



Annals of Medicine

ISSN: 0785-3890 (Print) 1365-2060 (Online) Journal homepage: www.tandfonline.com/journals/iann20

Awareness of time during sleep

William H Moorcroft & Joseph L Breitenstein

To cite this article: William H Moorcroft & Joseph L Breitenstein (2000) Awareness of time during sleep, *Annals of Medicine*, 32:4, 236-238, DOI: [10.3109/07853890009011766](https://doi.org/10.3109/07853890009011766)

To link to this article: <https://doi.org/10.3109/07853890009011766>



Published online: 08 Jul 2009.



Submit your article to this journal [↗](#)



Article views: 1002



View related articles [↗](#)



Citing articles: 1 View citing articles [↗](#)

Awareness of time during sleep

William H Moorcroft¹ and Joseph L Breitenstein²

One cognitive ability that has been demonstrated in many people when asleep is the capacity to keep track of time sufficiently so that they can self-awaken when desired. Possible practical, physiological and evolutionary sources of this skill are outlined. Such findings help to establish the likely presence of significant cognitive ability when asleep.

Key words: cognition; internal clock; self-awaken; sleep.

Ann Med 2000; 32: 236–238.

Introduction

In the industrialized world, sleep is often regarded as a state of little if any mental activity, save dreaming, and, other than being beneficial for bodily rest and restoration, not very useful. Indeed, with the advent of cheap and abundant artificial light, time asleep has been minimized as much as possible by many people. Research on sleep during the last 50 years has contradicted these views of the importance of sleep. For large mammals, other than a slight effect on the immune and endocrine systems, sleep has been discovered to be of greater importance for mental processes, especially memory and emotions. In addition, simple reflection and basic research show that several mental processes are active during sleep. Humans turn over in response to pressure or pain and awaken in response to a full bladder. Sleepers are aware of the location of the edge of the bed to avoid falling on the floor (1). They have awakened in response to stimuli of considerable personal significance, such as their name being called, but sleep soundly through equally intense but less meaningful stimuli (1). Added to this common knowledge is

research that shows the ability to respond while asleep (1) or dreaming (2) with a behaviour (such as pressing a finger switch) that was learned earlier while awake, and to self-awaken near a time chosen prior to sleep onset.

This latter ability suggests the presence of some kind of timing mechanism that is attended to during sleep. It is most likely that an internal clock or other source of internal time estimation may be responsible for this ability to awaken without or before an alarm or external source. It is well established that several kinds of internal clock-like mechanisms exist in animals to regulate circadian, infradian and ultradian physiological activities (3). Some of these involve sleep, such as the circadian sleep–wake propensity cycle and the ultradian non-rapid eye movement (NREM)–REM sleep cycling. It is well within the limits of possibility that these or other clock mechanisms could provide enough subconscious awareness of time to enable humans to self-awaken from sleep near a predetermined convenient time.

Past research

Even before the discovery of the existence of biological rhythms there was sufficient speculation about the existence of the ability to self-awaken to prompt over a century of occasional scientific investigation of this phenomenon. In 1892 Child found that 59% of a sample of 200 respondents claimed the ability to 'wake precisely at a given hour determined before going to sleep, without waking up many times before the appointed time' (4). However, 25% of these

From the ¹Sleep and Dreams Laboratory, Department of Psychology, and the ²Department of Psychology, Luther College, Decorah, IA, USA.

Correspondence: William H Moorcroft, PhD, Sleep and Dreams Laboratory, Department of Psychology, Luther College, 700 College Drive, Decorah, IA 52101, USA. E-mail: Moorcrwi@luther.edu, Fax: +1 319 3871080.

individuals admitted that they often failed. During the century that followed several additional reports of research results utilizing case studies, surveys, sleep logs and, more recently, sleep laboratory studies (reviewed in (5)) have shown that this ability exists at least to some extent in some humans. Several reviewers of this research have found self-awakening to be a valid confirmation of some kind of internal sense of time that is of functional utility in many people (cf (1, 6)).

Yet other sleep researchers have been skeptical of the ability to self-awaken at a set time (7) on the grounds that it is not a universal phenomena nor is it entirely reliable. However, there are many examples in medicine of genuine phenomena that are not found in all humans and the occurrence of which is irregular or periodic. Handedness is an example of the former and recall of specific items from long-term memory of the latter.

Source of self-awakening ability

In addition to imputed read-out of an internal biological clock, speculation about the source of this awareness of time during sleep has also included light sleep with frequent awakenings and periodic REM sleep. Frequent awakenings allow periodic survey of the situation, such as sunrise or time on a clock, until the barely awake person decides that it is time to fully awaken. Bell (6) has proposed that the ability to self-awaken consists of two components: the ability to induce more frequent awakenings coupled with the ability to use these awakenings to mark the passage of time. If Bell is correct, this still demonstrates considerable cognitive activity during sleep but less of a true internal sense of time.

REM sleep is a likely source for an internal time sense allowing predetermined self-awakening. It is a time of greater brain activation (thus easier to awaken from) and/or a time of greater capability of cognitive activity necessary to recognize time and follow the directions to awaken. REM sleep has a somewhat periodic occurrence during the sleep cycle, and it tends to get longer as the sleep period progresses. People also tend to arouse briefly (usually without awareness) before or after a period of REM sleep, which would occur often enough by chance close to the desired time of sleep termination. There is evidence to support this possibility that the ability to self-awaken is tied to REM sleep (8, 9).

More recently, research has shown an increase in adrenocorticotrophin release during the hour preceding the intended time of awakening that did not occur if the subjects were awakened well before this time (10). While this increase in adrenocorticotrophin may be an internal stimulus that contributes to self-

arousal, a question still remains regarding the connection between the mental intention to awaken at a particular time and the physiological change in adrenocorticotrophin.

The subjects in our recent research (5) gave various explanations of how they self-awakened close to the target time. The most common response was 'don't know' followed by habit, visualization of a clock set to wake-up time and some other kind of presleep ritual. Stress caused by the schedule of the next day was also mentioned by several subjects. Although it would seem that a consistent time of awakening from day to day might facilitate this ability, it was those subjects who widely varied their self-set time of awakening who were actually more accurate. However, those subjects who were more consistent in the amount of sleep they obtained from one night to the next were more accurate in their self-awakening than those who were more variable in sleep duration per night. Other factors, such as gender or working shift schedules, had no effect on this ability.

At least two studies (11, 12) have endeavoured to more directly test time awareness when asleep. The subjects in these studies were awakened at various times and asked to report on what time they thought it was. The results were positive but not very impressive. However, this may be a different kind of time awareness than that of awakening at a specific time as there is no behavioural significance attached to it.

It is probably not surprising that many humans have the ability to self-awaken when desired because accurate personal external time keeping machines have not been available until quite recently in human history (13). Yet the need to awaken at a specific time in order to attend to duties may have evolved after humans started farming, hunting, soldiering, travelling, sailing, and so forth. Those individuals who had the ability to self-awaken reasonably close to a desired time, we might envision, may have had a survival advantage allowing them to create offspring with genes for the ability to self-awaken. However, not all humans manifest this ability. In all studies, some people were unable to self-awaken at a desired time. Either the ability to self-awaken remains latent in such people or, as evolutionary principles would suggest, the expression of this ability would vary naturally and not everyone would be expected to carry such genes.

Conclusion

Overall, these studies show that there is greater cognitive activity and control occurring during sleep than is generally believed. While it is not at the level of conscious awareness, it is nevertheless genuine and important. Cognitive control during sleep has been

shown to be useful in the control of enuresis (14), nightmares (15, 16), and positional sleep apnoea (17).

It is important to note that until the discovery of sleep apnoea, the body asleep was considered to operate in the same manner as the body awake. Now it is known that in many ways the physiology of the body is very different during sleep (3), and the field of sleep medicine has emerged, developed and taken its place among other medical specialties. Paralleling this

change is a revised understanding that the mind in sleep is cognitively active, which often includes being able to wake itself up. Future research is likely to further delineate the anatomical and physiological underpinnings of such internal timing mechanisms and attempt to establish the potential of teaching tactics for optimizing this ability. Such work could demonstrate that the mind asleep may even be superior in some regards to the mind awake.

References

1. Bootzin RR, Kihlstrom JF, Schacter DL, eds. *Sleep and cognition*. Washington, DC: American Psychological Association; 1990.
2. Antrobus JS, Antrobus J, Fischer C. Discrimination of dreaming and non-dreaming sleep. *Arch Gen Psychology* 1965; 12: 295–401.
3. Moorcroft WH. *Sleep, dreaming, and sleep disorders: an introduction*. Lanham, MD: University Press of America; 1993.
4. Child CM. Statistics of "unconscious cerebration". *Am J Psychology* 1892; 5: 249–59.
5. Moorcroft WH, Kayser KH, Griggs AJ. Subjective and objective confirmation of the ability to self-awaken at a self-predetermined time without using external means. *Sleep* 1997; 20: 40–5.
6. Bell CR. Awakening from sleep at a pre-set time. *Percept Motor Skills* 1980; 50: 503–8.
7. Zepelin H. Internal alarm clock. In: Carskadon MA, ed. *Encyclopedia of sleep and dreams*. New York, NY: Macmillan; 1993: 315.
8. Zepelin H. REM sleep and the timing of self-awakenings. *Bull Psychonomic Soc* 1986; 24: 254–6.
9. Lavie P, Oksenberg A, Zomer J. It's time, you must wake up now. *Percept Motor Skills* 1979; 49: 447–50.
10. Born J, Hansen K, Marshall L, Mölle M, Fern HL. Timing the end of nocturnal sleep. *Nature* 1999; 397: 29–30.
11. Boring EG, Boring LD. Temporal judgments after sleep. In: LD Boring, EG Boring, eds. *Studies in psychology, Titchner commemorative volume*. Worcester, Massachusetts: Private publication; 1917: 255–79.
12. Webb WB, Ross W. Estimation of the passing of four consecutive hours. *Percept Motor Skills* 1972; 35: 768–70.
13. Herman KB. Alarm clocks. In: Carskadon MA, ed. *Encyclopedia of sleep and dreams*. New York, NY: Macmillan; 1993: 19–21.
14. Mahowald MW, Rosen GM. Parasomnias in children. *Pediatrician* 1990; 17: 21–31.
15. Cartwright RD, Lamberg L. *Crisis dreaming: using your dreams to solve your problems*. New York, NY: Harper Collins; 1992.
16. Krakow B, Neidheadt J. *Conquering bad dreams & nightmares: a guide to understanding, interpretation, and cure*. New York, NY: Berkley; 1992.
17. Cartwright R, Ristanovic R, Diaz F, Calcatelli D, Alder G. A comparative study of treatments for positional sleep apnea. *Sleep* 1991; 14: 546–52.