Title

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Sleep the night before and after a treatment session: A critical ingredient for treatment adherence?

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Abstract

Objective—Sleep prepares key neural structures for next-day learning, and sleep obtained after learning promotes subsequent memory consolidation supporting long-term retention. This study examined whether sleep the night before and after a therapy session predicts aspects of treatment adherence.

Method—As part of a randomized clinical trial, 188 adults (61.7% female, mean age = 47.5, 80.5% Caucasian) with persistent insomnia received cognitive behavioral therapy for insomnia. Patients completed a sleep diary before and after treatment sessions. Minutes spent awake during the night (total wake time; TWT) and total sleep time (TST) were used as measures of sleep disturbance. At each treatment session, therapists rated participant understanding of the session and homework compliance from the previous session.

Results—Compared to longer TWT, before session shorter TWT was associated with increased treatment understanding the next day. After session shorter TWT was also associated with increased understanding, but not homework compliance the subsequent session compared to participants with longer TWT. Similar results were obtained for TST.

Conclusions—Improving sleep may benefit patient adherence to treatment. Sleep may influence processes related to initial learning and subsequent consolidation of treatment information. Future

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studies should examine whether improved sleep within other psychiatric disorders is also an ingredient to the successful outcome of psychosocial interventions.

Keywords

sleep; cognitive behavioral therapy; treatment adherence; insomnia; learning

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Nearly 30% of the American population experience mental illness in any 12-month period (Kessler, Chiu, Demler, Merikangas, & Walters, 2005). Despite progress toward establishing evidence-based psychosocial treatments for many mental illnesses (Chambless & Ollendick, 2001), 50% of patients do not improve and 10% get worse (Lambert & Ogles, 2004; Mohr, 1995). Seminal progress toward improving outcome will require the identification of novel and modifiable contributors (Kazdin, 2007).

Treatment adherence is an important contributor to treatment outcome (Kazantzis, Whittington, & Dattilio, 2010), and could be targeted to improve treatment effectiveness. Treatment adherence occurs when a treatment is both received (i.e., the patient understands the treatment) and enacted (i.e., the patient practices the treatment outside of the session; Lichstein, Riedel, & Grieve, 1994). Research on treatment receipt indicates that therapist ratings of patient understanding are associated with treatment outcome (Abramowitz, Franklin, Zoellner, & DiBernardo, 2002). Treatment enactment measured by therapist-rated homework compliance is also a strong predictor of outcome (Kazantzis et al., 2010). Although many factors contribute to treatment adherence (e.g., personality, mood, or motivation), sleep may be particularly helpful for fostering treatment understanding and homework compliance.

Sleep is a potential novel and modifiable pathway to improving treatment adherence by supporting memory and learning (Harvey et al., 2014). Sleep before learning prepares key neural structures for efficient next-day memory encoding of fact-based information (Cohen's $d = 0.81$; Mander et al., 2014; Mander, Santhanam, Saletin, & Walker, 2011). Conversely, continued time awake results in the deterioration of learning ability (Cohen's $d = 0.62$–1.74), associated with impaired hippocampal-encoding activity (Mander et al., 2011; Yoo, Hu, Gujar, Jolesz, & Walker, 2007). In the context of insomnia, a disorder characterized by nocturnal wakefulness, patients demonstrate decreased memory consolidation despite similar sleep duration (Cohen's $d = 1.83$; Nissen et al., 2006). The impact of sleep deprivation on memory formation is especially pronounced for emotional material such that sleep-deprived participants exhibit a 40% reduction in the ability to form new memories (Walker & Stickgold, 2006). Sleep after learning also plays a critical role in the consolidation of episodic declarative memories (Cohen's $d = 1.42$; Gais, Lucas, & Born, 2006). More specifically, and as reviewed by Stickgold and Walker (2013), sleep (a) enhances cognitive flexibility in problem solving, (b) assists in the integration of new information, and (c) helps to promote memory associations. In contrast, extended wakefulness and/or a lack of sufficient sleep after learning can impair memory consolidation success (Abel, Havekes, Saletin, & Walker, 2013).

Together this evidence raises an interesting and novel treatment target; namely, would improving sleep the night before and after a treatment session, thereby reducing time awake at night, also improve treatment adherence? The present study sought to begin evaluating this potential novel target and examined whether sleep the night before and after a treatment session predicts two aspects of treatment adherence: patient understanding of the content of the treatment and homework compliance. It was hypothesized that (1) decreased sleep disturbance the night before the treatment session will predict improvements in treatment adherence over the course of treatment and (2) decreased sleep disturbance the night after the treatment session will predict improvements in treatment adherence at the subsequent session over the course of treatment.

Method

Participants

Participants were recruited from March 2008 to November 2011 at two sites in Canada and the United States. Detailed information on study design including inclusion and exclusion criteria can be found elsewhere (Harvey et al., 2014). Participants with persistent insomnia (n = 188) were randomized to behavior therapy, cognitive therapy, or cognitive behavioral therapy for insomnia (CBTI). Demographic and pre-treatment sleep characteristics are displayed in Table 1. Each treatment was 8 sessions. All study procedures were approved by the university institutional review boards. Informed consent was obtained for all participants.

Measures

Structured Clinical Interview for DSM-IV (SCID)—The SCID assessed diagnostic criteria for Axis I disorders and the Duke Structured Interview for Sleep Disorders assessed diagnostic criteria for sleep disorders (Edinger et al., 2004; First, Spitzer, Miriam, & Williams, 2002).

Sleep Diary—A daily sleep diary is the gold standard subjective measure of sleep (Buysse, Ancoli-Israel, Edinger, Lichstein, & Morin, 2006; Carney et al., 2012). Total wake time (TWT) and total sleep time (TST) were selected as the measures of sleep disturbance for this study. TWT was calculated as a composite of sleep onset latency (SOL) + wake after sleep onset (WASO) + early morning awakening (EMA; Morin, Kowatch, & Wade, 1989). TWT was chosen because insomnia is defined as distress or impairment resulting from difficulties with SOL, WASO, or EMA (American Psychiatric Association, 2013), and TWT has been previously identified as an indicator of treatment response (Eidelman, Talbot, Gruber, & Harvey, 2010; McCrae et al., 2008; Morin et al., 1989; Talbot et al., 2012). Shorter TST is associated with impaired learning and memory ability (Yoo et al., 2007). Sleep diary was recorded each day of the week, which made it possible to examine sleep before and after the treatment session.

Treatment Adherence Rating Scale – Therapist Report (TARS-TR)—The TARS-TR is derived from Lichstein, Riedel, and Grieve’s (1994) treatment implementation model, and measures aspects of treatment adherence. The TARS-TR was used at the end of each weekly treatment session on a scale from 0–100% (Supplemental Material 1). The present analysis included items 1 (treatment understanding) and 3 (homework compliance). The

TARS-TR has good internal consistency (Cronbach's α = .87) and good test-retest reliability (ICC range: .76–.91; Dong, Lee, & Harvey, under review).

Data analysis

Random effects Tobit regression was used because the data is censored at 100% and has repeated measurements (see Supplemental Figure 1; Twisk & Rijmen, 2009). Models examined the effect of before session or after session sleep disturbance (TWT or TST) × session number (Time) on treatment adherence variables. Models did not examine the effect of before session sleep disturbance (TWT or TST) × session number (Time) on homework compliance because the TARS-TR evaluates homework compliance during the previous week. Following the convention described by Aiken and West (1991), simple slopes were used to probe significant interactions. Simple slopes were determined by one standard deviation (SD) above and below the mean for TWT or TST. One SD above the mean was considered to be 'longer TWT' or 'longer TST' and one SD below the mean was considered to be 'shorter TWT' or 'shorter TST'.

All analyses were conducted across treatment condition for the following three reasons. First, previous evidence suggests that all treatment groups will have similar impacts on sleep (Harvey, Bélanger, et al., 2014; Morin et al., 2006). Second, we are not aware of empirical evidence suggesting that one treatment would have a differential impact on the relationship between sleep and adherence. Third, this decision will reduce the number of statistical comparisons, which decreases the risk of Type I error. All analyses were performed using Stata version 14.0 software (StataCorp, 2015).

Results

Total Wake Time and Treatment Adherence

Results from random effects Tobit regression are presented in Table 2. Before session TWT × session number significantly predicted treatment understanding; hence, simple slope analyses were conducted (Figure 1A). Treatment understanding increased over the course of treatment for participants with both shorter ($z = 6.93$, $p < .001$) and longer ($z = 2.27$, $p = .023$) before session TWT. This increase was greater for those with shorter compared to longer before session TWT, $z = -3.43$, $p < .001$.

After session TWT × session number significantly predicted understanding of the session content at the subsequent session (Figure 1B). Although understanding increased throughout treatment for participants with shorter after session TWT, $z = 4.86$, $p < .001$, there was no such association for participants with longer after session TWT, $z = -0.03$, $p = .975$. After session TWT × session number significantly predicted homework compliance at the subsequent session (Figure 1C). Homework compliance decreased over treatment for participants with both shorter ($z = -2.32$, $p = .021$) and longer ($z = -6.97$, $p < .001$) after session TWT. This decrease was greater for those with longer compared to shorter after session TWT, $z = -3.71$, $p < .001$.

Total Sleep Time and Treatment Adherence

Before session TST × session number significantly predicted understanding of the session content (Figure 1D). Treatment understanding increased for participants with both longer ($z = 6.94$, $p < .001$) and shorter ($z = 2.54$, $p = .011$) before session TST during treatment. This increase was greater for longer compared to shorter before session TST, $z = 2.98$, $p = .003$.

After session TST × session number significantly predicted understanding with the session content at the subsequent session (Figure 1E). While understanding increased throughout treatment for participants with longer after session TST, $z = 5.15$, $p < .001$, there was no such association for those with shorter after session TST, $z = 1.51$, $p = .131$. After session TST × session number significantly predicted homework compliance at the next session (Figure 1F). Homework compliance decreased over treatment for participants with both longer ($z = −4.02$, $p < .001$) and shorter ($z = −6.87$, $p < .001$) after session TST. This decrease was greater for shorter compared to longer after session TST, $z = 2.67$, $p = .008$.

Discussion

The present study examined whether sleep the night before and after a treatment session supports treatment adherence. Our first hypothesis was partially supported. Consistent with evidence that healthy sleep prepares the brain for next-day encoding while continued time awake erodes learning ability (Mander et al., 2011), shorter TWT and longer TST the night before a treatment session predicted higher therapist-rated understanding over the course of treatment. A finding that was surprising was that both longer TWT and shorter TST also predicted higher therapist-rated understanding over the course of treatment. It is possible that these findings are driven by differential mechanisms. While less sleep disturbance may foster retention of treatment information, one could speculate that participants experiencing more sleep disturbance may be more motivated to understand treatment following a night of poor sleep. However, the potential effect of motivation appears to not completely counteract the effect of sleep disturbance, as understanding increased to a greater degree for individuals with less sleep disturbance. Additional research will be necessary to distinguish memory versus motivational processes driving treatment adherence, particularly given the strong connection between motivation and learning (Daw & Shohamy, 2008).

In support of the second hypothesis, participants with shorter TWT and longer TST after the session had higher therapist-rated understanding at the subsequent session over the course of treatment. These results are consistent with the hypothesis that better sleep following a learning session, thus minimizing excess time awake, supports consolidation of treatment information and that poorer sleep after a learning opportunity may negatively impact consolidation and retention (Abel et al., 2013). These results are also consistent with evidence that sleep after exposure therapy may support memory and learning processes (Kleim et al., 2014).

Homework compliance decreased over the course of treatment for all participants. This finding is perhaps not surprising given that homework compliance in treatment is often low (Jungbluth & Shirk, 2013; Leahy, 2002). Alternatively, it may be that enthusiasm or motivation to complete homework wanes after initial homework assignments (Worthington, 1986). Despite an overall decrease in homework compliance over the course of treatment in this sample, it is notable that homework compliance decreased more for participants with longer TWT compared to shorter TWT. It may be that decreased sleep duration and more time awake negatively impacts memory for homework recommendations. Alternatively, individuals with poorer sleep may be less motivated to complete their homework.

Although the present study provides promising evidence for the link between sleep and treatment adherence, several limitations are important to consider. First, the TARS-TR is not a direct measure of learning or memory. However, the TARS-TR is significantly associated with a patient recall task (Dong, Lee, & Harvey, 2017). Second, our study considered the influence of sleep on treatment adherence in a disorder characterized by sleep disruption. While this may limit the generalizability of these findings, there is encouraging evidence that sleep may also be an important contributor to anxiety disorder treatment (Kleim et al., 2014; Ramsawh, Bomyea, Stein, Cissell, & Lang, 2016). Third, the present study was not designed for causal inference, and treatment adherence may also impact sleep. Post-hoc analyses indicated that treatment adherence was not related to TWT, which is the primary target of CBTI. However, increased treatment understanding was associated with longer TST over the course of treatment ($z = 3.65$, $p < .001$; Supplemental Table 1). These analyses appear to support this study's findings regarding TWT, but also suggest that increased treatment understanding may be related to greater TST. Future studies would benefit from an experimental manipulation of sleep to help determine the directionality of these results, particularly because CBTI includes instructions to restrict TST and a meta-analysis indicated that CBTI has a small effect on TST (Okajima, Komada, & Inoue, 2011). Fourth, participant report of treatment adherence was not available. A comparison of therapist and patient reported treatment adherence may provide a better understanding of treatment adherence, and should be a priority in future research. Finally, the present study did not include polysomnography, and memory processes are also influenced by REM sleep and NREM slow oscillations (Abel et al., 2013). Future studies should determine whether these other components of sleep can influence memory and learning in psychotherapy.

In sum, the current study provides support for the hypothesis that improving sleep may benefit the extent to which patients understand the treatment, consistent with the benefits of sleep for learning and memory, limiting the detrimental effects of extended wakefulness. However, the current findings do not appear to improve homework compliance. Sleep may influence processes related to initial learning and subsequent consolidation of treatment information delivered to patients. However, future studies should explore if sleep has a causal influence on treatment adherence in other psychosocial interventions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

References

Abel T, Havekes R, Saletin JM, Walker MP. Sleep, plasticity and memory from molecules to whole-brain networks. Current Biology: CB. 2013; 23(17):R774–88. http://doi.org/10.1016/j.cub.2013.07.025. [PubMed: 24028961]

Abramowitz JS, Franklin ME, Zoellner LA, DiBernardo CL. Treatment compliance and outcome in obsessive-compulsive disorder. Behavior Modification. 2002; 26(4):447–63. [PubMed: 12205821]

Aiken, LS., West, SG. Multiple regression. Thousand Oaks: 1991.

American Psychiatric Association. Diagnostic and statistical manual of mental disorders. Diagnostic and Statistical Manual of Mental Disorders. 5. Arlington, VA: American Psychiatric Publishing, Inc; 2013.

Buysse DJ, Ancoli-Israel S, Edinger JD, Lichstein KL, Morin CM. Recommendations for a standard research assessment of insomnia. Sleep. 2006; 29(9):1155–73. [PubMed: 17040003]

Carney CE, Buysse DJ, Ancoli-Israel S, Edinger JD, Krystal AD, Lichstein KL, Morin CM. The consensus sleep diary: standardizing prospective sleep self-monitoring. Sleep. 2012; 35(2):287–302. http://doi.org/10.5665/sleep.1642. [PubMed: 22294820]

Chambless DL, Ollendick TH. Empirically supported psychological interventions: controversies and evidence. Annual Review of Psychology. 2001; 52:685–716. http://doi.org/10.1146/annurev.psych.52.1.685.

Daw ND, Shohamy D. The Cognitive Neuroscience of Motivation and Learning. Social Cognition. 2008; 26(5):593–620. http://doi.org/10.1521/soco.2008.26.5.593.

Dong L, Lee JY, Harvey AG. The Development and Validation of the Treatment Adherence Rating Scale (TARS). 2016 Manuscript Submitted for Publication.

Dong L, Lee JY, Harvey AG. Do improved patient recall and the provision of memory support enhance treatment adherence? Journal of Behavior Therapy and Experimental Psychiatry. 2017; 54:219–228. http://doi.org/10.1016/j.jbtep.2016.08.017. [PubMed: 27614662]

Edinger JD, Bonnet MH, Bootzin RR, Doghramji K, Dorsey CM, Espie CA, … Stepanski EJ. Derivation of research diagnostic criteria for insomnia: report of an American Academy of Sleep Medicine Work Group. Sleep. 2004; 27(8):1567–96. [PubMed: 15683149]

Eidelman P, Talbot LS, Gruber J, Harvey AG. Sleep, illness course, and concurrent symptoms in inter-episode bipolar disorder. Journal of Behavior Therapy and Experimental Psychiatry. 2010; 41(2):145–9. http://doi.org/10.1016/j.jbtep.2009.11.007. [PubMed: 20004888]

First, MB., Spitzer, RL., Miriam, G., Williams, JB. Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Non-patient Edition. (SCID-I/NP). New York: Biometrics Research, New York State Psychiatric Institute; 2002.

Gais S, Lucas B, Born J. Sleep after learning aids memory recall. Learning & Memory (Cold Spring Harbor, NY). 2006; 13(3):259–62. http://doi.org/10.1101/lm.132106.

Harvey AG, Bélanger L, Talbot LS, Eidelman P, Beaulieu-Bonneau S, Fortier-Brochu É, … Morin CM. Comparative efficacy of behavior therapy, cognitive therapy, and cognitive behavior therapy for chronic insomnia: a randomized controlled trial. Journal of Consulting and Clinical Psychology. 2014; 82(4):670–83. http://doi.org/10.1037/a0036606. [PubMed: 24865869]

Harvey AG, Lee J, Williams J, Hollon SD, Walker MP, Thompson MA, Smith R. Improving Outcome of Psychosocial Treatments by Enhancing Memory and Learning. Perspectives on Psychological Science: A Journal of the Association for Psychological Science. 2014; 9(2):161–179. http://doi.org/10.1177/1745691614521781. [PubMed: 25544856]

Jungbluth NJ, Shirk SR. Promoting homework adherence in cognitive-behavioral therapy for adolescent depression. Journal of Clinical Child and Adolescent Psychology. 2013; 42(4):545–53. http://doi.org/10.1080/15374416.2012.743105. [PubMed: 23237021]

Kazantzis N, Whittington C, Dattilio F. Meta-Analysis of Homework Effects in Cognitive and Behavioral Therapy: A Replication and Extension. Clinical Psychology: Science and Practice. 2010; 17(2):144–156. http://doi.org/10.1111/j.1468-2850.2010.01204.x.

Kazdin AE. Mediators and mechanisms of change in psychotherapy research. Annual Review of Clinical Psychology. 2007; 3:1–27. http://doi.org/10.1146/annurev.clinpsy.3.022806.091432.

Kessler RC, Chiu WT, Demler O, Merikangas KR, Walters EE. Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. Archives of General Psychiatry. 2005; 62(6):617–27. http://doi.org/10.1001/archpsyc.62.6.617. [PubMed: 15939839]

Kleim B, Wilhelm FH, Temp L, Margraf J, Wiederhold BK, Rasch B. Sleep enhances exposure therapy. Psychological Medicine. 2014; 44(7):1511–9. http://doi.org/10.1017/S0033291713001748. [PubMed: 23842278]

Lambert, MJ., Ogles, BM. The efficacy and effectiveness of psychotherapy. In: Lambert, MJ., editor. The efficacy and effectiveness of psychotherapy. 5. New York: Wiley; 2004. p. 139-193.

Leahy RL. Improving homework compliance in the treatment of generalized anxiety disorder. Journal of Clinical Psychology. 2002; 58(5):499–511. http://doi.org/10.1002/jclp.10028. [PubMed: 11967876]

Lichstein KL, Riedel BW, Grieve R. Fair tests of clinical trials: A treatment implementation model. Advances in Behaviour Research and Therapy. 1994; 16(1):1–29. http://doi.org/10.1016/0146-6402(94)90001-9.

Mander BA, Rao V, Lu B, Saletin JM, Ancoli-Israel S, Jagust WJ, Walker MP. Impaired prefrontal sleep spindle regulation of hippocampal-dependent learning in older adults. Cerebral Cortex (New York, NY: 1991). 2014; 24(12):3301–9. http://doi.org/10.1093/cercor/bht188.

Mander BA, Santhanam S, Saletin JM, Walker MP. Wake deterioration and sleep restoration of human learning. Current Biology: CB. 2011; 21(5):R183–4. http://doi.org/10.1016/j.cub.2011.01.019. [PubMed: 21377092]

McCrae CS, McNamara JPH, Rowe MA, Dzierzewski JM, Dirk J, Marsiske M, Craggs JG. Sleep and affect in older adults: using multilevel modeling to examine daily associations. Journal of Sleep Research. 2008; 17(1):42–53. http://doi.org/10.1111/j.1365-2869.2008.00621.x. [PubMed: 18275554]

Mohr DC. Negative Outcome in Psychotherapy: A Critical Review. Clinical Psychology: Science and Practice. 1995; 2(1):1–27. http://doi.org/10.1111/j.1468-2850.1995.tb00022.x.

Morin CM, Bootzin RR, Buysse DJ, Edinger JD, Espie CA, Lichstein KL. Psychological and behavioral treatment of insomnia: update of the recent evidence (1998–2004). Sleep. 2006; 29(11): 1398–414. [PubMed: 17162986]

Morin CM, Kowatch RA, Wade JB. Behavioral management of sleep disturbances secondary to chronic pain. Journal of Behavior Therapy and Experimental Psychiatry. 1989; 20(4):295–302. [PubMed: 2534597]

Nissen C, Kloepfer C, Nofzinger Ea, Feige B, Voderholzer U, Riemann D. Impaired sleep-related memory consolidation in primary insomnia--a pilot study. Sleep. 2006; 29(8):1068–1073. [PubMed: 16944676]

Okajima I, Komada Y, Inoue Y. A meta-analysis on the treatment effectiveness of cognitive behavioral therapy for primary insomnia. Sleep and Biological Rhythms. 2011; 9(1):24–34. http://doi.org/10.1111/j.1479-8425.2010.00481.x.

Ramsawh HJ, Bomyea J, Stein MB, Cissell SH, Lang AJ. Sleep Quality Improvement During Cognitive Behavioral Therapy for Anxiety Disorders. Behavioral Sleep Medicine. 2016; 14(3): 267–78. http://doi.org/10.1080/15402002.2014.981819. [PubMed: 26244485]

StataCorp. Stata Statistical Software: Release 14. 2015; 2015

Stickgold R, Walker MP. Sleep-dependent memory triage: evolving generalization through selective processing. Nature Neuroscience. 2013; 16(2):139–45. http://doi.org/10.1038/nn.3303. [PubMed: 23354387]

Talbot LS, Stone S, Gruber J, Hairston IS, Eidelman P, Harvey AG. A test of the bidirectional association between sleep and mood in bipolar disorder and insomnia. Journal of Abnormal Psychology. 2012; 121(1):39–50. http://doi.org/10.1037/a0024946. [PubMed: 21842957]

Twisk J, Rijmen F. Longitudinal tobit regression: a new approach to analyze outcome variables with floor or ceiling effects. Journal of Clinical Epidemiology. 2009; 62(9):953–8. http://doi.org/10.1016/j.jclinepi.2008.10.003. [PubMed: 19211221]

Walker MP, Stickgold R. Sleep, memory, and plasticity. Annual Review of Psychology. 2006; 57:139–66. http://doi.org/10.1146/annurev.psych.56.091103.070307.

Worthington EL. Client compliance with homework directives during counseling. Journal of Counseling Psychology. 1986; 33(2):124–130. http://doi.org/10.1037/0022-0167.33.2.124.

Yoo SS, Hu PT, Gujar N, Jolesz FA, Walker MP. A deficit in the ability to form new human memories without sleep. Nature Neuroscience. 2007; 10(3):385–92. http://doi.org/10.1038/nn1851. [PubMed: 17293859]

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Public health significance

This study highlights the potential importance of sleep for patient adherence to treatment. This raises the possibility that a modifiable mechanism (i.e., nocturnal wakefulness and sleep duration) can be targeted in treatment to improve treatment adherence.

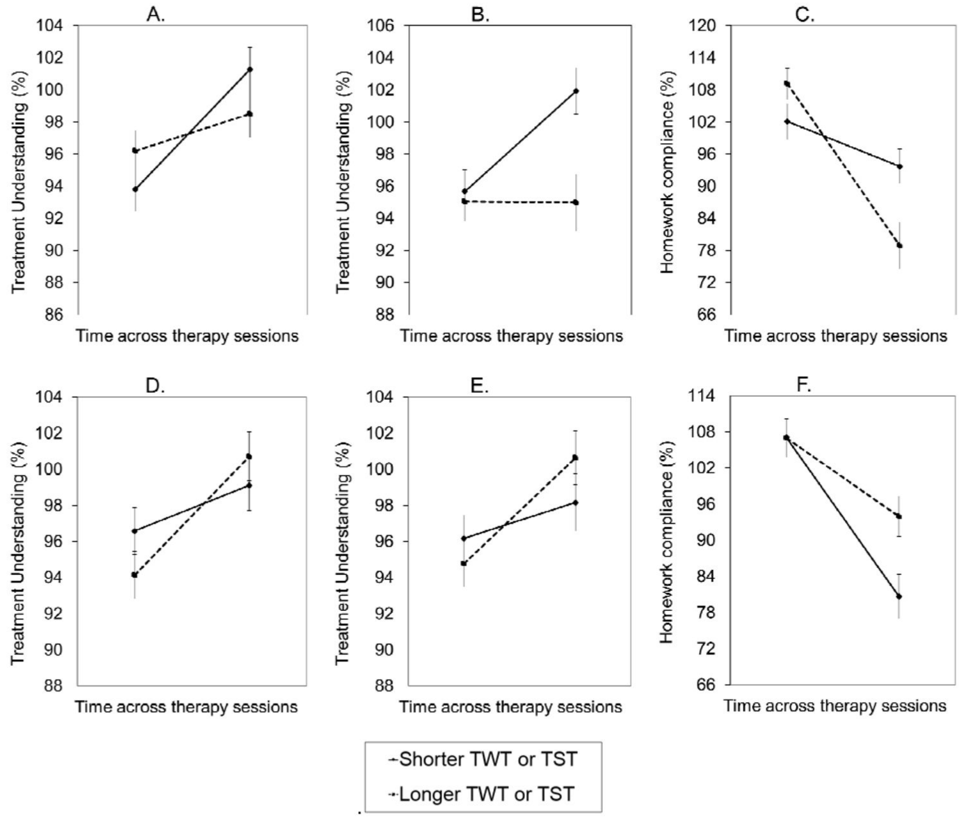

Figure 1.

Simple slopes for (A) treatment understanding and before session TWT, (B) treatment understanding and after session TWT, (C) homework compliance and after session TWT, (D) treatment understanding and before session TST, (E) treatment understanding and after session TST, (F) homework compliance and after session TST.

Note. Y-axis exceeds 100% because plotted values are based on adjusted linear predictions from simple slopes analyses.

Table 1

Means, standard deviations, and/or percentages for demographic and baseline sleep variables.

	M or N	% or SD
Age (Years)	47.48	12.55
Female	116	62.70%
Race		
American Indian/Alaska native	1	0.54%
Asian	13	7.03%
Native Hawaiian/Pacific Islander	0	0.00%
Black or African American	5	2.70%
White	149	80.54%
Hispanic/Latino	5	2.70%
Other	9	4.86%
Education		
Elementary or less	5	2.70%
Secondary/High school	13	7.03%
Vocational training	5	2.70%
Junior college/Professional	31	16.76%
University (Bachelor)	71	38.38%
University (Master)	52	28.11%
University (PhD)	7	3.78%
Marital Status		
Single	52	28.11%
Married	70	37.84%
Live with partner	30	16.22%
Divorced	23	12.43%
Separated	7	3.78%
Widowed	3	1.62%
Occupational Status		
Full time	106	57.30%
Part time	30	16.22%
Retired	26	14.05%
Unemployed	19	10.27%
Work Type		
Daytime work	133	71.89%
Night work	0	0.00%
Rotating shift	6	3.24%
Income		
Less than $20 000	20	10.81%
Between $20 000 and $35 000	17	9.19%
Between $35 000 and $50 000	36	19.46%
Between $50 000 and $65 000	32	17.30%

	M or N	% or SD
More than $65 000	54	29.19%
Declined to respond	26	14.05%
Living Situation		
Living alone	41	22.16%
With spouse or partner	55	29.73%
With spouse / partner and children	55	29.73%
With family members	8	4.32%
With friends/roommates	10	5.41%
Other	16	8.65%
Sleep		
Time in Bed (TIB)	477.40	66.49
Total Sleep Time (TST)	341.07	89.71
Total Wake Time (TWT)	136.82	86.58
Sleep onset latency (SOL)	30.19	36.27
Wake after sleep onset (WASO)	59.02	58.70
Early morning awakening (EMA)	47.42	60.98
Sleep efficiency (SE)	71.66	17.20

Note. Not all percentages add up to 100% because of missing data.

Table 2

Coefficient estimates from random effects Tobit panel model of sleep disturbance (TWT or TST) × Time (session number) predicting treatment adherence variables.

	β	***se***	***z***	***p***	**95% CI**
	Total Wake Time (TWT)				
Before session					
Understanding	−0.007	0.002	−3.430	0.001	[−0.011, −0.003]
After session					
Understanding	−0.008	0.003	−3.200	0.001	[−0.013, −0.003]
Homework compliance	−0.028	0.008	−3.710	0.000	[−0.043, −0.013]
	Total Sleep Time (TST)				
Before session					
Understanding	0.005	0.002	3.070	.002	[0.002, 0.009]
After session					
Understanding	0.005	0.002	2.290	.022	[0.001, 0.010]
Homework compliance	0.017	0.006	2.630	.009	[0.004, 0.030]