

Nasal Cycle Dilemma: Nasal Cycle Is Associated to Brain Wake/REM States or Is Associated to Conscious State in Them?

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Abstract

Experimental and theoretical arguments have been described in favor of the hypothesis that the nasal cycle reversals of the nostril's airflow occurs only in the consciousness states of the brain (during awake/wake state, REM state and during dreams in St.1, 2 of the non-REM sleep). This finding gives possibility to use nasal cycle as “marker for consciousness states”. An idea for clinical application of the hypothesis is proposed.

Keywords

Nasal Cycle, Sleep Cycle, Consciousness, EEG Waves

1. Introduction

The nasal cycle defines as switch of dominate nostril airflow from left to right side and reverse is well studied during diurnal period of the day over healthy persons in awake (wakefulness) consciousness state [1] [2]. During diurnal time, the periods of the nasal cycle may have duration between 1.0 and 5.0 hours with mean duration during wakefulness about 1.5 hours [3]. The diurnal nasal cycle has random pattern under influence of various psychophysical factors [4] [5] [6]. During the night sleep, the switch of the nostrils occurred nearly in the same interval with periodicity multiplies by one sleep cycle ~1.5 h. In this case, the mean duration of the nasal cycle is about 3 h with dominance of the 3 h nasal cycles (60%), 1.5 h nasal cycles (30%) and 1.5 h nasal cycles (10% from all cases) [7] [8]. The experimental studies of Atanasov *et al.* [7] [8] and Kimura *et al.* [9] have shown the nasal cycle during night sleep is mutually connected to REM stages of the sleep. The experimental results have shown the change of dominate nostril airflow occurs during one of the stages of REM sleep and never not happening

during slow-wave sleep. The principal situation of the nasal cycle reversals (NCR) during diurnal and night (sleep) time is shown in **Figure 1**.

The modern concept for wakefulness (awake/wake) and REM stage of the sleep is both to be considered as consciousness states [11] (see **Figure 2**). The consciousness is ambiguous concept, which is focused on multi-disciplinart debates concerning the cells sensation [12] and the animals psych functions [13]. However, up to now, there is no universal definition for consciousness covering all its essential characters.

Recently, the awake/wake consciousness regard as “primary consciousness state”, wireless the REM stage of the sleep regard as “secondary consciousness state” or “proto-consciousness” state [11] [14]. The clinically defined consciousness is characterized by two main components-awareness and arousal [15].

The presence of one or both of these consciousness components gives reason to believe that the given person is in a consciousness or is near to consciousness state. During diurnal period of the day the healthy person normally is in waking consciousness. In this state of consciousness, the sensation and perception are

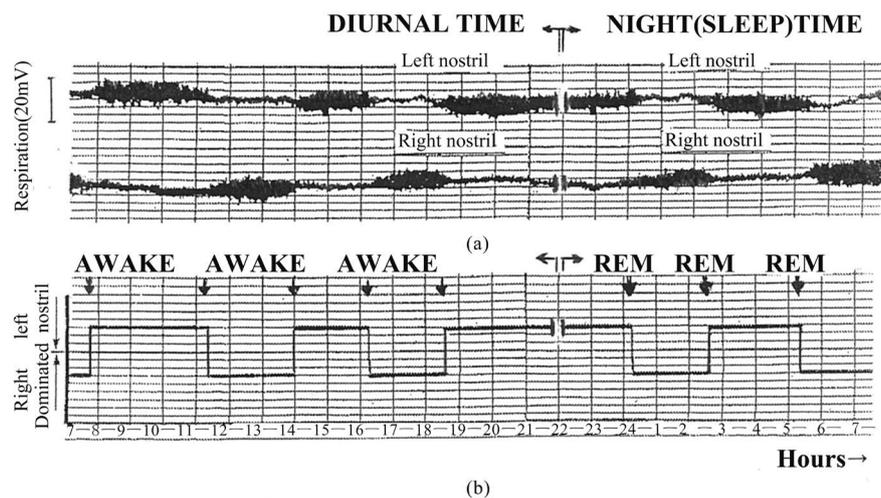


Figure 1. Principal scheme of the nasal cycle reversal during wakefulness and REM stages of the sleep (unpublished data by Atanasov [7] [10]). (a) Record of the breathing streams through the left and right nostrils during diurnal (wakefulness) time and night (sleep) time. (b) Nasal cycle periodicity (arrows shows the moments of the nasal cycle reversals).



Figure 2. The principal scheme of consciousness states of the brain. Legend: awake and REM consciousness refers to daytime and to sleep (dream) time, respectively. Sleep stages 1 and 2, which are neighboring to awake and REM stages are taken as consciousness states during dream.

vivid and externally generated. The thought is logical and progressive. The movement is continuous and voluntary. The characteristics of consciousness during night sleep are poorly studied. The sleep is divided to non-REM and REM stages, which alternate in a certain sequence forming about 1.5 hours periods [16]. It is established that in REM “proto-consciousness” stage of the sleep there is reason to consider that there is “minimum threshold” of consciousness [11] [14]. In “REM proto-consciousness” the sensation and perceptions are vivid and internally generated, and the thought is illogical and bizarre. The movement is command but inhibited. Whatever, just in REM stages of the sleep, it becomes about 84% NCR between the nostrils [7] [8] [9]. During the non-REM stages of the sleep the sensation and perception are absent. If the sleeper is awakened from REM sleep, dream recall rates are very high, between 80 and 90 percent of the awakenings yield some kind of dream report [17]. Even after non-REM awakenings (in stage 2), some mental content has been reported quite often [18]. Some researchers [17] [18] advocate the hypothesis that the mind never sleeps, that is, dreaming of some kind is present during the entire sleep process.

According to other authors [19], sleep that contains dream is considered as conscious state, while dreamless sleep is unconscious. Lucid dreams are reported far more often in REM sleep too [19] [20] [21]. In fact, the lucid dreams could be considered a hybrid state combining essential elements of REM sleep and waking consciousness. Therefore, dreams are the event that defines the consciousness. The studies of Foulkes [22] and others researches [23] [24] [25] showed that dream-like mentation may occur during non-REM stage of sleep and more precisely in the neighborhood of the awake state St.1 and St.2 of sleep [25]. “Light sleepers” can experience dreaming during stage 2 non-REM sleep, whereas “deep sleepers”, upon awakening in the same stage, are more likely to report “thinking” but not “dreaming”. Despite this wealth of descriptive information about the stages of sleep, the functional purposes of the various sleep states are not known. Whereas most sleep researchers accept the idea that the purpose of non-REM sleep is at least in part restorative, the function of REM sleep remains a matter of considerable controversy. The main difference between REM and non-REM dream is the mental content of activity. However, the dreams in REM and non-REM sleep differ by many characteristics, and mean only 40% of volunteers-sleepers associated dreaming with non-REM sleep [14] [17] [26] in comparison to mean 80% of sleepers associated dreaming with REM sleep [17] [26] [27]. Thus, the non-REM sleep can present some consciousness state in St.1, 2 of the sleep [27]. **Figure 3** shows a principal scheme of connection between the consciousness states and NCR in humans.

Recently, there is enough experimental evidence for association between the conscious states and NCR. Indeed, the association between the nasal cycle reversals and awake/wake state and REM stages is well documented [7] [8] [9], while the connection between the NCR and St.1, 2 is under consideration. In the study of Atanasov *et al.* [7] 75% of the NCR are associated to REM sleep and

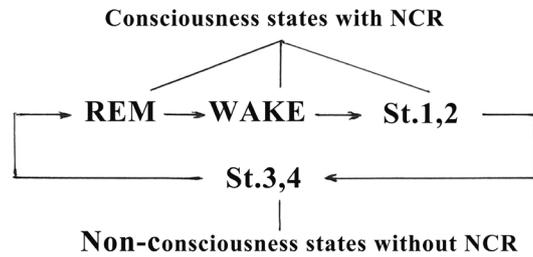


Figure 3. Cycle of the human consciousness. The wake stage is taken to be basic. The newborn to basic wake stages (REM and St.1, 2) are considered as “conscious states”.

25% are associated to other body factors. In the study of Kimura *et al.* [9] 68.8% of the NCR tended to be associated with REM sleep and 18.8% tended to be associated to postural change in St.1, 2. The half of these 18.8% NCR are made in “left-right” body position and the other half of NCR are made in “supine” body position. But, it is documented [3] [9] [28] that the “supine” body position does not itself cause nasal cycle reversal, unlike “left” or “right” body position. From these results leads that the NCR can associate not only with postural changes, but also with St.1, 2 of the sleep and “dream-like mentation” in these stages.

On **Figure 3**, the wake state of consciousness is taken to be “basic”, but in infants the REM stage appears “basic” state of the brain. In the premature neonates and normal newborns the REM stage can occupy from 50% to 80% of the day and constitutes the main state of the brain. In this case a wake and St.1, 2 are adjacent to the major REM stage. For mature peoples the basic brain stage appears an awake, while the REM stage constitutes about 25% of the sleep [29].

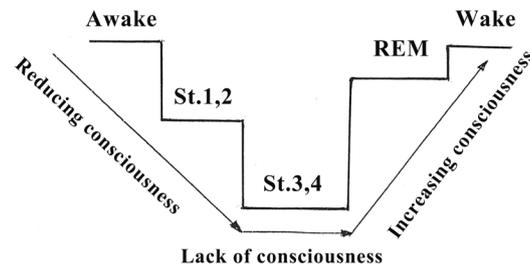
2. Hypothesis

The experiments showed that NCR can observe in awake/wake stage, in St.1, 2 and REM stage of the sleep. Just in these EEG stages certain characteristics of consciousness are retained during wake and dream. Therefore, registration the NCR during awake/wake, St.1, 2 and REM stage can associate to presence of primary and secondary consciousness in these EEG states. **Table 1** gives the connection between the brain EEG stages, mental consciousness states and NCR as a confirmation of the hypothesis. From **Table 1**, it can be seen that the NCR can associate both, with EEG brain stages (wake, REM and 1, 2 stages of sleep) and with conscious states of the brain in these EEG states. Such connection between the EEG stages and corresponding conscious states in them leads to the nasal cycle dilemma. Accordingly to this dilemma the nasal cycle reversals occur only in awake state, REM-dreams and in St.1, 2-dreams of the sleep. If there are no dreams in REM or in St.1, 2 stage of sleep, than there should be no nasal cycle reversals in them.

The transition from awake to sleep can regard as consecutive cycles of progressive awareness and arousal, followed by period of reducing and lack of consciousness and a period of gradually increasing consciousness. On **Figure 4** the transition from awake to St.1, 2 is accompanied by a reduction of consciousness

Table 1. EEG states, mental consciousness states and presence (+) or absence (0) of the NCR

EEG state	Mental state	Presence of NCR
Awake	Normal conscious state	(+)
REM	Dream conscious state	(+)
Stage 1	Non-REM dream (conscious state)	(+)
Stage 2	Non-REM dream (conscious state)	(+)
Stage 3	Non-REM (non-conscious state)	(0)
Stage 4	Non-REM (non-conscious state)	(0)

**Figure 4.** Presentation of “one consciousness cycle”. The transition from “awake to St.1, 2 and to St.3, 4” is accompanied of reducing consciousness. The transition from “REM to wake” is accompanied of increasing consciousness.

characteristics. In St.3, 4 it is observed lack of consciousness. In reverse transition from St.3, 4 to REM and to wake states there is a gradual increase of consciousness characteristics.

The “consciousness cycle” presented on **Figure 4** repeat some times during night sleep. Whatever, it is possible the similar “daytime conscious cycle” to persist in diurnal time, because the mean duration of the nasal cycle during daytime is about 1.5 hours. This duration correspond to mean length of the sleep cycle [3] [29]. The daytime conscious cycle will only represent a periodic increase and decrease of consciousness characteristics without being present lack of consciousness.

3. Possible Application of the Hypothesis in Clinical Medicine

The evidence that the NCR becomes in consciousness states of the brain gives possibility the NCR to be used as “marker” for consciousness *i.e.* as a peculiar “marker” for consciousness. Exactly, around the moment of NCR the brain is in a conscious state or as close as possible to the conscious state. From the above presentation it can assume that the pattern of nasal cycle can present a new method for detection of consciousness.

Until 2003 year, when REM and NCR association and synchronization was registered for first time by Atanasov *et al.* [7] [8], there was no assumed relationship between the two cycles. So far, the similar is situation in relation to dynamics of the nasal cycle during brain diseases, including disorders of consciousness, coma and related states [30] [31]. The recent methods for detection

of consciousness consist mainly of three groups: neuro-imaging technics, electroencephalography technics and behavior assessment [19] [32]. In addition to these well-established techniques the presence or absence of nasal cycle reversals in patients with brain diseases can be new method for detection of consciousness. One issue of fundamental importance is whether there is a nasal cycle (NCR) in the absence of consciousness, what we have in the states of coma. Another fundamental issue is the relationship between the parameters of the nasal cycle and the tendency of recovering the patients from coma and related states. **Figure 5** gives the scheme of cerebral metabolism in norm and coma states and presence or absence of nasal cycle reversals in them.

From **Figure 5**, it can be seen that cerebral metabolism decreases to 60% from normal consciousness to deep sleep. In coma and related states (minimally consciousness states and vegetative state) the cerebral metabolism is less than 50%. Only in “locked in syndrome” the cerebral metabolism is near to REM stage of sleep. The nasal cycle reversals are detected only in “Normal Conscious State” with 100% cerebral metabolism and in “REM Conscious State” with 90% cerebral metabolism. In “Deep Sleep” with 60% cerebral metabolism there is no nasal cycle reversals. Thus, the presence or absence of nasal cycle reversals during coma and related states will give an opportunity to understand how much nasal cycle reversals is related to the level of cerebral metabolism and consciousness in norm and pathology. If such a link exists, the time for the transition of nasal air-flow from left to right nostril and reverse (during NCR) may use patients to be derived from some coma states. As a support of this idea can be quoted the correlation patterns of the brain hemispheric dominance and the nasal cycle dynamics, reported by Werntz *et al.* [33] and Shannahoff-Khalsa [34]. The alternation of the nasal cycle rhythms can present also an index of the diseased [35].

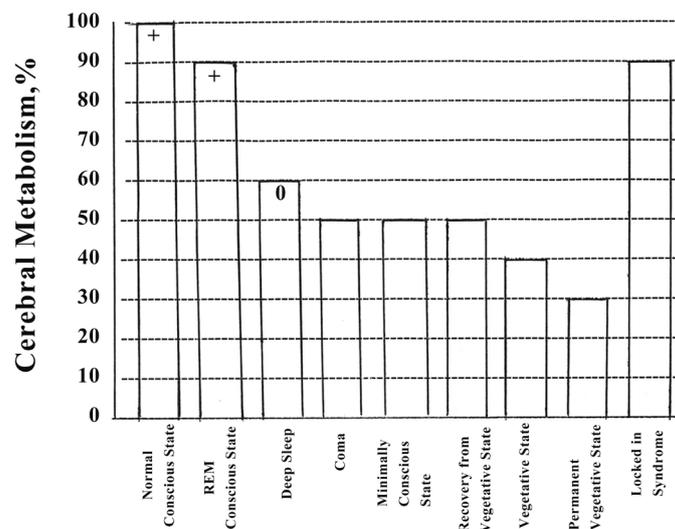


Figure 5. Cerebral metabolism during normal conscious, coma and related states (by Laureys *et al.* [31] modified by Atanasov). *Legend*-with “+” is signed presence of NCR, and with “0” is signed absence of NCR.

4. Conclusion

The novelty in this research consists of some new ideas: Firstly, for possible connection between the NCR and consciousness states of the brain during wakefulness and dreams; Secondly, the possibility NCR to be used as markers for consciousness in some brain diseases. Up to now there is no data for nasal cycle measurement during coma and related states. The possible link between consciousness and the nasal cycle reversals can give a new methodology to awaken people in coma.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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