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THE MYSTERY OF DREAMING AND REM SLEEP

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Abstract

Sleep is usually related to dreaming. However, it is still unknown why people dream and what is the importance of having a dream. This article will explore previous theories regarding dreaming and its association with REM sleep. The earliest research on sleeping and dreaming was marked by Eugene Aserinsky and professor Nathaniel Kleitman, which found a new stage of sleep called rapid eye movement or REM sleep. Then William Dement developed more research specifically in the field of dream observation. Both Aserinsky and Dement, along with Kleitman as their supervisor, became pioneers in sleep and dream studies. More studies were then developed with theory and hypothesis that tried to explain the mystery of dreaming, such as psychoanalytical dream theory and the activation – synthesis hypothesis. Despite both perspectives were opposed, those studies helped researcher in the field of dream to understand the relation between dreaming and REM sleep. Future research is needed in order to conduct a reliable interpretation of the manifest dream content and a stronger scientific basis in understanding the latent content of the dream.

Keywords: Dreaming, REM Sleep, psychoanalytical dream theory, activation – synthesis hypothesis

THE DISCOVERY OF REM SLEEP

The year 1953 marks a turning point in the research on sleeping and dreaming. Graduate student Eugene Aserinsky (1921-1998) and his professor Nathaniel Kleitman (1895-1999), the grandfather of sleep research, both affiliated to the University of Chicago, published their discovery of periods in the nightly sleep which were associated with atypical rapid eye movements. Aserinsky registered the eyes of his son Armond so carefully that he sometimes noticed periods with jerky, large and rapid eye movements. These eye movements were associated with a low tone in the main body muscles and an EEG pattern that had similarities with the waking pattern. Aserinsky supposed that he had found a new sleep stage in the nightly sleep and called this the 'rapid eye movement', or REM sleep in contrast with the 'normal' passive sleep ('slow wave sleep') with large EEG waves in the EEG and slow eye movements. It took some time to convince the skeptical Kleitman, the man of the passive sleep theory, of the active nature of REM sleep and its unique state. Moreover, Aserinsky casually remarked that he often noticed that his son was dreaming during these sleep periods. Since both researchers were not directly interested in this phenomenon, it was another student of Kleitman, William Dement (1928-) who was very interested in this dreaming observation. Almost immediately he got the idea that REM sleep could be the type of sleep for dreaming. In a later paper he indeed showed that there was a strong association between REM sleep and dreaming and claimed that REM sleep could be the exclusive type for dreaming, forming an objective paradigm for the study of this mysterious experience. Looking back is it thus evident that the discovery of REM sleep is one of the most important

findings in sleep and dream research, since it was always the hope to find a new method to study the enigmatic and elusive dream phenomenon. The papers of Aserinsky and Kleitman [1] and Dement and Kleitman [2] are therefore regarded as genuine milestones in sleep and dream studies.

ANCIENT VIEWS ON DREAMING

Until that time there were many speculative opinions and meanings about dreams and dreaming. In several ancient cultures people believed that dreams were messages of supernatural beings such as gods, angels and demons. Dreams contained, often hidden, messages; warning the sleeper for danger, predicting the future, clarifying situations, or rewarding or punishing the sleeper. Many religious people assumed that Gods preached through dreams. Remarkable was the dream view of the ancient Chinese culture, distinguishing soul and body (Figure 1). The soul leaves the body of a sleeping person during the dream and visits creatures and places the sleeper experiences in his dream. A careful awakening was required, since the soul needed time to return into the body and a too fast awakening could be fatal. The famous Greek philosopher Aristotle (384-322 BC) was the first to believe that dreams were produced by ourselves and that they were not of an external origin [3]. He had the idea that dreams were the remains of the waking experiences and the dreaming mind could communicate with the body. As such, dreams could analyze illnesses and predict diseases and function as a diagnostic means. Nevertheless, the ancient view that dreams are external and caused by supernatural beings dominated during the entire mediaeval time.

Figure 1. *The ancient Chinese distinguished body and soul. The soul leaves the body at the start of the dream, to return at the end. It is discussed whether the waking world or the dreaming world is the real world. In the words of the ancient Chinese philosopher Chuang-tzu: 'I do not know whether I am a man dreaming of a butterfly, or whether I am a butterfly dreaming of a man'.*

PSYCHOANALYTICAL DREAM THEORY

In the 19th century the Austrian psychiatrist Sigmund Freud (1856-1939), who extensively studied dream theories and dream interpretations, took over several elements of Aristotle's dream opinions. He integrated these elements in his dream theory, which he laid down in his impressive work 'Die Traumdeutung' ('The Interpretation of Dreams') published in 1900 [4]. Based on the dream recall of several of his psychiatric patients, he came to the view that dreams were expressions of profound desires and fears, often related to repressed childhood memories and obsessions. The content of the dream was driven by the fulfillment of deep, often inappropriate, unconscious wishes. According to Freud, the unconscious continues to influence our behavior and experiences, even though we are unaware of these underlying influences. In the view of Freud, the dream forms an access to the unconscious mind: 'dreams are the royal

road to the unconscious'. Dreams have both a manifest and a latent content. The manifest content is that what a dreamer later can recall of a dream, often bizarre and meaningless stories, while the latent content includes the real meaning, related to the unconscious wishes or fantasies. It is the aim to extract the latent content from the manifest content, by careful analyzing the dream, thus bringing the unconscious into consciousness. To understand the dream, the psychotherapist has to explore the latent content of the dream by the process of free association. The dreamer tells fully free in a relaxed way to a trusted psychotherapist what is in his mind. Through spontaneous utterances and associations the therapist tries to understand what is in the unconscious mind of the dreamer. A basic idea is that in this familiar situation the repression is reduced and the unconscious can easier come into consciousness. This forms the basis of psychoanalysis, and many versions of this therapy are still in use, although the scientific basis is regularly under discussion (Figure 2). Mostly criticized is that the method of the free association might allow a relative random interpretation by the psychoanalyst, colored with his own visions and ideas. Nonetheless, the psychoanalytical dream theory is still one of the most popular dream theories (Figure 5).

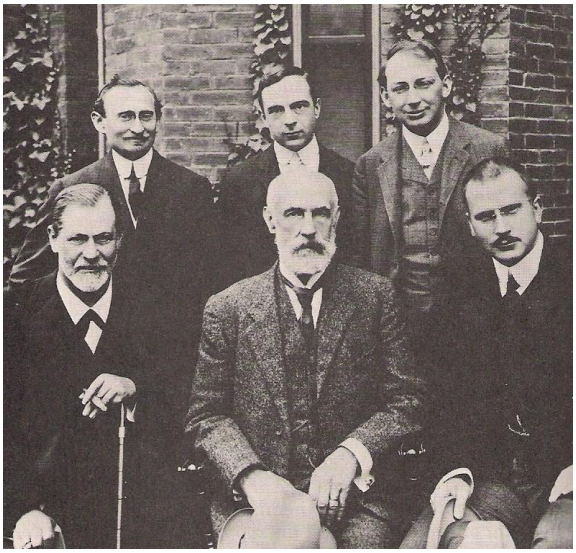

Figure 2. *Six great psychoanalysts on a meeting in Worcester (USA) in 1909 at the Clark University. Left to right standing: Abraham Brill - Ernest Jones - Sándor Ferenczi. Left to right sitting: Sigmund Freud - Stanley Hall - Carl Gustav Jung. Both Freud and Jung got there a 'doctorate honoris causa'.*

REM SLEEP AND DREAM RECALL

Kleiman's graduate student William Dement noticed as the first that REM sleep was strongly associated with dreaming. He even wondered whether dreaming should take place exclusively during REM sleep. Rigorous attempts to test this idea were carried out. Many people came to the sleep lab and were aroused during REM sleep and control experiments were performed by arousing sleeping subjects from non-REM sleep. In 1957 he published with Kleitman the first well-controlled recall study [2]. In 80 to 90% of awakenings from REM sleep a vivid dream recall was obtained, but this almost never occurred in arousals from non-REM sleep. The researchers were excited by the high percentage of REM recall by awakenings from REM sleep and this finding could be replicated by more research teams. But this was not the situation for the very low percentage of dreams by awakening for non-REM sleep.

Great differences were obtained in the recall from non-REM sleep, varying from 0 to 75%. Especially the sometimes high percentage of non-REM recalls jeopardized the idea that REM sleep was the exclusive sleep for dreaming, but also that REM sleep and dreaming were two sides of the same coin. A bulk of studies were performed to understand the percentage of recalls from slow wave sleep. That those were remains from dreams from an earlier REM period could be excluded directly. However, it was a problem that a dream could not be defined exactly and people could perhaps indicate a dream when in reality something just flashed through their minds. This important issue was finally tackled by Gene Orlinsky, a graduate student of Allan Rechtschaffen (1927-) [5]. He tried to solve this problem by performing an experiment in which he used an eight-point scale for the judgment of dream reports. Indeed, Orlinsky found clear differences between non-REM and REM reports in the sense that a non-REM recall is generally poorer, less vivid and less dreamlike but more a thinking report as compared to a REM recall. But he also found that occasionally a long, vivid dream was reported after a non-REM arousal. In about 5% of cases he found a dream report that could not be differentiated from a REM dream report (Figure 3). To their disappointment sleep scientists had to come to the conclusion that REM sleep cannot be considered as exclusively synonymous with dreaming!!

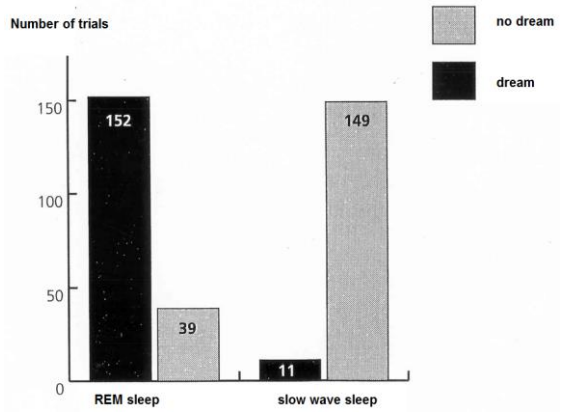

Figure 3. *A main cornerstone for the view that dreaming and REM sleep are not belonging to the same process is that dreams can occur outside REM sleep. (After Dement and Kleitman [2])*

The dream recall studies revealed two facts jeopardizing the vision that REM sleep and dreaming are the expressions of the same process, such as the scarce absence of a recall by awakenings from REM sleep and the sometimes vivid recall by arousals from non-REM sleep. Despite these findings the general public opinion of REM sleep is that this type of sleep is the dreaming sleep and that the minor exceptions are caused by the vague and slippery nature of the dream.

HYPNAGOGIC HALLUCINATIONS

Hypnagogic hallucinations are vivid, often frightening dreams that occur at sleep onset. Most people have experienced these visual, tactile or auditory images that occur at the transition from waking to sleep. Sometimes these perceptions are accompanied by sleep paralysis or by an intense muscle shock. Feelings of falling in a hole, or flying, can also be experienced in these hallucinations. When they take place upon awakening these hallucinations are called hypnopompic. The Dutch physician Ysbrand van Diemerbroeck (1609-1674), who worked as a doctor during the black death epidemic raging in Nijmegen (The Netherlands), in 1635/1636 and who became later a

professor of medicine at Utrecht University, was the first who described these dream hallucinations [6]. Mostly, these experiences are called dreamlike, for the reason that they occur at the transition from waking to sleep. The EEG pattern is active, but the type of sleep cannot be qualified as REM sleep. This underlines the view that REM sleep and dreaming are separate processes. In narcoleptic patients, suffering from the intrusion of REM sleep when they are awake, similar hallucinatory phenomena occur. During a narcoleptic attack, frightening and dreamlike hallucinations can emerge, associated with sleep paralysis and cataplexy.

Figure 4. *Hypnagogic hallucinations at sleep onset. The devil appeared into the dream of the composer Giuseppe Tartini and inspired him to compose the Violin Sonata in G Minor, 'The Devils Thrill'. (Tartini's Dream by Louis-Léopold Boilly, 1824)*

In these hypnagogic hallucinations at sleep onset and at narcoleptic attacks, reality and dream fantasies are often mixed. The story of the devil's thrill started with a hypnagogic hallucination (Figure 4). The composer Giuseppe Tartini (1692–1770) dreamed that he had handed the devil his violin to test the devil's musical skills, and the devil played a song with exceptional virtuosity! Tartini tried to recollect the music afterwards and composed based on the devil's music a beautiful sonata known as 'The Devil's Thrill'. In a similar way, the German chemist August Kekulé (1829-1896) dreamed of a snake with his tail in his mouth and found thereby the circular molecular structure of benzene.

THE ACTIVATION - SYNTHESIS HYPOTHESIS

It is now convincingly demonstrated that dreaming can take place outside REM sleep. A dream can emerge in non-REM sleep , presumably when the fluctuating brain activity is high enough. Also at sleep onset and upon awakening dreams can come into action as hypnagogic and hypnopompic hallucinations. A common feature of all these states is associated with a degree of consciousness almost reaching waking consciousness, thus with a fairly high brain activity. It was originally proposed by Harvard neuroscientists Allan Hobson (1933-) and Robert McCarley (1937-) that dreaming is the result from the attempts of the brain to make sense of the high neural activity during sleep. They called this the 'activation-synthesis' hypothesis [7]. The neurophysiologists were aware that circuits in the brain stem are activated, leading to REM sleep. The produced activity ascends by PGO waves to higher brain areas involved in sensations, emotions and memories, and the cortex synthesizes these internal processes, together with the limited external information into a story creating a meaning from all these signals. This results in dreaming images and since the brain has difficulties in producing an acceptable story of all these signals, this leads to chaotic scenes, objects and stories, forming an often surreal, illogical, emotional and bizarre narrative, which is curiously enough felt as a lifelike reality. This implies that the dream itself is regarded as a byproduct of the activity associated with REM sleep, initially originating in the brainstem and spreading to higher cortical areas. In this view the REM sleep has an important, though unknown, function, while the dream is an

unintentionally, senseless byproduct. Hence, the activation-synthesis dream hypothesis is therefore a genuine counterpart of the psychoanalytical dream theory (Figure 5).

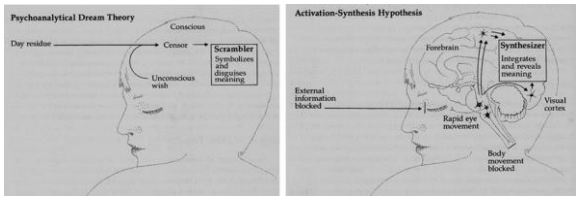

Figure 5. *The two leading dream theories. The psychoanalytical dream theory (left) and the activation-synthesis hypothesis (right), modeled by J. Allan Hobson in his book 'The Dreaming Brain' with the subtitle 'How the brain creates both the sense and the nonsense of dreams'* [8].

TWO OPPONENT DREAM THEORIES: A SYNTHESIS

The activation-synthesis hypothesis of the dream process infers that dreams are a senseless byproduct of REM sleep. But, does this indeed mean that dreams are completely meaningless? Perhaps not completely. If it is assumed that the brain contains memories full of relevant information, it can be accepted that even when areas of the brain are randomly activated, important memory information is reactivated. The more impact this information has for a person, the more memory space shall be occupied. And thereby is the likelihood greater that these impact containing areas are activated. Thus, situations and events often appearing in dreams seem to have had a strong impact to the sleeper, and it is not the detailed story which is relevant, but the events and the persons often appearing in dreams, evoking emotional reactions. In this view, the psychoanalytical dream theory obtains to some degree a scientific basis. Allan Hobson said it in an alternative way: 'Dreaming may be our most creative conscious state, one in which the chaotic, spontaneous recombination of cognitive elements produces novel configurations of information in new ideas. While many or even most of these ideas may be nonsensical, if even a few of its fanciful products are truly useful, our dream time will not have been wasted' [8].

Thus even when the dream is a genuine epiphenomenon of REM sleep, without any direct function or meaning, it can contain relevant information since useful memory traces are activated. Indeed the content of the recalled dream, consists frequently of memory images with a mix of remote and recent memory traces. In the psychoanalytical dream theory, a certain interpretation of a dream content seems often possible, although the dream interpretation is often regarded as speculative, having a limited scientific basis. The question now is whether a reliable interpretation of the manifest dream content is possible in the future. Perhaps, when the insight in the unconscious mind is growing the methodology of bringing the unconscious to consciousness will get a more solid scientific basis.

CONCLUSIONS

The most important notion that emerges from the literature is that the general assumption that REM sleep is the equivalent of dreaming needs a thorough revision. REM sleep and dreaming are not identical processes and REM sleep has to be divorced from dreaming [9]. REM sleep and dreaming are dissociable states: brain stem mechanisms are controlling REM sleep, while dreaming is controlled by forebrain mechanisms [10]. Dreams are the expression of high amplitude brain activity during sleep and that explains why dreaming occurs at sleep onset and at sleep ending, and, almost always during REM sleep, since this type of sleep is generally associated with a high brain activity. This gives the impression that REM sleep and dreaming

are so highly connected that it seems evident that they are belonging to the same process.

It is now more likely that REM sleep serves an own unknown function, while the dream is a random byproduct of REM sleep, caused by the high brain activity, with no direct function and meaning. The original enthusiasm around the discovery of REM sleep has now two sides: it has delivered new, interesting questions concerning the function of the mysterious REM sleep phenomenon, but it has unfortunately not brought more insight into the nature of dreams, the most intriguing experiences in life. Looking back the '1953 turning point in sleep and dream research' was highly relevant for sleep but not for dream studies. The only advantage for REM sleep in dream research is that it delivers an opportunity to obtain many vivid dreams in a relative easy way. Hence the only possibility to study dreams and dreaming is presently again the interpretation of the dream content. It is the hope that in the future the 'psychoanalytical dream theory' can be made more reliable, with a stronger scientific basis in understanding the latent content of the dream.

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