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Dysfunctional cognitions about sleep as mediators of outcome in cognitive-behavioral therapy and acupuncture for insomnia

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Abstract

Study objectives

Reduction in maladaptive beliefs about sleep mediates the effectiveness of cognitive-behavioral therapy for insomnia (CBT-I). Complex interventions, such as acupuncture, have a strong placebo component of which the cognitive model of insomnia may be involved. We aimed to compare the role of dysfunctional cognitions about sleep as mediators on the effectiveness of CBT-I and acupuncture.

Methods

Data of 2 randomized waitlist-controlled trials were analyzed (CBT-I: 312 participants, mean age 38.4 years, 71.2% female; acupuncture: 224 participants, mean age 53.4 years, 75.4% female). Internet-based CBT-I was provided weekly for 6 weeks. Acupuncture was given 3 times per week for 3 weeks. Insomnia Severity Index (ISI) and sleep-diary-derived sleep efficiency (SE) at 4-week follow-up were outcome measures. Changes in the 16-item Dysfunctional Beliefs and Attitudes about Sleep Scale (DBAS) scores from baseline to posttreatment were potential mediators. Moderated mediation analyses, with posttreatment severity of insomnia, age, gender, and educational level as covariates, were performed.

Results

Changes in the DBAS total, “consequences”, “worry/helplessness”, and “sleep expectations” subscale scores mediated the effect of CBT-I on ISI, but not on sleep-diary-derived SE, while none of the DBAS scores mediated the effect of acupuncture. Compared with acupuncture, CBT-I resulted in a significantly greater reduction in the DBAS “sleep expectations” subscale score and had a significantly greater indirect effect of treatment on ISI through changes in DBAS total and “worry/helplessness” subscale scores.

Conclusions

The role of dysfunctional cognitions about sleep as mediators of improvement is relatively less important in acupuncture compared with CBT-I.

Keywords*:* Cognitive-behavioral therapy, acupuncture, insomnia, cognition, mediator

Brief Summary

Current Knowledge/Study Rationale: Dysfunctional cognitions about sleep mediate the effectiveness of cognitive-behavioral therapy for insomnia, but their roles in acupuncture, of which patients adopt a passive role and there exists a strong placebo component, are unclear. Moderated mediation analyses were performed to examine the mediating effects of Dysfunctional Beliefs and Attitudes about Sleep Scale scores from baseline to posttreatment on outcomes at 4-week follow-up.

Study Impact: Although the placebo component of acupuncture may have reduced dysfunctional cognitions about sleep, our findings suggest that the role of dysfunctional cognitions as mediators of improvement is relatively less important in acupuncture compared with CBT-I. Further studies should explore the added values of integrating a cognitive perspective of insomnia in acupuncture treatment for insomnia.

Dysfunctional cognitions about sleep as mediators of outcome in cognitive-behavioral therapy and acupuncture for insomnia

Introduction

Insomnia is a highly prevalent condition that is associated with substantial distress, psychosocial impairment, and medical and psychiatric morbidities (Fernandez-Mendoza J, Vgontzas AN. Insomnia and its impact on physical and mental health. Curr Psychiatry Rep 2013;15:418). Cognitive, behavioral and hyperarousal models are the widely accepted theoretical models of insomnia (Espie, 2002). Cognitive-behavioral therapy for insomnia (CBT-I) is a multifaceted treatment targeting sleep-related dysfunctional beliefs, maladaptive cognitive processes, and counterproductive coping (Morin & Espie, 2003). Although studies have consistently reported a significantly greater reduction in dysfunctional cognitions from pre- to posttreatment of CBT-I, compared to control interventions, most of these studies were correlation analyses, which test only the concurrent changes in mediators and outcomes. Mediation analyses which determine whether there are important statistical relationships between an intervention, the suggested mechanisms, and outcomes, are uncommon and the results have been inconsistent. Two separate groups (Espie et al., 2014);(Lancee, Eisma, van Straten, & Kamphuis, 2015) found that dysfunctional cognitions mediated the effects of an online CBT-I program on sleep improvement. However, a study in Japan (Okajima, Nakajima, Ochi, & Inoue, 2014) found no mediating effect of dysfunctional cognitions on outcome after 6 sessions of individualized CBT-I.

Acupuncture is one of the complementary and alternative medicine therapies for insomnia (Yeung et al., 2014). Previous systematic reviews and randomized placebo-controlled trials have shown that acupuncture possesses mild hypnotic effect for primary and comorbid insomnia (Cheuk, Yeung, Chung, & Wong, 2012; Chung et al., 2015; Yeung, Chung, Zhang, Yap, & Law, 2009). Acupuncture is usually performed by inserting needles at

special points on the body, called acupoints, followed by manual or electrical stimulation. For the treatment of insomnia, acupuncture has to be provided a few times per week for a few weeks and each session usually takes about 30 minutes (Yeung, Chung, Zhang, Yap, & Law, 2009). The mechanism of action of acupuncture is unclear, but a substantial part of its effect may be due to placebo factors, including the ambiance of the practice setting, the time and quality of attention provided by the practitioner, and the expectations of the patient (MacPherson & Hammerschlag, 2012). Studies have shown that the effect size associated with acupuncture compared to placebo acupuncture is usually small, in the range of 0.15-0.25. When compared to waitlist, standard care, or no treatment, the effect size is moderate, around 0.50 (Moffet, 2009). Like pharmacotherapy, acupuncture is a treatment of which patients are passive recipients of treatment and care, in contrast to the active role taken by recipients of CBT-I for its effectiveness. The active and passive patient roles may have different implications in the process of recovery. Nevertheless, there have been no previous studies that contrast the effects of CBT-I and acupuncture on insomnia using the cognitive model.

The aim of this secondary analysis was to compare the role of sleep-related dysfunctional cognitions in mediating improvements following CBT-I and acupuncture. Although the data is based on different clinical trials, study participants are ethnic Chinese from the same locality. We used moderated mediation analyses and controlled for age, gender, educational level, and insomnia severity to contrast the application of the cognitive model of insomnia in CBT-I and acupuncture. We hypothesized that dysfunctional cognitions might be more relevant mediators of improvements following CBT-I compared to acupuncture, despite the placebo factors in acupuncture.

Methods

Subjects

Data was obtained from 2 randomized controlled trials (RCTs) (ClinicalTrial.gov identifiers: NCT01719120 and NCT01891097). Participants of an internet-based CBT-I study (Ho, Chung, Yeung, Ng, & Cheng, 2014) were recruited through the internet, emails, public talks, and mass media. The major inclusion criteria were: (1) ethnic Chinese aged 18 years or above; (2) self-reported difficulty initiating or maintaining sleep, early morning awakening, or non-restorative sleep that were associated with distress or impairment in social, occupational and other important areas of functioning for at least 3 nights per week for at least 3 months; and (3) having no suicidal ideation.

Participants of the acupuncture study were recruited through the mass media and in 3 regional psychiatric clinics. The major inclusion criteria were: (1) ethnic Chinese aged 18 years or above; (2) fulfilling criteria A to E of the Diagnostic and Statistical Manual, 5th Edition (DSM-5) diagnosis of insomnia disorder (American Psychiatric Association, 2013); and (3) sleep onset latency or wake after sleep onset >30 minutes for at least 3 nights per week and average sleep efficiency (SE) <85% based on 1-week sleep diary at baseline. Subjects were excluded if they: (1) had any current major depressive disorder, generalized anxiety or panic disorder, manic or hypomanic episode, substance use disorder, organic mental disorder, or schizophrenia or other psychotic disorder; (2) had a 17-item Hamilton Depression Rating Scale ($HDRS_{17}$) (Hamilton, 1960) score > 18; (3) had a significant risk of suicide based on the $HDRS_{17}$ item on suicide scored ≥ 3; (4) had any unstable psychiatric conditions or serious physical illnesses; (5) had received any acupuncture or auricular acupuncture during the previous 12 months, which might possess residual hypnotic effects; (6) were receiving psychotropic medications with dosage changes in the last 4 weeks; or (7) had any sleep disorders, including sleep phase disorders, parasomnia, obstructive sleep apnea (apnea-hypopnea index ≥10), or periodic limb movement disorder (periodic limb movement disorder index ≥15) detected during screening or by in-laboratory overnight

polysomnography. Self-help CBT-I and acupuncture were provided free of charge. No monetary incentive was provided in the CBT-I study, but a HK$200 (US$26) travel allowance was paid after completion of the acupuncture study.

Procedure

The studies were reviewed and approved by the local institutional review board. Informed consent was obtained prior to all study procedures. Of the CBT-I study, 312 participants were randomly assigned to CBT-I with telephone support (n = 103), CBT-I without telephone support (n= 104), and waitlist (n = 105) (Ho et al., 2014). Weekly telephone support for roughly 15 min each time was provided by a psychology graduate (FYH) using a semi-structured script. Regarding the acupuncture study, 224 participants were randomized in a 3:3:1 ratio to acupuncture (n = 96), combined acupuncture and auricular acupuncture (n = 96), and waitlist (n = 32). Block randomization was done by an independent administrator using a computer-generated list of numbers, with a block size of 9 in the CBT-I study and 14 in the acupuncture study. Major assessments were conducted at baseline, posttreatment, and 4-week follow-up.

Intervention

The internet-based self-help CBT-I lasted for 6 weeks, with treatment materials delivered once per week. The content was adopted from a well-established CBT-I manual (Morin & Espie, 2003) and included sleep education, relaxation training, stimulus control, sleep restriction, and cognitive therapy. Materials were presented in Chinese, mostly in text, together with some diagrams and a 15-minute audio clip on relaxation training. Full details of the CBT-I sessions are available in our paper (Ho, Chung, Yeung, Ng, & Cheng, 2014).

Acupuncture or combined acupuncture and auricular acupuncture were given 3 times per week for 3 consecutive weeks. Treatments were performed by acupuncturists who were registered Chinese medicine practitioners with at least 3 years of experience. Subjects were

inserted with needles bilaterally at Ear Shenmen, Sishencong (EX-HN1), Anmian, Neiguan (PC6), Shenmen (HT7), and Sanyinjiao (SP6), and unilaterally at Yintang (EX-HN3) and Baihui (GV20). Deqi was achieved if possible. Surgical tapes or hair pins were used to secure the needles. An electric stimulator (ITO ES160, Japan) was connected to all needles and delivered a constant current, 0.4-ms, square-wave, brief-pulse stimulus of 4 Hz. The needles were left for 30 minutes and then removed. Auricular acupuncture by borneol crystals was placed at Ear Shenmen, Heart, Kidney, Liver, Spleen, Occiput, and Subcortex and secured using adhesive plasters. The acupoint selection for acupuncture and auricular acupuncture was based on expert opinion, systematic reviews (Yeung, Chung, Leung, Zhang, & Law, 2009; Yeung et al., 2012), and our previous studies (Chung et al., 2015; Yeung et al., 2011; Yeung, Chung, Zhang, et al., 2009).

Measures

To obtain a comprehensive picture, we examined 2 outcome measures, sleep-diary-derived SE and the Insomnia Severity Index (ISI) (Bastien, Vallieres, & Morin, 2001). Both outcome measures are standard research assessments of insomnia (Buysse, Ancoli-Israel, Edinger, Lichstein, & Morin, 2006). Participants reported their sleep-wake pattern using the Expanded Consensus Sleep Diary for Morning (CSD-M) (Carney et al., 2012) for 7 consecutive days. SE was calculated as total sleep time divided by time in bed expressed in % averaged over 1 week. The ISI is a 7-item self-rating scale on perceived severity of insomnia, degree of satisfaction with sleep, and associated functional impairment in the previous week. Participants rated their insomnia using a 5-point Likert scale, with scores ranging from 0 to 28; higher scores indicating more severe insomnia. The Chinese version of ISI has been shown to be valid and reliable (Chung, Kan, & Yeung, 2011). The 16-item Dysfunctional Beliefs and Attitudes about Sleep Scale (DBAS) (Morin, Vallieres, & Ivers, 2007) was used to assess dysfunctional sleep-related cognitions and it has 4 subscales covering

"consequences", "worry/helplessness", "sleep expectations", and "medication". Participants used a 10-point Likert scale to indicate their degree of endorsement ranging from "strongly disagree" to "strongly agree", with higher scores suggestive of more dysfunctional cognitions. A Chinese version of the 16-item DBAS has been shown to have better internal consistency, a reproducible factor structure, strong concurrent validity, and is more sensitive to change than the 30-item and 10-item versions (Chung, Ho, & Yeung, 2016).

Data analysis

Data were analyzed using an intention-to-treat approach. Participants who did not complete all assessments were included in analyses. Missing data were handled using the expectation maximization algorithm.

Moderated mediation analyses were conducted to examine whether therapy type (CBT-I vs. acupuncture) would moderate the indirect effect of group (treatment vs. control) on changes in ISI and sleep-diary-derived SE through changes in DBAS scores. To examine the temporal precedence criterion of mediation (Murphy, Cooper, Hollon, & Fairburn, 2009), we analyzed the effect of changes in DBAS scores from baseline to posttreatment on ISI and sleep-diary-derived SE at 4-week follow-up. The posttreatment level of the independent variable (ISI or SE), age, gender, and educational level were included as covariates. Figure 1 illustrates the proposed moderated mediation model. Path c is the total effect of the independent variable on the dependent variable without controlling for the mediator. Path a is the effect of the independent variable on the mediator. Path b is the effect of the mediator on the dependent variable. Path c' is the direct effect of the independent variable on the dependent variable while controlling for the mediator. The product of path a and path b (path ab) is the indirect effect of the independent variable on the dependent variable through the mediator. The moderating effects of therapy type on these paths were analyzed. Path coefficients were estimated using a series of regression analyses with interaction terms

(Muller, Judd, & Yzerbyt, 2005). Group (1 = *treatment*, 0 = *control*), therapy type (1 = *CBT-I*, 0 = *acupuncture*) and gender (1 = *male*, 0 = *female*) are dummy coded. Changes on DBAS scores were mean-centered.

Conditional indirect effects across the two types of therapy and indexes of moderation mediation were computed using the SPSS macro PROCESS developed by Hayes (2013). Bias corrected 95% confidence intervals with 1000 bootstrap resamples were generated to test the significance of the conditional indirect effects and indexes of moderation. A significant index of moderated mediation would indicate that the indirect effect differed between CBT-I and acupuncture.

Results

Table 1 presents the sociodemographic and clinical characteristics of the analyzed sample. There are significant differences in age, years of education, marital status, occupation, insomnia duration, and baseline ISI score and sleep-diary derived SE between participants in the CBT-I and acupuncture studies (all $p < 0.001$). Table 2 presents the results of moderated mediation analyses of the relationships among therapy type, group, changes in DBAS from baseline to posttreatment, and outcomes at 4-week follow-up. A number of significant moderating effects were observed. The treatment effect in reducing the DBAS "sleep expectations" subscale score was significantly greater for CBT-I than acupuncture. The effects of the reductions in the DBAS total, "worry/helplessness", and "sleep expectations" subscale scores on reduced ISI was significantly greater for CBT-I than acupuncture. The effect of the reduction in the DBAS "worry/helplessness" subscale score on improved SE was significantly greater for CBT-I than acupuncture.

Table 3 presents the conditional indirect effects and indexes of moderated mediation. The effect of CBT-I on ISI was significantly mediated by changes in the DBAS total, "consequences", "worry/helplessness", and "sleep expectations" subscale scores, while the

effect of CBT-I on SE was not mediated by changes in the DBAS scores. On the contrary, changes in the DBAS scores did not mediate the effects of acupuncture on ISI and SE. Indexes of moderated mediation demonstrated that the indirect effect of treatment on ISI through changes in the DBAS total and "worry/helplessness" subscale scores was significantly greater for CBT-I than acupuncture.

Discussion

To the best of our knowledge, this is the first study contrasting the role of dysfunctional cognitions about sleep as mediators on the effectiveness of CBT-I and acupuncture. Firstly, we found that CBT-I resulted in a greater reduction in dysfunctional cognitions about sleep compared with acupuncture. Secondly, the impact of a reduction in dysfunctional cognitions was more apparent in recipients of CBT-I than those of acupuncture. Thirdly, the mediating role of dysfunctional cognitions about sleep was only shown in outcome measured by sleep questionnaire, such as ISI, but not by sleep-diary-derived SE. Lastly, the indirect effect of treatment through changes in dysfunctional cognitions was significantly greater for CBT-I compared with acupuncture. Our findings support the role of dysfunctional cognitions about sleep as mediators of improvements following CBT-I. Although a placebo component exists in acupuncture and a reduction in dysfunctional cognitions has occurred, the role of dysfunctional cognitions as mediators on the effectiveness of acupuncture is not apparent and relatively less important compared with CBT-I.

The effect of CBT-I and acupuncture on dysfunctional cognitions was significantly different only in the DBAS "sleep expectations" subscale. The finding suggests that the placebo factors of acupuncture have relatively less impact on participants' attitude toward sleep need and the need to catch up on sleep loss, as measured by the "sleep expectations" subscale; while the "consequences", "worry/helplessness", and "medication" subscales are

equally affected by the 2 treatments. Perhaps due to the active role adopted by the recipients of CBT-I, the effect of a reduction in dysfunctional cognitions about sleep on outcome is greater for CBT-I than acupuncture. It is possible that participants receiving CBT-I can better understand the vicious cycle among dysfunctional cognitions, counter-productive behaviors, and sleep than those receiving acupuncture. Further studies should look into an integration of the cognitive model of insomnia in treatments of which patients adopt a passive role. As shown in our study, a reduction in dysfunctional cognitions about sleep was found in recipients of acupuncture, but the effect of the reduction in dysfunctional cognitions on outcomes was relatively weaker compared with those receiving CBT-I. We found that the effect of CBT-I on ISI was significantly mediated by changes in the "consequences", "worry/helplessness", and "sleep expectations" subscales, while the effect of CBT-I on sleep-diary-derived SE was not mediated by changes in DBAS scores. The impact of dysfunctional cognitions is stronger with ISI than SE; perhaps due to the stronger effects of dysfunctional cognitions on distress and functional impairments than on the quantitative measures of sleep. Among various dysfunctional cognitions, our results suggest that excessive worrying and feeling helpless about sleep has a significantly more important role in mediating outcome for CBT-I than acupuncture. A previous study showed that excessive worrying and feeling helpless about sleep mediated improvements after CBT-I (Espie et al., 2014), but other mediation studies either did not analyze DBAS subscales (Lancee et al., 2015) or could not find any significant associations between a reduction in dysfunctional cognitions and sleep improvement (Okajima et al., 2014). Our findings suggest that the relationship among excessive worrying and feeling helpless about sleep, sleep-related behaviors and sleep may require special emphasis in acupuncture and other treatments of which patients adopt a passive role.

One of the major limitations is that there are significant differences in sociodemographic and baseline severity between participants of the 2 treatments and in the inclusion and exclusion criteria, study procedure, and the mode of delivery of the treatments. Although we have controlled for age, gender, educational level, and insomnia severity in mediation analysis, the different effects of CBT-I and acupuncture on dysfunctional cognitions about sleep and the different effects of dysfunctional cognitions on outcomes of CBT-I and acupuncture may be due to a combination of factors related to treatments and participants' characteristics. Another limitation is that we have not examined other cognitive factors such as sleep effort, self-efficacy, sleep locus of control and sleep-related behaviors, which may have different mediating effects on the effectiveness of CBT-I and acupuncture. Lastly, the study is also limited by a lack of an objective measure of sleep.

In conclusion, the cognitive model of insomnia seems to be more applicable to CBT-I than acupuncture. Although the placebo elements of patient-therapist interaction and treatment setting in acupuncture have reduced dysfunctional cognitions, our findings suggest that the role of dysfunctional cognitions as mediators of improvement is not apparent and relatively less important in acupuncture compared with CBT-I. Further studies should explore the added values for an integration of the cognitive model of insomnia in acupuncture and other treatments of which patients adopt a passive role.

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Table 1. Sociodemographic and clinical characteristics and baseline severity

Variables [a]	CBT-I (n = 312)	Acupuncture (n = 224)
Age, y	38.4 ± 12.5	53.4 ± 9.6
Sex, male/female	90/222	55/169
Full-time education, y	14.3 ± 5.1	11.0 ± 3.8
Marital status		
Single	170 (54.5)	26 (11.6)
Married	132 (42.3)	158 (70.5)
Divorced/Widowed	10 (3.2)	40 (17.9)
Occupation		
Professional and associate professional	113 (36.2)	27 (12.1)
Clerical, service or production workers	68 (21.8)	46 (20.5)
Students	51 (16.3)	0 (0.0)
Housewives	22 (7.1)	90 (40.2)
Retired	22 (7.1)	46 (20,5)
Unemployed/others	36 (11.5)	15 (6.7)
Insomnia duration, y	8.5 ± 8.6	12.5 ± 10.6
Hypnotics use ≥ 1 time/wk	47 (27.3)	72 (35.0)
Alcohol use ≥ 1 time/wk	13 (7.6)	22 (10.6)
Baseline Insomnia Severity Index score	15.7 ± 4.5	19.4 ± 4.3
Baseline Sleep-diary-derived sleep efficiency	78.3 ± 13.8	59.5 ± 14.5
Baseline DBAS total	102.4 ± 22.0	105.5 ± 24.8
Baseline DBAS “consequences”	36.0 ± 9.3	34.5 ± 10.2
Baseline DBAS “worry/helplessness”	41.5 ± 10.2	44.0 ± 9.9
Baseline DBAS “sleep expectations”	14.0 ± 4.7	13.8 ± 4.6
Baseline DBAS “medication”	10.8 ± 6.4	13.2 ± 7.1

DBAS, Dysfunctional Belief and Attitudes about Sleep Scale.

[a] Values are expressed in n (%) or mean ± SD.

Table 2. Moderated mediation analyses on Insomnia Severity Index (ISI) and sleep-diary-derived sleep efficiency (SE) at follow-up

	Model 1: Total effect (c)	Model 2: Effect of *X* on *Me* (a)	Model 3: Effect of *Me* on *Y* (b) and direct effect (c')
	ISI (*Y*)	DBAS total (*Me*)	ISI (*Y*)
Group (*X*)	-1.10*	-.90	-1.13*
Therapy type (*Mo*)	-1.97**	-.93	-2.13***
X × *Mo*	.83	-5.10	1.12
DBAS total (*Me*)			.01
Me × *Mo*			.03**
	ISI (*Y*)	DBAS consequences (*Me*)	ISI (*Y*)
Group (*X*)	-1.10*	-1.45	-1.07*
Therapy type (*Mo*)	-1.97**	-2.10	-1.98**
X × *Mo*	.83	-.46	.97
DBAS consequences (*Me*)			.04
Me × *Mo*			.05
	ISI (*Y*)	DBAS worry/helplessness (*Me*)	ISI (*Y*)
Group (*X*)	-1.10*	-1.00	-1.11*
Therapy type (*Mo*)	-1.97**	-.84	-2.11***
X × *Mo*	.83	-1.27	1.06
DBAS worry/helplessness (*Me*)			.00
Me × *Mo*			.08**
	ISI (*Y*)	DBAS sleep expectations (*Me*)	ISI (*Y*)
Group (*X*)	-1.10*	.79	-1.10*
Therapy type (*Mo*)	-1.97**	.96	-2.04**
X × *Mo*	.83	-1.81*	.91
DBAS sleep expectations (*Me*)			-.03
Me × *Mo*			.11*
	ISI (*Y*)	DBAS medication (*Me*)	ISI (*Y*)
Group (*X*)	-1.10*	.75	-1.12*
Therapy type (*Mo*)	-1.97**	1.05	-2.02**
X × *Mo*	.83	-1.55	.91
DBAS medication (*Me*)			-.01
Me × *Mo*			.06

	SE (*Y*)	DBAS total (*Me*)	SE (*Y*)
Group (*X*)	1.71	-3.79	1.72
Therapy type (*Mo*)	2.50*	-1.61	2.53*
X × *Mo*	-1.74	-2.46	-1.76
DBAS total (*Me*)			.00
Me × *Mo*			-.01
	SE (*Y*)	DBAS consequences (*Me*)	SE (*Y*)
Group (*X*)	1.71	-2.41*	1.69
Therapy type (*Mo*)	2.50*	-2.30	2.44*
X × *Mo*	-1.74	.42	-1.69
DBAS consequences (*Me*)			-.01
Me × *Mo*			.02
	SE (*Y*)	DBAS worry/helplessness (*Me*)	SE (*Y*)
Group (*X*)	1.71	-1.99	1.90
Therapy type (*Mo*)	2.50*	-.82	2.80*
X × *Mo*	-1.74	-.29	-2.01
DBAS worry/helplessness (*Me*)			.10*
Me × *Mo*			-.12*
	SE (*Y*)	DBAS sleep expectations (*Me*)	SE (*Y*)
Group (*X*)	1.71	.18	1.73
Therapy type (*Mo*)	2.50*	.40	2.44*
X × *Mo*	-1.74	-1.37	-1.70
DBAS sleep expectations (*Me*)			-.07
Me × *Mo*			.12
	SE (*Y*)	DBAS medication (*Me*)	SE (*Y*)
Group (*X*)	1.71	.43	1.75
Therapy type (*Mo*)	2.50*	1.10	2.56*
X × *Mo*	-1.74	-1.23	-1.78
DBAS medication (*Me*)			-.10
Me × *Mo*			.09

DBAS, Dysfunctional Belief and Attitudes about Sleep Scale; ISI, Insomnia Severity Index; *Me*, mediator; *Mo*, moderator; SE, sleep-diary-derived sleep efficiency; *X*, independent variable; *Y*, dependent variable. Posttreatment level of the dependent variable (ISI or SE), gender, age, and education level are included as covariates. Group (1 = *treatment*, 0 = *control*), therapy type (1 = c*ognitive-behavioral therapy for insomnia*, 0 = *acupuncture*) and gender (1 = *male*, 0 = *female*) are dummy coded. Unstandardized coefficients are reported.

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3. Conditional effects and indexes of moderated mediation on Insomnia Severity Index (ISI) and sleep-diary-derived sleep efficiency (SE) at follow-up

X	*Me*	*Y*	Therapy type (*Mo*)	Total effect (c)	Effect of *X* on *Me* (a)	Effect of *Me* on *Y* (b)	Direct effect (c')	Indirect effect (ab)	Index of moderated mediation
Group	DBAS total	ISI	Acupuncture	-1.10*	-.90	.01	-1.13*	-.01 [-.13, .05]	-.24* [-.53, -.05]
			CBT-I	-0.27	-6.00**	.04***	-.02	-.24* [-.53, -.07]	
Group	Consequences	ISI	Acupuncture	-1.10*	-1.45	.04	-1.07*	-.06 [-.30, .03]	-.11 [-.35, .11]
			CBT-I	-0.27	-1.91*	.09***	-.10	-.17* [-.41, -.04]	
Group	Worry/helplessness	ISI	Acupuncture	-1.10*	-1.00	.00	-1.11*	-.00 [-.14, .07]	-.19* [-.48, -.004]
			CBT-I	-0.27	-2.26*	.09***	-.05	-.20* [-.48, -.03]	
Group	Sleep expectations	ISI	Acupuncture	-1.10*	.79	-.03	-1.10*	-.03 [-.31, .04]	-.05 [-.26, .12]
			CBT-I	-0.27	-1.02*	.08*	-.19	-.08* [-.27, -.001]	
Group	Medication	ISI	Acupuncture	-1.10*	.75	-.01	-1.12*	-.01 [-.04, .17]	-.07 [-.26, .04]
			CBT-I	-0.27	-.81	.07*	-.21	-.08 [-.28, .01]	
Group	DBAS total	SE	Acupuncture	1.71	-3.79	.00	1.73	-.02 [-.51, .17]	.03 [-.33, .46]
			CBT-I	-.03	-6.26**	-.00	-.04	.01 [-.28, .24]	
Group	Consequences	SE	Acupuncture	1.71	-2.41*	-.01	1.69	.03 [-.47, .51]	-.04 [-.58, .46]
			CBT-I	-.03	-1.99*	.01	-.01	-.02 [-.23, .19]	
Group	Worry/helplessness	SE	Acupuncture	1.71	-1.99	.10*	1.89	-.20 [-.93, .03]	.25 [-.05, .92]
			CBT-I	-.03	-2.28*	-.02	-.11	.05 [-.11, .24]	
Group	Sleep expectations	SE	Acupuncture	1.71	.18	-.07	1.73	-.01 [-.39, .15]	-.05 [-.35, .29]
			CBT-I	-.03	-1.19*	.05	.03	-.06 [-.32, .11]	
Group	Medication	SE	Acupuncture	1.71	.43	-.10	1.75	-.05 [-.46, .09]	.06 [-.17, .50]
			CBT-I	-.03	-.80	-.01	-.03	.01 [-.09, .28]	

CBT-I, cognitive-behavioral therapy for insomnia; DBAS, Dysfunctional Belief and Attitudes about Sleep Scale; ISI, Insomnia Severity Index; *Me*, mediator; *Mo*, moderator; SE, sleep-diary-derived sleep efficiency; *X*, independent variable; *Y*, dependent variable. Unstandardized coefficients are reported.

*$p < .05$. **$p < .01$. ***$p < .001$.

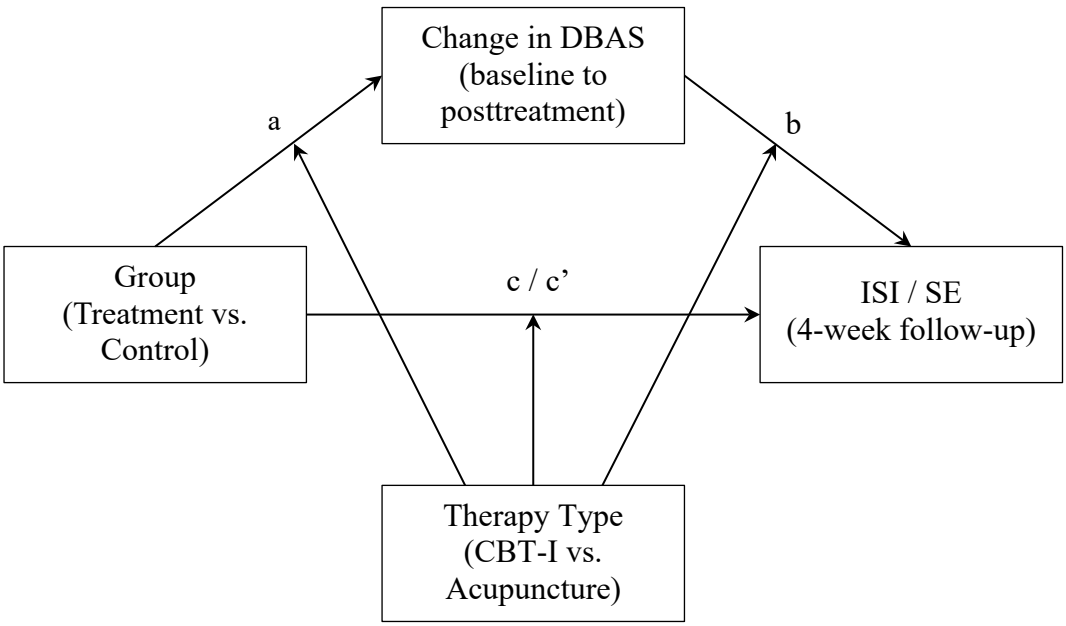

Figure 1. Graphical illustration of the moderated mediation model. CBT-I, cognitive-behavioral therapy for insomnia; DBAS, Dysfunctional Belief and Attitudes about Sleep Scale; ISI, Insomnia Severity Index; SE, sleep-diary-derived sleep efficiency. Posttreatment level of the dependent variable (ISI or SE), gender, age, and education level are included as covariates.

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