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Authors

Sarfan, Laurel

Morin, Charles

Harvey, Allison

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12-month follow-up: Comparative efficacy of cognitive therapy, behavior therapy, and cognitive behavior therapy for patients with insomnia

Laurel D. Sarfan[a], **Charles M. Morin**[b], **Allison G. Harvey**[a]

[a]University of California, Berkeley

[b]Laval University, Quebec City

Abstract

Objective: Treatments that alleviate insomnia over the long term are critical. We evaluated the relative long-term efficacy of cognitive therapy (CT), behavior therapy (BT), and cognitive behavior therapy (CBT) for insomnia.

Method: Patients (N = 188, 62.2% female, 81.1% White, 6.5% Hispanic or Latino/a, M age = 47.4 years) with insomnia were randomized to eight sessions of CT, BT, or CBT for insomnia. Assessments at pre-treatment and 12-month follow-up measured insomnia severity, insomnia response/remission, sleep diary parameters, and daytime functioning.

Results: Patients in all three treatment groups improved on insomnia severity, sleep onset latency, wake after sleep onset, total sleep time, sleep efficiency, work and social adjustment, and mental health (ps < .05). Moreover, in each treatment group, a substantial proportion of patients achieved remission and response. CBT was associated with larger improvements in insomnia severity relative to CT as well as greater remission and improvements in physical health, relative to CT and BT (ps < .05). For patients with a psychiatric comorbidity, CBT was associated with greater improvements in work and social adjustment and mental health, relative to CT (ps < 0.05). CT was not associated with change in time in bed, and none of the treatment conditions were associated with change in daytime fatigue (ps > .05).

Conclusions: These encouraging results suggest that therapists may be able to offer CBT, BT, or CT to improve nighttime and daytime symptoms of insomnia over the long-term, with CBT offering a relative advantage for select outcomes and subgroups.

Keywords

insomnia; cognitive behavior therapy; cognitive therapy; behavior therapy

Corresponding Author. Allison G. Harvey, University of California, Berkeley, Department of Psychology, 2121 Berkeley Way #1650, Berkeley, CA 94720-1650. Phone: (510) 642-7138. aharvey@berkeley.edu.

Introduction

Insomnia is the most common sleep and circadian disorder (American Psychological Association, 2013). The front-line treatment is cognitive behavior therapy (CBT) for insomnia, with improvements sustained at least 10 years after treatment (Edinger et al., 2021; Jernelov et al., 2022). In particular, there is strong evidence for the Behavior Therapy (BT) components of CBT—namely, sleep restriction (i.e., limiting time in bed to sleep duration; Spielman et al., 1987) and stimulus control (i.e., strengthening association between bed and sleep; Bootzin et al., 1979) (Edinger et al., 2021). In contrast, little research has investigated the Cognitive Therapy (CT) components of CBT for insomnia, which targets cognitive processes that impact sleep (e.g., sleep-related attentional biases, unhelpful beliefs, and worry) (Harvey et al., 2007; Morin et al., 2003). Evidence for CT is strong across other disorders (e.g., Beck & Dozois, 2011), but practice guidelines for insomnia have not included CT due to insufficient research (Edinger et al., 2021).

To our knowledge, only one randomized controlled trial—the parent trial of the present study—has directly compared CT with BT and full CBT for insomnia (Harvey et al., 2014; R01MH079188). In this trial, all three treatments were comparably acceptable and associated with improvements at posttreatment and six-month follow-up in insomnia symptoms, sleep-wake parameters (e.g., total sleep time, sleep efficiency) and daytime functioning. Overall, CBT was associated with the most robust outcome. Interestingly, psychiatric comorbidity predicted fewer treatment responders in CT and BT at posttreatment, but not at six-month follow-up (Belanger et al., 2016). Importantly, at six-month follow-up, delayed improvements were seen for patients in CT on response and remission, whereas response in BT declined (Harvey et al., 2014).

Given that improvements were differentially sustained over time, the present study sought to extend the parent trial by comparing CT, BT, and full CBT at *12 months* after treatment. Based on Harvey et al. (2014), we hypothesized that CBT would be associated with the greatest improvements in nighttime and daytime outcomes but that patients in all conditions would improve from pre-treatment to 12-month follow-up. As a secondary aim, we sought to extend Belanger et al. (2016) by evaluating whether psychiatric comorbidity moderated outcomes at 12-month follow-up. Following their findings, we hypothesized that insomnia response, but not severity or remission, would be poorer for patients with versus without a psychiatric comorbidity in CT and BT but not CBT.

Method

Study Overview

Patients (N = 188) were recruited across two sites: Laval University and University of California, Berkeley. All procedures were approved by the Institutional Review Boards at both sites, and all participants provided informed consent. The final sample was 62.2% female, 6.5% Hispanic or Latinx, and 81.1% White. The mean age was 47.4 years (SD = 12.6) and 23.9% met criteria for a psychiatric comorbidity at pre-treatment. Participants were randomized to CT (n = 65), BT (n = 63), or full CBT (n = 60), stratified by age (25–49 versus 50+ years) and presence of a comorbid psychiatric disorder. For the present study,

assessments from pre-treatment (PRE) and 12-month follow-up (12FU) were used. See Harvey et al. (2014) for more on study design and Supplement for flow diagram, screening, and inclusion criteria.

Measures

Measures consisted of the parent trial's preregistered primary outcomes (NCT00869934). *Insomnia Severity Index* (ISI; Bastien et al., 2001) was scored following Harvey et al. (2014): total score/severity, treatment response (change of 8 points or more), and remission (final score below 8). Patients kept daily *sleep diaries* for two weeks at PRE and 12FU. Parameters were selected per Buysse et al. (2006) as follows: sleep onset latency (SOL), wake after sleep onset (WASO), total sleep time (TST), time in bed (TIB), and sleep efficiency (SE = [total sleep time] / [time in bed] x 100). Daytime impairment was assessed via the *Multidimensional Fatigue Inventory* (Smets et al., 1995), *Work and Social Adjustment Scale* (Mundt et al., 2002) and *SF-36 Health Survey Version 2* (Jenkinson et al., 1999). The *SF-36* consists of physical and mental health measures, on which higher scores indicate better health.

Treatments

All treatments consisted of eight weekly individual sessions. CT and BT sessions were 45–60 minutes, and CBT sessions were 75 minutes. All treatments included: sleep diary, "Self-Management Approach" (i.e., patients play an active role in treatment), 3 P Model of Insomnia (Spielman et al., 1987), treatment goals, and sleep hygiene information. CT focused on reversing the cognitive mechanisms of insomnia (following Beck, 1979). BT consisted of stimulus control (Bootzin, 1979) and sleep restriction (Spielman et al., 1987). CBT integrated CT and BT. See Supplement for more information, including a description of content in each session.

Data Analyses

Mirroring the parent trial (Harvey et al., 2014), all analyses controlled for site and strata (age and comorbid psychiatric disorder), except analyses assessing psychiatric comorbidity as a moderator did not control for it. For continuous outcomes, repeated measures mixed models were estimated with maximum likelihood and robust standard errors. The fixed component of the models consisted of a dummy coded variable for time (0 = PRE, 1 = 12FU), two dummy coded variables for treatment conditions, time-by-treatment interaction terms, and the variables for which we controlled (site, strata). For each outcome, two models were run: one with CBT as the reference group (0 = CBT, 1 = CT, 2 = BT) and one with CT as the reference group (0 = CT, 1 = CBT, 2 = BT). This allowed for comparisons between all treatment groups. The random component consisted of a random intercept for participants and level-1 (occasion) error term. For each model, the parameter of interest was the time-by-treatment interaction. Significant interactions indicate differences between treatment conditions from PRE to 12FU. Postestimation contrasts and margins were used to evaluate change for each treatment condition. To evaluate psychiatric comorbidity as a moderator, models were estimated with time-by-condition-by-comorbidity (0 = no, 1 = yes) interactions as the predictor of interest.

For binary outcomes (i.e., response and remission), logistic regression was used with condition as the predictor. Post-estimation average marginal effects estimated predicted probabilities of outcomes for each condition. To evaluate psychiatric comorbidity as a moderator, logistic regression was used with condition-by-comorbidity interactions as the predictor of interest. As with above, models were run with CBT then CT as the reference group.

Transparency and Openness

Analyses were performed using Stata version 16.1. Data and treatment manuals are available upon request. The code is available in the Supplemental Materials. The parent trial, including the 12-month follow-up, was preregistered on clinicaltrials.gov (NCT00869934). Note that hypotheses deviated slightly from the preregistered hypotheses, given published findings from posttreatment and six-month follow-up (Belanger et al., 2016; Harvey et al., 2014).

Results

Table 1 presents means and effect sizes at PRE and 12FU by condition. All results below describe change in continuous outcomes from PRE to 12FU or response/remission at 12FU.

Insomnia

See Table 2. For the *Insomnia Severity Index* total score, significantly more change occurred in CBT relative to CT, though patients in all conditions significantly improved. Participating in CT or BT, versus CBT, significantly decreased the log odds of insomnia remission by 1.09 and 0.99, respectively. Specifically, the average predicted probability of remission was 0.65 for CBT, 0.39 for CT, and 0.41 for BT. For response, there were no significant differences between groups. The average predicted probability of response was 0.74 for CBT, 0.62 for CT, and 0.59 for BT.

Sleep Diary

See Table 3. Change in SOL, WASO, and TST did not significantly differ by condition. Patients in all conditions improved on these outcomes, though effect sizes were variable, particularly for SOL, favoring CBT and BT. SE improved more in BT relative to CT, though patients in all three conditions improved. TIB only significantly decreased in CBT and BT.

Daytime Impairment

See Table 4. Only patients in CBT improved significantly in physical health on the *SF-36*.Change on the *Work and Social Adjustment Scale* and mental health on the *SF-36* did not significantly differ by condition, and patients in all three conditions improved on these outcomes. However, effect sizes were variable, favoring CT for work and social adjustment and CBT/BT for mental health. There was no evidence for change in the *Multidimensional Fatigue Inventory*.

Psychiatric Comorbidity

See Table 5. Psychiatric comorbidity moderated change on the *Work and Social Adjustment Scale* and mental health on the *SF-36* such that patients with (versus without) psychiatric comorbidities improved more in CBT, relative to CT.

Discussion

This study evaluated the relative efficacy of CT, BT, and CBT for insomnia 12 months after treatment. All three treatments were associated with improvements in most outcomes. Additionally, psychiatric comorbidity moderated few outcomes. These encouraging results suggest that therapists may be able to offer a variety of treatment approaches to improve insomnia over the long-term. This variation may be particularly important, because some patients struggle to use stimulus control, sleep restriction, or cognitive approaches (Dryberg et al., 2021). Offering a choice—i.e., strategies assembled as CT, BT, or CBT— may improve adherence and outcome.

There were a few exceptions to this overall pattern of results. First, SOL and mental health decreased significantly in all three groups from pre-treatment to 12-month follow-up, but effect sizes were smaller in CT relative to BT and CBT, whereas the opposite pattern (i.e., larger effect for CT) was found for work and social adjustment. These patterns may point to relative strengths of each treatment. Second, relative to CT and BT, CBT was associated with better probability of remission and was the only condition associated with improvements in physical health. Similarly, for individuals with (versus without) psychiatric comorbidities, CBT was associated with greater improvements in work and social adjustment and mental health, relative to CT. One possible implication is that maximizing physical health and remission and treating patients with more complex presentations may require strategies from both CT *and* BT. Third, CT was associated with less robust outcomes for insomnia severity, TIB, and SE, relative to CBT and/or BT—although each of these outcomes did improve, except for TIB. The latter finding makes sense when considering that BT and CBT directly target TIB via stimulus control and sleep restriction, whereas CT does not.

Importantly, all three treatments were associated with more TST from pre-treatment to 12-month follow-up, suggesting that behavioral *and* cognitive pathways may comparably increase nighttime sleep. This is notable, because while TST often remains low post-treatment, some scholars posit that it may increase over time (Edinger et al., 2021). However, the evidence for this is mixed. For instance, a recent meta-analysis of CBT for insomnia did not find support for improvements in TST at 12-month follow-up, though the authors underscored the small number of studies and heterogeneity (van der Sweede et al., 2019). In contrast, in a recent study, TST improved over time after CBT—but only 58% of patients increased TST by at least 30 minutes at follow up (Scott et al., 2022). The present findings add to this evolving literature by suggesting that CT and BT may also increase TST over the long-term, but more work is needed to clarify the circumstances and extent to which TST improves after treatment.

Taking a broader lens, for most outcomes, the 12-month follow-up findings were similar to those published from six-month follow-up (Harvey et al., 2014). However, a few key differences emerged. Specifically, at six months, there were no differences in insomnia severity, remission, or physical health across treatment arms. In contrast, at 12 months, CBT was associated with significantly greater improvements in insomnia severity and remission, relative to CT, as well as physical health, relative to CT and BT. Additionally, for TIB at six-month follow-up, patients in BT experienced more improvement than patients in CT. At 12-month follow-up, however, patients in BT *and* CBT experienced more improvements relative to patients in CT. These findings have two meaningful implications. First, they suggest that the gap between improvements in CBT relative to BT and CT may widen over time for select—although not all—outcomes. Second, the similarities between the six-month and 12-month findings may inform clinical decision-making by indicating that, for most outcomes, the patterns of relative change are fairly consistent up to a year after treatment ends.

Of note, in the present study and consistent with posttreatment and six-month follow-up (Harvey et al., 2014), none of the treatments were associated with improvements in daytime fatigue. One possible explanation is that, while all three treatments directly target nighttime sleep, many predictors of daytime fatigue are *not* necessarily targeted (e.g., anxiety, depression, inactivity, smoking) (Theorell-Haglow et al., 2006). Interestingly, little research has evaluated the impact of BT and CT on fatigue (Edinger et al., 2021), and to our knowledge, only one prior study has investigated fatigue following CBT for patients with insomnia and comorbid psychiatric disorders—but CBT was delivered via an online, self-guided program and fatigue was assessed with a different measure than that used in the present study (Thorndike et al., 2013). Together, clarifying the effects of insomnia treatment on daytime fatigue and exploring ways to strengthen these effects may reflect fruitful areas for future research.

Several methodological limitations are worth consideration. First, CBT sessions were 75 minutes long, whereas CT and BT sessions were 45–60 minutes long, and all conditions were delivered over eight sessions. Although alternative designs were considered (e.g., fewer sessions of briefer and equal length), the session lengths and number of sessions were selected to allow therapists to feasibly incorporate the treatment content in each condition (see Supplement Table 1). However, it is worth noting that (a) CT often involves more than eight sessions (e.g., Beck & Dozois, 2011; Harvey et al., 2007), and thus the present study's dose may have been insufficient, (2) CBT sessions were longer than the other conditions so that all BT and CT content could be covered in each session, which may represent a confound, and (c) the number of sessions (i.e., eight) may limit translatability to routine practice settings with more time constraints. Moreover, given that most participants attended all eight sessions and session attendance did not differ across conditions (Harvey et al., 2014), future research might compare the length and number of sessions needed to maximize relative efficacy of each treatment. Second, the present study sample was predominantly White. Evidence suggests that, for individuals of minoritized racial identities, additional factors—such as those related to systemic racism—can contribute to sleep problems (e.g., Slopen et al., 2016). Future research should evaluate these three treatments with a more diverse sample and consider whether modules that target a wider range of

insomnia predictors are needed. Third, data collection was completed in November 2011, prior to publication of the Consensus Sleep Diary (Carney et al., 2012). The sleep diary used in the present study followed expert recommendations (Buysse et al., 2006). However, this nevertheless may limit comparisons with other studies. Fourth, some evidence suggests that people with insomnia who are also short sleepers (i.e., < 6 hours; Bathgate et al., 2017) may have a "blunted response" to CBT. It is possible that additional differences between conditions would have emerged, had the present study included individuals with insomnia who slept more than 6.5 hours. These limitations notwithstanding, findings from the present study indicate that all three treatments improve nighttime and daytime symptoms over the long-term. Future research should evaluate whether matching CT, BT, and CBT to patients' needs and preferences further improves symptoms for patients with insomnia.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This research was funded by the National Institute of Mental Health R01MH079188. The analyses herein used data from a randomized controlled trial that was preregistered on clinicaltrials.gov (NCT00869934). The randomized controlled trial data have been reported in six prior studies. Only two of these prior studies utilized the 12-month follow-up data. The first reported indirect effects of a mediation analysis and the second reported differential effects comparing two of the three treatment conditions. In other words, neither study analyzed overall outcomes from the 12-month follow-up. Moreover, neither study included all of the preregistered primary outcomes. In contrast, the present submission evaluated the overall outcomes of all three treatments for all preregistered primary outcomes at 12-month follow-up. In other words, the present study is distinct from prior research with respect to the research questions, treatment conditions, and outcomes.

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What is the public health significance of this article?

Cognitive therapy, behavior therapy, and cognitive behavior therapy were all associated with improvements in nighttime and daytime symptoms of insomnia that lasted at least a year after treatment. These findings suggest that therapists and patients can choose between these three treatments (e.g., depending on patients' needs, preferences, and clinical presentation) to achieve long-term benefits.

Narrative Description of Prior Studies from Dataset

The randomized controlled trial data have been reported in six prior studies. Only two of these prior studies utilized the 12-month follow-up data. The first (published) reported indirect effects of a mediation analysis, and the second (published) reported differential effects comparing two of the three treatment conditions. In other words, neither study analyzed overall outcomes from the 12-month follow-up. Moreover, neither study included all of the preregistered primary outcomes. In contrast, the present submission evaluated the overall outcomes of all three treatments for all preregistered primary outcomes at 12-month follow-up. Together, the present study is distinct from prior research with respect to the research questions, treatment conditions, and outcomes.

Table 1.

Means, Standard Deviations, and Effect Sizes for Continuous Outcomes at Pre-treatment and 12-month Follow-up Assessments

	Pre						12FU								
	CT		BT		CBT		CT		BT		CBT		Effect Size		
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	CT *d*	BT *d*	CBT *d*
Insomnia Symptoms															
ISI	17.58	3.50	18.30	3.40	17.88	3.42	8.76	5.07	8.80	4.88	7.04	4.69	−2.52	−2.80	−3.17
Sleep Diary															
SOL *(min)*	30.59	25.33	36.67	30.87	29.04	21.02	24.59	39.60	20.41	23.59	16.77	15.73	−0.24	−0.53	−0.58
WASO *(min)*	57.60	30.89	60.81	39.79	54.50	32.33	38.45	32.61	31.88	26.10	35.85	30.44	−0.62	−0.73	−0.58
TST *(min)*	339.02	56.99	340.44	64.72	354.10	58.10	380.52	75.58	391.60	55.17	393.82	52.86	0.73	0.79	0.68
TIB *(min)*	476.56	41.59	487.15	59.22	490.56	47.04	485.10	485.10	466.36	36.63	474.48	43.69	0.21	−0.35	−0.34
SE *(%)*	71.54	12.80	70.10	11.35	72.57	11.11	78.61	14.84	83.98	9.62	82.96	9.12	0.55	1.22	0.94
Daytime Measures															
WSAS	3.38	1.77	3.48	1.83	2.98	1.66	1.25	1.59	1.67	1.69	1.18	1.30	−1.21	−0.99	−1.09
MFI	57.85	5.42	58.02	4.50	57.69	4.36	57.87	5.19	57.42	4.08	57.16	4.38	0.004	−0.13	−0.12
SF-36 - Physical	50.82	6.26	50.21	8.71	49.74	7.81	48.67	8.51	49.81	7.90	52.14	5.27	−0.34	−0.05	0.31
SF-36 - Mental	45.71	10.56	46.24	8.97	47.50	8.80	50.58	11.08	52.27	8.65	53.37	6.84	0.46	0.67	0.67

Note. 12FU = 12-month follow-up. CT = cognitive therapy. BT = behavior therapy. CBT = cognitive behavior therapy. Min = minutes. ISI = Insomnia Severity Index. SOL = sleep onset latency. WASO = wake after sleep onset. TST = total sleep time. TIB = time in bed. SE = sleep efficiency (total sleep time/time in bed × 100). d = effect size for treatment effects from pre-treatment to 12-month follow-up, calculated using mean change scores and pretreatment raw SD, based on Cumming (2013). WSAS = Work and Social Adjustment Scale. MFI = Multidimensional Fatigue Inventory. SF-36 - Physical = SF-36 Health Survey - Physical Component. SF-36 - Mental = SF-36 Health Survey - Mental Component.

Table 2.

Mixed Models and Postestimation Contrasts and Margins for Insomnia Outcomes

	coefficient/contrast/margin	SE	*p*-value	95% Confidence Interval
ISI Severity				
Interactions				
CT vs. BT	−0.39	1.04	0.71	−2.43, 1.65
CBT vs. CT	2.08	1.00	**0.04**	0.13, 4.04
CBT vs. BT	1.69	1.00	0.09	−0.27, 3.65
Postestimation Contrasts				
CT	−8.84	0.73	**<0.001**	−10.28, −7.41
BT	−9.23	0.74	**<0.001**	−10.28, −7.41
CBT	−10.92	0.68	**<0.001**	−12.25, −9.60
ISI Response				
Interactions				
CT vs. BT	−0.15	0.41	0.72	−0.94, 0.65
CBT vs. CT	−0.58	0.43	0.18	−1.42, 0.27
CBT vs. BT	−0.73	0.44	0.10	−1.58, 0.13
Margins				
CT	0.62	0.06	**<0.001**	0.50, 0.75
BT	0.59	0.07	**<0.001**	0.46, 0.72
CBT	0.74	0.06	**<0.001**	0.62, 0.86
ISI Remission				
Interactions				
CT vs. BT	0.10	0.40	0.80	−0.69, 0.89
CBT vs. CT	−1.09	0.41	**0.01**	−1.90, −0.29
CBT vs. BT	−0.99	0.42	**0.02**	−1.80, −0.18
Margins				
CT	0.39	0.06	**<0.001**	0.26, 0.51
BT	0.41	0.07	**<0.001**	0.28, 0.54
CBT	0.65	0.07	**<0.001**	0.52, 0.78

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Note. Significant *p*-values are bolded. SE = standard error. ISI = Insomnia Severity Index. CT = cognitive therapy. BT = behavior therapy. CBT = cognitive behavior therapy. "Coefficient" header applies to "*Interactions,*" "contrasts" header applies to "*Postestimation Contrasts,*" and margin header applies to "*Margins.*" For interactions, the first treatment listed represents the reference group (e.g., for "CT vs. BT," the reference group is CT).

Table 3.

Mixed Models and Postestimation Contrasts for Sleep Diary Outcomes

	coefficient/contrasts	SE	*p*-value	95% confidence interval
Sleep onset latency (*min*)				
Interactions				
CT vs. BT	−8.95	5.02	0.08	−18.79, 0.89
CBT vs. CT	3.80	3.98	0.34	−4.00, 11.59
CBT vs. BT	−5.15	4.61	0.26	−14.18, 3.88
Postestimation Contrasts				
CT	−6.69	3.13	**0.03**	−12.83, 0.55
BT	−15.63	3.9	**<0.001**	−23.27, −8.00
CBT	−10.49	2.45	**<0.001**	−15.28, −5.69
Wake after sleep onset (*min*)				
Interactions				
CT vs. BT	−11.39	6.11	0.06	−23.37, 0.59
CBT vs. CT	1.47	5.90	0.80	−10.08, 13.03
CBT vs. BT	−9.92	5.87	0.09	−21.42, 1.58
Postestimation Contrasts				
CT	−19.61	4.35	**<0.001**	−28.14, −11.08
BT	−31.00	4.30	**<0.001**	−39.43, −22.57
CBT	−21.08	4.00	**<0.001**	−28.92, −13.24
Total Sleep Time (*min*)				
Interactions				
CT vs. BT	9.88	11.22	0.38	−12.11, 31.87
CBT vs. CT	−2.10	12.38	0.87	−26.36, 22.15
CBT vs. BT	7.78	11.45	0.50	−14.67, 30.22
Postestimation Contrasts				
CT	39.37	8.59	**<0.001**	22.53, 56.22
BT	49.25	7.20	**<0.001**	35.14, 63.37
CBT	41.48	8.89	**<0.001**	24.04, 58.91
Time in Bed (*min*)				

	coefficient/contrasts	SE	*p*-value	95% confidence interval
Interactions				
CT vs. BT	−30.99	7.69	**<0.001**	−46.06, −15.91
CBT vs. CT	23.04	9.08	**0.01**	5.25, 40.84
CBT vs. BT	−7.94	8.46	0.35	−24.53, 8.64
Postestimation Contrasts				
CT	6.07	5.90	0.30	−5.49, 17.62
BT	−24.92	4.90	**<0.001**	−34.49, −15.32
CBT	−16.98	6.89	**0.01**	−30.49, −3.46
Sleep efficiency *(%)*				
Interactions				
CT vs. BT	7.06	2.06	**0.001**	3.02, 11.09
CBT vs. CT	−3.86	2.06	0.06	−7.89, 0.17
CBT vs. BT	3.20	2.05	0.12	−0.81, 7.21
Postestimation Contrasts				
CT	7.08	1.46	**<0.001**	4.22, 9.95
BT	14.14	1.45	**<0.001**	11.30, 16.98
CBT	10.94	1.44	**<0.001**	8.11, 13.77

Note. Significant *p*-values are bolded. SE = standard error. Min = minutes. CT = cognitive therapy. BT = behavior therapy. CBT = cognitive behavior therapy. “Coefficient” header applies to “*Interactions*” and “contrasts” header applies to “*Postestimation Contrasts*.” For interactions, the first treatment listed represents the reference group (e.g., for “CT vs. BT,” the reference group is CT).

Table 4.

Mixed Models and Postestimation Contrasts for Daytime Outcomes

	coefficient/contrasts	SE	*p*-value	95% confidence interval
WSAS				
Interactions				
CT vs. BT	0.30	0.35	0.39	−0.39, 0.99
CBT vs. CT	−0.29	0.32	0.35	−.92, 0.33
CBT vs. BT	0.01	0.35	0.99	−.67, 0.68
Postestimation Contrasts				
CT	−2.12	0.23	**<0.001**	−2.57, −1.67
BT	−1.82	0.27	**<0.001**	−2.34, −1.30
CBT	−1.82	0.22	**<0.001**	−2.26, −1.39
MFI				
Interactions				
CT vs. BT	−0.62	0.93	0.51	−2.44, 1.20
CBT vs. CT	0.83	0.94	0.38	−1.02, 2.68
CBT vs. BT	0.22	0.88	0.81	−1.51, 1.95
Postestimation Contrasts				
CT	0.07	0.70	0.92	−1.30, 1.43
BT	−0.55	0.61	0.37	−1.75, 0.66
CBT	−0.77	0.64	0.23	−2.02, 0.48
SF-36 – Physical				
Interactions				
CT vs. BT	2.36	1.46	0.11	−0.50, 5.21
CBT vs. CT	−4.31	1.32	**0.001**	−6.90, 1.71
CBT vs. BT	−1.95	1.37	0.15	−4.63, 0.73
Postestimation Contrasts				
CT	−1.86	1.00	0.06	−3.82, 0.10
BT	0.50	1.058	0.64	−1.58, 2.57
CBT	2.45	0.87	**0.01**	0.75, 4.15
SF-36 – Mental				

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	coefficient/contrasts	SE	*p*-value	95% confidence interval
Interactions				
CT vs. BT	1.08	1.65	0.51	−2.15, 4.31
CBT vs. CT	−0.73	1.76	0.68	−4.19, 2.73
CBT vs. BT	0.35	1.58	0.82	−2.75, 3.46
Postestimation Contrasts				
CT	5.05	1.29	**<0.001**	2.53, 7.58
BT	6.14	1.03	**<0.001**	4.12, 8.15
CBT	5.78	1.20	**<0.001**	3.42, 8.14

Note. Significant *p*-values are bolded. SE = standard error. CT = cognitive therapy. BT = behavior therapy. CBT = cognitive behavior therapy. WSAS = Work and Social Adjustment Scale. MFI = Multidimensional Fatigue Inventory. SF-36 - Physical = SF-36 Health Survey - Physical Component. SF-36 - Mental = SF-36 Health Survey - Mental Component. "Coefficient" header applies to "*Interactions*" and "contrasts" header applies to "*Postestimation Contrasts.*" For interactions, the first treatment listed represents the reference group (e.g., for "CT vs. BT," the reference group is CT).

Table 5.

Psychiatric Comorbidity Moderating the Effect of Treatment Condition on Outcomes

	Interaction Coefficient	SE	*p*-value	95% Confidence Interval
ISI Severity				
CT vs. BT	−2.56	2.88	0.38	−8.21, 3.10
CBT vs. CT	3.18	3.00	0.29	−2.69, 9.05
CBT vs. BT	0.63	2.92	0.83	−5.09, 6.34
ISI Response				
CT vs. BT	0.51	0.92	0.58	−1.29, 2.30
CBT vs. CT	−1.29	1.05	0.22	−3.36, 0.77
CBT vs. BT	−0.79	1.09	0.47	−2.93, 1.36
ISI Remission				
CT vs. BT	1.73	0.99	0.08	−0.21, 3.67
CBT vs. CT	−1.93	1.04	0.06	−3.96, 0.10
CBT vs. BT	−0.20	1.01	0.84	−2.18, 1.78
Sleep onset latency (*min*)				
CT vs. BT	−17.04	10.30	0.10	−37.21, 3.14
CBT vs. CT	−2.72	7.47	0.72	−17.36, 11.93
CBT vs. BT	−19.75	10.10	0.051	−39.55, 0.05
Wake after sleep onset (*min*)				
CT vs. BT	8.90	14.48	0.54	−19.48, 37.29
CBT vs. CT	4.83	17.77	0.79	−30.00, 39.65
CBT vs. BT	13.73	15.68	0.38	−17.00, 44.46
Total Sleep Time (*min*)				
CT vs. BT	23.96	25.83	0.35	−26.67, 74.59
CBT vs. CT	0.17	35.06	0.99	−68.53, 68.88
CBT vs. BT	24.14	29.68	0.42	−34.03, 82.31
Time in Bed (*min*)				
CT vs. BT	7.95	17.44	0.65	−26.23, 42.13
CBT vs. CT	−6.21	27.27	0.82	−59.66, 47.25
CBT vs. BT	1.74	26.76	0.95	−50.70, 54

	Interaction Coefficient	SE	*p*-value	95% Confidence Interval
Sleep efficiency *(%)*				
CT vs. BT	4.63	4.23	0.27	−3.66, 12.93
CBT vs. CT	−0.05	5.98	0.99	−11.77, 11.67
CBT vs. BT	4.59	5.46	0.40	−6.12, 15.29
WSAS				
CT vs. BT	−1.71	1.35	0.20	−4.35, 0.93
CBT vs. CT	2.25	0.79	**0.004**	0.71, 3.80
CBT vs. BT	0.54	1.30	0.68	−2.01, 3.10
MFI				
CT vs. BT	−1.39	2.19	0.53	−5.67, 2.90
CBT vs. CT	−1.80	1.89	0.34	−5.50, 1.90
CBT vs. BT	−3.19	2.06	0.12	−7.23, 0.86
SF-36 – Physical				
CT vs. BT	7.25	3.77	0.06	−0.15, 14.65
CBT vs. CT	−6.22	4.74	0.19	−15.52, 3.07
CBT vs. BT	1.03	4.32	0.81	−7.44, 9.49
SF-36 – Mental				
CT vs. BT	8.01	4.87	0.10	−1.54, 17.56
CBT vs. CT	−12.62	4.46	**0.005**	−21.36, −3.88
CBT vs. BT	−4.61	4.35	0.29	−13.13, 3.92

Note. Significant *p*-values are bolded. SE = standard error. ISI = Insomnia Severity Index. CT = cognitive therapy. BT = behavior therapy. CBT = cognitive behavior therapy. Min = minutes. WSAS = Work and Social Adjustment Scale. MFI = Multidimensional Fatigue Inventory. SF-36 - Physical = SF-36 Health Survey - Physical Component. SF-36 - Mental = SF-36 Health Survey - Mental Component. Coefficients represent time-by-condition-by-comorbidity interactions for continuous outcomes and condition-by-comorbidity interactions for binary outcomes. For interactions, the first treatment listed represents the reference group (e.g., for “CT vs. BT,” the reference group is CT). For time and psychiatric comorbidity, pre-treatment and no comorbidity are the reference groups.

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