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THE DREAM BETWEEN NEUROSCIENCE AND PSYCHOANALYSIS

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The year 2003 marked the 50th anniversary of the discovery of REM sleep. This revolutionized our concept of sleep, and opened the gate to the neurosciences, where until 1953 sleep had been rigorously excluded.

In actual fact Freud had already opened the gateway to dreams in 1895 (14), with his *Project for a Scientific Psychology*, but it was not until 1900 (15) that his *Traumdeutung* recounted his explorations there. In the 50 years since then, dreams have remained in the field of psychoanalysis which built up its concept of the unconscious and its theory of the mind around them.

Sleep, on the other hand, has always attracted more physiological than psychological interest. Starting from Pavlov's experiments in and around 1915, sleep was considered an *active* phenomenon induced by neocortical inhibition. However, in 1935, Bremer (9) suggested sleep was a *passive* event, due to sensory deafferentation. In 1972, the reticular theory took the same line, viewing sleep as the result of loss of tone in the ascending activating reticular system (24).

Electrophysiology has helped us understand sleep and its phases. Up to the 1950s sleep was believed to involve synchronous electroencephalographic activity, with high-voltage slow waves. Its phases were considered more or less deep depending on the degree of synchronization of the EEG rhythms. From falling asleep to the phase of deep sleep, the rhythms get gradually slower and more synchronous. No-one seems to have given great importance to a phase in man that paradoxically resembled waking, although it had already been described in cats (12).

In 1953, Aserinski and Kleitman (2) described this "paradoxical" phase in children, and a decade later Jouvet (18) investigated its neurophysiological features. This paradoxical sleep was electrophysiologically similar to the waking state, with EEG desynchronization, and rapid, low-voltage electrical rhythms in the cortex.

This phase of sleep also has other characteristics: there is the complete loss of postural tone, rapid eye movements – which give the phase its name, REM – ponto-geniculo-occipital (PGO) monophasic waves, and neurovegetative upheavals with cardiac and respiratory arrhythmias, changes in blood pressure and the output of various hormones, especially thyroid and adrenal ones.

In 1953, Aserinski and Kleitman's findings (2) brought the study of sleep into the realm of the neurosciences. These authors' phenomenological description of REM

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sleep enabled Dement and Kleitman (11), then other researchers too, to study mental activity in humans during the various phases of sleep. It was soon noticed that a very high proportion of people who were woken during or at the end of an episode of REM sleep reported visual representations (hallucinations), self-representations, strongly emotional events, and spatial-temporal alterations of reality. This clearly meant they had been dreaming. When the people were woken outside the REM phase, or right in a non-REM phase, they reported a thought-like experience, more connected to reality, without hallucinations, self-representations or any emotional component to the "story". This led to a dichotomous model of REM/non-REM sleep as the physiological representation of the different mental activity during sleep – dreaming in REM and thought – like, closer to reality, in non-REM.

REM sleep thus began to be seen as a "neurobiological framework" within which the dream could organise itself and be narrated. This was made possible by the EEG desynchronisation, indicative of neocortical activation and hippocampal theta activity, expressing limbic activity. With the eye movements and the PGO waves, these neurophysiological processes are seen as the expression of the decodification and reading of information from inside the nervous system, and the dreamer lives them like a story, made up of strange facts and happenings, emotions and visual hallucinations, that can actually be told.

Psychophysiological research in 1984 has shown that one hemisphere is dominant in the components of dreams in REM sleep: the right hemisphere deals with geometric-spatial organization and activation of emotions, and the left remembers and tells the story (Bertini and Violani, (4). On the basis of this model, many theories have been proposed to show that dreaming is essentially a biological event, regardless of the dreamer's personal history, affects and emotions.

When the neurosciences entered the field, there was an inevitable shift from analysis of the content to examination of the form. A major player in this shift was Allan Hobson (16) who focussed particularly on the brain structures that generate emotions and perceptions, and are selectively activated in REM sleep. His *activation-synthesis* hypothesis, formulated with in 1977 McCarley (17), suggests that the activation of the pontine structures that induce this phase of sleep stimulate the brain from within, producing information that is projected onto the forebrain and limbic system and processed by these structures to recuperate the memory, construct the story, and participate emotionally in the dream.

Hobson (16) also considered the main cognitive features of dreaming: a) loss of awareness; b) loss of orientational stability; c) loss of directed thought; d) loss of logical reasoning; e) poor memory within and after the dream. Various physiological features correspond to these dysfunctions: a) selective *activation* of brain structures underlying emotion and perception, b) selective *inhibition* of brain structures underlying memory, thoughts, self-reflexive awareness and logical reasoning.

All these processes of neuronal activation and inhibition arising inside the brain are responsible for the various mental functions during dreaming. This is what led Hobson to the radical suggestion that the mind is nothing other than the self-activated brain.

Bio-imaging studies in humans have confirmed there is increased activity in various brain areas during REM sleep: activation of the pontine tegmentum, bilateral amygdala, left thalamus, cingulate cortex and right parietal operculum – this last region being important for spatial construction. Limbic activation might be the physiological substrate for emotional participation in dreams (23).

Braun *et al.* (7) helped distinguish the structural levels of the mechanisms of waking and REM sleep, confirming that during the REM phase there is activation of the limbic and paralimbic areas, including the insula, cingulate and medial temporal cortexes. The same group (Braun *et al.,* 8) subsequently reported increases during REM sleep in the activity of the hippocampus and parahippocampal gyrus, and the extrastriatal cortices. The striate cortex, however, is inactive during REM sleep, like the dorsolateral and orbital prefrontal cortex. This suggests that the visual hallucination requires activation of the visual associative cortex and inactivation of the specific areas. Inactivation of the prefrontal cortex might explain why we forget dreams so easily.

Neuropsychological research on patients with brain lesions (25) indicated that dreams and REM sleep originate from different anatomical structures. Dream organisation is not regulated only by the structures of the pons, because patients with extensive brainstem lesions still dream. Those with lesions to the forebrain and corresponding associative cortices, however, do not. Subjects with lesions to the temporo-occipital associative cortex dream, though without the hallucinatory component, while those with damage to the limbic associative structures no longer distinguish dreams from reality, and live in a sort of permanent dream-like state.

It was Solms, in 1999 (25), who suggested a dissociation between dreams and the various states of brain activation. A person dreams when the dopaminergic circuits in the ventromedial forebrain are activated. This might also explain the changes occurring in male and female genitals during REM sleep (Mancia, 21).

Just last year, Bassetti (3) noted that patients with focal lesions in the inferior parietal, medial temporo-occipital or bifrontal brain areas stopped dreaming, and that dreams were altered in subjects with various limbic or temporal lobe pathology.

Taken together these findings raise doubts about the very reductive hypothesis of *activation and synthesis,* at the same time raising the question of the activation in REM sleep of ample areas of association – temporo-parietal, frontal and limbic – considered responsible for the memory, and the semantic, symbolic and emotional functions involved in dreams.

Cognitivist research on dreaming (1, 10, 13) has looked into how dreams form and become organised. Certain conditions appear to be essential: a) activation of the cerebral cortex; b) maturation of the associative cortex, which governs the symbolic organisation of experience; c) possibility for the brain to build up a "multimedial" experience comparable to waking.

In line with this cognitivist theory is the suggestion by Llinas and Paré (19) that dreaming during REM sleep is an inward-looking state of attention, focused on one's own recollections stored in the memory.

Psychophysiological research (Bosinelli *et al.*, 5; Bosinelli & Cicogna, 6; Foulkes, 13) assigned less importance to REM sleep for dream production. Mental activity comparable to that recorded during this phase is also seen in non-REM sleep and the falling asleep phase, although there are differences. For instance, the spatial organisation of the dream, the extent to which the dreamer "participates" in it, the number of words used to describe it, and even how bizarre it is, are all more present and more clearly defined in the REM phase than in non-REM sleep. In REM sleep brain activation offers better conditions for recuperating the dream from the memory, so it can be told in greater detail (Antrobus, 1). Rapid cortical activity at 40 Hz, seen during REM sleep by Llinas and Ribary (20), suggests better cognitive activity and more detailed linguistic organisation.

Logically, therefore, the lower degree of cortical activation in non-REM sleep suggests that the resulting dreams will involve less elaboration of the experience recalled, with poorer narrative capacity. However, both types of sleep involve mental activity with certain shared characteristics that suggest a *single system of dream production*, relatively independent of the biological phases in which they occur.

We now have to ask what relation there is between dreams as studied by neuroscientists and cognitivists and dreams elaborated by psychoanalysts. Freud raised a similar question in 1895 (14) when he proposed a mind-brain relation in his *Project for a Scientific Psychology*. He had sensed the role of motor inhibition and detachment from reality in dream production. On the basis of his instincts model, he proposed that the hallucination in dreams was an expression of fulfillment of a desire repressed in infancy, so that dreams were actually the hallucinatory satisfaction of these desires.

In the last fifty years this approach has changed markedly, as the instincts model has been replaced by a relational model of the mind. This assigns value to the dreamer's personal, affective and emotional history, dating from the child's primary relation with its mother and the setting where it grew up. These early experiences are linked to sensory events and to the body, through which a mother communicates the affects and emotions the child needs for its mental development.

Psychoanalysis teaches us that dreams themselves create symbols, as they render symbolically what were originally presymbolic experiences, so that even originally preverbal events can be expressed verbally. Through this process a dream can enable us to think about past emotions – even without the actual recollection – stored in the implicit memory, forming structural parts of this unrepressed unconscious (22). The dream thus "brings on stage" affects and emotions rooted in a person's past, which can come to light in a specific analytical situation (21).

This is possible through the transference, a tool used specifically by psychoanalysts, but not by neuroscientists. It can be defined as a relational situation from the past that is transferred to the present while, at the same time, it is like a projection into the analyst, of the patient's internal objects, meaning affect-laden representations from his far-off past.

It is through this transference that a patient can present the state – which may be conflictual – of his internal figures (i.e. the *intrapsychic dimension* of the dream),

and their relations with reality (i.e. the *intersubjective dimension* of the dream). The story in the dream is thus rooted in the person's relational history and the structure of his unconscious (repressed or not).

Thus a dream examined within an analytical relationship casts light on the dreamer's inner world, particularly the unconscious dimensions of his primary experiences, even if they were traumatic, hence also fantasies and defences stored in the implicit memory, that the person has no way of recalling. Thus, the difference between a dream studied in psychoanalysis and one studied in neuroscience lies essentially in the different epistemological approaches.

If we now go back to Hobson's reductive hypothesis (16) that the dream is merely a state of chaotic cerebral activation, and is therefore a straightforward physiological event, we can confute this conclusion by noting that the activation of the brain's various parts during sleep is what permits the mental activity that is expressed as a dream. But this mental activity is *not* a physiological process; it is a pictographic representation, by the mind, made possible by the brain's specific physiological organisation at that moment.

It is therefore logical to assume a single *ontological* thread running through dream production, although we still know nothing about the detailed steps by which dream-thoughts emerge from neuronal activation. However, as a mental phenomenon, the dream transcends neuroscientific experience, calling for a *dual epistemological approach* to its study.

From analytical experience we have learned that dreaming is a process of internal activation that is only apparently chaotic, but in fact is rich in significance drawn from the person's affective and emotional past. It is produced by the brain which, when disconnected from perceptive reality, can activate itself independently. But the thoughts, perceptions and emotions in dreams are specific to each individual dreamer, serving as a bridge – a *pontifex* – between the earliest experiences of infancy activated by the transference, and those currently present there.

The dream that interests the psychoanalyst – unlike the neuroscientist – is an emotional tale that permits reconstruction, serving as a tool to achieve transformation of the dreamer's personality through interpretation.

SUMMARY

The dream is tackled sometimes from the neurobiological viewpoint, sometimes from the neuropsychological angle, or from the positions of experimental and psychoanalytical psychology. Interest in dreams started with psychoanalysis in 1900, and 53 years later the discovery of REM sleep by Aserinski and Kleitman, and subsequent psychophysiological findings took the dream into the realm of biology.

The dichotomous model of REM and non-REM sleep is described, as a basis for thought-like activity (non-REM sleep) and dreaming (REM sleep). This led to Hobson and McCarley's theory of activation-synthesis, suggesting that the mind while dreaming is simply the brain self-activated in REM sleep.

Psychophysiological research has shown that people dream in all phases of sleep, from falling asleep to waking, but that the characteristics of the dreams may differ in the different phases.

Bio-imaging studies indicate that during REM sleep there is activation of the pons, the amygdala bilaterally, and the anterior cingulate cortex, and disactivation of the posterior cingulate cortex and the prefrontal cortex. The images suggest there is a neuroanatomical frame within which dreams can be generated and then forgotten.

Psychoanalysis studies the dream from a completely different angle. Freud believed it was the expression of hallucinatory satisfaction of repressed desires. Today it is interpreted as the expression of a representation of the transference in the *hic et nunc* of the session. At the same time it also has symbol-generating functions which provide an outlet by which affective experiences and fantasies and defences stored as parts of an unrepressed unconscious in the implicit memory can be represented in pictorial terms, then thought and rendered verbally. From the psychoanalytical point of view, the dream transcends neurobiological knowledge, and looks like a process of internal activation that is only apparently chaotic, but is actually rich in meanings, arising from the person's affective and emotional history.

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