

# [The involvement of noradrenaline in rapid eye movement sleep mentation](https://assignbuster.com/the-involvement-of-noradrenaline-in-rapid-eye-movement-sleep-mentation/)

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The nature of human mind activity varies greatly during the sleep–waking cycle. During waking, mental activity is reflective, logically organized, and involves learning processes that lead to memories. During slow wave sleep (SWS), mentation most often comprises “ thought-like” content that is seldom visual and that has “ a higher degree of correspondence with reality” (p 23; [Foulkes, 1962](#B62) ; for ref. see [Gottesmann, 2001](#B76) ). This mental content seems to correspond to the secondary process of [Freud (1911)](#B66) , which follows the reality principle. As previously underlined by [Rechtschaffen et al. (1963)](#B166) , during SWS these “ secondary process characteristics… are assigned to pre-conscious mentation” (p 546). Recent studies have shown that SWS mental activity reproduces or is the continuation of waking cognitive processes ( [Nielsen, 2003](#B152) ; [Euston et al., 2007](#B54) ; [Ji and Wilson, 2007](#B106) ). At the same time, it was shown early on that some dreams occur during SWS ( [Foulkes, 1962](#B62) ; [Tracy and Tracy, 1974](#B194) ; [Cavallero et al., 1992](#B38) ; [Bosinelli, 1995](#B23) ; [Cavallero, 2003](#B37) ), even though it has been emphasized that dreaming can only occur in the presence of certain neurobiological features of the rapid eye movement (REM) dreaming sleep stage ( [Takeuchi et al., 1999](#B191) , [2001](#B190) ; [Nielsen, 2003](#B152) ).

The mental activity of REM sleep has been “ defined as an experience that involves vivid and complex multi-modal imagery, a progression of events and sense of reality” (p 180; [Dement, 1965](#B49) ; for ref. see [Gottesmann, 2005b](#B78) ); this is once again contrary to SWS mentation, which comprises “ background thoughts that occur during the day” (p 180). Today, in fact, it is necessary to distinguish between the mental activity of REM sleep that occurs at sleep onset descending stage I (Sleep Onset REM Sleep: SOREM) and REM sleep occurring after ascending stage II, in more advanced night sleep stages. Even further, within the latter, some authors have distinguished between “ active” dreams occurring during the REM bursts and “ passive” ones occurring outside of these periods ( [Dement and Wolpert, 1958](#B47) ; [Berger and Oswald, 1962](#B16) ); these studies, however, have not been followed up. It has been underlined by several authors, with the seeming exception of one recent study ( [Malcolm-Smith et al., 2007](#B129) ), that REM sleep dreaming is most often characterized by threatening content ( [Manacéine, 1897](#B130) ; [Revonsuo, 2003](#B169) ). This is less often the case in SOREM, during which dreams are roughly equivalent in positive and negative content ( [Foulkes and Vogel, 1965](#B63) ; see [Gottesmann, 2005b](#B78) ). Finally, with respect to the psychological quality of REM sleep mentation, it has been long noted by philosophers such as Kant and Schopenhauer, writers such as Alfred Maury, neurophysiopathologists such as Hughlings Jackson, and neuropsychiatrists such as Henri Ey, that numerous similarities exist between dreaming and madness ( [Gottesmann, 2010b](#B83) ). Today, the properties of dreams, with their hallucinatory perceptions, bizarre imagery, diminished self-reflective awareness, orientational instability, intensification of emotion, and instinctual behaviors ( [Hobson et al., 2000](#B99) ), are strongly reminiscent of the symptoms of schizophrenia ( [Gottesmann, 2005a](#B77) , [2006](#B79) ; [Gottesmann and Gottesman, 2007](#B84) ).

While various neurotransmitters [glutamate, gamma aminobutyric acid (GABA), and neuromodulators (acetylcholine, dopamine, serotonin, histamine…] also contribute to forebrain functioning, here I will attempt to provide a beginning of an explanation of how noradrenaline (NA) influences the mental activity occurring during REM sleep.

## Cortical Noradrenergic Function

Noradrenergic neurons of the locus coeruleus (LC), the primary source of NA to the forebrain, fire maximally, although at a slow rate, during waking. Their discharges decrease during SWS and then become silent during REM sleep ( [Hobson et al., 1975](#B98) ; [Aston-Jones and Bloom, 1981a](#B10) ; [Rasmussen et al., 1986](#B164) ; [Takahashi et al., 2010](#B189) ). As a consequence of this progression, both pontine ( [Shouse et al., 2000](#B180) ) and prefrontal cortex ( [Léna et al., 2005](#B123) ) release of NA is highest during waking and lowest during REM sleep. This neuromodulator plays important roles in the control of forebrain function. In certain rare cases of noradrenergic neuron stimulation in the LC, patients described “ well being (and) improved clarity of… thinking” (p 179; [Libet and Gleason, 1994](#B124) ). Moreover, numerous results have shown that NA depletion increases error responses to irrelevant stimuli and decreases responses in attentional tasks ( [Selden et al., 1990](#B179) ; [Milstein et al., 2007](#B144) ); also, increased NA release is concomitant to cognitive improvement through the collection and processing of salient sensory information ( [Berridge and Waterhouse, 2003](#B20) ). The positive effect of NA on cognitive processes is further evidenced by the observation that attentional processes can be impaired by lesions of the dorsal NA bundle ( [Leconte and Hennevin, 1981](#B122) ; [Tait et al., 2007](#B188) ) or by prefrontal neurotoxic inhibition of dopamine-β-hydroxylase ( [Milstein et al., 2007](#B144) ; [McGaughy et al., 2008](#B140) ), the enzyme that catalyzes the conversion of dopamine to noradrenaline. As described by [Arnsten and Pliszka (2011)](#B9) “ in humans, lower activity of dopamine-β-hydroxylase… is associated with poor sustained attention ( [Greene et al., 2009](#B88) ), poor executive function ( [Kieling et al., 2008](#B114) ), and impulsiveness ( [Hess et al., 2009](#B96) ).”

There are two modalities of LC neuron activity. First, there is a basic tonic firing pattern, and second, a phasic firing pattern is superimposed onto the tonic firing. The tonic firing increases with vigilance, and its function is presumably to prevent unimportant sensory events from disturbing the perception of threshold and above-threshold stimuli ( [Berridge and Waterhouse, 2003](#B20) ; [Johnson, 2003](#B108) ). In contrast, the phasic discharges are sensitive to novel sensory modifications of sub-threshold intensity, and increases in such discharges precede behavioral changes that can take place during tasks ( [Bouret and Sara, 2005](#B25) ). “ Phasic NA activity serves to interrupt ongoing neural processes when a significant new event is experienced” (p 689; [Johnson, 2003](#B108) ; see also [Waterhouse et al., 1998](#B206) ). All LC neurons fire together, and only 10% of the neurons are sufficient to maintain normal cortical function ( [Berridge et al., 1993](#B19) ), because of compensatory NA neuron processes ( [Chiodo et al., 1983](#B42) ).

Noradrenaline was first shown to primarily inhibit cortical neurons ( [Krnjevic and Phillis, 1963](#B117) ; [Frederickson et al., 1971](#B65) ; [Nelson et al., 1973](#B151) ; [Foote et al., 1975](#B61) ; [Reader et al., 1979](#B165) ; [Manunta and Edeline, 1999](#B131) ; [Wang et al., 2010](#B203) ), specifically through α 2 receptors. Noradrenaline has an important function in cortex efficiency, as it increases the fidelity of signal detection and transmission in neurons and synapses; it does this by increasing the signal-to-noise ratio of incoming information ( [Foote et al., 1975](#B61) ; [Aston-Jones and Bloom, 1981b](#B11) ; [Waterhouse et al., 1990](#B205) ; [Warren and Dykes, 1996](#B204) ; [Berlucchi, 1997](#B17) ), thereby reducing synaptic noise resulting from parasitic afferents relative to the informative stimulus ( [Berlucchi, 1997](#B17) ; [Berridge and Waterhouse, 2003](#B20) ; for ref. see [Gottesmann, 2008](#B81) ).

Noradrenaline acts through the α 1 , α 2 , and β receptors. Prefrontal α 1 receptor activation impairs cognitive processes, as shown through the administration of agonists to rats ( [Arnsten et al., 1999](#B8) ) and monkeys ( [Arnsten and Jentsch, 1997](#B6) ; [Mao et al., 1999](#B132) ). In contrast, postsynaptic α 2 receptor activation improves these processes ( [Steere and Arnsten, 1997](#B184) ; [Mao et al., 1999](#B132) ), acting specifically in the prefrontal cortex ( [Ramos and Arnsten, 2007](#B162) ). This activation is restricted to the NA level ( [Arnsten and Li, 2005](#B7) ), in the maximal zone of an inverted U-curve ( [Arnsten and Dudley, 2005](#B5) ). It should be underlined that it is particularly the postsynaptic α 2a receptors, whose activation threshold is much lower than that of the α 1 receptors, which are responsible for this improvement in cognitive processes. Indeed, mice with mutations in the α 2a subtype show an unusual absence of improved working memory following administration of the α 2a receptor-specific agonist guanfacine ( [Franowicz et al., 1998](#B64) ). At the postsynaptic level, the activation of these receptors reinforces the prefrontal connections between pyramidal cells by blocking potassium channels through the inhibition of cyclic adenosine monophosphate (cAMP), thereby “ increasing the efficacy of network inputs, and facilitating prefrontal cortex function” ( [Arnsten and Pliszka, 2011](#B9) ). Beta receptors, which have the lowest affinity to NA and which activate pyramidal neurons ( [McCormick et al., 1991](#B138) ), have restricted influence on cognitive processes. Nevertheless, β 1 antagonists infused into the prefrontal cortex or administered systemically improve working memory in rats and monkeys, while β 1 –β 2 receptor blocking compounds have no effect. Thus, prefrontal β 1 receptor activation appears to impair cognitive functions ( [Ramos et al., 2005](#B163) ).

Due to the silencing of the noradrenergic LC neurons during REM sleep, the level of NA in the prefrontal cortex drops from 20. 9 × 10 −10 M during waking to 9. 98 × 10 −10 M during this sleep period ( [Léna et al., 2005](#B123) ). A low level of NA is still maintained because it is diffusely released at the varicosity level ( [Fuxe et al., 1968](#B68) ; [Descarries et al., 1977](#B50) ; [Seguela et al., 1990](#B178) ), without rapid enzymatic destruction at the synapse by catecholamine- *O* -methyl transferase (COMT), or reuptake by transporters. However, this low level is insufficient to support normal cortical function. From a neurophysiological standpoint, NA is now well known to induce regular spiking activity in the cortex instead of burst firing ( [McCormick et al., 1993](#B139) ). However, it has long been established that the pyramidal neurons fire in bursts that are separated by silences of spiking during REM sleep, demonstrating a decrease in inhibitory influences controlling the frequency-limiting process ( [Evarts, 1964](#B55) ). Thus, the level of NA available during REM sleep is clearly insufficient to regularize pyramidal neuron firing. Since the affinity of NA is highest for the α 2a receptors, these are likely the only ones activated during REM sleep to sustain normal prefrontal function. However, because of dorsolateral deactivation ( [Maquet et al., 1996](#B134) ; [Braun et al., 1997](#B27) ; in spite of phasic activation during the eye movement bursts, particularly on the right side ( [Hong et al., 1995](#B100) ; [Kubota et al., 2011](#B119) – but interestingly not related to LC phasic discharges; [Takahashi et al., 2010](#B189) , and K. Sakai, Personal Communication 2011) – and the lower levels of dopamine, serotonin, and acetylcholine (see [Gottesmann, 2006](#B79) , [2010a](#B82) ), NA is not sufficient to support normal prefrontal function by itself. In addition, there are reciprocal relations between the LC and the prefrontal cortex, with the latter promoting LC function ( [Jodo et al., 1998](#B107) ). It can be assumed that, in humans, the prefrontal dorsolateral deactivation that occurs during REM participates in the silencing of the LC, which in turn contributes to the impairment of cortical function. The strong decrease in cortical noradrenaline during REM sleep ( [Léna et al., 2005](#B123) ) probably also contributes to the abnormalities observed in synchronized gamma rhythms. Indeed, it has been shown that NA, but not serotonergic, reuptake inhibitors favor gamma rhythms in the septo-hippocampal system ( [Hajos et al., 2003](#B92) ) and that their intracortical and hippocampal synchronization is impaired during REM sleep ( [Perez-Garci et al., 2001](#B158) ; [Cantero et al., 2004](#B34) ; [Massimini et al., 2005](#B136) ; [Montgomery et al., 2008](#B148) ), when cortical NA is at its lowest level. Thus, the cortex, and particularly the prefrontal cortex (which is the most phylogenetically recent structure to appear, responsible for the highest integrated processes), is impaired during REM sleep, as evidenced by its deactivation in the dorsolateral area and partly by the decrease in NA release. Simultaneously, the availabilities of dopamine ( [Léna et al., 2005](#B123) ), serotonin ( [Cespuglio et al., 1992](#B40) ), and acetylcholine ( [Marrosu et al., 1995](#B135) ) are also reduced, while the level of glutamate remains unchanged ( [Gottesmann, 2005a](#B77) ; [Léna et al., 2005](#B123) ).

Another property of REM sleep is the inhibition of sensory afferents ( [Williams et al., 1962](#B209) , [1964](#B208) ), which was first shown through an increased arousal threshold by peripheral stimulation ( [Dement and Kleitman, 1957](#B46) ; [Dement, 1958](#B48) ; for ref. see [Gottesmann, 2001](#B76) ). The notion of an involvement of cortical deactivation of primary sensory cortices ( [Braun et al., 1998](#B28) ) in the inhibition of afferents has been strongly challenged ( [Hong et al., 2009](#B101) ; [Miyauchi et al., 2009](#B147) ). The thalamic transmission process is under the positive influence of postsynaptic α 1 receptors, while α 2 and β receptors mediate inhibition; the facilitating influences follow an inverted U-curve ( [Devilbiss et al., 2006](#B51) ). During REM sleep, the decrease in noradrenaline levels possibly shifts the curve to the best functional level ( [Alsene et al., 2011](#B2) ), favoring postsynaptic activation ( [Sakakura and Iwama, 1965](#B171) ; [Iwama et al., 1966](#B103) ; [Dagnino et al., 1969](#B44) ; [Ghelarducci et al., 1970](#B71) ; [Gandolfo et al., 1980](#B70) ). In addition, the decreased NA level observed during REM sleep has both ascending and descending postsynaptic influences on thalamocortical neurons, since in addition to the above described ascending processes, corticothalamic glutamatergic influences ( [McCormick and Krosigk, 1992](#B137) ; [Bonjean et al., 2011](#B22) ) are also disinhibited through NA silencing ( [Castro-Alamancos and Calcagnotto, 2001](#B36) ). In contrast, vestibular influences ( [Morrison and Pompeiano, 1966](#B149) ) and the (GABAergic) activation (or disinhibition) of the thalamic reticular nucleus ( [Hong et al., 2009](#B101) ) inhibit thalamic inputs. Indeed, it has been consistently shown that, particularly during the REM bursts occurring during REM sleep, there is a presynaptic inhibition of thalamic input ( [Sakakura and Iwama, 1965](#B171) ; [Iwama et al., 1966](#B103) ; [Dagnino et al., 1969](#B44) ; [Ghelarducci et al., 1970](#B71) ; [Gandolfo et al., 1980](#B70) ). This presynaptic inhibition can explain the increased sensory and arousal threshold that is present during REM sleep. Moreover, the absence of gamma rhythm resetting by peripheral stimulation during REM sleep ( [Llinas and Ribary, 1993](#B127) ) is presumably also related to sensory deafferentation. Finally, REM sleep is also characterized by an unexpected shortening of the cortical recovery cycle of responsiveness in both animals ( [Rossi et al., 1965](#B170) ; [Allison, 1968](#B1) ) and humans, as shown by deficits in prepulse inhibition ( [Kisley et al., 2003](#B115) ). This failure of gate-control processes is certainly at least partly related to cortical NA disinhibition.

To conclude, although some results have supported the notion that the above described waking learning processes are replicated during REM sleep ( [Smith and Lapp, 1991](#B183) ; [Hennevin et al., 1995](#B94) , [2007](#B95) ; [Smith, 1995](#B182) ; [Peigneux et al., 2003](#B156) ) despite a strong NA deficit, these conclusions have been strongly disputed ( [Siegel, 2001](#B181) ; [Vertes, 2004](#B199) ; [Vertes and Siegel, 2005](#B200) ). Finally, and surprisingly, the rapid evanescence of dreams at arousal could be related to both the precocious recovery of waking NA processes ( [Gottesmann, 2008](#B81) ) and to the re-establishment associated with the late recovery of dorsolateral prefrontal cortex function ( [Balkin et al., 2002](#B13) ); both of these processes induce the withdrawal of insufficiently recorded memory traces.

Although the cortex and principally the “ prefrontal circuits have the unique ability… to guide behavior, thought, and affect” ( [Ramos and Arnsten, 2007](#B162) ), other forebrain structures are also strongly involved in determining the mental activity associated with REM sleep.

## The First Next Major Structure Involved in Mentation is the Nucleus Accumbens

Dysfunction of this limbic structure is responsible for mental disturbances such as hallucinations and delusion. For decades, the main neuromodulator involved in its function was thought to be dopamine ( [MacKay et al., 1982](#B128) ). However, it is now known that the nucleus accumbens is subjected to strong glutamatergic influences originating from the prefrontal cortex ( [Brake et al., 2000](#B26) ; [Jackson et al., 2001](#B104) ), hippocampus ( [Lipska et al., 1993](#B126) ), and amygdala ( [Floresco et al., 1998](#B60) ). This structure also has NA afferents mainly originating in the medulla oblongata A 1 and A 2 nuclei, and secondarily from the LC ( [Delfs et al., 1998](#B45) ). These influences are now considered to be important, since the NA concentration in the nucleus accumbens is as high as that of dopamine ( [Tong et al., 2006](#B193) ) and varies in parallel with the level of glutamate ( [Swanson and Schoepp, 2003](#B187) ; [Léna et al., 2005](#B123) ).

Accumbal NA release is controlled by presynaptic α 2 autoreceptors, the sensitivity of which varies with the NA concentration at the synapse ( [Aono et al., 2007](#B3) ; [Verhelj and Cools, 2009a](#B197) ). Alpha-2 receptor agonists promote dopamine release by inhibiting NA release ( [Pothos et al., 1991](#B159) ), and postsynaptic α 2 receptors (heteroreceptors) inhibit dopamine release ( [Verhelj and Cools, 2009b](#B198) ). In some cases, β receptor activation favors dopamine release ( [Misoguchi et al., 2008](#B145) ; [Verhelj and Cools, 2009b](#B198) ). However, the activation thresholds of the different NA receptors (again, α 2 < α 1 < β favor NA-mediated inhibition of dopamine release; as evidence of this, dopamine release is only increased after massive NA concentrations are attained by inhibition of reuptake ( [Misoguchi et al., 2008](#B145) ). Finally, noradrenaline also controls dopamine availability, as there is dopamine uptake at NA terminals ( [Carboni and Silvagni, 2004](#B35) ).

During REM sleep, the activation of the nucleus accumbens is evidenced by the presence of even more active neuron firing than occurs during waking ( [Callaway and Henriksen, 1992](#B33) ). The concentration of NA is minimal during this sleep stage ( [Léna et al., 2005](#B123) ). Although the A 1 and A 2 medulla oblongata nuclei have not been recorded during the sleep–waking cycle, they seem to be inhibited during REM sleep-like the LC; as confirmation of this, the firing of another low brainstem NA nucleus, A 5 , also becomes silent during REM sleep ( [Fenik et al., 2002](#B56) ). Because of the above described different influences that NA has on the regulation of dopamine, the near absence of NA is presumably, at least in part, responsible for the maximal dopamine release that takes place during REM sleep ( [Léna et al., 2005](#B123) ), and could explain the abnormal mental activity of dreaming, with its hallucinations and delusions characteristic of high accumbal levels of dopamine ( [MacKay et al., 1982](#B128) ).

In contrast to aspartate, glutamate release also decreases during REM sleep ( [Léna et al., 2005](#B123) ). This could be related to the prefrontal dorsolateral deactivation ( [Maquet et al., 1996](#B134) ; [Braun et al., 1997](#B27) ), but could also partly result from hippocampal dysfunction. Indeed, although the same theta rhythm is present during REM sleep ( [Cadilhac et al., 1961](#B32) ; [Michel et al., 1961](#B143) ) as during active waking ( [Jung and Kornmüller, 1938](#B112) ; [Green and Arduini, 1954](#B87) ), hippocampal function should be different, particularly because of the noradrenergic ( [Segal, 1974](#B174) ; [Segal and Bloom, 1976](#B177) ) and serotonergic ( [Segal, 1981](#B175) , [1990](#B176) ) silence observed during REM sleep. For example, a nearly continuous hippocampal theta rhythm is observed not only in “ cerveau isolé” transected cats ( [Tokizane, 1965](#B192) ; [Olmstead and Villablanca, 1977](#B154) ) and rats ( [Gottesmann et al., 1980](#B85) ), but also in transections injuring the posterior hypothalamus ( [Glin et al., 1991](#B72) ). Thus, hippocampal electrophysiological field activity is not a faithful criteria of the functional state of this structure ( [Gottesmann, 2000](#B75) ) or of the level of glutamate released during REM sleep.

## The Second Structure I will Address here is the Amygdala

The amygdala is the main central structure involved in encoding emotional information and promoting avoidance learning storage ( [Ferry et al., 1999](#B58) ). Its afferents bring affectively charged information from the environment, and the amygdala triggers appropriate emotional responses. Several nuclei have a predominant function, and the output of the amygdala is primarily influenced by NA, as 54% of pyramidal neurons respond to NA whereas only nearly 3% respond to dopamine ( [Miyajima et al., 2010](#B146) ). First, the basolateral complex is considered one functional unit, since the basalis and lateral nuclei react similarly to NA, being inhibited in 64 and 74% of cases, respectively ( [Buffalari and Grace, 2007](#B29) ). The basolateral complex is reciprocally related to the LC, with each structure activating the other. However, the amygdala also receives afferents from the medulla oblongata NA A 1 and A 2 nuclei. The centralis nucleus seems to be under the inhibitory control of the basolateral complex, and its efferents on the one hand are directed to the LC, also activating A 2 and adrenergic C 2 nuclei ( [Wallace et al., 1992](#B201) ; [Bouret et al., 2003](#B24) ; the latter controlling LC functioning), and on the other hand promote hypothalamic vegetative influences supporting behavioral characteristics of stress ( [Cecchi et al., 2002](#B39) ; [Buffalari and Grace, 2007](#B29) ). It is noteworthy that, in the same way, dorsal raphe nucleus afferents to the centralis nucleus inhibit the neurons ( [Jha et al., 2005](#B105) ), leading to a complementary disinhibition of glutamate output during REM sleep ( [Grace, 2000](#B86) ; [Tran and Keele, 2011](#B195) ), and as a consequence of this, a reinforced affective load of mentation.

Both stimulation of the LC and stress increase the release of NA in the basolateral area ( [Buffalari and Grace, 2007](#B29) ), and NA deficits impair the consolidation of avoidance reactions and suppress c-Fos expression in the amygdala ( [Radwanska et al., 2010](#B161) ). Noradrenaline infusion into the basolateral area inhibits the majority of pyramidal neurons by activating GABAergic interneurons ( [Kaneko et al., 2008](#B113) ) via the activation of α 1 receptors ( [Lazzaro et al., 2010](#B121) ). Emotional memory consolidation by NA has been confirmed in humans, since clonidine (an α 2 receptor agonist) inhibits this process ( [Groch et al., 2011](#B89) ), while reboxetine (a reuptake inhibitor) promotes it ( [Gais et al., 2011](#B69) ). Moreover, the α 2 receptor antagonist idazoxan infused into the basolateral amygdala enhances avoidance memory consolidation ( [Ferry and McGaugh, 2008](#B57) ). Finally, while NA and β-agonists favor avoidance memory consolidation while requiring α 1 receptor activation in a first step ( [Ferry et al., 1999](#B58) ), magnetic resonance imaging (MRI) has shown that activation of the amygdala by emotional pictures, or verbal stimuli can be decreased by blockade of the β receptor ( [Strange and Dolan, 2004](#B186) ; [Stegeren van et al., 2005](#B185) ); consistent with this, β antagonists are used as anxiolytics ( [Hurlemann et al., 2010](#B102) ).

The amygdala is activated during REM sleep, as was first shown by neuron recordings. There are units firing at a higher rate than during SWS (similar to the rate observed during waking; [Reich et al., 1983](#B168) ; [Zhang et al., 1986](#B211) ; [Gulyani et al., 2002](#B91) ), as well as REM sleep-on specific neurons, which fire at high or low rates and which are disinhibited because of, at least in part, NA silence. Indeed, as both LC stimulation and footshocks inhibit neurons of the amygdala ( [Chen and Sara, 2007](#B41) ), the silence or near silence of LC neurons during REM sleep should also disinhibit the amygdala. Indeed, NA is strongly reduced in the amygdala during REM sleep [by from 61 ( [Park, 2002](#B155) ) to 85% ( [Shouse et al., 2000](#B180) ) as compared to waking]. In addition, tomographic studies have also shown that the amygdala is activated during REM sleep ( [Maquet and Franck, 1997](#B133) ).

Since glutamate release is decreased in the nucleus accumbens during REM sleep, very probably as a result of prefrontal and hippocampal dysfunction, the remaining accumbal glutamate could mainly be a product of the (NA-mediated) disinhibition of the amygdala ( [Grace, 2000](#B86) ). The NA deficit present during REM sleep, like experimental deficits induced during waking, could impair amygdala ( [Strange and Dolan, 2004](#B186) ) and hippocampal-based ( [Kukolja et al., 2011](#B120) ) emotional encoding, and retrieval of mental processes ( [Murchison et al., 2011](#B150) ); this is the case even though an often excessive emotional activity is operative during REM sleep, explaining affectively loaded dreams. Moreover, glutamate release by the activation of the amygdala could participate in the increase in dopamine in the nucleus accumbens ( [Floresco et al., 1998](#B60) ), promoting hallucinations, and delusions during dreaming. As seen above, the nature of the emotional load during SOREM and REM sleep dreams appears to be different. Certainly partly due to NA influence, this distinction is probably related to differences in glutamate output in the amygdala. In this structure, NA seems to be more involved in the affective quality of mental activity than in the encoding of dreams, since SOREM dreams are not known to be better retrieved than REM sleep dreams.

A complementary neurobiological alternative to explain the rapid evanescence of dreams upon awakening ( [Gottesmann, 2006](#B79) , [2008](#B81) ) could be the usually rapid reappearance of NA in the few seconds prior to behavioral arousal ( [Aston-Jones and Bloom, 1981a](#B10) ; [Takahashi et al., 2010](#B189) ). This precocious restoration of some forebrain waking processes, with a highly probable re-establishment of intracortical ( [Perez-Garci et al., 2001](#B158) ; [Corsi-Cabrera et al., 2003](#B43) ), intra-hippocampal ( [Montgomery et al., 2008](#B148) ), and hippocampo-cortical ( [Cantero et al., 2004](#B34) ) relations, could erase previous fragile memory traces ( [Gottesmann, 2008](#B81) ). This possible NA-mediated basis for forgetting upon exit from REM sleep could be reinforced by the later recovery of function in the prefrontal cortex ( [Balkin et al., 2002](#B13) ), the brain area involved in long-term memory storage.

## Discussion

As recalled above, the forebrain is an interdependent ensemble of structures which are subjected to numerous neurotransmitters and neuromodulators acting simultaneously at different types of receptors situated presynaptically, postsynaptically, or both; further, several types of receptors, noradrenergic in the present case, can be localized on the same target neurons with distinct activation thresholds. Moreover, a single structure, here the LC, can project to and differently influence several forebrain areas: the LC maximally influences the somatosensory cortex when tonically firing at 0. 5 Hz, whereas in the thalamic ventroposterior medial nucleus the highest sensitivity occurs at 1 Hz stimulation. Moreover, such LC firing inhibits the somatosensory cortex neurons in 63% of cases, whereas it activates the thalamic neurons in 65% of cases ( [Devilbiss and Waterhouse, 2004](#B52) ). Thus, interpreting the neurochemical basis of mental activities requires caution, all the more so since 31% of somatosensory cortex neurons are activated by NA.

Although today this notion has been partly questioned ( [Domhoff, 2007](#B53) ), the main characteristic of REM sleep mentation is its similarity to symptoms of schizophrenia ( [Gottesmann, 1999](#B74) , [2005a](#B77) , [2006](#B79) ); indeed, 11 published neurobiological properties of REM sleep ( [Gottesmann, 2007](#B80) , [2010a](#B82) ) represent powerful potential endophenotypes ( [Gottesman and Gould, 2003](#B73) ) of this disease ( [Gottesmann and Gottesman, 2007](#B84) ; [Gottesmann, 2010a](#B82) ). It is noteworthy that although some neurobiological criteria of REM sleep are also encountered in syndromes like depression and bipolar psychotic disorders, we have now identified fourteen strong similarities with schizophrenia. As confirmation of this, NA reuptake inhibiting factors are included in antipsychotic formulations ( [Friedman et al., 1999](#B67) ; [Linner et al., 2002](#B125) ) because of the deficit of this neuromodulator in schizophrenia, although this is also the case in other conditions, particularly depression.

Moreover, NA promotes prefrontal attentional processes, and although its decrease cannot be expected to single-handedly account for dorsolateral prefrontal deactivation – which also occurs in schizophrenia, particularly when cognitive performances are impaired ( [Buschbaum et al., 1982](#B31) ; [Weinberger et al., 1986](#B207) ; [Berman et al., 1993](#B18) ; [Fletcher et al., 1998](#B59) ) – the NA deficit seen in both states seems at least to be responsible for the anarchic firing of cortical pyramidal neurons ( [Evarts, 1964](#B55) ; [McCormick et al., 1991](#B138) ). This reduced efficiency of cognitive processes during REM sleep and in schizophrenia is certainly related to the decrease in the signal/noise ratio of neuron activity. In the same way, NA favors gamma rhythm activity. The lowered NA level in both states could explain the corresponding cerebral disconnections, as shown by the disappearance of coupled gamma activity during REM sleep (see above) as well as the dysfunction in this rhythm in schizophrenia ( [Uhlaas and Singer, 2010](#B196) ), a complementary index of impaired intracerebral relations ( [Young et al., 1998](#B210) ; [Meyer-Lindenberg et al., 2001](#B142) , [2005](#B141) ; [Peled et al., 2001](#B157) ; [Kubicki et al., 2008](#B118) ). Moreover, in the nucleus accumbens, which is involved in the hallucinations and delusions observed in both states, the decrease in NA is, at least in part, responsible for the increased level of dopamine ( [Pothos et al., 1991](#B159) ); this occurs by disinhibition of release and loss of uptake in NA terminals ( [Carboni and Silvagni, 2004](#B35) ). Finally, in the amygdala, the lower level of NA during REM sleep disinhibits the pyramidal neurons, allowing the activated structure (see above) to excessively manifest itself, particularly by glutamate release in the nucleus accumbens; this results from deficits in prefrontal and hippocampal afferents ( [Grace, 2000](#B86) ) and promotes the threatened mental activity often encountered during dreaming and in schizophrenia.

Another possible relationship between dreaming and schizophrenia has been shown by responsiveness studies, which have demonstrated the presence of a cortical disinhibition in animals and humans that takes place during REM sleep and which could be consecutive to an NA decrease; the same disinhibition has been observed in schizophrenia by a deficit in prepulse inhibition ( [Kisley et al., 2003](#B115) ). The thalamic sensory deafferentation that occurs during REM sleep due to presynaptic inhibition of afferents, could contribute both to this sleep stage and to schizophrenic hallucinations ( [Behrendt and Young, 2005](#B14) ). The involvement of NA in thalamic transmission processes could also be hypothesized based on the difference in the sensory arousal threshold during SOREM, when it is low ( [Dement and Kleitman, 1957](#B46) ; and personal observations) while the NA level is very probably close to the waking level, and during REM sleep, when the threshold is high (see above) while NA is very low. However, mismatch negativity, an index of a kind of sensory detection, can be observed not during SWS but during SOREM ( [Nittono et al., 2001](#B153) ) and REM sleep ( [Sculthorpe et al., 2009](#B173) ), revealing a similar “ pre-conscious level of processing” ( [Sculthorpe et al., 2009](#B173) ), or a kind of “ protoconsciousness” ( [Hobson, 2009](#B97) ).

Finally, it is possible that the muscular atonia present during REM sleep ( [Jouvet and Michel, 1959](#B110) ; [Berger, 1961](#B15) ; [Michel et al., 1961](#B143) ), which is induced by lower brainstem processes ( [Jouvet and Mounier, 1960](#B111) ; [Jouvet and Delorme, 1965](#B109) ; [Henley and Morrison, 1974](#B93) ), conceals some symptoms of attention deficit hyperactivity disorder (ADHD), which is also related to an NA deficit ( [Arnsten and Dudley, 2005](#B5) ; [Arnsten and Pliszka, 2011](#B9) ; [Gronier, 2011](#B90) ). Indeed, the “ vivid” mentation of REM sleep ( [Reeves et al., 2001](#B167) ), the classical jumping from one subject to another, the emotional instability, and the impulsivity, attention, and memory consolidation deficits ( [Prehn-Kristensen et al., 2011](#B160) ) are also encountered in ADHD. In both states, there is an impairment of inhibitory control processes regulating mentation and behavior, i. e., a kind of “ say no” ( [Aston-Jones and Gold, 2009](#B12) ) ability deficit, which is partly related to right inferior frontal ( [Aston-Jones and Gold, 2009](#B12) ) and left dorsolateral prefrontal dysfunction ( [Burgess et al., 2010](#B30) ); both of these are concomitant to the NA decrease. While Methylphenidate, a dopamine/NA reuptake inhibitor, improves ADHD by activating prefrontal dopamine D 1 as well as NAα 2a receptors ( [Gronier, 2011](#B90) ) (the latter at least partly located on GABAergic interneurons: [Wang et al., 2011](#B202) ), the more specific α 2a , agonist guanfacine, while also acting on postsynaptic α 2a receptors in the dorsolateral prefrontal cortex ( [Arnsten, 2011](#B4) ), also improves patients with ADHD ( [Scahill et al., 2001](#B172) ; [Biederman et al., 2008](#B21) ; [Kollins et al., 2011](#B116) ).

Thus, partly related to the NA deficit, the dorsolateral prefrontal deactivation occurring during REM sleep, together with consecutive or simultaneous amygdala, and nucleus accumbens disinhibition, could provide the basis for the emotional and psychotic-like – and most often not definitively stored – dreaming activity that takes place during this sleep phase. At the same time, similar prefrontal deficits and correlative activation and disinhibition of other main cortical areas could explain the usually lively, unstable, and disorganized mental content of dreams, which is also observed in ADHD: “ deficits in prefrontal cortex function are evident in most neuropsychiatric disorders” ( [Ramos and Arnsten, 2007](#B162) ).

## Conflict of Interest Statement

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## References

Allison, T. (1968). Recovery cycles of primary evoked potentials in cats sensorimotor cortex. *Experientia* 24, 240–241.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=5661415) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=5661415) | [CrossRef Full Text](http://dx.doi.org/10.1007/BF02152792)

Alsene, K. M., Rajbhandari, A. K., Bamaker, M. J., and Bakshi, V. P. (2011). Discrete forebrain neuronal networks supporting noradrenergic regulation of sensorimotor gating. *Neuropsychopharmacology* 36, 1003–1014.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21248721) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21248721) | [CrossRef Full Text](http://dx.doi.org/10.1038/npp.2011.47)

Aono, Y., Saigusa, T., Watanabe, S., Iwakami, T., Mizoguchi, N., Ikeda, H., Oshige, K., Tomiyama, K., Oi, Y., Ueda, K., Rausch, W. D., Waddington, J. L., Ito, Y., Koshikawa, N., and Cools, A. R. (2007). Role of alpha adrenoceptors in the nucleus accumbens in the control of accumbal noradrenaline efflux: a microdialysis study with freely moving rats. *J. Neural Transm.* 114, 1135–1142.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17533511) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17533511) | [CrossRef Full Text](http://dx.doi.org/10.1007/s00702-007-0745-1)

Arnsten, A. F. (2011). Catecholamine influences on dorsolateral prefrontal cortical networks. *Biol. Psychiatry* 69, e89–e99.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21489408) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21489408) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.biopsych.2011.03.010)

Arnsten, A. F., and Dudley, A. G. (2005). Methylphenidate improves prefrontal cortical cognitive function through alpha2 adrenoceptor and dopamine D1 receptor actions: relevance to therapeutic effects in attention deficit hyperactivity disorder. *Behav. Brain Funct.* 1, 2.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=15916700) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=15916700) | [CrossRef Full Text](http://dx.doi.org/10.1186/1744-9081-1-2)

Arnsten, A. F., and Jentsch, J. D. (1997). The alpha-1 adrenergic agonist, cirazoline, impairs spatial working memory in aged monkeys. *Pharmacol. Biochem. Behav.* 58, 55–59.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9264070) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9264070) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0091-3057%2896%2900477-7)

Arnsten, A. F., and Li, B. M. (2005). Neurobiology of executive functions: catecholamine influences on prefrontal cortical functions. *Biol. Psychiatry* 57, 1377–1384.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=15950011) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=15950011) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.biopsych.2004.08.019)

Arnsten, A. F., Mathew, R., Ubriani, R., Taylor, J. R., and Li, B. M. (1999). Alpha-1noradrenergic receptor stimulation impairs prefrontal cortical cognitive function. *Biol. Psychiatry* 45, 26–31.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9894572) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9894572) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0006-3223%2898%2900296-0)

Arnsten, A. F., and Pliszka, S. R. (2011). Catecholamine influences on prefrontal cortical function: relevance to treatment of attention deficit/hyperactivity disorder and related disorders. *Pharmacol. Biochem. Behav.* 99, 211–216.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21295057) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21295057) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.pbb.2011.01.020)

Aston-Jones, G., and Bloom, F. E. (1981a). Activity of norepinephrine-containing neurons in behaving rats anticipates fluctuations in the sleep-waking cycle. *J. Neurosci.* 1, 876–886.

Aston-Jones, G., and Bloom, F. E. (1981b). Norepinephrine-containing locus coeruleus neurons in behaving rat exhibit pronounced responses to non-noxious environmental stimuli. *J. Neurosci.* 1, 887–900.

Aston-Jones, G., and Gold, J. I. (2009). How we say no: norepinephrine, inferior frontal gyrus, and response inhibition. *Biol. Psychiatry* 65, 548–549.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=19281881) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=19281881) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.biopsych.2009.01.022)

Balkin, T. J., Braun, A. R., Wesensten, N. J., Jeffries, K., Varga, M., Baldwin, P., Belenky, G., and Herscovitch, P. (2002). The process of awakening: a PET study of regional brain activity patterns mediating the re-establishment of alertness and consciousness. *Brain* 125, 2308–2319.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12244087) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=12244087) | [CrossRef Full Text](http://dx.doi.org/10.1093/brain/awf228)

Behrendt, R. P., and Young, C. (2005). Hallucinations in schizophrenia, sensory impairment and brain disease: an unified model. *Behav. Brain Sci.* 27, 771–787.

Berger, R. (1961). Tonus of extrinsic laryngeal muscles during sleep and dreaming. *Science* 134, 840.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17817398) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17817398) | [CrossRef Full Text](http://dx.doi.org/10.1126/science.134.3482.840)

Berger, R. J., and Oswald, I. (1962). Eye movements during active and passive dreams. *Science* 137, 601.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=13867678) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=13867678) | [CrossRef Full Text](http://dx.doi.org/10.1126/science.137.3530.601)

Berlucchi, G. (1997). One or many arousal system? Reflections on some of Guiseppe Moruzzi’s foresights and insights about intrinsic regulation of brain activity. *Arch. Ital. Biol.* 135, 5–14.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9139583) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9139583)

Berman, K. F., Doran, A. R., Pickar, D., and Weinberger, D. R. (1993). Is the mechanism of prefrontal hypofunction in depression the same as in schizophrenia? Regional cerebral blood flow during cognitive activation. *Br. J. Psychiatry* 162, 183–192.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=8435688) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=8435688) | [CrossRef Full Text](http://dx.doi.org/10.1192/bjp.162.2.183)

Berridge, C. W., Page, M. E., Valentino, R. J., and Foote, S. L. (1993). Effects of locus coeruleus inactivation on electroencephalographic activity in neocortex and hippocampus. *Neuroscience* 55, 381–393.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=8104319) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=8104319) | [CrossRef Full Text](http://dx.doi.org/10.1016/0306-4522%2893%2990507-C)

Berridge, C. W., and Waterhouse, B. D. (2003). The locus coeruleus-noradrenergic system: modulation of behavioral state and state-dependent cognitive processes. *Brain Res. Rev.* 42, 33–84.

[CrossRef Full Text](http://dx.doi.org/10.1016/S0165-0173%2803%2900143-7)

Biederman, J., Melmed, R. D., McBurnett, K., Donahue, J., and Lyne, A. (2008). Long-term, open-label extension study of guanfacine extended release in children and adolescents with ADHD. *CNS Spectr.* 13, 1047–1055.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=19179940) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=19179940)

Bonjean, M., Baker, T., Lemieux, M., Timofeev, I., Sejnowski, T. J., and Bazhenov, M. (2011). Corticothalamic feedback controls sleep spindle duration in vivo. *J. Neurosci.* 31, 9124–9134.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21697364) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21697364) | [CrossRef Full Text](http://dx.doi.org/10.1523/JNEUROSCI.0077-11.2011)

Bosinelli, M. (1995). Mind and consciousness during sleep. *Brain Res.* 69, 195–201.

Bouret, S., Duvel, A., Onat, S., and Sara, S. J. (2003). Phasic activation of locus coeruleus neurons by the central nucleus of the amygdala. *J. Neurosci.* 23, 3491–3497.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12716958) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=12716958)

Bouret, S., and Sara, S. J. (2005). Network reset: a simplified overarching theory of locus coeruleus noradrenaline function. *Trends Neurosci.* 28, 574–582.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=16165227) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=16165227) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.tins.2005.09.002)

Brake, W. G., Flores, G., Francis, D., Meaney, M. J., Srivastava, L. K., and Gratton, A. (2000). Enhanced nucleus accumbens dopamine and plasma corticosterone stress responses in adult rats with neonatal excitotoxic lesions to the medial prefrontal cortex. *Neuroscience* 96, 687–695.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=10727787) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=10727787) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0306-4522%2800%2900002-6)

Braun, A. R., Balkin, T. J., Wesensten, N. J., Carson, R. E., Varga, M., Baldwin, P., Selbie, S., Belenky, G., and Herscovitch, P. (1997). Regional cerebral blood flow throughout the sleep-wake cycle: an 150 PET study. *Brain* 120, 1173–1197.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9236630) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9236630) | [CrossRef Full Text](http://dx.doi.org/10.1093/brain/120.5.761)

Braun, A. R., Balkin, T. J., Wesensten, N. J., Gwardry, f., Carson, R. E., Varga, M., Baldwin, P., Belenky, G., and Herscovitch, P. (1998). Dissociated pattern of activity in visual cortices and their projections during human rapid eye movement sleep. *Science* 279, 91–95.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9417032) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9417032) | [CrossRef Full Text](http://dx.doi.org/10.1126/science.279.5347.91)

Buffalari, D. M., and Grace, A. A. (2007). Noradrenergic modulation of basolateral amygdala neuronal activity: opposing influences of alpha-2 and beta receptor activation. *J. Neurosci.* 27, 12358–12366.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17989300) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17989300) | [CrossRef Full Text](http://dx.doi.org/10.1523/JNEUROSCI.2007-07.2007)

Burgess, G. C., Depue, B. E., Ruzic, L., Willcutt, E. G., Du, Y. P., and Banich, M. T. (2010). Attentional control activation relates to working memory in attention-deficit/hyperactivity disorder. *Biol. Psychiatry* 67, 632–640.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=20060961) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=20060961) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.biopsych.2009.10.036)

Buschbaum, M. S., Ingvar, D. H., Kessler, R., Waters, R. N., Cappelletti, J., Van Kammen, D. P., King, A. C., Johnson, J. L., Manning, R. G., Flynn, R. W., Bunney, W. E. J., and Sokoloff, L. (1982). Cerebral glucography with positron tomography, use in normal subjects and in patients with schizophrenia. *Arch. Gen. Psychiatry* 39, 251–259.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=6978119) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=6978119) | [CrossRef Full Text](http://dx.doi.org/10.1001/archpsyc.1982.04290030001001)

Cadilhac, J., Passouant-Fontaine, T., and Passouant, P. (1961). Modifications de l’activité de l’hippocampe suivant les divers stades du sommeil spontané chez le Chat. *Rev. Neurol.* 105, 171–176.

Callaway, C. W., and Henriksen, S. I. (1992). Neuronal firing in the nucleus accumbens is associated with the level of cortical arousal. *Neuroscience* 51, 547–553.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=1488114) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=1488114) | [CrossRef Full Text](http://dx.doi.org/10.1016/0306-4522%2892%2990294-C)

Cantero, J. L., Atienza, M., Madsen, J. R., and Stickgold, R. (2004). Gamma EEG dynamics in neocortex and hippocampus during human wakefulness and sleep. *Neuroimage* 22, 1271–1280.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=15219599) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=15219599) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neuroimage.2004.03.014)

Carboni, E., and Silvagni, A. (2004). Dopamine reuptake by norepinephrine neurons: exception or rule? *Crit. Rev. Neurobiol.* 16, 121–128.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=15581407) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=15581407) | [CrossRef Full Text](http://dx.doi.org/10.1615/CritRevNeurobiol.v16.i12.130)

Castro-Alamancos, M. A., and Calcagnotto, M. E. (2001). High-pass filtering of corticothalamic activity by neuromodulators released in the thalamus during arousal: in vitro and in vivo. *J. Neurophysiol.* 85, 1489–1497.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11287472) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11287472)

Cavallero, C. (2003). “ REM sleep = dreaming: the never-ending story,” in *Sleep and Dreaming. Scientific Advances and Reconsideration* , eds E. Pace-Schott, M. Solms, M. Blagrove, and S. Harnard (Cambridge: Cambridge University Press), 127–128.

Cavallero, C. P. Cicogna, V., Natale, M., and Occhionero, A. Z. (1992). Slow wave sleep dreaming. *Sleep* 15, 562–566.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=1475572) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=1475572)

Cecchi, M., Khoshbouei, H., and Morilak, D. A. (2002). Modulatory effects of norepinephrine, acting on alpha 1 receptors in the central nucleus of the amygdala, on behavioral and neuroendocrine response to acute immobilization stress. *Neuropharmacology* 43, 1139–1147.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12504920) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=12504920) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0028-3908%2802%2900292-7)

Cespuglio, R., Houdouin, F., Oulerich, M., El Mansari, M., and Jouvet, M. (1992). Axonal and somato-dendritic modalities of serotonin release: their involvement in sleep regulation, triggering and maintenance. *J. Sleep Res.* 1, 150–156.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=10607044) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=10607044) | [CrossRef Full Text](http://dx.doi.org/10.1111/j.1365-2869.1992.tb00030.x)

Chen, F. J., and Sara, S. J. (2007). Locus coeruleus activation by foot shock or electrical stimulation inhibits amygdala neurons. *Neuroscience* 144, 472–481.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17097235) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17097235) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neuroscience.2006.09.037)

Chiodo, L. A., Acheson, A. L., Zigmond, M. J., and Stricker, E. M. (1983). Subtotal destruction of central noradrenergic projections increases the firing rate of locus coeruleus cells. *Brain Res.* 264, 123–126.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=6133579) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=6133579) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2883%2991128-9)

Corsi-Cabrera, M., Miro, E., del Rio Portilla, Y., Perez-Garci, E., Villanueva, Y., and Guevera, M. (2003). Rapid eye movement sleep dreaming is characterized by uncoupled EEG activity netween frontal abd perceptual cortical regions. *Brain Cogn.* 51, 337–345.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12727188) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=12727188) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0278-2626%2803%2900037-X)

Dagnino, N., Favale, E., Loeb, C., Manfredi, M., and Seitun, A. (1969). Presynaptic and postsynaptic changes in specific thalamic nuclei during deep sleep. *Arch. Ital. Biol.* 107, 668–684.

Delfs, J. M., Zhu, Y., Druhan, J. P., and Aston-Jones, G. S. (1998). Origin of noradrenergic afferents to the shell subregion of the nucleus accumbens: anterograde and retrograde tract-tracing studies in the rat. *Brain Res.* 806, 127–140.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9739125) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9739125) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0006-8993%2898%2900672-6)

Dement, W., and Kleitman, N. (1957). Cyclic variations in EEG during sleep and their relation to eye movements, body motility, and dreaming. *Electroencephalogr. Clin. Neurophysiol.* 9, 673–690.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=13480240) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=13480240) | [CrossRef Full Text](http://dx.doi.org/10.1016/0013-4694%2857%2990088-3)

Dement, W., and Wolpert, E. A. (1958). The relation of eye movements, body motility, and external stimuli to dream content. *J. Exp. Psychol.* 55, 543–553.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=13563767) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=13563767) | [CrossRef Full Text](http://dx.doi.org/10.1037/h0040031)

Dement, W. C. (1958). The occurrence of low voltage fast electroencephalogram patterns during behavioral sleep in the cat. *Electroencephalogr. Clin. Neurophysiol.* 10, 291–296.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=13548075) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=13548075) | [CrossRef Full Text](http://dx.doi.org/10.1016/0013-4694%2858%2990037-3)

Dement, W. C. (1965). Dreams and dreaming. *Int. J. Neurol.* 5, 168–186.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=5878145) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=5878145)

Descarries, L., Watkins, K. C., and Lapierre, Y. (1977). Noradrenergic axon terminals in the cerebral cortex of rats III. Topometric ultrastructural analysis. *Brain Res.* 133, 197–222.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=902092) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=902092) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2877%2990759-4)

Devilbiss, D. M., Page, M., and Waterhouse, B. D. (2006). Locus coeruleus regulates sensory encoding by neurons and networks in waking animals. *J. Neurosci.* 26, 9860–9872.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17005850) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17005850) | [CrossRef Full Text](http://dx.doi.org/10.1523/JNEUROSCI.1776-06.2006)

Devilbiss, D. M., and Waterhouse, B. D. (2004). The effects of tonic locus coeruleus output on sensory-evoked responses of ventral posterior medial thalamus and barrel field cortical neurons in the awake rat. *J. Neurosci.* 24, 10773–10785.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=15574728) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=15574728) | [CrossRef Full Text](http://dx.doi.org/10.1523/JNEUROSCI.1573-04.2004)

Domhoff, G. W. (2007). “ Realistic stimulation and bizarreness in dream content: past findings and suggestions for future research,” in *The New Science of Dreaming* , Vol. 2, eds D. Barrett and P. McNamara (Westport: Praeger), 1–27.

Euston, D. R., Tatsuno, M., and McNaughton, B. L. (2007). Fast-forward playback of recent memory sequences in prefrontal cortex during sleep. *Science* 318, 1147–1150.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18006749) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18006749) | [CrossRef Full Text](http://dx.doi.org/10.1126/science.1148979)

Evarts, E. V. (1964). Temporal patterns of discharge of pyramidal tract neurons during sleep and waking in the monkey. *J. Neurophysiol.* 27, 152–171.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=14129768) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=14129768)

Fenik, V., Marchenko, V., Janssen, P., davies, R. O., and Kubin, L. (2002). A5 cells are silenced when REM sleep-like signs are elicited by pontine carbachol. *J. Appl. Physiol.* 93, 1448–1456.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12235046) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=12235046)

Ferry, B., and McGaugh, J. L. (2008). Involvement of basolateral amygdala alpha adrenoreceptors in modulating consolidation of inhibitory avoidance memory. *Learn. Mem.* 15, 238–243.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18391184) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18391184) | [CrossRef Full Text](http://dx.doi.org/10.1101/lm.760908)

Ferry, B., Roozendaal, B., and McGaugh, J. L. (1999). Basolateral amygdala noradrenergic influences on memory storage are mediated by an interaction between beta- and alpha1-adrenoreceptors. *J. Neurosci.* 19, 5119–5123.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=10366644) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=10366644)

Fletcher, P. C., McKenna, P. J., Frith, C. D., Grasby, P. M., Friston, K. J., and Dolan, R. J. (1998). Brain activation in schizophrenia during a graded memory task studied with functional neuroimaging. *Arch. Gen. Psychiatry* 55, 1001–1008.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9819069) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9819069) | [CrossRef Full Text](http://dx.doi.org/10.1001/archpsyc.55.11.1001)

Floresco, S. B., Yang, C. R., Phillips, A. G., and Blaha, C. D. (1998). Basolateral amygdala stimulation evokes glutamate receptor-dependent dopamine efflux in the nucleus accumbens of the anesthetized rat. *Eur. J. Neurosci.* 10, 1241–1251.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9749778) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9749778) | [CrossRef Full Text](http://dx.doi.org/10.1046/j.1460-9568.1998.00133.x)

Foote, S. L., Freedman, R., and Oliver, A. P. (1975). Effects of putative neurotransmitters on neuronal activity on monkey auditory cortex. *Brain Res.* 86, 229–242.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=234774) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=234774) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2875%2990699-X)

Foulkes, W. D. (1962). Dream reports from different stages of sleep. *J. Abnorm. Soc. Psychol.* 65, 14–25.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=13894288) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=13894288) | [CrossRef Full Text](http://dx.doi.org/10.1037/h0040431)

Foulkes, W. D., and Vogel, G. (1965). Mental activity at sleep onset. *J. Abnorm. Psychol.* 70, 231–243.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=14341704) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=14341704) | [CrossRef Full Text](http://dx.doi.org/10.1037/h0022217)

Franowicz, J. S., Kessler, L., Morgan, C., and Arnsten, A. F. T. (1998). The alpha-2 noradrenergic, guanfacine, improves spatial working memory in wild type mice but not mice with point mutations of the gene for the alpha-2A receptor. *Abstr. Soc. Neurosci.* 24, 711. [quoted by Ramos and Arnsten 2007].

Frederickson, R. C. A., Jordan, L. M., and Phillis, J. W. (1971). The action of noradrenaline on cortical neurons: effects of pH. *Brain Res.* 35, 556–560.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=5135551) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=5135551) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2871%2990500-2)

Freud, S. (1911). *Formulations on the Two Principles of Mental Functioning* . Vol. XII, ed. S. Edition London: The Hogarth Press.

Friedman, J. I., Adler, D. N., and Davis, K. L. (1999). The role of norepinephrine in the physiopathology of cognitive disorders: potential applications to the treatment of cognitive dysfunction in schizophrenia and Alzheimer’s disease. *Biol. Psychiatry* 46, 1243–1252.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=10560029) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=10560029) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0006-3223%2899%2900232-2)

Fuxe, K., Hamberger, B., and Hökfelt, T. (1968). Distribution of noradrenaline nerve terminals in cortical areas in the rat. *Brain Res.* 8, 125–131.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=5650798) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=5650798) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2868%2990175-3)

Gais, S., Rasch, B., Dahmen, J. C., and Born, J. (2011). The memory function of noradrenergic activity in Non-REM sleep. *J. Cogn. Neurosci.* 23, 2582–2592.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21261452) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21261452) | [CrossRef Full Text](http://dx.doi.org/10.1162/jocn.2011.21622)

Gandolfo, G., Arnaud, C., and Gottesmann, C. (1980). Transmission in the ventrobasal complex of rat during the sleep-waking cycle. *Brain Res. Bull.* 5, 921–927.

[CrossRef Full Text](http://dx.doi.org/10.1016/0361-9230%2880%2990262-2)

Ghelarducci, B., Pisa, M., and Pompeiano, M. (1970). Transformation of somatic afferent volleys across the prethalamic and thalamic components of the lemniscal sytem during the rapid eye movements of sleep. *Electroencephalogr. Clin. Neurophysiol.* 29, 348–357.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=4097204) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=4097204) | [CrossRef Full Text](http://dx.doi.org/10.1016/0013-4694%2870%2990042-8)

Glin, L., Zernicki, B., and Gottesmann, C. (1991). Hippocampal and cortical EEG activity in rats with transected hypothalamus. *Brain Res. Bull.* 27, 637–640.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=1756382) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=1756382) | [CrossRef Full Text](http://dx.doi.org/10.1016/0361-9230%2891%2990039-M)

Gottesman, I. I., and Gould, T. D. (2003). The endophenotype concept in psychiatry: etymology and strategic intentions. *Am. J. Psychiatry* 160, 636–645.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12668349) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=12668349) | [CrossRef Full Text](http://dx.doi.org/10.1176/appi.ajp.160.4.636)

Gottesmann, C. (1999). Neurophysiological support of consciousness during waking and sleep. *Prog. Neurobiol.* 59, 469–508.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=10515665) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=10515665) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0301-0082%2899%2900014-3)

Gottesmann, C. (2000). Each different type of mentation is supported by specific brain functioning. *Behav. Brain Sci.* 23, 941–943.

[CrossRef Full Text](http://dx.doi.org/10.1017/S0140525X00434023)

Gottesmann, C. (2001). The golden age of rapid eye movement sleep discoveries. I. Lucretius *-* 1964. *Prog. Neurobiol.* 65, 211–287.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11473789) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11473789) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0301-0082%2801%2900014-4)

Gottesmann, C. (2005a). Dreaming and schizophrenia. A common neurobiological background. *Sleep Biol. Rhythms* 3, 64–74.

[CrossRef Full Text](http://dx.doi.org/10.1111/j.1479-8425.2005.00164.x)

Gottesmann, C. (2005b). *The Golden Age of Rapid Eye Movement Sleep Discoveries: 1965–1966* . New York: Nova Science Publishers, Inc.

Gottesmann, C. (2006). The dreaming sleep stage: a new neurobiological model of schizophrenia? *Neuroscience* 140, 1105–1115.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=16650940) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=16650940) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neuroscience.2006.02.082)

Gottesmann, C. (2007). Schizophrenia: a conjectured daytime psychobiological invasion by rapid eye movement (REM) sleep. *Schizophr. Res* . Available at: [http://www. schizophreniaforum. org/idea/idealab-print. asp](http://www.schizophreniaforum.org/idea/idealab-print.asp)

[CrossRef Full Text](http://dx.doi.org/10.1016/j.neuroscience.2006.02.082)

Gottesmann, C. (2008). Noradrenaline involvement in basic and higher integrated REM sleep processes. *Prog. Neurobiol.* 82, 237–272.

[CrossRef Full Text](http://dx.doi.org/10.1016/j.pneurobio.2008.04.002)

Gottesmann, C. (2010a). The development of the science of dreaming. *Int. Rev. Neurobiol.* 92, 1–29.

[CrossRef Full Text](http://dx.doi.org/10.1016/S0074-7742%2810%2992001-1)

Gottesmann, C. (2010b). To what extent do neurobiological sleep-waking processes support psychoanalysis. *Int. Rev. Neurobiol.* 92, 233–290.

[CrossRef Full Text](http://dx.doi.org/10.1016/S0074-7742%2810%2992012-6)

Gottesmann, C., and Gottesman, I. I. (2007). The neurobiological characteristics of the rapid eye movement (REM) dreaming sleep stage are candidate endophenotypes of depression, schizophrenia, mental retardation and dementia. *Prog. Neurobiol.* 81, 237–250.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17350744) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17350744) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.pneurobio.2007.01.004)

Gottesmann, C., User, P., and Gioanni, H. (1980). Sleep: a physiological cerveau isolé stage? *Waking Sleeping* 4, 111–117.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=7405184) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=7405184)

Grace, A. A. (2000). Gating information flow within the limbic system and the pathophysiology of schizophrenia. *Brain Res. Rev.* 31, 330–341.

[CrossRef Full Text](http://dx.doi.org/10.1016/S0165-0173%2899%2900049-1)

Green, J. D., and Arduini, A. (1954). Hippocampal electrical activity in arousal. *Electroencephalogr. Clin. Neurophysiol.* 17, 532–557.

Greene, C. M., Bellgrove, M. A., and Robertson, I. H. (2009). Noradrenergic genotype predicts lapses in sustained attention. *Neuropsychologia* 47, 591–594.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18973765) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18973765) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neuropsychologia.2008.10.003)

Groch, S., Wilhelm, I., Diekelman, S., Sayk, F., Gais, S., and Born, J. (2011). Contribution of norepinephrine to emotional memory consolidation during sleep. *Psychoneuroendocrinology* 36, 1342–1350.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21493010) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21493010) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.psyneuen.2011.03.006)

Gronier, B. (2011). In vivo electrophysiological effects of methylphenidate in the prefrontal cortex: involvement of dopamine D1 and alpha 2 adrenergic receptors. *Eur. Neuropsychopharmacol.* 21, 192–204.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21146374) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21146374) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0924-977X%2811%2970255-3)

Gulyani, S., Wu, M. F., Nienhuis, R., John, J., and Siegel, C. (2002). Cataplexy-related neurons in the amygdala of the narcoleptic dog. *Neuroscience* 112, 355–365.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12044453) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=12044453) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0306-4522%2802%2900089-1)

Hajos, M., Hoffmann, W. E., Robinson, D. D., Yu, J. H., and Hajos-Korcsok, E. (2003). Norepinephrine but not serotonin reuptake inhibitors enhance theta and gamma activity of the septo-hippocampal system. *Neuropschopharmacology* 28, 857–864.

Henley, K., and Morrison, A. R. (1974). A re-evaluation of the effects of lesions of the pontine tegmentum and locus coeruleus on phenomena of paradoxical sleep in the cat. *Acta Neurobiol. Exp. (Wars)* 34, 215–232.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=4368348) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=4368348)

Hennevin, E., Hars, B., Maho, C., and Bloch, V. (1995). Processing of learning: information in paradoxical sleep: relevance for memory. *Behav. Brain Res.* 69, 125–135.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=7546303) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=7546303) | [CrossRef Full Text](http://dx.doi.org/10.1016/0166-4328%2895%2900013-J)

Hennevin, E., Huetz, C., and Edeline, J. M. (2007). Neural representations during sleep: from sensory processing to memory traces. *Neurobiol. Learn. Mem.* 87, 416–440.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17178239) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17178239) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.nlm.2006.10.006)

Hess, C., Reif, A., Boreatti-Hümmer, A., Heine, M., Lesch, K. P., and Jacob, C. P. (2009). A functional dopamine beta-hydroxylase gene promoter polymorphism is associated with impulsive personality styles but not with affective disorders. *J. Neural Transm.* 116, 121–130.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18982239) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18982239) | [CrossRef Full Text](http://dx.doi.org/10.1007/s00702-008-0138-0)

Hobson, J. A. (2009). REM sleep and dreaming: towards a theory of protoconsciousness. *Nat. Rev. Neurosci.* 10, 803–813.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=19794431) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=19794431)

Hobson, J. A., McCarley, R. W., and Wyzinski, P. W. (1975). Sleep cycle oscillation: reciprocal discharge by two brainstem neuronal groups. *Science* 189, 55–58.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=1094539) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=1094539) | [CrossRef Full Text](http://dx.doi.org/10.1126/science.1094539)

Hobson, J. A., Pace-Schott, E., and Stickgold, R. (2000). Dreaming and the brain: towards a cognitive neuroscience of conscious states. *Behav. Brain Sci.* 23, 793–842.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11515143) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11515143) | [CrossRef Full Text](http://dx.doi.org/10.1017/S0140525X00003976)

Hong, C. C. H., Gillin, J. C., Dow, B. C., Wu, J., and Buschbaum, M. S. (1995). Localized and lateralized cerebral glucose metabolism associated with eye movements during REM sleep and wakefulness: a positron emission tomography (PET) study. *Sleep* 18, 570–580.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=8552928) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=8552928)

Hong, C. C. H., Harris, J. C., Pearlson, G. D., Kim, J.-S., Calhoun, V. C., Fallon, J. H., Golay, X., Gillen, J. S., Simmonds, D. J., van Zijl, P. C. M., Zee, D. S., and Pekar, J. J. (2009). fMRI evidence for multisensory recruitment associated with rapid eye movements during sleep. *Hum. Brain Mapp.* 30, 1705–1722.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18972392) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18972392) | [CrossRef Full Text](http://dx.doi.org/10.1002/hbm.20635)

Hurlemann, R., Walter, H., Rehme, A. K., Kukolja, J., Santoro, S. C., Schmidt, C., Schnell, K., Musshof, F., Keysers, C., Maier, W., Kendrick, K. M., and Onur, O. A. (2010). Human amygdala reactivity is diminished by the b-noradrenergic antagonist propanolol. *Psychol. Med.* 40, 1839–1848.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=20102667) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=20102667) | [CrossRef Full Text](http://dx.doi.org/10.1017/S0033291709992376)

Iwama, K., Kawamoto, T., Sakkakura, H., and Kasamatsu, T. (1966). Responsiveness of cat lateral geniculate at pre- and post-synaptic levels during natural sleep. *Physiol. Behav.* 1, 45–53.

[CrossRef Full Text](http://dx.doi.org/10.1016/0031-9384%2866%2990040-0)

Jackson, M. E., Frost, A. S., and Moghaddam, B. (2001). Stimulation of prefrontal cortex at physiologically relevant frequencies inhibits dopamine release in nucleus accumbens. *J. Neurochem.* 78, 920–923.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11520912) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11520912) | [CrossRef Full Text](http://dx.doi.org/10.1046/j.1471-4159.2001.00499.x)

Jha, S. K., Ross, R. J., and Morrison, A. R. (2005). Sleep-related neurons in the central nucleus of the amygdala of rats and their modulation by the dorsal raphe nucleus. *Physiol. Behav.* 86, 415–426.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=16137725) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=16137725) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.physbeh.2005.06.033)

Ji, D., and Wilson, M. (2007). Coordinated memory replay in the visual cortex and hippocampus during sleep. *Nat. Neurosci.* 10, 100–107.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17173043) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17173043) | [CrossRef Full Text](http://dx.doi.org/10.1038/nn1825)

Jodo, E., Chiang, C., and Aston-Jones, G. (1998). Potent excitatory influence of prefrontal cortex activity on noradrenergic locus coeruleus. *Neuroscience* 83, 63–79.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9466399) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9466399) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0306-4522%2897%2900372-2)

Johnson, J. D. (2003). Noradrenergic control of cognition: global attenuation and an interrupt function. *Med. Hypotheses* 60, 689–692.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12710903) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=12710903) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0306-9877%2802%2900342-0)

Jouvet, M., and Delorme, F. (1965). Locus coeruleus et sommeil paradoxal. *C. R. Seances Soc. Biol. Fil.* 159, 895–899.

Jouvet, M., and Michel, F. (1959). Corrélations électromyographiques du sommeil chez le Chat décortiqué et mésencéphalique chronique. *C. R. Seances Soc. Biol. Fil.* 153, 422–425.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=13663472) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=13663472)

Jouvet, M., and Mounier, D. (1960). Effets des lésions de la formation réticulaire pontique sur le sommeil du Chat. *C. R. Seances Soc. Biol. Fil.* 154, 2301–2305.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=13790856) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=13790856)

Jung, R., and Kornmüller, A. E. (1938). Eine Methodik der Abteilung lokalisierter Potentialschwankungen aus subcorticalen Hirngebieten. *Arch. Psychiatr. Nervenkr.* 109, 1–30.

[CrossRef Full Text](http://dx.doi.org/10.1007/BF02157817)

Kaneko, K., Tamamaki, N., Owada, H., Kakizaki, T., Kuma, N., Totsuka, M., yamamoto, T., Yawo, H., Yagi, T., Obata, K., and Yanagawa, Y. (2008). noradrenergic excitation of a subpopulation of GABAergic cells in the basolateral amygdala via both activation of nonselective cationic conductance and suppression of resting K+ conductance: a study using glutamate decarboxylase 67-green fluorescent protein knock-in mice. *Neuroscience* 157, 781–797.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18950687) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18950687) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neuroscience.2008.09.029)

Kieling, C., Genro, J. P., Hurtz, M. H., and Rohde, I. A. (2008). The 1021 C/T polymorphism is associated with neuropsychological performance among children and adolescents with ADHD. *Am. J. Med. Genet. B Neuropsychiatr. Genet.* 147B, 485–490.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18081028) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18081028) | [CrossRef Full Text](http://dx.doi.org/10.1002/ajmg.b.30636)

Kisley, M. A., Olincy, A., Robbins, E., Polk, S. D., Adler, L. E., Waldo, M. C., and Freedman, R. (2003). Sensory gating impairement associated with schizophrenia persists into REM sleep. *Psychophysiology* 40, 29–38.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12751801) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=12751801) | [CrossRef Full Text](http://dx.doi.org/10.1111/1469-8986.00004)

Kollins, S. H., Lopez, F. A., Vince, B. D., Tumbow, J. M., Farrand, K., Lyne, A., Wigal, S. B., and Roth, T. (2011). Psychomotor functioning and alertness with guanfacine extended release in subjects with attention-deficit/hyperactivity disorder. *J. Child Adolesc. Psychopharmacol.* 21, 111–120.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21476931) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21476931) | [CrossRef Full Text](http://dx.doi.org/10.1089/cap.2010.0064)

Krnjevic, K., and Phillis, J. W. (1963). Actions of certain amines on cerebral cortex neurons. *Br. J. Pharmacol.* 20, 471–490.

Kubicki, M., Styner, M., Gerig, G., Markant, D., Smith, K., MacCarley, R. W., and Shenton, M. E. (2008). Reduced interhemispheric connectivity in schizophrenic-tractography based segmentation of the corpus callosum. *Schizophr. Res.* 106, 125–131.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18829262) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18829262) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.schres.2008.08.027)

Kubota, Y., Takasu, N. N., Horita, S., Kondo, M., Shimizu, M., Okada, T., Wakamura, T., and Tolchi, M. (2011). Dorsolateral prefrontal cortical oxygenation during REM sleep in humans. *Brain Res.* 1389, 83–92.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21382356) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21382356) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.brainres.2011.02.061)

Kukolja, J., Klingmüller, D., Maier, W., Fink, G. R., and Hurlemann, R. (2011). Noradrenergic-glucocorticoid modulation of emotional memory encoding in the human hippocampus. *Psychol. Med.* 4, 1–10.

Lazzaro, S. C., Hou, M., Cunha, C., LeDoux, J. E., and Cain, C. K. (2010). Antagonism of lazteral amygdala alpha-1 adrenergic receptors facilitates fear conditioning and long-term potentiation. *Learn. Mem.* 17, 489–493.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=20870745) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=20870745) | [CrossRef Full Text](http://dx.doi.org/10.1101/lm.1918210)

Leconte, P., and Hennevin, E. (1981). Post-learning paradoxical sleep, reticular activation and noradrenergic activity. *Physiol. Behav.* 26, 587–594.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=6267624) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=6267624) | [CrossRef Full Text](http://dx.doi.org/10.1016/0031-9384%2881%2990129-3)

Léna, I., Parrot, S., Deschaux, O., Muffat, S., Sauvinet, V., Renaud, B., Suaud-Chagny, M. F., and Gottesmann, C. (2005). Variations in the extracellular levels of dopamine, noradrenaline, glutamate and aspartate across the sleep-wake cycle in the medial prefrontal cortex and nucleus accumbens of freely moving rats. *J. Neurosci. Res.* 81, 891–899.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=16041801) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=16041801) | [CrossRef Full Text](http://dx.doi.org/10.1002/jnr.20602)

Libet, B., and Gleason, G. A. (1994). The human locus coeruleus and anxiogenesis. *Brain Res.* 634, 178–180.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=8156389) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=8156389) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2894%2990274-7)

Linner, L., Wiker, C., Wadenberg, M. L., Schalling, M., and Svensson, T. H. (2002). Noradrenaline reuptake inhibition enhances the antipsychotic-like effect of raclopride and potentiates D2-blockade-induced dopamine release in the medial prefrontal cortex of the rat. *Neuropsychopharmacology* 27, 691–698.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12431844) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=12431844) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0893-133X%2802%2900350-0)

Lipska, B. K., Jaskiw, G., and Weinberger, D. R. (1993). Postpubertal emergence of hyperresponsiveness to stress and to amphetamine after neonatal excitotoxic hippocampal damage: a potential animal model of schizophrenia. *Neuropsychopharmachology* 9, 67–75.

Llinas, R., and Ribary, U. (1993). Coherent 40 Hz oscillation characterizes dream state in humans. *Proc. Natl. Acad. Sci. U. S. A.* 90, 2078–2081.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=8446632) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=8446632) | [CrossRef Full Text](http://dx.doi.org/10.1073/pnas.90.24.11743)

MacKay, A. V., Iversen, L. L., Rossor, M., Spokes, E., Bird, E., Arregui, A., and Snyder, S. (1982). Increased brain dopamine and dopamine receptors in schizophrenia. *Arch. Gen. Psychiatry* 39, 991–997.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=7115016) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=7115016) | [CrossRef Full Text](http://dx.doi.org/10.1001/archpsyc.1982.04290090001001)

Malcolm-Smith, S., Solms, M., Turnbull, O., and Tredoux, C. (2007). Threat in dreams: an adaptation. *Conscious. Cogn.* 17, 1281–1291.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17702604) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17702604) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.concog.2007.07.002)

Manacéine, M. d. (1897). *Sleep: Its Physiology, Pathology, Hygiene, and Psychology* . London: Walter Scott.

Manunta, Y., and Edeline, J. M. (1999). Effects of noradrenaline on frequency tuning of auditory cortex neurons during wakefulness and slow wave sleep. *Eur. J. Neurosci.* 11, 2134–2150.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=10336682) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=10336682) | [CrossRef Full Text](http://dx.doi.org/10.1046/j.1460-9568.1999.00633.x)

Mao, Z. M., Arnsten, A. F., and Li, B. M. (1999). local infusion of an alpha-1 adrenergic agonist into the prefrontal cortex impairs spacial working memory performance in monkeys. *Biol. Psychiatry* 46, 1259–1265.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=10560031) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=10560031) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0006-3223%2899%2900139-0)

Maquet, P., and Franck, G. (1997). REM sleep and amygdala. *Mol. Psychiatry* 2, 195–196.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9152982) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9152982) | [CrossRef Full Text](http://dx.doi.org/10.1038/sj.mp.4000239)

Maquet, P., Peters, J. M., Aerts, J., Delfiore, G., Degueldre, C., Luxen, A., and Franck, G. (1996). Functional neuroanatomy of human rapid-eye-movement sleep and dreaming. *Nature* 383, 163–166.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=8774879) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=8774879) | [CrossRef Full Text](http://dx.doi.org/10.1038/383163a0)

Marrosu, F., Portas, C., Mascia, M. F., Casu, M. A., Fa, M., Giagheddu, M., Imperato, A., and Gessa, G. L. (1995). Microdialysis measurement of cortical and hippocampal acetylcholine release during sleep-wake cycle in freely moving cats. *Brain Res.* 671, 329–332.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=7743225) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=7743225) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2894%2901399-3)

Massimini, M., Ferrarelli, F., Huber, R., Esser, S. K., Singh, H., and Tononi, G. (2005). Breakdown of cortical effective connectivity during sleep. *Science* 309, 2228–2232.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=16195466) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=16195466) | [CrossRef Full Text](http://dx.doi.org/10.1126/science.1117256)

McCormick, D. A., and Krosigk, V. M. (1992). Corticothalamic activation modulates thalamic firing through glutamate “ metabotropic” receptors. *Proc. Natl. Acad. Sci. U. S. A.* 89, 2774–2778.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=1313567) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=1313567) | [CrossRef Full Text](http://dx.doi.org/10.1073/pnas.89.8.3635)

McCormick, D. A., Pape, H. C., and Williamson, A. (1991). Actions of norepinephrine in the cerebral cortex and thalamus: implications for function of the central noradrenergic system. *Prog. Brain Res.* 88, 293–305.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=1726028) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=1726028) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0079-6123%2808%2963817-0)

McCormick, D. A., Wang, Z., and Huguenard, J. (1993). Neurotransmitter control of neocortical neuronal activity and excitability. *Cereb. Cortex* 3, 387–398.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=7903176) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=7903176) | [CrossRef Full Text](http://dx.doi.org/10.1093/cercor/3.5.387)

McGaughy, J., Ross, R. S., and Eichenbaum, H. (2008). Noradrenergic, but not cholinergic, deafferentation of prefrontal cortex impairs emotional set-shifting. *Neuroscience* 153, 63–71.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18355972) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18355972) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neuroscience.2008.01.064)

Meyer-Lindenberg, A., Olsen, R. K., Kohn, P. D., Brown, T., Egan, M. F., Weinberber, D. R., and Berman, K. F. (2005). Regionally specific disturbance of dorsolateral prefrontal-hippocampal function connectivity in schizophrenia. *Arch. Gen. Psychiatry* 62, 379–386.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=15809405) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=15809405) | [CrossRef Full Text](http://dx.doi.org/10.1001/archpsyc.62.4.379)

Meyer-Lindenberg, A., Poline, J. B., Kohn, P. D., Holt, J. L., Egan, M. F., Weinberger, D. R., and Berman, K. F. (2001). Evidence for abnormal cortical functional connectivity during working memory in schizophrenia. *Am. J. Psychiatry* 158, 1809–1817.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11691686) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11691686) | [CrossRef Full Text](http://dx.doi.org/10.1176/appi.ajp.158.11.1809)

Michel, F., Klein, M., Jouvet, D., and Valatx, J. L. (1961). Etude polygraphique du sommeil chez le Rat. *C. R. Seances Soc. Biol. Fil.* 155, 2389–2392.

Milstein, J. A., Lehmann, O., Theobald, D. E., Dalley, J. W., and Robbins, E. (2007). Selective depletion of cortical noradrenaline by anti-domaine beta-hydroxylase-saporin impairs attentional function and enhances the effect of guafacine in the rat. *Psychopharmacology* 190, 51–63.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17096085) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17096085) | [CrossRef Full Text](http://dx.doi.org/10.1007/s00213-006-0594-x)

Misoguchi, N., Saigusa, T., Aono, Y., Sekino, R., Takada, K., Oi, Y., Ueda, K., Koshikawa, N., and Cools, A. R. (2008). The reboxetine-induced increase of accumbal dopamine efflux is inhibited by l-propranolol: a microdialysis study with freely moving rats. *Eur. J. Pharmacol.* 601, 94–98.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18996113) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18996113) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.ejphar.2008.10.045)

Miyajima, M., Ozaki, M., Wada, K., and Sekiguchi, M. (2010). Noradrenaline-induced spontaneous inhibitory postsynaptic currents in mouse basolateral nucleus of amygdala pyramidal neurons: comparison with dopamine-induced currents. *Neurosci. Lett.* 480, 167–172.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=20553995) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=20553995) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neulet.2010.06.001)

Miyauchi, S., Misaki, M., Kan, S., Fukunaga, T., and Koike, T. (2009). Human brain activity time-locked to rapid eye movements during REM sleep. *Exp. Brain Res.* 192, 657–667.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18830586) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18830586) | [CrossRef Full Text](http://dx.doi.org/10.1007/s00221-008-1579-2)

Montgomery, S. M., Sirota, A., and Buzsaki, G. (2008). Theta and gamma coordination of hippocampal networks during waking and rapid eye movement sleep. *J. Neurosci.* 28, 6731–6741.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=18579747) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=18579747) | [CrossRef Full Text](http://dx.doi.org/10.1523/JNEUROSCI.1227-08.2008)

Morrison, A. R., and Pompeiano, O. (1966). Vestibular influences during sleep. IV. Functional relations between vestibular nuclei and lateral geniculate nucleus during desynchronized sleep. *Arch. Ital. Biol.* 104, 425–458.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=5982752) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=5982752)

Murchison, C. F., Schutsky, K., Jin, S. H., and Thomas, S. A. (2011). Norepinephrine and beta (1)-adrenergic signaling facilitate activation of hippocampal CA1 pyramidal neurons during contextual memory retrieval. *Neuroscience* 181, 109–116.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21377513) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21377513) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neuroscience.2011.02.049)

Nelson, C. N., Hoffer, B. J., Chu, N. S., and Bloom, F. E. (1973). Cytochemical and pharmacological studies on polysensory neurons in the primate frontal cortex. *Brain Res.* 62, 115–133.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=4148775) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=4148775) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2873%2990623-9)

Nielsen, J. B. (2003). “ A review of mentation in REM and NREM sleep: ‘ covert’ REM sleep as a possible reconciliation of two opposing models,” in *Sleep and Dreaming. Scientific Advances and Reconsiderations* , eds E. Pace-Schott, M. Solms, M. Blagrove, and S. Harnad (Cambridge: Cambridge University Press), 59–74.

Nittono, H., Momose, D., and Hori, T. (2001). The vanishing point of the mismatch negativity at sleep onset. *Clin. Neurophysiol.* 112, 732–739.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11336887) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11336887) | [CrossRef Full Text](http://dx.doi.org/10.1016/S1388-2457%2801%2900491-6)

Olmstead, C. E., and Villablanca, J. (1977). Hippocampal theta rhythm persists in the permanently isolated forebrain of the cat. *Brain Res. Bull.* 2, 93–100.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=880491) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=880491) | [CrossRef Full Text](http://dx.doi.org/10.1016/0361-9230%2877%2990004-1)

Park, S. P. (2002). In vovo microdialysis measures of extracellular norepinephrine in the rat amygdala during sleep-wakefulness. *J. Korean Med. Sci.* 17, 395–399.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12068146) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=12068146)

Peigneux, P., Laurey, S., Fuchs, S., Destrebecqz, A., Collette, F., Delbeuck, X., Phillips, C., Aerts, J., Del Flore, G., Delguedre, C., Luxen, A., Cleeremans, A., and Maquet, P. (2003). Learned material content and acqisition level modulate cerebral reactivation during postraining rapid-eye-movement sleep. *Neuroimage* 20, 125–134.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=14527575) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=14527575) | [CrossRef Full Text](http://dx.doi.org/10.1016/S1053-8119%2803%2900278-7)

Peled, A., Geva, A. B., Kremen, W. S., Blankfeld, H. M., Esfandiarfard, R., and Nordahl, T. E. (2001). Functional connectivity and working memory in schizophrenia: an EEG study. *Int. J. Neurosci.* 106, 47–61.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11264908) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11264908) | [CrossRef Full Text](http://dx.doi.org/10.3109/00207450109149737)

Perez-Garci, E., del Rio-Portilla, Y., Guevara, M. A., Arce, C., and Corsi-Cabrera, M. (2001). Paradoxical sleep is characterized by uncoupled gamma activity between frontal and perceptual cortical regions. *Sleep* 24, 118–126.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11204047) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11204047)

Pothos, E., Rada, P., Mark, G. P., and Hoebel, B. G. (1991). Dopamine microdialysis in the nucleus accumbens during acute and chronic morphine, naloxone-precipited withdrawal and clonidine treatment. *Brain Res.* 566, 348–350.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=1814554) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=1814554) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2891%2991724-F)

Prehn-Kristensen, A., Göder, R., Fischer, J., Wilhelm, I., Seeck-Hirschner, M., Aldenhoff, J., and Baving, L. (2011). Reduced sleep-associated consolidation of declarative memory in attention-deficit/hyperactivity disorder. *Sleep Med.* 12, 672–679.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21697007) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21697007) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.sleep.2010.10.010)

Radwanska, K., Nikolaev, E., and Kaczmarek, L. (2010). Central noradrenergic lesion induced by DSP-4 impairs the acquisition of avoidance reactions and prevents molecular changes in the amygdala. *Neurobiol. Learn. Mem.* 94, 303–311.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=20650329) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=20650329) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.nlm.2010.07.002)

Ramos, B. P., and Arnsten, A. F. T. (2007). Adrenergic pharmacology and cognition: focus on the prefrontal cortex. *Pharmacol. Ther.* 113, 523–536.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17303246) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17303246) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.pharmthera.2006.11.006)

Ramos, B. P., Colgan, L., Ovadia, S., Wilson, S. R., and Arnsten, A. F. (2005). The beta-1 adrenergic antagonist, betaxolol, improves working memory performance in rats and monkeys. *Biol. Psychiatry* 58, 894–900.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=16043136) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=16043136) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.biopsych.2005.05.022)

Rasmussen, K., Morilak, D. A., and Jacobs, B. L. (1986). Single unit activity of locus coeruleus neurons in the freely moving cat I. Naturalistic behaviors and in response to simple and complex stimuli. *Brain Res.* 371, 324–334.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=3697761) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=3697761) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2886%2990371-9)

Reader, T. A., Ferron, A., Descarries, L., and Jasper, H. H. (1979). Modulatory role for biogenic amines in the cerebral cortex. Microiontopheric studies. *Brain Res.* 160, 219–229.

[CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2879%2990420-7)

Rechtschaffen, A., Vogel, G., and Shaikun, G. (1963). Interelatedness of mental activity during sleep. *Arch. Gen. Psychiatry* 9, 536–547.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=14056834) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=14056834) | [CrossRef Full Text](http://dx.doi.org/10.1001/archpsyc.1963.01720180008002)

Reeves, M., Lindholm, D. E., Myles, P. S., Fletcher, H., and Hunt, J. O. (2001). Adding ketamine to morphine for patient-controlled analgesia after major abdominal surgery: a double-blind, randomized trial. *Anesth. Analg.* 93, 116–120.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11429351) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11429351)

Reich, H., Ruppecht, U., Stumpf, H., and Stock, G. (1983). Modulation of unit activity in the amygdala of restrained cats during the sleep-waking cycle. *Neurosci. Lett.* 35, 209–214.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=6856196) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=6856196) | [CrossRef Full Text](http://dx.doi.org/10.1016/0304-3940%2883%2990552-9)

Revonsuo, A. (2003). “ The reinterpretation of dreams: an evolutionary hypothesis of the function of dreaming,” in *Sleep and Dreaming. Scientific Advances and Reconsiderations* , eds E. Pace-Schott, M. Solms, M. Blagrove, and S. Harnad (Cambridge: Cambridge University Press), 85–109.

Rossi, G. F., Palestini, M., Pisano, M., and Rosadini, G. (1965). “ An experimental study of the cortical reactivity during sleep and wakefulness,” in *Aspects anatomo-fonctionnels de la physiologie du sommeil* (Paris: CNRS), 509–532.

Sakakura, H., and Iwama, K. (1965). Presynaptic inhibition and postsynaptic facilitation in lateral geniculate body and so-called deep sleep wave activity. *Tohoku J. Exp. Med.* 87, 40–51.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=5857725) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=5857725) | [CrossRef Full Text](http://dx.doi.org/10.1620/tjem.87.40)

Scahill, L., Chappell, P. B., Kim, Y. S., Schultz, R. T., Katsovitch, L., Shepperd, E., Arnsten, A. F., Cohen, D. J., and Leckman, J. F. (2001). A placebo-controlled study of guanfacine in the treatment of children with tic disorders and attention deficit hyperactivity disorder. *Am. J. Psychiatry* 158, 1067–1074.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11431228) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11431228) | [CrossRef Full Text](http://dx.doi.org/10.1176/appi.ajp.158.7.1067)

Sculthorpe, L. D., Ouellet, D. R., and Campell, K. B. (2009). MMN elicitation during natural sleep to violations of an auditory pattern. *Brain Res.* 1290, 52–62.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=19527697) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=19527697) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.brainres.2009.06.013)

Segal, M. (1974). The action of norepinephrine in the rat hippocampus. I. Iontophoretic studies. *Brain Res.* 72, 79–97.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=4364476) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=4364476) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2874%2990652-0)

Segal, M. (1981). Regional differences in neuronal responses to 5-HT: intracellular studies in hippocampal slices. *J. Physiol. Paris* 77, 373–375.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=7288653) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=7288653)

Segal, M. (1990). Potassium currents activated in hippocampal neurons by serotonin are mediated by a change in intracellular calcium concentrations. *Eur. J. Pharmacol.* 181, 299–301.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=2116972) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=2116972) | [CrossRef Full Text](http://dx.doi.org/10.1016/0014-2999%2890%2990093-L)

Segal, M., and Bloom, F. E. (1976). The action of norepinephrine in the rat hippocampus. III. Hippocampal cellular responses to locus coeruleus stimulation in the awake rat. *Brain Res.* 107, 499–551.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=178410) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=178410) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2876%2990140-2)

Seguela, P., Watkons, K. C., Geffard, M., and Descarries, L. (1990). Noradrenaline axon terminals in adult rat neocortex: an immunocytochemical analysis in serial thin sections. *Neuroscience* 35, 249–264.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=2116602) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=2116602) | [CrossRef Full Text](http://dx.doi.org/10.1016/0306-4522%2890%2990079-J)

Selden, N. R. W., Robbins, T. W., and Everitt, B. J. (1990). Enhanced behavioral conditioning to context and impaired behavioral and neuroendocrine responses to conditioned stimuli following ceruleocortical noradrenergic lesions: support for an attentional hypothesis of central noradrenergic function. *J. Neurosci.* 10, 531–539.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=2303858) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=2303858)

Shouse, M. N., Staba, R. J., Saquib, S. F., and Farber, P. R. (2000). Monoamines and sleep: microdialysis findings in pons and amygdala. *Brain Res.* 860, 181–189.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=10727641) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=10727641) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0006-8993%2800%2902013-8)

Siegel, J. M. (2001). The REM sleep – memory consolidation hypothesis. *Science* 294 1058–1063.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11691984) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11691984) | [CrossRef Full Text](http://dx.doi.org/10.1126/science.1063049)

Smith, C. (1995). Sleep states and memory processes. *Behav. Brain Res.* 69, 137–145.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=7546305) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=7546305) | [CrossRef Full Text](http://dx.doi.org/10.1016/0166-4328%2895%2900024-N)

Smith, C., and Lapp, L. (1991). Increases in number of REMS and REM density in humans following an intense learning period. *Sleep* 14, 325–330.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=1947596) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=1947596)

Steere, J. C., and Arnsten, A. F. (1997). The alpha-2 noradrenergic receptor agonist guanfacine improves visual object discrimination reversal performance in aged rhesus monkeys. *Behav. Neurosci.* 111, 883–891.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9383511) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9383511) | [CrossRef Full Text](http://dx.doi.org/10.1037/0735-7044.111.5.883)

Stegeren van, A. H., Goekoop, R., Everaerd, W., Scheltens, P., Barkhof, F., Kuijer, J. P., and Trombouts, S. A. (2005). Norasrenaline mediates amygdala activation in men and women during encoding of emotional material. *Neuroimage* 24, 898–909.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=15652324) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=15652324) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neuroimage.2004.09.011)

Strange, B. A., and Dolan, R. J. (2004). Beta-adrenergic modulation of emotional memory-evoked human amygdala and hippocampal responses. *Proc. Natl. Acad. Sci. U. S. A.* 101, 11454–11458.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=15269349) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=15269349) | [CrossRef Full Text](http://dx.doi.org/10.1073/pnas.0404282101)

Swanson, C. J., and Schoepp, D. D. (2003). A role for noradrenergic transmission in the actions of phencyclidine and the antipsychotic and antistress effects of mGlu2/3 receptor agonists. *Ann. N. Y. Acad. Sci.* 1003, 309–317.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=14684454) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=14684454) | [CrossRef Full Text](http://dx.doi.org/10.1196/annals.1300.019)

Tait, D. S., Brown, V. J., Farovik, A., Theobald, D. E., Dalley, J. W., and Robbins, T. W. (2007). Lesions of the dorsal noradrenergic bundle impair set-shifting in the rat. *Eur. J. Neurosci.* 25, 3719–3733.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=17610591) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=17610591) | [CrossRef Full Text](http://dx.doi.org/10.1111/j.1460-9568.2007.05612.x)

Takahashi, K., Kayama, Y., Lin, J. S., and Sakai, K. (2010). Locus coeruleus neuronal activity during the sleep-waking cycle in mice. *Neuroscience* 169, 1115–1126.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=20542093) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=20542093) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neuroscience.2010.06.009)

Takeuchi, T., Miyasita, A., Inugami, M., and Yamamoto, Y. (2001). Intrinsic dreams are not produced without REM sleep mechanims: evidence through elicitation of sleep onset periods. *J. Sleep Res.* 10, 43–52.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=11285054) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=11285054) | [CrossRef Full Text](http://dx.doi.org/10.1046/j.1365-2869.2001.00237.x)

Takeuchi, T., Ogilvie, R. D., Ferrelli, A. V., Murphy, T., Yamamoto, Y., and Inugami, M. (1999). Dreams are not produced without REM sleep mechanisms. *Sleep Res. Online* 2(Suppl. 1), 279.

Tokizane, T. (1965). “ Sleep mechanism: hypothalamic control of cortical activity,” in *Aspects anatomo-fonctionnels de la physiologie du sommeil* , ed. CNRS (Paris: CNRS), 151–185.

Tong, J., Hornykiewicz, O., and Kish, S. J. (2006). Identification of a noradrenaline-rich subdivision of the human nucleus accumbens. *J. Neurochem.* 96, 349–354.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=16336226) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=16336226) | [CrossRef Full Text](http://dx.doi.org/10.1111/j.1471-4159.2005.03546.x)

Tracy, R. L., and Tracy, L. N. (1974). Reports of mental activity from sleep stages 2 and 4. *Percept. Mot. Skills* 38, 647–648.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=4824104) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=4824104) | [CrossRef Full Text](http://dx.doi.org/10.2466/pms.1974.38.2.647)

Tran, L., and Keele, N. B. (2011). P-chlorophenylalanine increases glutamate receptor 1 transcription in rat amygdala. *Neuroreport* 22, 758–761.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21876464) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21876464) | [CrossRef Full Text](http://dx.doi.org/10.1097/WNR.0b013e32834ae2a1)

Uhlaas, P. J., and Singer, W. (2010). Abnormal neural oscillations and synchrony in schizophrenia. *Nat. Rev. Neurosci.* 11, 100–113.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=20087360) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=20087360) | [CrossRef Full Text](http://dx.doi.org/10.1038/nrn2774)

Verhelj, M. M., and Cools, A. R. (2009a). Accumbental noradrenaline that contributes to the alpha-adrenoceptor-mediated release of dopamine from reserpine-sensitive storage vesicles in the nucleus accumbens is derived from alpha-methyl-para-tyrosine-senitive pools. *J. Neural Transm.* 116, 389–394.

[CrossRef Full Text](http://dx.doi.org/10.1007/s00702-009-0190-4)

Verhelj, M. M., and Cools, A. R. (2009b). Mesolimbic alpha-, but not beta-adrenoceptors control the accumbal release of dopamine that is derived from reserpine-sensitive storage vesicles. *Neuroscience* 162, 1163–1173.

[CrossRef Full Text](http://dx.doi.org/10.1016/j.neuroscience.2009.05.034)

Vertes, R. (2004). Memory consolidation in sleep; dream or reality. *Neuron* 44, 135–144.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=15450166) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=15450166) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neuron.2004.08.034)

Vertes, R., and Siegel, J. (2005). Time for the sleep community to take a critical look at the purported role of sleep in memory processing. *Sleep* 28, 1228–1229.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=16295207) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=16295207)

Wallace, D. M., Magnuson, D. J., and Gray, T. C. (1992). Organization of amygdaloid projections to brainstemp dopaminergic, noradrenergic, and adrenergic cell groups in the rat. *Brain Res. Bull.* 28, 447–454.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=1591601) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=1591601) | [CrossRef Full Text](http://dx.doi.org/10.1016/0361-9230%2892%2990046-Z)

Wang, Y., Liu, J., Gui, Z. H., Ali, U., Fan, L. L., Hou, C., Wang, T., Chen, T., and Li, Q. (2011). Alpha2-adrenoceptor regulates the spontaneous and the GABA/glutamate modulated firing activity of the rat medial prefrontal cortex pyramidal neurons. *Neuroscience* 182, 193–202.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=21402127) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=21402127) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.neuroscience.2011.03.016)

Wang, Y., Zhang, G. J., Liu, J., Ali, U., Gui, Z. H., Hui, Y. P., Wang, T., Chen, L., and Li, G. (2010). Noradrenergic lesion of the locus coeruleus increases the firing activity of the medial prefrontal cortex pyramidal neurons and the role of alpha2-adrenoreceptors in normal and medial forebrain bundle lesioned rats. *Brain Res.* 1324, 64–74.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=20153300) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=20153300) | [CrossRef Full Text](http://dx.doi.org/10.1016/j.brainres.2010.02.009)

Warren, R. A., and Dykes, R. W. (1996). Transient and long-lasting effects of iontophoretically administered norepinephrine on somatosensory cortical neurons in halothane-anesthetized cats. *Can. J. Physiol. Pharmacol.* 74, 38–57.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=8963951) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=8963951) | [CrossRef Full Text](http://dx.doi.org/10.1139/y95-225)

Waterhouse, B. D., Azizi, S. A., Burne, R. A., and Woodward, D. (1990). Modulation of rat cortical area 17 neuronal responses to moving visual stimuli during norepinephrine and serotonin microiontophoresis. *Brain Res.* 514, 276–292.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=2357542) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=2357542) | [CrossRef Full Text](http://dx.doi.org/10.1016/0006-8993%2890%2991422-D)

Waterhouse, B. D., Moises, H. C., and Woodward, D. J. (1998). Phasic activation of the locus coeruleus enhances responses of primary sensory cortical neurons to peripheral receptive field stimulation. *Brain Res.* 790, 33–44.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9593812) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9593812) | [CrossRef Full Text](http://dx.doi.org/10.1016/S0006-8993%2898%2900117-6)

Weinberger, D. R., Berman, K. F., and Zec, R. F. (1986). Physiological dysfunction of dorsolateral prefrontal cortex in schizophrenia 1. Regional cerebral blood flow evidence. *Arch. Gen. Psychiatry* 43, 114–124.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=3947207) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=3947207) | [CrossRef Full Text](http://dx.doi.org/10.1001/archpsyc.1986.01800020020004)

Williams, H. L., Hammack, J. T., Daly, R. L., Dement, W. C., and Lubin, A. (1964). Responses to auditory stimulation, sleep loss and the EEG stages of sleep. *Electroencephalogr. Clin. Neurophysiol.* 16, 269–279.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=14128872) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=14128872) | [CrossRef Full Text](http://dx.doi.org/10.1016/0013-4694%2864%2990109-9)

Williams, H. L., Tepas, D. I., and Morlock, J. H. C. (1962). Evoked responses to clicks and electroencephalographic stages of sleep in man. *Science* 138, 685–686.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=14000871) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=14000871) | [CrossRef Full Text](http://dx.doi.org/10.1126/science.138.3541.674)

Young, C. E., Arima, K., Hu, L., Beach, T. G., Falkai, P., and Honer, W. G. (1998). SNAP-25 deficit and hippocampal connectivity in schizophrenia. *Cereb. Cortex* 8, 261–268.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=9617921) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=9617921) | [CrossRef Full Text](http://dx.doi.org/10.1093/cercor/8.3.261)

Zhang, J. X., Harper, R. M., and Frysinger, R. C. (1986). Respiratory modulation of neuronal discharge in the central nucleus of the amygdala during sleep and waking states. *Exp. Neurol.* 91, 193–207.

[Pubmed Abstract](http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=3940875) | [Pubmed Full Text](http://eutils.ncbi.nlm.nih.gov/entrez/eutils/elink.fcgi?db=pubmed&cmd=prlinks&retmode=ref&id=3940875) | [CrossRef Full Text](http://dx.doi.org/10.1016/0014-4886%2886%2990037-3)