5-15-2020

Sleep/wake detection by behavioral response to haptic stimuli may be confounded by the sleep stage during which the haptic stimuli are delivered

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https://doi.org/10.5664/jcsm.8364

JCSM | Journal of Clinical Sleep Medicine

LETTERS TO THE EDITOR

Sleep/wake detection by behavioral response to haptic stimuli may be confounded by the sleep stage during which the haptic stimuli are delivered

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Miller and colleagues[1] have proposed an innovative approach for assessing movement-free waking from sleep (MFW) during actigraphy by measuring the behavioral responses to haptic stimuli during the sleep period. MFW is a common feature of insomnia that is registered as sleep by conventional actigraphy, resulting in an imprecise measure of sleep efficiency (SE). The authors studied 18 participants who received a vibratory stimulus from a stimulating actigraph or "Wakemeter" (Mbientlab, San Francisco, California)[1] in conjunction with overnight polysomnography (PSG). The Wakemeter administered a 1-second gentle vibratory stimulus every 10 minutes during sleep, and participants were instructed to squeeze a device if they detected the stimulus. A squeeze occurring within 10 seconds of a haptic stimulus was scored as a response. Wakemeter-derived SE was estimated by dividing the total number of 10-minute nonresponse epochs (denoting sleep) by the total number of 10-minute epochs in the sleep period. MFW by PSG denoted periods when electroencephalogram and electromyogram signals were consistent with wake but unaccompanied by artifacts indicative of body movement. Wakemeter- and PSG-derived estimates of SE were highly correlated ($\rho = 0.69$, $P = .001$); however, this correlation became much weaker (figure 4 in the Miller et al study[1]) when the Wakemeter-derived SE was <50%, leading the authors[1] to comment that a Wakemeter-derived SE rating of <50% may be artifactual.

One possible basis for this discrepancy in SE measures[1] when the Wakemeter-derived SE was <50% is the variation in cutaneous perception according to sleep stage.[2] Savin and colleagues[3] first reported that scratching during sleep in reaction to itch perception was primarily related to the physiology of the sleep stage rather than the underlying pruritic dermatologic condition; the highest frequency (scratching frequency was positively related to the underlying sympathetic tone) of scratching was noted in Stage 1 of Non-Rapid Eye Movement (NREM) sleep (N1 sleep), with decreasing frequency through Stage 2 of NREM sleep (N2) and Stage 3 of NREM sleep (N3), and scratching during rapid eye movement (Stage R sleep) was closer to N2 sleep.[2,3] These findings have been replicated in subsequent studies.[2]

A common PSG feature of chronic insomnia is a relative increase in N1 and decrease in N3 sleep,[4] and some long-term users of hypnotic medications may experience relatively more N2 sleep. A similar shift in sleep architecture in some participants (6 participants used hypnotics nightly[1]) could have decreased the threshold for perception of a Wakemeter-delivered vibration and been associated with a stronger behavioral response to the Wakemeter-delivered stimuli, similar to the differences in endogenously mediated scratching depending upon the sleep stage.[2,3] An underlying sleep architecture with relatively more N1 and/or N2 sleep could therefore lead to a lower Wakemeter- versus PSG-derived estimate of SE.

CITATION

Gupta MA, Gupta AK. Sleep/wake detection by behavioral response to haptic stimuli may be confounded by the sleep stage during which the haptic stimuli are delivered. *J Clin Sleep Med*. 2020;16(5):823.

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SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication January 26, 2020
Submitted in final revised form January 30, 2020
Accepted for publication January 31, 2020
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DISCLOSURE STATEMENT

All authors have seen and approved the manuscript. The authors report no conflicts of interest.