Send Orders for Reprints to reprints@benthamscience.ae

The Open Psychology Journal, 2017, *10*, 49-54

BENTHAM OPEN

CrossMark

The Open Psychology Journal

Content list available at: www.benthamopen.com/TOPSYJ/

DOI: 10.2174/1874350101710010049

REVIEW ARTICLE

Why Do Healthy Men Experience Morning Erections?

Gahyun Youn*

Department of Psychology, Chonnam National University, 77 Yongbong-Ro, Gwangju 61186, Korea

Received: March 04, 2017 Revised: March 15, 2017 Accepted: April 10, 2017

Abstract: People begin the sleep cycle with a period of non-rapid eye movement (NREM) sleep, followed by a very short period of rapid eye movement (REM) sleep. During a normal night of sleep, humans usually experience about four or five periods of REM sleep. Penile erections have generally been considered to be an epiphenomenon of REM sleep-related physiological changes for healthy males. Thus, men are very likely to awaken in the morning with a REM sleep-related erection, which is also known as nocturnal penile tumescence (NPT). Men who are physically under great strain or serious psychological stress may find it difficult to maintain a psychogenic erection. The best time for them to have sex would be during sleep time, such as when they are experiencing REM sleep-related erections. It is reasonable to assume that the NPT phenomena might have evolved as a tool for having sex, in the context of both procreation and recreation.

Keywords : REM sleep, Morning erection, Nocturnal penile tumescence, Sexual intercourse, Procreation, Recreational sex.

REM SLEEP

Mammalian sleep consists of natural cycles of activity in the brain and has distinct states: rapid eye movement (REM) sleep and non-rapid eye movement (NREM) sleep which consists of Stages 1 through 3 [1]. Typically, people begin the sleep cycle with a period of NREM sleep followed by a very short period of REM sleep. Dreams generally occur in the REM state of sleep [2, 3]. Usually, REM sleep occurs 90 minutes after sleep onset. The first period of REM typically lasts 10 minutes, with each recurring REM state lengthening, and the final one lasting up to an hour. That is, the proportion of REM sleep in total sleep time in humans increases as morning approaches. During a normal night of sleep, humans usually experience about four or five periods of REM sleep. REM sleep in adult humans occupies approximately 20-25% of total sleep, or about 90-120 minutes. Some people tend to wake, or experience a period of very light sleep, for a short time immediately after a bout of REM [2 - 6].

There are many theories about the functions of REM sleep, but they are not understood well. It has been hypothesized that the REM state serves a sentinel function, bringing about a brief, but periodic, awakening after preparing the organism for immediate fight or escape [7, 8]. That is, REM sleep activates an animal periodically to scan the environment for possible predators. Such a built-in physiological mechanism presumably would provide maximal security from external danger compatible with minimal disturbance to the continuity of sleep. Apparently, humans are more alert when aroused from REM sleep than NREM sleep [2, 8, 9]. Many researchers argue that REM sleep serves an important function for the survival of mammalian and avian species. In both humans and experimental animals, REM sleep loss leads to several behavioral and physiological abnormalities [2, 8, 10, 11]. In addition, some researchers state that REM sleep may function to influence and promote social bonding or attachment in the developing organism and in adults [11 - 14].

* Address correspondence to this author at the Department of Psychology, Chonnam National University, 77 Yongbong-Ro, Gwangju 61186, Korea; Tel: +82 62-530-2655, +82 10 6612-2655; Fax: +82 62 530-2659; Emails: ghyoun@jnu.ac.kr, you90900@naver.com

NOCTURNAL PENILE TUMESCENCE

Penile Erections During Sleep

Spontaneous awakening from sleep is significantly associated with the erection cycle [5] and the association had already documented in the early 1940s [15]. Sleep is different for each individual, but most men have four to five full erections during REM sleep, with each erection lasting about 25-35 minutes. The erections are a normal part of REM sleep for males of all ages, even in infants and children. The relationship between REM sleep and erections is the reason that men are likely to awaken directly from REM sleep, or soon after a long morning REM period has ended. Thus, even though men do not always wake up at the end of each episode of REM sleep, they are very likely to awaken in the morning with an REM sleep-related erection [5, 16]. Morning erections are scientifically defined as involuntary sleep-related erections (SREs) or nocturnal penile tumescence (NPT) and are a healthy and normal physiological response that most men experience [5, 16 - 19].

Erections are considered a normal part of sleep physiology in men. Evaluation of NPT is one of the earlier tests devised to study erectile dysfunction (ED). After demonstrating that NPT was a general phenomenon in healthy males 3 to 79 years old, Karacan, in the early 1970s, suggested that NPT could be used to evaluate ED [4, 20]. The mechanism of NPT is presumed to rely on neurovascular response mechanisms similar to those seen in erotically induced erections. Thus, men who are documented to have normal NPT are presumed to have a normal capacity for spontaneous, erotically induced erections. As a matter of fact, the primary function of NPT tests is to distinguish psychogenic causes of ED from organic causes [18, 21 - 23]. Men who do not have erections because of psychological problems can still have erections during deep sleep. If a lack of morning erections is accompanied by a lack of overall erections, a physical cause is suggested rather than a psychological cause [21, 23, 24].

Physiology of NPT

Although it has been known for some time that every REM cycle is associated with penile erections in males and clitoral engorgement in females, it is not known why this sexual excitation occurs. The erections are not related to erotic content of dreams, previous sexual activity, or a full or empty bladder [11]. Oddly enough, the erections have generally been considered as mere epiphenomena of REM sleep-related physiologic changes [3, 11, 16]. That is, morning erections have been connected to some hormones and neurotransmitters.

Sex-related hormones have been selectively associated with REM sleep. Testosterone modulates nearly every component involved in erectile function, from pelvic ganglions to smooth muscle and the endothelial cells of the corpora cavernosa. Testosterone also regulates the timing of the erectile process as a function of sexual desire, coordinating penile erection with sex [25 - 27]. Testosterone levels are higher early in the morning compared to the afternoon or evening in males. In general, the levels rise on falling asleep, are highest at the transition from non-REM to REM sleep state, peak around the time of the first REM sleep period, and remain constant until awakening. Testosterone has been found to be the cause of NPT [11, 17, 18, 27 - 29]. Prolactin is also known to be crucial for the development of reproductive and sexual behaviors. It stimulates an array of testicular functions in males and ovarian functions in females [30]. Its release is dependent on REM sleep, with its level rising rapidly at sleep onset and peaking around 3-5 a.m. when REM sleep dominates [11, 30].

Penile erection is neurologically controlled by the autonomic nervous system. Several neurotransmitters, especially norepinephrine and acetylcholine, are well-known regulators of penile erection [19]. During REM sleep, high levels of acetylcholine in the hippocampus suppress feedback from the hippocampus to the neocortex, and lower levels of acetylcholine and norepinephrine in the neocortex encourage the spread of associational activity within neocortical areas, without control from the hippocampus [31, 32]. This leads to the cessation of histamine, norepinephrine, and serotonin neuron activity during REM sleep [3, 6]. The erections in REM sleep occur when neurological stimulators cause blood to flow into the penis. This ensures that oxygen is properly delivered to the penis and helps keep penile tissue healthy [2, 33].

Functions of NPT

What are fundamental functions of NPT? It is reported that REM sleep is present during a considerably higher percentage of the sleeping time of infants and children than adults. Since penile erections tend to be synchronous with REM sleep, this again suggests that the erections may not be primarily a sexual phenomenon, at least to infants and children [34]. There are two types of erections. One is a psychogenic erection which occurs due to the stimulation of

some parts of the brain, and the other is reflex erection which may spontaneously appear at any time, such as NPT [35]. A psychogenic erection is triggered by sexual stimulation and sexual arousal [19].

The major functions of sexual interaction are both procreation and recreation [36]. A man should maintain either a psychogenic or reflex erection for penile-vaginal intercourse. If he wants sex with a psychogenic erection, he should be awake and sexually aroused by the erotic and/or emotional stimuli. He could, however, have sex with an REM sleep-related erection, even without stimuli. Here, it is possible to surmise the reason why men experience REM sleep-related erections spontaneously, in the context of procreation. The brain of every man instinctively seeks to eternal generation. On the instinctive level, this leads to a man looking for a sexual partner to transfer his genes to create future generations [37]. This is the most important role played by erections, as they are one of the most necessary tools for sexual intercourse.

Sexual Intercourse with NPT

In general, men who are physically under great strain may have difficulty maintaining a psychogenic erection [38]. For instance, monogamous men, in prehistoric societies, might come back home with physically fatigued from gathering and/or hunting. If so, it might not be pertinent for them to have sexual intercourse immediately after coming back from work early in the evening. The best time for them to have sex would be after getting enough rest during sleep time, such as experiencing REM sleep. Thus, men's REM sleep-related erections during sleep might have evolved to allow procreation irrespective of their will or intention [11].

What about the men of today? The life of the modern men is full of stresses and constant strain, both physically and psychologically. If they work all of the time, take care of kids, and stay busy most of the day, it might not be easy to have sex before they fall asleep [39]. Also, there are many men who suffer from ED, owing to psychological strain [22, 23]. Under psychologically serious stress, men become too anxious to get or maintain an erection, and thus, suffer from either the loss of erection and/or premature ejaculation [38]. For instance, men who have relationship problems with female partners do not attempt to have sex owing to anxiety [40]. They fear that when they initiate sex, their female partners might reject the initiation. Even though the female partners might not reject the initiation, the men would experience erectile problems and/or premature ejaculation [38].

Women experience clitoral enlargement, as men do penile erections, during the REM sleep state due to increased blood flow to genital organs [6, 41]. This indicates that a woman's body is ready to have sex during the REM sleep state. It also indicates that women who are semi-awake would be less resistant to their partner, even if they are currently uncomfortable with their partner [42]. As mentioned earlier, some researchers stated that REM sleep evolved to promote attachment in unattached sexual partners [12, 13]. That is, men who have relationship problems may try sexual intercourse by genital erections during REM sleep [14].

As for Korean couples, some who had relationship problems with their spouses do not choose divorce or separation as a solution. Many of them tend to believe that the problems can be solved if they have sex with their partners [42]. This means that they believe marital conflicts might be solved through sex, no matter the situation [42, 43]. Many couples in marital conflict choose sleeping in separate rooms for a specific period of time (e.g., for a week, month, or even longer than that) as a solution [43, 44]. While researching these couples, the authors met many women who reported having sex with their husbands during the separate room arrangement. Women, who refused their husbands at other times, did not reject their husbands who came to their room while they were sleeping, when they had penile erections [42 - 44]. This indicates that their sexual encounters by the REM sleep-related erections would serve a palliative function especially during time of physical and/or psychological stress [14].

According to a study of part-time college students who had their sexual partners, some of them reported to have sex early in the morning before getting up. In general, the majority of sexual encounters take place at bedtime, that is, people begin to sleep after having sex, while some of the encounters do occur during the daytime [45]. However, approximately 20% of sexual encounters take place early in the morning [46]. It is reasonable to assume that REM sleep-related erections have a function of recreation, such as resolving marital conflict. According to *Komsomolskaya Pravda*, some Russian women said they had sex during the sleep. Many women who never experienced orgasm before are reported to have achieved peak of sexual satisfaction while having sex half-asleep [47].

Moreover, sex with an REM sleep-related erection could be advantageous to procreation. If a man has sex with his partner who is in a sleepy state, she may lie back for sex and not move her body much. It is more suitable for sperm to reach her cervix, and thus she can retain more sperm [48]. This means the chances of getting pregnant might be

somewhat higher in sex with the REM sleep-related erections than other times. That is, if REM sleep might have compensatory and reproductive functions, then the REM sleep-related erections may exert a strong influence on the reproductive success that has greater evolutionary importance [11 - 14].

CONCLUSION

Healthy men experience erections owing to physiological changes such as sex-related hormonal release during REM sleep. The hormone release leads to REM sleep-related erections. Men are able to have sex with these erections, which may have the benefits of enabling sexual excitation, couples resolving marital conflicts, and their partners getting involved [11, 16, 19, 42, 49]. In conclusion, it can be said that REM sleep promotes development of both attachable and/or recreational and reproductive strategies in human beings [11 - 13], while REM sleep-related erection has been observed to be helpful for couples who are under stress physically or psychologically to have sex [13, 14]. Accordingly, it is said that sex with an REM sleep-related erection would be the best opportunity for both procreation and recreation.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

HUMAN AND ANIMAL RIGHTS

No Animals/Humans were used for studies that are base of this research.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGEMENTS

Declared none.

REFERENCES

[1] Iber C, Ancoli-Israel S, Chesson A, Quan SF. The AASM manual for the scoring of sleep and associated events: rules, terminology and technical specifications. Westchester, Illinois: AASM 2007; Vol. 1.

[2] Carskadon MA, Dement WC. Monitoring and staging human sleep. In: Kryger MH, Roth T, Dement WC, Eds. Principles and practice of sleep medicine. St. Louis: Elsevier Saunders 2011; pp. 16-26.
[http://dx.doi.org/10.1016/B978-1-4160-6645-3.00002-5]

[3] Hobson JA, Stickgold R, Pace-Schott EF. The neuropsychology of REM sleep dreaming. Neuroreport 1998; 9(3): R1-R14.
[http://dx.doi.org/10.1097/00001756-199802160-00033] [PMID: 9512371]

[4] Karacan I, Hursch CJ, Williams RL, Littell RC. Some characteristics of nocturnal penile tumescence during puberty. Pediatr Res 1972; 6(6): 529-37.
[http://dx.doi.org/10.1203/00006450-197206000-00001] [PMID: 4340042]

[5] Schulz H, Salzarulo P. Forerunners of REM sleep. Sleep Med Rev 2012; 16(1): 95-108.
[http://dx.doi.org/10.1016/j.smrv.2011.05.006] [PMID: 21906979]

[6] Siegel JM. REM sleep. In: Kryger MH, Roth T, Dement WC, Eds. Principles and practice of sleep medicine. Philadelphia: Saunders 2005; pp. 120-35.
[http://dx.doi.org/10.1016/B0-72-160797-7/50017-3]

[7] Horne J. Why REM sleep? Clues beyond the laboratory in a more challenging world. Biol Psychol 2013; 92(2): 152-68.
[http://dx.doi.org/10.1016/j.biopsycho.2012.10.010] [PMID: 23174692]

[8] Horne JA. Human REM sleep: influence on feeding behaviour, with clinical implications. Sleep Med 2015; 16(8): 910-6.
[http://dx.doi.org/10.1016/j.sleep.2015.04.002] [PMID: 26122167]

[9] Snyder F. Toward an evolutionary theory of dreaming. Am J Psychiat 1966; 123(2): 121-42.
[http://dx.doi.org/10.1176/ajp.123.2.121] [PMID: 5329927]

[10] Banks S, Dinges DF. Behavioral and physiological consequences of sleep restriction. J Clin Sleep Med 2007; 3(5): 519-28.
[PMID: 17803017]

[11] McNamara P, Dowdall J, Auerbach S. REM sleep, early experience, and the development of reproductive strategies. Hum Nat 2002; 13(4):

405-35.
[http://dx.doi.org/10.1007/s12110-002-1001-x] [PMID: 26193088]

[12] McNamara P. REM sleep: A social bonding mechanism. New Ideas Psychol 1996; 14: 35-46.
[http://dx.doi.org/10.1016/0732-118X(95)00023-A]

[13] McNamara P, Andresen J, Clark J, Zborowski M, Duffy CA. Impact of attachment styles on dream recall and dream content: A test of the attachment hypothesis of REM sleep. J Sleep Res 2001; 10(2): 117-27.
[http://dx.doi.org/10.1046/j.1365-2869.2001.00244.x] [PMID: 11422726]

[14] Zborowski MJ, McNamara P. Attachment hypothesis of REM sleep: Toward an integration of psychoanalysis, neuroscience, and evolutionary psychology and the implications for psychopathology research. Psychoanal Psychol 1998; 15: 115-40.
[http://dx.doi.org/10.1037/0736-9735.15.1.115]

[15] Halverson H. Genital and sphincter behavior of the male infant. Pedagog Semin J Gen 1940; 56: 95-136.
[http://dx.doi.org/10.1080/08856559.1940.9944066]

[16] Schmidt MH. Neural mechanisms of sleep-related penile erections. In: Kryger MH, Roth T, Dement WC, Eds. Principles and practice of sleep medicine. Philadelphia: Saunders 2005; pp. 305-18.
[http://dx.doi.org/10.1016/B0-72-160797-7/50032-X]

[17] Foresta C, Caretta N, Rossato M, Garolla A, Ferlin A. Role of androgens in erectile function. J Urol 2004; 171(6 Pt 1): 2358-62.
[http://dx.doi.org/10.1097/01.ju.0000124323.02868.68] [PMID: 15126821]

[18] Hirshkowitz M, Schmidt MH. Sleep-related erections: clinical perspectives and neural mechanisms. Sleep Med Rev 2005; 9(4): 311-29.
[http://dx.doi.org/10.1016/j.smrv.2005.03.001] [PMID: 15994100]

[19] Jung J, Jo HW, Kwon H, Jeong NY. Clinical neuroanatomy and neurotransmitter-mediated regulation of penile erection. Int Neurourol J 2014; 18(2): 58-62.
[http://dx.doi.org/10.5213/inj.2014.18.2.58] [PMID: 24987557]

[20] Karacan I. Clinical value of nocturnal erection in the prognosis and diagnosis of impotence. Med Aspects Hum Sex 1970; 27: 382.

[21] Kaneko S, Bradley WE. Evaluation of erectile dysfunction with continuous monitoring of penile rigidity. J Urol 1986; 136(5): 1026-9.
[PMID: 3773061]

[22] Rew KT, Heidelbaugh JJ. Erectile dysfunction. Am Fam Physician 2016; 94(10): 820-7.
[PMID: 27929275]

[23] Shamloul R, Ghanem H. Erectile dysfunction. Lancet 2013; 381(9861): 153-65.
[http://dx.doi.org/10.1016/S0140-6736(12)60520-0] [PMID: 23040455]

[24] Papagiannopoulos D, Khare N, Nehra A. Evaluation of young men with organic erectile dysfunction. Asian J Androl 2015; 17(1): 11-6.
[http://dx.doi.org/10.4103/1008-682X.139253] [PMID: 25370205]

[25] Gupta SK, Lindemulder EA, Sathyan G. Modeling of circadian testosterone in healthy men and hypogonadal men. J Clin Pharmacol 2000; 40(7): 731-8.
[http://dx.doi.org/10.1177/00912700022009486] [PMID: 10883414]

[26] Isidori AM, Buvat J, Corona G, *et al.* A critical analysis of the role of testosterone in erectile function: from pathophysiology to treatment-a systematic review. Eur Urol 2014; 65(1): 99-112.
[http://dx.doi.org/10.1016/j.eururo.2013.08.048] [PMID: 24050791]

[27] Luboshitzky R, Herer P, Levi M, Shen-Orr Z, Lavie P. Relationship between rapid eye movement sleep and testosterone secretion in normal men. J Androl 1999; 20(6): 731-7.
[PMID: 10591612]

[28] Moir A, Jessel D. Brain sex: The real difference between men and women. New York: A Delta Book 1992; pp. 104-5.

[29] Resko JA, Eik-nes KB. Diurnal testosterone levels in peripheral plasma of human male subjects. J Clin Endocrinol Metab 1966; 26(5): 573-6.
[http://dx.doi.org/10.1210/jcem-26-5-573] [PMID: 5938372]

[30] Dzaja A, Wehrle R, Lancel M, Pollmächer T. Elevated estradiol plasma levels in women with restless legs during pregnancy. Sleep 2009; 32(2): 169-74.
[http://dx.doi.org/10.1093/sleep/32.2.169] [PMID: 19238803]

[31] Hasselmo ME. Neuromodulation: acetylcholine and memory consolidation. Trends Cogn Sci (Regul Ed) 1999; 3(9): 351-9.
[http://dx.doi.org/10.1016/S1364-6613(99)01365-0] [PMID: 10461198]

[32] Vazquez J, Baghdoyan HA. Basal forebrain acetylcholine release during REM sleep is significantly greater than during waking. Am J Physiol – Reg I 2001; 280: R598-601.

[33] Padmanabhan P, McCullough AR. Penile oxygen saturation in the flaccid and erect penis in men with and without erectile dysfunction. J Androl 2007; 28(2): 223-8.
[http://dx.doi.org/10.2164/jandrol.106.001313] [PMID: 17021333]

[34] Chodoff P. A critique of Freud's theory of infantile sexuality. Am J Psychiatry 1966; 123(5): 507-18.
[http://dx.doi.org/10.1176/ajp.123.5.507] [PMID: 5331925]

[35] Andersson KE, Wagner G. Physiology of penile erection. Physiol Rev 1995; 75(1): 191-236. [PMID: 7831397]

[36] Benagiano G, Mori M. The origins of human sexuality: procreation or recreation? Reprod Biomed Online 2009; 18(Suppl. 1): 50-9. [http://dx.doi.org/10.1016/S1472-6483(10)60116-2] [PMID: 19281665]

[37] Cartwright J. Evolution and human behavior: Darwinian perspectives on human nature. Cambridge, Massachusetts: MIT Press 2000.

[38] Rosen RC. Psychogenic erectile dysfunction: Classification and management. Urol Clin North Am 2001; 28(2): 269-78. [http://dx.doi.org/10.1016/S0094-0143(05)70137-3] [PMID: 11402580]

[39] Gager CT, Yabiku ST. Who has the time? The relationship between household labor time and sexual frequency. J Fam Issues 2010; 31(2): 135-63. [http://dx.doi.org/10.1177/0192513X09348753]

[40] Abdo CH. The impact of ejaculatory dysfunction upon the sufferer and his partner. Transl Androl Urol 2016; 5(4): 460-9. [http://dx.doi.org/10.21037/tau.2016.05.08] [PMID: 27652218]

[41] Goldstein I. Female sexual arousal disorder: New insights. Int J Impot Res 2000; 12(S4)(Suppl. 4): S152-7. [http://dx.doi.org/10.1038/sj.ijir.3900596] [PMID: 11035405]

[42] Park J, Youn G. Gender differences in attitudes towards "sleeping in separate rooms" in response to marital conflict. Korean J Androl 2011; 29: 199-205. [http://dx.doi.org/10.5534/kja.2011.29.3.199]

[43] Park J, Youn G. Sleeping in separate rooms due to marital conflict: Psychological characteristics of married Korean women. INT J Psychol Behav Sci 2015; 5(2): 53-61.

[44] Youn G. Marital and sexual conflicts in elderly Korean people. J Sex Marital Ther 2009; 35(3): 230-8. [http://dx.doi.org/10.1080/00926230802716369] [PMID: 19360521]

[45] Refinetti R. Time for sex: Nycthemeral distribution of human sexual behavior. J Circadian Rhythms 2005; 3(1): 4. [http://dx.doi.org/10.1186/1740-3391-3-4] [PMID: 15790406]

[46] Jankowski KS, Díaz-Morales JF, Randler C. Chronotype, gender, and time for sex. Chronobiol Int 2014; 31(8): 911-6. [http://dx.doi.org/10.3109/07420528.2014.925470] [PMID: 24927370]

[47] Naumov A. Sexual satisfaction depends greatly on time of the day. Komsomolskaya Pravda 2016 November 20; Available from: http://www.pravdareport.com/society/sex/20-11-2006/85566-sex-0/?mode=print.

[48] Singh D, Meyer W, Zambarano RJ, Hurlbert DF. Frequency and timing of coital orgasm in women desirous of becoming pregnant. Arch Sex Behav 1998; 27(1): 15-29. [http://dx.doi.org/10.1023/A:1018653724159] [PMID: 9494687]

[49] Rampin O, Giuliano F, Benoit G, Jardin A. Central nervous system control of erection. Prog Urol 1997; 7(1): 17-23. [PMID: 9116734]