

Sleep Extension and Behavior of Young Children

University of Massachusetts, Amherst Protocol Record 2015-2739

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Study Protocol

Sleep Measures

Actigraphy. Actiwatch Spectrum wristwatches (Spectrum 2; Philips Respironics) were used to measure sleep and wake onset times and confirm that experimental manipulations were followed. The Actiwatch has off-wrist detection and a triaxial accelerometer that samples activity at 32Hz, with a sensitivity of <0.01g. Activity was stored in 15-second epochs. Actigraphy is a reliable index of time spent asleep and awake in developmental populations.

Polysomnography (PSG). Polysomnography electrode caps (EasyCap) were used to record overnight sleep physiology. Data was collected from 24 EEG electrodes, 2 electrooculogram electrodes, and 2 electromyogram electrodes (affixed to the chin) referenced to a mid-forehead ground (FPz) and referenced to Cz and contralateral mastoids.

Sleep Diary. Sleep diaries were used to validate scoring of actigraphy data. Caregivers logged their child's sleep latency, sleep onset time, and morning wake onset time each day of the experimental protocol.

Behavioral Measures

Go/No-Go Task. A developmentally appropriate Go/No-Go task was used to assess inhibitory control. In Go trials (75% of trials), images of various animals (e.g., giraffe, elephant, panda) were presented. In No-Go trials (25% of trials), a chimpanzee was presented. Displayed images were 3 inches in height and 4 inches in length, centered on a 14-inch computer screen positioned approximately 15 inches from participants.

Each trial began with the presentation of an animal image for 500 ms. Children were instructed to respond, via a button press on a computer mouse, for all of the animals (Go trials) except for the chimpanzee for which they were to inhibit their response (No-Go trials). A blank screen was presented for 500 ms between trials. Children were given 12 practice trials to ensure they understood task instructions. Subsequently, test trials were presented in 2 blocks of 60 trials each. Two pseudo-random trial orders were used for all participants (for evening and morning sessions). Trial order was counterbalanced across sessions (morning and evening), conditions (baseline and extension), and participants.

Procedure

Procedures were approved by the local Institutional Review Board. Accordingly, researchers described the procedures and caregiver consent was obtained at an in-home visit. During this initial visit, the sleep diary was given to the caregiver. Child assent was obtained and the Actiwatch was fitted to child's non-dominant wrist. Children and caregivers were shown how to use the Actiwatch and an instruction sheet was provided for future reference. Caregivers were asked to oversee the child's use of the Actiwatch and complete the sleep diary each day. Children and caregivers were instructed that the child must maintain their habitual wake time across the two 5-day testing periods. For consistency, maintaining habitual wake time was intended to ensure that sleep extension was a product of earlier sleep onset time and not delayed wake time. Children's wake time is also often constrained by bus schedules and school start times.

There were two conditions, a baseline condition and a sleep extension condition. During the baseline condition, children followed their normal bedtime routine for five consecutive nights. During the extension condition, caregivers were instructed to put their child to bed 90 minutes earlier than their habitual bedtime for five consecutive nights. Caregivers were provided a list of

tips to aid in implementing the earlier bedtime.

On the last night of the baseline and extension conditions, children, accompanied by a caregiver, arrived at the sleep laboratory approximately one hour before their habitual (baseline condition) or extended (extension condition) bedtime. After settling in, children completed a baseline assessment of the Go/No-Go task. Children were then fitted with a PSG cap. Children and caregivers slept in the lab (in separate beds in the same room) overnight. The following morning, children woke at their habitual wake time. The PSG cap was removed and children were given time to complete their normal morning routine. Children then completed the morning assessment of the Go/No-Go task. This concluded the overnight visit. At the end of each in-lab visit, the Actiwatch and sleep diaries were collected. Caregivers were provided monetary compensation and children chose an age-appropriate prize.

There was approximately one week between the baseline and extension conditions. The order of conditions was counterbalanced across participants. Whenever possible, the conditions were matched for the day of the week they took place.

Statistical Analyses

Statistical analyses were performed in SPSS, and an alpha of 0.05 was used to determine significance.

Sleep

Actigraphy data was used to assess the efficacy of the sleep extension intervention in extending sleep time from baseline. Children and their caregivers were instructed to press an event marker on the Actiwatch when the child went to sleep and woke up each day. Event markers and sleep diary entries were used to confirm the start and end time of each sleep bout. Actiware software (Philips Respironics) was then used to differentiate intervals of sleep and wake. Sleep onset time was set at the first of three consecutive minutes of sleep and wake onset time was set at the last of five consecutive minutes of sleep. Total sleep time was defined as the total minutes scored as sleep between sleep onset and wake onset.

A repeated-measures ANOVA was used to compare sleep-timing variables (i.e., sleep onset and total sleep time) between the baseline and extension conditions across groups. In these models, sleep-timing variables were independently entered as outcome variables. Condition (baseline and extension) was entered as a within-subjects factor and group (ADHD and TD) was entered as a between-subjects factor.

Polysomnography was scored according to the revised American Academy of Sleep Medicine manual by a trained researcher. Due to recording error, five participants in the TD group did not have usable PSG data.

Repeated-measures ANOVAs were used to compare PSG outcome variables (i.e., total sleep time and time spent in distinct sleep stages) between conditions and groups. Here too, condition was entered as a within-subjects factor and group as a between-subjects factor.

Inhibitory Control

To determine whether sleep extension improved inhibitory control in children with and without ADHD, a repeated-measures ANOVA was used. In this model, inhibitory control, as measured by accuracy (% correct) on No-Go trials, was entered as the outcome variable. Condition and time (evening and morning) were entered as within-subject factors and group was entered as a between-subjects factor. Separate repeated-measures ANOVAs were then run independently

for each group to assess group-specific changes in inhibitory control following the sleep manipulation.