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Beyond mean values: Quantifying intraindividual variability in pre-sleep arousal and sleep in younger and older community-dwelling adults

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ABSTRACT

Intraindividual variability is an often understudied aspect of health outcomes research that may provide additional, complementary information to average values. The current paper aims to further our understanding of intraindividual variability in health research by presenting the results of a daily diary study of sleep and pre-sleep arousal. Pre-sleep arousal is often implicated in poor sleep outcomes, although the arousal–sleep association is not uniform across age groups. The examination of intraindividual variability in different age groups may provide a more complete understanding of these constructs, which, in turn, can inform future research. The overall objectives of the current study are to quantify the amount of intraindividual variability in pre-sleep arousal and sleep and to examine age differences in this variability. A sample of older ($n=50$) and younger ($n=50$) adults recruited from North Central Florida and online completed 14-consecutive-day diaries assessing pre-sleep arousal and sleep outcomes. Significant age differences were found for sleep and pre-sleep arousal; older adults displayed poorer, more variable sleep for the majority of sleep outcomes, and higher levels of pre-sleep arousal than younger adults. The high amount of intraindividual variability has implications for the assessment of pre-sleep arousal and sleep across age groups.

1. Introduction

Pre-sleep arousal, both cognitive and somatic, has been implicated in poor sleep outcomes [10,17,19,30]. However, the pre-sleep arousal/sleep association is not uniform across age groups, with cognitive and somatic pre-sleep arousal showing differing associations with sleep in younger and older adults [23]. The examination of intraindividual variability (IIV), an often understudied factor in health outcomes research, may provide a more complete understanding of

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these constructs to inform future research. It is well known that sleep is a variable process, but the literature is unclear regarding age differences in IIV in sleep. Mezick et al. [15] and Van Hilten [28] reported no age differences in IIV in sleep. Yet, Dillon and colleagues [8] identified that IIV in sleep was actually lower at older ages. Furthermore, compared with the literature support for IIV in sleep [13,18,28], less is known about IIV of pre-sleep arousal, and how pre-sleep arousal IIV may vary across ages. If pre-sleep arousal and sleep show considerable IIV, the traditional analytic approach of relying on the examination of mean values, or single measurements, may not be the most appropriate level of measurement for these variables [10]. As variability in a behavior increases, mean values become less accurate, suggesting that for highly variable processes, the use of IIV values may add complementary information to the mean values [7,27].

Of the few studies that have examined daily values, there are none, to our knowledge, that examined IIV in pre-sleep arousal and sleep on a daily basis in both younger and older adults. Notably, the study by Shoji et al. [23] examined age differences in the arousal–sleep relationship by investigating whether mean or daily pre-sleep arousal better predicted sleep outcomes, but did not specifically examine or quantify IIV in these constructs. The current study extends these findings by explicitly quantifying IIV (and age differences in this variability) in pre-sleep arousal and sleep outcomes across 14 days, in both younger and older adults.

Prior research suggests that good sleepers are often younger [16] and older adults experience more sleep problems, such as taking longer to fall asleep, more awakenings, less total sleep time, and spending more time in light sleep [18]. Importantly, however, the majority of changes in sleep occur before the age of 60 [18]. Other factors besides age, but often associated with aging, may contribute to sleep disturbances (e.g., co-occurring physical or mental health conditions [2]). In other words, it may not be age specifically that is associated with poorer sleep, but changes associated with aging that result in poorer sleep in older adults [29].

Whereas traditional analyses have relied on mean values to represent a construct, there may be a significant amount of additional information gleaned from examining IIV. In a study of older adults with and without insomnia, Buysse et al. [4] found little correlation between sleep variables from night-to-night. Furthermore, compared to good sleepers, older adults with insomnia showed greater IIV on sleep measures including sleep onset latency, wake after sleep onset, and total sleep time, suggesting an association between greater IIV and poorer sleep overall [4].

Examination of intraindividual fluctuations in nightly pre-sleep arousal is an understudied area that may inform future research on disordered or disrupted sleep. Sánchez-Ortuño et al. [22] examined IIV of sleep variables and pre-sleep arousal in adults (mean age=47.1 years) classified as having either primary insomnia (PI) or insomnia related to a mental disorder (IMD). The authors found that participants with IMD displayed more IIV in total sleep time and emotional arousal than the PI group, and exhibited higher levels of mean levels of emotional arousal. Additionally, the association between arousal and sleep was stronger in the PI group, who displayed more stability in their arousal and sleep outcome ratings from one night to the next [22], suggesting the predictive utility of pre-sleep arousal may depend on the IIV fluctuations in arousal and sleep outcomes. Although the above-mentioned research assessed IIV in sleep and emotional arousal, the sample was comprised only of individuals with insomnia and, further, did not include older adults. Therefore, there is a need for research examining age-related differences in IIV in pre-sleep arousal and sleep.

1.1. *Aims and hypotheses of the present study*

The overall objective of the present study is to quantify the extent of IIV in pre-sleep arousal and sleep, and to examine age differences in this variability. Quantification of IIV is a foundational step for research examining behaviors that potentially fluctuate on a daily basis [21]. The findings could have clinical implications for the assessment of arousal and sleep in younger and older adults. Furthermore, quantification of IIV could prove useful for the development of treatment targets such as the reduction of IIV in arousal or sleep.

The first specific aim of the present study was to examine age differences in mean levels of pre-sleep arousal and sleep outcomes. Mean values were obtained to present the traditional descriptive metric (means) as a point of comparison for the subsequent analyses. Given previous research indicating poorer sleep outcomes for older adults, we hypothesize that older adults will report worse mean sleep outcomes. Since previous findings are unclear regarding age differences in arousal, the first aim is exploratory for the arousal variables. In addition, because findings for cognitive arousal have differed from those for somatic arousal, these two types of pre-sleep arousal will be investigated separately in analyses.

The second aim of this study was to determine the extent of IIV in pre-sleep arousal and sleep outcomes. This aim contrasted the amount of variance in these variables that can be attributed to IIV versus between-person differences. Since sleep is highly variable, we hypothesize that there will be a substantial amount of IIV in sleep (e.g., greater than five percent [11]). The literature on variability in arousal is limited, making this part of the second aim of the study exploratory in nature.

The third aim of this study was to examine age differences in IIV in pre-sleep arousal and sleep outcomes. There has been limited research investigating age differences in IIV in sleep and arousal outcomes. Although existing research on age differences in IIV in sleep lacks consensus, greater IIV in sleep outcomes is observed in poor sleepers, suggesting that older adults, who are expected to display poorer sleep than younger adults, may also display greater IIV in sleep outcomes. Therefore, we hypothesize that older adults will display more IIV in sleep outcomes than younger adults. Given the scarcity of literature examining pre-sleep arousal across age groups, the comparison of IIV in arousal across age groups is exploratory.

2. Method

2.1. *Participants*

Participants were community-dwelling individuals recruited from North Central Florida and online. Recruitment materials consisted of flyers posted around the University of Florida and the community of Gainesville, FL, online advertisements in community classifieds such as Craigslist, announcements in undergraduate psychology courses from the University of Florida, the Undergraduate Psychology Research Pool, and mailings to individuals listed on the University of Florida's Age Network Participant Registry. Participants were screened for eligibility based on the following exclusionary criteria: (a) currently working shift work; (b) unable to complete study materials using a computer; (c) visual deficits that precluded participation (e.g., have severe self-reported difficulty reading the newspaper); (d) on vacation or planning to take a vacation during the study; (e) diagnosed with a dementia disorder; (f) diagnosed with sleep disorders other than insomnia (e.g., periodic limb movement disorder, sleep apnea); and (g) currently pregnant.

The sample was comprised of both younger (n=50) and older adults (n=50). The median age for the younger adults was 19, with a range of 12 (18–30 years old). The median age for the older adults was 65.5, with a range of 35 (60–95 years old). The younger adults were primarily female (72%), average age of 19.88 (SD=2.76), Caucasian (70%), college-educated (80%), lived with another person (86%), were single (96%), reported good health (M=3.84, SD=0.89), and reported less than one health condition (M=0.34, SD=0.69). The older adults were primarily female (60%), average age of 67.81 (SD=6.73), Caucasian (90%), college-educated (92%), lived with another person (71.40%), were married (59.20%), reported good health (M=3.48, SD=0.84), and reported one health condition on average (M=1.24, SD=1.25). Overall the older and younger adults were similar, with the exceptions that the majority of the older adults were married while the younger adults were single, and that older adults reported more health conditions on average than younger adults. Although the age groups differed slightly in the number of self-reported health conditions, the overall sample is healthy relative to age.

2.2. Procedure

The University of Florida Institutional Review Board approved the current study. Participants completed all study materials via Internet. Before the study, individuals completed informed consent, demographics information, and health information. After collecting pre-study information, participants were asked to complete a set of questionnaires on a daily basis upon awakening for 14 consecutive days. The questionnaires assessed social rhythmicity, light exposure, arousal during the day and at bedtime, affect, and sleep behavior. Once the daily questionnaires were submitted, participants were not able to access or edit entries from prior days.

2.3. Measures

2.3.1. Sleep variables

Sleep outcomes were collected using sleep diaries, which are considered a preferred index of sleeping behavior [5] with internal consistency values of 0.91 [6]. Participants reported: time spent napping, bedtime, time to fall asleep, number of nightly awakenings, total time spent awake after bedtime, wake time, time spent awake in bed after final awakening, and sleep quality (5 point Likert-type scale; 1=very poor and 5=excellent [14]). The following variables were selected from the sleep diary: sleep onset latency (SOL; time it takes to fall asleep initially), wake time after sleep onset (WASO; time spent awake from sleep onset to last awakening), total sleep time (TST; time-in-bed minus SOL, WASO, and TWAK [time spent awake in bed after final awakening]), and sleep quality rating (SQR; self-report of sleep quality). These variables were selected as they represented quantitative (SOL, WASO, and TST) and qualitative (SQR) components of the sleep experience.

2.3.2. Arousal variables

Pre-sleep arousal was measured daily using the Pre-Sleep Arousal Scale (PSAS), developed by Nicassio et al. [17]. The PSAS has Cronbach alphas ranging from 0.67 to 0.88 in college students, normal sleepers (mean age=39.27), and those with insomnia (mean age=35.27). Additionally, it has adequate convergent, discriminant, and construct validity [17]. The PSAS is a 16-item self-report questionnaire that asks about the state of arousal when falling asleep. Respondents are asked to indicate how intensely they experience each item on a 5-point Likert scale that ranges from 1 (*not at all*) to 5 (*extremely*). The PSAS is composed of two subscales: cognitive arousal and somatic arousal. The cognitive subscale (PSAS cognitive) contains items such as worry about falling asleep, being mentally alert at bedtime, and inability to shut off thoughts. The somatic subscale (PSAS somatic) contains items addressing physical arousal such as racing heart, muscle tension, and rapid breathing. Participants completed the PSAS every day with regard to their arousal the previous evening at bedtime.

3. Results

3.1. Age differences in sleep and arousal

Missing data was minimal. Missing values were not replaced but were treated as missing in all analyses. Means and standard deviations for the variables are presented in Table 1. To examine age differences in mean values, two MANOVAs were computed for arousal variables (PSAS cognitive and PSAS somatic means) and sleep outcomes (SOL, WASO, TST, and SQR means). For both variables, Box's M test was significant ($p<0.05$), suggesting a violation of the assumption of homogeneity of covariance. Given that Box's M test is sensitive and can be unstable, Hotelling's Trace values are reported. With two groups of equal sample size, Hotelling's Trace is robust to violations of the homogeneity of covariance matrices assumption [9]. There was a statistically significant difference between younger and older adults on sleep outcomes, F (4, 94)=7.88, $p<0.01$, Hotelling's T=0.42, partial ε^2=0.30, and on arousal variables, F (1, 97)=4.02, p=0.02, Hotelling's T=0.08, partial ε^2=0.08. Levene's Test of equality of error variances was significant for all sleep outcomes except TST and for both PSAS cognitive and PSAS somatic. Square root transformations were performed, but

Table 1 – Descriptive statistics for arousal and sleep variables.

Variable	Younger adults Mean (SD)	Older adults Mean (SD)
SOL	14.17*(11.01)	25.60* (20.09)
WASO	7.19* (12.43)	27.50* (25.70)
TST	472.53* (53.77)	418.89* (67.11)
SQR	3.82 (0.45)	3.66 (0.62)
PSAS somatic	8.82 (1.11)	9.89 (4.01)
PSAS cognitive	11.08* (2.57)	13.17* (4.47)

* Denote statistically significant differences between older and younger adults ($p<0.01$).

Table 2 – Amount of within-person variance for arousal and sleep variables.

Variable	1-ICC (within-person variance)	
	Intraindividual variability #(younger adult)	Intraindividual variability #(older adult)
SOL	0.83	0.63
WASO	0.85	0.70
TST	0.84	0.57
SQR	0.78	0.61
PSAS somatic	0.75	0.32
PSAS cognitive	0.76	0.18

did not improve equality of error variances. To compensate for this assumption violation, a stringent alpha of 0.01 was used to examine between-subject effects [25]. It was found that significant age group differences existed for SOL (F (1, 98)=16.13; p=0.001; partial ε^2=0.11), WASO (F (1, 98)=25.31; p=0.001; partial ε^2=0.21), TST (F (1, 98)=19.46; p=0.001; partial ε^2=0.17), and PSAS cognitive (F (1, 98)=8.11; p=0.005; partial ε^2=0.08). There were no significant age-group differences for SQR or PSAS somatic. Overall, results suggest that older adults took longer to fall asleep, spent more time spent awake during the night, and had less total sleep time. Further, older adults had more cognitive arousal than younger adults.

Next, intraclass correlations (ICCs) were computed separately for each age group for each variable (Table 2). ICCs were used for this aim as they enable the examination of the relative proportion of total variance attributed to IIV versus between-person differences in pre-sleep arousal and sleep. ICCs were calculated by running null (predictor-free) multilevel models with each sleep and arousal variable as the outcome variable. By subtracting the amount of variability due to between-person effects from the total amount of variability, an estimation of IIV was obtained. For sleep outcomes, 78–84% and 57–70% of the total variance could be attributed to IIV for younger and older adults, respectively (compared to 15–22% and 30–43% of between-person variance for younger and older adults, respectively). For pre-sleep arousal IIV accounted for 75% (cognitive) and 76% (somatic) of total variability in younger adults (compared to 25% and 24%, respectively, due to between-person variability). In older adults, IIV in pre-sleep arousal accounted for 32% (cognitive) and 18% (somatic) of total variability (compared to 68% and 82%, respectively, due to between-person variability).

Finally, to determine if there were significant age differences in the IIV in arousal and sleep outcomes, intraindividual standard deviations (ISDs) were calculated (Table 3) and age differences in IIV was compared using two MANOVAs. ISDs were used for this aim as they provide a value for each individual that can be used for inferential statistical analyses. First, ISDs were calculated by de-trending the data to remove the effects of time, leaving unstandardized residuals for each variable of interest. De-trending data is a common practice when data is derived from repeated measurements in which the effects of time (e.g. practice effects) may distort the data. These residuals were then used to calculate ISDs, which represent the amount an individual fluctuates around their individual mean.

Table 3 – Intraindividual standard deviations (ISDs) for arousal and sleep variables.

Variable	Younger adults ISD	Older adults ISD
SOL	13.01	17.84
WASO	13.51*	25.79*
TST	98.27*	70.78*
SQR	2.31*	3.02*
PSAS somatic	1.22	1.46
PSAS cognitive	3.40	2.71

* Denote statistically significant differences between older and younger adults ($p<0.05$).

A MANOVA was used to assess age differences in the ISDs of the arousal variables of interest (PSAS somatic and PSAS cognitive). A second MANOVA assessed age differences in ISDs of the sleep outcomes (SOL, WASO, TST, and SQR). Box's M test was significant for the sleep outcomes, but not for the arousal variables. However, Hotelling's Trace values are reported for both MANOVAs to maintain consistency. There was a statistically significant difference between younger and older adults on variability in sleep outcomes, F (4, 94)=19.61, $p<0.01$, Hotelling's T=1.04, partial ε^2=0.51, but not variability in arousal, F (1, 97)=2.79, p=0.06, Hotelling's T=0.58, partial ε^2=0.05. Significant age group differences existed for WASO (F (1, 98)=6.09; p=0.02; partial ε^2=0.06), SQR (F (1, 98)=11.26; p=0.001; partial ε^2=0.10) and TST (F (1, 98)=17.35; $p<0.01$; partial ε^2=0.15). Significant age group differences were not found for SOL, PSAS somatic, or PSAS cognitive. Overall, the findings suggest greater IIV in time spent awake during the night and sleep quality ratings and less IIV in total sleep time in older adults as compared to younger adults.

4. Discussion

To our knowledge, this was the first study to compare young and older adults on both mean values and IIV in pre-sleep arousal. In summary, there were significant age differences in mean values for the majority of the sleep and arousal variables examined. IIV in sleep and pre-sleep arousal was evident throughout the entire sample, with age differences emerging in sleep IIV. Age differences in arousal IIV were not identified. These findings are discussed in greater detail, with consideration of limitations and subsequent implications.

4.1. *Age differences in mean levels of pre-sleep arousal and sleep*

The present study used self-report measures of pre-sleep arousal, which allowed for differentiation between perceptions of cognitive and somatic arousal. Older adults reported significantly higher cognitive pre-sleep arousal, but were not significantly different from younger adults in their reports of somatic arousal. Hence, older adults were more likely to endorse items such as “worry about falling asleep; can't shut off your thoughts; being distracted by sounds, noises in the environment (e.g., ticking of the clock, house noises, traffic)”. This significant age difference is an important finding, given the detrimental association between pre-sleep cognitive arousal and sleep in good sleepers [26], as well as the tendency for increased cognitive pre-sleep arousal to predict longer sleep onset latency in older adults [23]. Subsequently, these results further underscore the need to consider, and potentially target, pre-sleep cognitive arousal when studying or assessing sleep in older adult populations. It is important to consider the possible bidirectionality of the associations found in the present study. For example, one possible explanation for older adults displaying greater cognitive arousal than younger adults might be due to longer SOL reported in older adults. That is to say, are older adults more sensitive to noticing and reporting cognitive arousal than younger adults simply because they are lying awake in bed for longer periods of time?

The finding that older adults reported greater time to sleep onset than younger adults is consistent with previous research [2,16,18]. Since older adults spend more time in the lighter stages of sleep than younger adults, they are more susceptible to awakenings during the night [18], which would explain the finding of greater WASO for older adults. Further, results indicating that older adults spend less total time sleeping are consistent with polysomnographic studies suggesting sleep architecture changes with age, such that total sleep time tends to decrease across the lifespan [18].

4.2. *Variability in pre-sleep arousal and sleep*

Intraclass correlations revealed that a substantial amount of IIV in both sleep outcomes and pre-sleep arousal remained to be explained after examination of between-person effects. Specifically, 57–85% of sleep outcomes and 18–76% of pre-sleep arousal outcomes could be attributed to fluctuations within individuals. For sleep outcomes, a very high level of IIV was uncovered; the sleep of an individual was as likely to resemble the sleep of a complete stranger, from night-to-night, as it was to resemble their own sleep. Pre-sleep arousal was less variable but still showed considerable IIV for younger adults. These results suggest that mean values may provide an incomplete picture, warranting examination of IIV. Furthermore, the extent of IIV may differ depending on the domain being measured. There was a high level of IIV in sleep across both age groups, while IIV in pre-sleep arousal was found primarily among younger adults. Therefore, the examination of IIV may be more or less relevant depending on the construct of interest and the age group. Nonetheless, repeated measures of pre-sleep arousal and sleep are needed to represent the full magnitude of these constructs.

4.3. *Age differences in variability in pre-sleep arousal and sleep*

Examination of age-differences in IIV in pre-sleep arousal and sleep revealed significant differences in the variability of sleep outcomes, with older adults exhibiting greater IIV in time spent awake after falling asleep and the quality ratings of their sleep. These findings add to previous research examining age differences in IIV in sleep (e.g. [18]). Greater IIV in sleep may contribute to the experience of poorer sleep by some older adults. For one sleep variable, total sleep time, younger adults reported greater IIV. Given age differences in lifestyle factors that could impact total sleep time (e.g., school and work obligations), it is not surprising that younger adult showed greater variability in total sleep time, especially since we did not control for differences in weekdays versus weekends.

An interesting finding of this study is that older adults displayed higher levels of pre-sleep arousal but the IIV in that arousal did not differ by age group. Additionally, although older adults showed worse sleep outcomes, they did not uniformly demonstrate greater IIV in sleep outcomes compared to younger adults for these outcomes. Previous research has demonstrated differences in inter-and intraindividual variability across numerous constructs such as pain [1,24] and heart rate variability [12] suggesting that age differences may manifest at within and/or between-person levels. Consequently, examination of both IIV and between-person differences may provide complementary information on pre-sleep arousal and sleep variables across age-groups.

The present results indicate that although older adults experienced higher overall levels of cognitive pre-sleep arousal, these levels remained as stable on a day-to-day basis as the pre-sleep cognitive arousal experienced by younger adults. Notably, although older adults reported significantly greater cognitive pre-sleep arousal, the mean levels were still within the “not at all” to “slightly” range for both age groups (e.g., item level $M=1.65/5.00$ for older adults and $M=1.39/5.00$ for younger adults). Perhaps, although older adults experience higher levels of pre-sleep arousal, they are able to regulate their emotions sufficiently to avoid large fluctuations in pre-sleep arousal. Röcke et al. [20] found that older adults had less affective reactivity than older adults, suggesting to the ability of older adults to regulate their emotions may partially explain the lack of age differences in pre-sleep arousal IIV. Future researchers may glean additional information from examining linkages between constructs that demonstrate IIV, such as cognition, stress, or pain. However, the examination of these linkages is beyond the scope of the present paper, which primarily aimed to highlight the need to examine sleep and pre-sleep arousal at both the mean and IIV levels.

4.4. *Limitations*

There are several limitations in the current study. First, the sample was homogeneous in terms of race and education level, which limits the generalizability of the results. In addition, since previous studies have found discrepancies between objective and subjective measures of sleep, the inclusion of both types of measures may provide the most accurate representation of sleep. Additionally, there was a relatively large gap in age between the two groups of interest and the sleep pattern of young college students may not be representative of young adults not in school. In addition, Dillon et al. (2014) identified age-related changes in sleep variability were associated with sociodemographic factors, such as race and sex, which suggests the current sample may have limited generalizability in terms of sociodemographic features. However, certain similarities in demographic features (e.g., college students and highly educated older adults) suggest that these are reasonable comparison groups. Finally, 59% of older adults were married compared to only 4% of younger adults. It is possible that sharing a bed with a partner contributed to the sleep disturbances reported in the older adult group.

4.5. *Implications*

The present study makes contributions to the current literature on sleep and pre-sleep arousal, as well as to the growing study of IIV. Relative to between-person variability, these findings highlight the tendency of IIV to uniquely contribute to the overall variability in sleep and pre-sleep arousal. Therefore, future research focused on individual experiences occurring on the daily level is an important avenue of study, due to the more complete understanding that this methodology yields with regards to potentially variable constructs.

In addition to advancing our understanding of the importance of the study of sleep at the within-person level, the present findings also have potential implications for the prevention, and potential differential treatment focus, of sleep problems. Specifically, the identified age differences in pre-sleep arousal suggest that, relative to younger adults, pre-sleep arousal may be a more relevant target for intervention in older adults. Further, the findings that both pre-sleep arousal and sleep itself are variable at the within-person level potentially reinforce the utility of incorporating daily records of nightly sleep when assessing sleep. Finally, given the unanticipated findings regarding age differences in mean levels of pre-sleep arousal, this construct should be examined in more detail both to identify specific components of somatic and cognitive pre-sleep arousal that may be contributing to age associated increases in overall pre-sleep arousal and to better understand the potential role that pre-sleep arousal may play in contributing to normative age-related changes in sleep architecture. For example, if increased cognitive pre-sleep arousal were found across the entire day in older adults, it would parallel previous research that has found increased metabolic arousal throughout the day contributes to poor sleep at night [3]. Further research is needed to examine the interplay of pre-sleep arousal and sleep in samples of individuals where pre-sleep arousal may be more or less prevalent (e.g., older adults with health concerns). Broadly speaking, when examining constructs that are affected by aging it is important to consider that many of these constructs fluctuate, thus making the investigation of IIV a fruitful endeavor in this population. These natural temporal fluctuations may be overlooked in traditional approaches to measurement with an emphasis on stability and exclusion of variability.

Examination of IIV provides insight into dynamic or changing characteristics (e.g., regulation in response to contextual factors). The knowledge gained from studies examining IIV can be used to develop specific treatment targets or outcomes, such as decreasing sleep variability. The use of intraindividual standard deviations (ISDs) allows quantification of these dynamic processes, which is critical for the application of research findings to treatment advances.

Conflict of interest

This is not an industry supported study. Drs. Dautovich and McCrae, and Kristy Shoji and Caitlan Tighe have indicated no financial conflicts of interest.

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