen)
6. Banknote = Sitzgelegenheit + Musikzeichen

Am 8. März 2007 um 13:59 Uhr | Permalink

7. **Christian Rogge hat geschrieben:**

Wie wär's denn mit Barock (Bar + Rock)?
Oder Barkasse (Bar + Kasse)?
Oder Kuba (Kuh + Bar)?
Dann gibt's natürlich noch die Rumba (Rum + Bar)
Leider klappt's bei Sandale (Sand + Aale) mit der Betonung nicht…

Am 8. März 2007 um 16:23 Uhr | Permalink

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8. **Traute Becker hat geschrieben:**

… und weiter:
Malerei (Maler/Anstreicher + Ei)
Nesthocker (Vogelnest + Hocker/Sitzgelegenheit)
Reform (Reh + Kuchen-Form)
Retorte (Reh + Torte)

Am 8. März 2007 um 16:40 Uhr | Permalink

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9. **Frank Oswalt hat geschrieben:**

1. Partitur (Party + Tour), zugegebenermaßen nicht gut darstellbar.
2. Randale (Rand + Aale), leider Mehrzahl und mit den Silben kommt das irgendwie nicht ganz hin.

Am 8. März 2007 um 21:19 Uhr | Permalink

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10. **Angelika hat geschrieben:**

Sekunde = See + Kunde
Herrschaft = Herr + Schaft (wie in Stiefelschaft)

Am 8. März 2007 um 22:26 Uhr | Permalink

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11. **Angelika hat geschrieben:**

Leider viele der Kriterien nicht erfüllend, aber auch sehr schön sind die 6 Tanten.

Am 9. März 2007 um 07:49 Uhr | Permalink

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12. **Sandra Zammert hat geschrieben:**

Pastor = Pass (Reisepass) + Tor (z.B. Fußballtor) — alles eindeutig darstellbar und mit vielfältigen Assoziationen behaftet. Die Verbindung von Religion, Grenzüberschreitung und (sportlichen) Konflikten müsste doch ein Traum für jeden Psychoanalytiker sein…

Am 9. März 2007 um 11:14 Uhr | Permalink

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13. **Christian Rogge hat geschrieben:**

6 Tanten bringen mich auf Zephir (Zeh 4), Leider sind auch hier die meisten gefragten Kriterien nicht erfüllt.

Besser sieht's da schon beim Zenit aus: Zeh + Niet…

Am 9. März 2007 um 11:23 Uhr | Permalink

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14. **Gudrun hat geschrieben:**

Terror - der Teer + das Rohr
Fetisch - die Fee + der Tisch
Büffelei - der Büffel + das Ei
Alarm - das All + der Arm
Heilungen - der Hai + die Lungen
Kreuzungen - das Kreuz + die Zungen
Wandlungen - die Wand + die Lungen

Zentrum - der Cent + der Rum
Kleber - der Klee + der Bär
Pomade - der Po + die Made
Rektor - das Reck + das Tor
Fraktur - der Frack + die Tour
Herberge - der Herr + die Berge

Textur - der Text + die Uhr
Waldung - der Wal + der Dung
Manieren - der Mann + Nieren
Termine - der Teer + die Mine
Terrasse - der Teer + die Rasse
Tortur - das Tor + die Tour
Ballungen - der Ball + die Lungen
Kamel - der Kamm + das Mehl
Lamelle - das Lamm + die Elle

Und diese ein bisschen fraglicher wegen der Aussprache, der Pluralform, der Darstellung… oder oder:

Heizungen - der Hai + die Zungen
Einakter - das Ei + Nackter (Mann)
der Heilige - der Hai + die Liege
die Selige - der See + die Liege
Schlamassel - der Schlamm + die Assel
Regeneration - das Reh + die Generation
Rotunden - das Rot + die Tunten
Aktante - der Akt + die Tante
Turniere - die Tour + die Niere
Autogramm - das Auto + das Gramm

gehen Orte/ Namen?
Bismarck - der Biss + die Mark
Bukarest - der Bug + der Arrest
Taunus - der Tau + die Nuss
Eifel - das Ei + das Fell

das wars erstmal.

Am 10. März 2007 um 11:07 Uhr | Permalink

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15. **Jana Steinig hat geschrieben:**

An dieser Stelle nochmal ein herzliches Dankeschön für alle bisherigen sehr schönen und einfallsreichen Ideen. Leider gibt es meist zumindest ein kleines Detail, welches eine Verwendung erschwert, z.B.:

- die bildliche Darstellung: bei Begriffen wie "Teer" "All", "Tour" usw. leider nicht ohne weiteres möglich. Auch "Pass" (von Pastor) ist leider schwierig, da man Gefahr läuft, nicht nur Pass, sondern Reisepass, Ausweis o.ä. nach Darbietung des Bildes zu erhalten — es muss also ein wirklich eindeutig erkennbarer Gegenstand sein, der keine weiteren Interpretationen zulässt, sondern nur als das gesehen werden kann, was er ist. Auch "Bar" würde sich als Besantdteil des Rebus so wunderbar anbieten, ist aber leider auch nicht eindeutig bildlich darstellbar.

- Plural (Heizungen, Handlungen): ist leider ungünstig, besser ist Singular.

Ich weiß — die Anforderungen sind hoch, aber ich bin trotzdem begeistert über die zahlreichen bisherigen Vorschläge, gehen sie doch zumindest alle in die richtige Richtung. Weiter so!!

Am 12. März 2007 um 18:03 Uhr | Permalink

16. **Susanne Schiering-Ro hat geschrieben:**

wie wäre es denn mit: Eimer - aus Ei und Meer?

Grüße
Susanne

Am 15. März 2007 um 23:04 Uhr | Permalink

17. **Teresa Günther hat geschrieben:**

Wie wäre es mit Erdbeeren = Erde (Globus) + Bären (Braun-, Eisbären)

oder Keilerei = Keiler/ Wildschwein + Ei?

Am 17. März 2007 um 11:41 Uhr | Permalink

18. **Reinhard Börger hat geschrieben:**

Hier noch zwei Vorschläge (falls Umgangssprache und substantivierte Adjektive erlaubt sind):

Pointe = Po + Ente
Bärtiger = Bär + Tiger

Am 19. März 2007 um 13:38 Uhr | Permalink

19. **Peter Müller hat geschrieben:**

Alle Tee Alete
Ball Ast Ballast
Bahn Ahne Banane
Bar Kasse Barkasse
Blase Balg Blasebalg
Brief Kopf Briefkopf
Chor Alle Koralle
Frack Tour Fraktur
Frack Zion Fraktion
General List Generalist
Kopf Last Kopflast
Kuh Gel Kugel
Lack Mus Lackmus
Leu Chemie Leukämie
Kamera List Kameralist
Knoten Punkt Knotenpunkt
Mohn Arche Monarche
Ohr Kahn Orkan
Ohr Rang Orang
Reh Gen Regen
Reh Tour Retour
Po Made Pomade
Schal Teer Schalter
Trank Elch Tran-Kelch

Kopf Stein Pflaster Kopfsteinpflaster
Mode Rad Tor Moderator
Ohr Gas Mus Orgasmus
Treppe Engel Länder Treppengeländer

Was ist tödlicher:
Wenn Fliegen um das Pils kreisen –

oder einen Fliegenpilz zu verspeisen?

Bass und Alt im Duett klingen schwer wie Basalt

Manch einer sucht Fun bei den Thai –
Beim Taifun geht das schnell vorbei.

Ein Franke erwarb viel Geld durch seinen Handel mit Dung –
Heute genießt er seinen gesellschaftlichen Wandel in Geltung

In einem Topf fand ein Alter einen Top-Falter!

Am 20. März 2007 um 10:36 Uhr | Permalink

20. **Ilse Schmid hat geschrieben:**

Mein Vorschlag ist:
As (Spielkarte) + Käse (Käsestück) ergibt Askese
Ansonsten schlage ich noch vor:
Glas + Uhr - Glasur
Dis (Note) + Tanz - Distanz
Brei + Tee - Breite
Akt + Ion - Aktion
Fuß + Ion - Fusion
8 + Zehen - 18

Am 22. März 2007 um 11:43 Uhr | Permalink

21. **Simon hat geschrieben:**

Klo + Bus = Globus

Am 26. März 2007 um 10:04 Uhr | Permalink

22. **Christian Rogge hat geschrieben:**

Schade, dass man weder Lack noch eine Ritze wirklich eindeutig im Bild darstellen kann, sonst wäre Lakritze ein guter Kandidat.
Bei Lamelle sieht's ähnlich aus: Eine Elle darzustellen ist schwer genug, aber wie bildet man ein Lamm so ab, dass niemand "Schaf" denkt…?

Am 3. April 2007 um 21:55 Uhr | Permalink

23. **Jana Steinig hat geschrieben:**

Tja, leider ist es tatsächlich gar nicht so einfach, alle gestellten Anforderungen zu erfüllen. Ein paar gelungene Vorschläge sind aber schon dabei, aber oftmals hakt es dann doch an dem einen oder anderen Detail. Kubus z.B. finde ich sehr schön, lässt sich auch super darstellen, allerdings weiß ich nicht, ob den Leuten da so viel zu einfallen wird (gleiches Problem stellt sich wohl leider auch bei Retorte).
Aber trotzdem - vielen Dank schonmal und weiter so!

Am 4. April 2007 um 09:49 Uhr | Permalink

24. **Rapsak hat geschrieben:**

Läuft der Wettbewerb noch? Hat man ein passendes Wort gefunden? Wenn ja, welches? Oder soll man hier noch weiter überlegen?

Am 21. April 2007 um 12:03 Uhr | Permalink

25. **Anatol Stefanowitsch hat geschrieben:**

Unser Wortwettbewerb ist nun zu Ende!

Jana Steinig, die „Schirmherrin" dieses Wortwettbewerbs schreibt:

> Liebe Wortschmiede!
>
> Nun ist der von mir ins Leben gerufene Wortwettbewerb vorbei und es in an der Zeit, den Gewinner bzw. die Gewinnerin zu küren.
>
> Über den 30,00€ Amazon-Gutschein kann sich Sandra Zammert mit ihrem „Pastor" freuen. Ich denke, dass ich einen Weg finden werde, den „Pass" eindeutig als solchen darzustellen und dann liefert der nach Verschmelzung mit einem „Tor" entstehende „Pastor" sicherlich eine Fülle vielfältiger Assoziationen.
>
> Ein herzliches Dankeschön aber auch an alle anderen, die sich am Wettbewerb beteiligt und so viele schöne, lustige und kreative Beiträge geliefert haben.
>
> Jana Steinig

Am 22. April 2007 um 11:56 Uhr | Permalink

Dies ist eine archivierte Seite des Bremer Sprachblogs, das von 2007 bis 2010 betrieben wurde. Anatol Stefanowitsch bloggt jetzt hier zu Themen rund um Sprache und Sprachen.

Eigenständigkeitserklärung

Hiermit versichere ich, dass ich die vorliegende Arbeit selbständig und ohne unerlaubte Hilfe angefertigt habe. Ich habe keine anderen als die von mir angegebenen Quellen und Hilfsmittel verwendet. Die den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen wurden als solche kenntlich gemacht.

Bremen, den 03.03.2011 Jana Steinig