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Usefulness and Utilization of Treatment Elements from the Transdiagnostic Sleep and Circadian Intervention for Adolescents with an Evening Circadian Preference

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Abstract

Objective: Existing research has demonstrated that patient ratings of usefulness and ratings of utilization of treatment elements are associated with treatment outcome. Few studies have examined this relationship among adolescents and with an extended follow-up. This study examined the extent to which elements of the Transdiagnostic Sleep and Circadian Intervention (TranS-C) were rated by youth as useful and utilized 6-months and 12-months after treatment.

Method: Participants were 64 adolescents with an evening circadian preference who were given TranS-C as a part of their participation in a NICHD-funded study. At 6-month and 12-month follow-up, they completed the Usefulness Scale, the Utilization Scale, a 7-day sleep diary assessing total sleep time (TST) and bedtime, and the Children's Morningness-Eveningness Preference Scale (CMEP).

Results: On average, adolescents rated treatment elements as moderately useful and they utilized the treatment elements occasionally. Ratings of usefulness were associated with TST at 6-month follow-up, but not with bedtime or CMEP. Ratings of utilization were associated with a change in bedtime from 6-month to 12-month follow-up, but not with TST or CMEP. Ratings of usefulness and utilization were associated with selected treatment outcome measures at both follow-ups.

Conclusions: These findings have implications for understanding mechanisms of change following treatment.

Keywords

sleep; circadian rhythms; usefulness; utilization; adolescents; transdiagnostic treatments

Mental illness is highly prevalent globally (Kessler et al., 2007; Murray et al., 2012; Vos et al., 2012). While there has been significant progress toward developing evidence-based treatments for many mental illnesses (Layard & Clark, 2014), there is room for

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Conflict of Interest

The authors declare no conflict of interest.

improvement: effect sizes are small to moderate, some patients do not improve or even get worse, and gains do not persist (Lambert, 2011; Rey, Marin, & Silverman, 2011). Identifying contributors to outcomes is essential (Kazdin, 2009). As a step toward identifying these contributors, dismantling studies have examined the impact of individual elements of interventions on outcome for several treatments (Cuijpers, Cristea, Karyotaki, Reijnders, & Hollon, 2017; Epstein, Sidani, Bootzin, & Belyea, 2012; Harvey et al., 2014; Williams et al., 2014). While this is important and worthwhile research, the present study adopts an additional approach to the identification of contributors to outcome: patient ratings of the elements from the treatment they find useful and actually utilize in their lives. In other words, we seek to examine patient ratings of usefulness (or helpfulness) and utilization (or how often they make use) of treatment elements as possible contributors to treatment outcome.

Within the existing literature on patient ratings of usefulness and utilization, there is a distinction between the sum or average of patient ratings of individual treatment elements and the ratings of the individual treatment elements themselves. We refer to the former as “total usefulness” and “total utilization.” These indices serve as an assessment of the patient’s overall/global experience of the usefulness and their utilization of the treatment package. Taking the research on total usefulness and total utilization first, a study of older adults receiving behavioral, cognitive, or psychodynamic interventions for depression assessed ratings of usefulness and utilization of 15 treatment elements. Total usefulness and total utilization of treatment elements were correlated with improvement in depression symptoms (Powers, Thompson, & Gallagher-Thompson, 2008). Similarly, greater total utilization of eight cognitive behavior therapy (CBT) for depression skills by adult patients has been associated with greater odds of responding to treatment and significant reductions in symptom severity (Jarrett, Vittengl, Clark, & Thase, 2011). Other studies of adults with mood disorders examined ratings of how often patients utilized several cognitive and behavioral skills. Change in total skill utilization from pre- to post-treatment was associated with improved treatment outcome (Hundt, Calleo, Williams, & Cully, 2016; Jacob, Christopher, & Neuhaus, 2011). Indeed, additional studies have demonstrated that patient ratings of total usefulness and total utilization of treatment elements are associated with better outcomes in CBT (Gallagher-Thompson, Gray, Dupart, Jimenez, & Thompson, 2008; Hundt, Mignogna, Underhill, & Cully, 2013; Terides et al., 2016). Taken together, this research indicates there is a relationship between treatment outcome with ratings of total usefulness and total utilization of treatment.

Moving on to research on individual treatment elements, prior findings have established that the usefulness and utilization of specific treatment elements is associated with treatment outcome. For example, adults with panic disorder and agoraphobia who received CBT rated each treatment element as at least somewhat useful. Further, usefulness was correlated with improvement in symptoms and functional impairment (Cox, Fergus, & Swinson, 1994). Another study examined patient ratings of the usefulness of seven components of CBT for insomnia. Patients rated all of the elements as at least somewhat useful, with stimulus control and psychoeducation about the effects of the environment on sleep receiving the highest usefulness scores (Vincent & Lionberg, 2001). Usefulness ratings of sleep hygiene, sleep restriction, and stimulus control were correlated with improvements in sleep. In two

other studies of CBT, ratings of the utilization of specific treatment elements were associated with improvement in symptoms and life satisfaction among adults with depression and anxiety (Hawley et al., 2017; Terides et al., 2016). In addition, Harvey et al. (2002) examined 10 treatment elements utilized by adults who received CBT for insomnia. While the majority of participants reported using seven of the treatment elements (relaxation techniques, avoiding naps during the day and evening, developing a pre-bedtime routine to unwind, altering lifestyle, stimulus control/sleep restriction, cognitive restructuring, and thought suppression), only stimulus control/sleep restriction and cognitive restructuring were associated with sleep improvement. Finally, adults with depression who received CBT for insomnia identified stimulus control and sleep restriction as the most utilized treatment elements throughout treatment, and while these elements were also rated as useful, changing expectations around sleep was rated as more useful (Manber et al., 2011). Although this study did not examine treatment outcome, it provides valuable data suggesting that usefulness and utilization are two different, measurable dimensions.

While existing studies have made good progress documenting the usefulness and utilization of treatments and their relationship to treatment outcome, at least three gaps remain to be addressed. First, most studies evaluate patient ratings and outcomes immediately post-treatment, with just a handful including short-term follow-ups (Gallagher-Thompson et al., 2008; Powers et al., 2008; Terides et al., 2016) and one study reporting cross sectional data from a longer follow-up (Harvey et al., 2002). Hence, longer-term evaluations of patient ratings of usefulness and utilization are needed and are important for providing a window into skills patients can use independently (Beck, 2011). Indeed, behavior maintenance theories highlight the importance of continued use of treatment elements in developing and maintaining healthier habits (Kwasnicka, Dombrowski, White, & Sniehotta, 2016). Second, while prior studies have examined patient ratings of the *utilization* of treatment elements of a sleep and/or circadian intervention, we are not aware of studies that have investigated patient ratings of the *usefulness* of treatment elements of sleep and/or circadian interventions. Third, the existing research on usefulness and utilization of treatment elements focuses on adults, not youth. To the best of our knowledge, while there have been several studies of efficacious adolescent sleep interventions (e.g., Bartel, Huang, Maddock, Williamson, & Gradisar, 2018; Blake, Sheeber, Youssef, Raniti, & Allen, 2017; Blake et al., 2016; Gradisar et al., 2011), these have not yet examined adolescent ratings of usefulness and utilization of treatment elements. The latter is important because adolescence is a period of development associated with many changes, including increased autonomy (Oudekerk, Allen, Hessel, & Molloy, 2015). Hence, research to explore the sustained use of treatment elements after the conclusion of treatment provides valuable information as to what adolescents find useful and choose to utilize in their lives after receiving treatment.

We focus on adolescents with an evening circadian preference, or adolescents with a preference for a delayed sleep-wake schedule – “night owls.” Approximately 40% of adolescents experience a shift towards wanting to go to bed later and wake up later (Carskadon, Vieira, & Acebo, 1993; Roenneberg et al., 2004). This shift, coupled with early school start times, contributes to a cycle of insufficient sleep during adolescence (Crowley, Wolfson, Tarokh, & Carskadon, 2018). An evening circadian preference is associated with an increase in risk for a host of negative outcomes including affective problems such as

depression, anxiety, and suicidality (Fares et al., 2015; Goldstein, Bridge, & Brent, 2008; Gregory & Sadeh, 2012); increased substance use and impulsivity (Adan, Natale, Caci, & Prat, 2010; Hasler, Soehner, & Clark, 2016; McGlinchey & Harvey, 2014); aggression and antisocial behavior (Díaz-Morales, Escribano, Jankowski, Vollmer, & Randier, 2014; Schlarb, Sopp, Ambiel, & Grünwald, 2014); poorer academic performance (Short, Gradisar, Lack, Wright, & Dohnt, 2013); and obesity (Asarnow, Greer, Walker, & Harvey, 2017; Malone et al., 2016). Hence, these adolescents are a particularly vulnerable group.

In the present study, we examined adolescent ratings of the usefulness and utilization of the Transdiagnostic Sleep and Circadian Intervention (TranS-C; Harvey & Buysse, 2017), a manualized psychosocial intervention targeting health and sleep, completed by adolescents with an evening circadian preference. The ratings of usefulness and utilization were made at the assessments conducted 6-months and 12-months after the end of treatment. Adolescents also participated in a pilot text messaging trial designed to support maintenance of treatment improvement (Dolsen, Dong, & Harvey, under review), as prior studies indicate that text messaging is an effective adjunct to treatment (Aguilera, Bruehlman-Senecal, Demasi, & Avila, 2017; Schlicker, Ebert, Middendorf, Titzler, & Berking, 2018). The present study focuses on the impact of the TranS-C intervention on the ratings of usefulness and utilization, as the text messaging intervention results are reported elsewhere and are beyond the scope of this paper (Dolsen et al., under review).

The first aim was to determine total usefulness and utilization of TranS-C and to report the ratings of usefulness and utilization of each individual treatment element at 6-month follow-up and 12-month follow-up. We had three hypotheses. The first hypothesis was that total usefulness, as well as the usefulness of specific treatment elements, would be rated as at least somewhat useful (1 or above out of 4). The second hypothesis was that total utilization, as well as the utilization of specific treatment elements, would be rated as utilized at least rarely (1 or above out of 4). Third, based on previous research (Harvey et al., 2002; Vincent & Lionberg, 2001), we hypothesized that avoidance of naps and engaging in a wind down would be reported as highly useful and utilized in this treatment. The second aim was to examine if total usefulness and total utilization were associated with treatment outcome. The hypothesis was that total usefulness and total utilization would be associated with improved outcome based on prior research and that ratings of treatment usefulness and utilization were associated with outcome. The third aim was to evaluate the relationship between the usefulness and utilization of specific treatment elements and their relationships to treatment outcome. As there is insufficient prior research in youth to offer a hypothesis, this aim was included on an exploratory basis.

Methods

Participants and Procedure

Participants were 64 adolescents drawn from those recruited to participate in a NICHD-funded treatment trial designed to improve eveningness and health in adolescents (Harvey et al., 2018). Participants were recruited through clinician referrals and advertisements. The present study includes only those adolescents randomly assigned to the Transdiagnostic Sleep and Circadian Intervention arm of the intervention (TranS-C). As this study evaluates

the treatment elements of TranS-C, adolescents in the Psychoeducation arm of the trial were not included. Participants were given the opportunity to participate in two treatment phases: six sessions of TranS-C, which all participants completed, and an optional text messaging intervention starting at 6- month follow-up, which a majority of the participants completed. For the first treatment phase, a total of 89 adolescents were randomly assigned to receive TranS-C and a total of 87 adolescents completed treatment. A total of 81 (91.01%) completed the post-treatment assessment that included a 7-day sleep diary and an in-person assessment. At both six months and twelve months after completing treatment, participants completed a 7-day sleep diary and an in-person assessment that included the administration of the Children's Morningness-Eveningness Preference Scale (CMEP), the Usefulness Scale, and the Utilization Scale. A total of 64 adolescents completed at least one of the 6-month follow-up outcome assessments along with the Usefulness Scale and Utilization Scale. Therefore, 64 adolescents were included in this study. Five of these adolescents were missing 12-month follow-up data, but were included at 6-month follow-up. For the second treatment phase, delivered between the 6-month and 12-month follow-ups, adolescents were randomly assigned to receive text messages reminding them of treatment information (n = 23), text messages prompting them to recall treatment information (n = 19), no text messages (n = 18), or did not participate in this portion of the study (n = 4) (Dolsen et al., under review). The results pertaining to the second treatment phase are beyond the scope of this paper and are reported elsewhere (Dolsen et al., under review).

Participants were eligible if they (a) were between 10 and 18 years old, living with a parent or guardian, and attending a class/job by 9am at least three days per week, (b) were fluent in English, (c) were able and willing to give informed assent, (d) reported eveningness as demonstrated by scoring in the lowest quartile on the Children's Morningness-Eveningness Preference Scale (CMEP; 27 or lower), had a 7-day sleep diary showing a sleep onset time of 10:40pm or later for 10-13 year olds, 11pm or later for 14-16 year olds, and 11:20pm or later for 17-18 year olds at least three nights per week, and this pattern had to be present for at least three months, and (e) had to fall in the "at-risk" range on measures in at least one of five health domains (behavioral, cognitive, emotional, social, physical) described in greater detail in Supplement 1.

Individuals were excluded if there were (a) an active, progressive physical illness or neurodegenerative disease directly related to the onset and course of the sleep disturbance, (b) evidence of obstructive sleep apnea, restless leg syndrome, or periodic limb movement disorder, (c) significantly impairing pervasive developmental disorder, (d) bipolar disorder, schizophrenia, or another Axis I disorder if there were risk of harm if treatment were delayed, (e) a history of substance abuse in the past six months, and (f) current suicide risk to preclude treatment on an outpatient basis. Individuals ceased taking medications that alter sleep (e.g., hypnotics) four weeks prior to the assessment (two weeks for melatonin) or were excluded.

Descriptive characteristics of the participants who completed TranS-C and completed the Usefulness and Utilization Scales at either the 6-month follow-up and/or the 12-month follow-up are described in Table 1.

All procedures were approved by the University of California, Berkeley, Committee for the Protection of Human Subjects. All participants provided informed assent or consent.

Treatments

TranS-C.—TranS-C (Harvey, 2015; Harvey & Buysse, 2017) is modular intervention that targets psychosocial, behavioral, and cognitive contributors to sleep and circadian dysfunction. TranS-C is transdiagnostic in two ways. First, it treats a range of the most common sleep and circadian problems that can overlap and simultaneously co-occur, such as insomnia and delayed sleep phase disorder. Second, it is designed to be helpful across mental and physical health problems and across the five health domains. This focus is important as sleep and circadian dysfunction are common across mental health problems (Taylor & Pruiksma, 2014) and physical health problems (Shochat, Cohen-Zion, & Tzischinsky, 2014).

TranS-C was delivered in six weekly 50-minute sessions. TranS-C is grounded in basic sleep and circadian science and sleep health theory (Buysse, 2014) and was derived from Cognitive Behavior Therapy for Insomnia (Morin et al., 2006; Perlis, Aloia, & Kuhn, 2011), Interpersonal and Social Rhythms Therapy (Frank et al., 2005), Chronotherapy (Wirz-Justice, Benedetti, & Terman, 2013), and Motivational Interviewing (Miller & Rollnick, 2002). The goal is to reverse maintaining cognitive, behavioral, and psychosocial processes. TranS-C includes cross-cutting modules featured in every session, core modules that apply to the vast majority of participants, and optional modules used less commonly, depending on the presentation. The cross-cutting modules are case formulation, education, behavior change and motivation, and goal-setting. The core modules are establishing regular sleep-wake times including learning a wind-down and wake-up routine, improving daytime functioning, correcting unhelpful sleep-related beliefs, and maintenance of behavior change. The optional modules are improving sleep efficiency, reducing time in bed, dealing with delayed phase, and reducing sleep-related worry/vigilance. The components directly drawn from CBT-I are the modules that address regularizing bed and wake times, correcting unhelpful beliefs about sleep, improving sleep efficiency, and reducing sleep-related worry/vigilance modules. All participants in the present study received TranS-C.

Text messaging intervention.—At the 6-month follow-up, adolescents were randomly assigned to receive 24 text messages reminding them of treatment information between the 6-month and 12-month follow-up, 24 text messages prompting them to recall treatment information between the 6-month and 12-month follow-up, or no text messages, or did not participate in this portion of the study. The text messaging conditions were informed by increasing evidence that memory support strategies can enhance memory for treatment, which is associated with improved treatment outcome (Dong, Lee, & Harvey, 2017; Harvey et al., 2016; Harvey, Lee, et al., 2014). Of the 64 participants included in the present study, 60 completed the text messaging intervention. The results are described in Dolsen et al. (under review). Dolsen et al(under review) examines the 12-month effects of TranS-C on adolescent sleep and health as well as if the text messaging intervention promotes the maintenance of treatment effects. In the full report of the text messaging intervention there was no effect of text messaging on adolescent ratings of usefulness nor on their ratings of

utilization (Dolsen et al., under review). Hence, in the present study, text messaging condition was included as a covariate to account for possible group effects in this study's analyses.

Measures

Sleep Diary.—A daily sleep diary is the gold standard subjective measure of sleep (D. Buysse, Ancoli-Israel, Edinger, Lichstein, & Morin, 2006). A 7-day sleep diary (Carney et al., 2012) was collected over the phone by a trained research assistant at post-treatment, 6-month follow-up, and at 12-month follow-up. Weeknight bedtime (bedtime) and total sleep time (TST) were established as the variables of interest as they were primary outcomes in the associated clinical trial (Harvey et al., 2018).

Children's Morningness-Eveningness Preference Scale (CMEP).—The CMEP is a 10-item self-report measure of circadian preference. It assesses timing preference for certain activities. Scores range from 10 (extreme evening preference) to 42 (extreme morning preference) (Carskadon et al., 1993). The CMEP was administered at post-treatment, 6-month follow-up, and at 12-month follow-up.

Usefulness Scale.—A Usefulness Scale listing each of the 14 treatment elements from TranS-C was administered at 6-month and 12-month follow-up. Each treatment element is rated on a 5-point Likert scale (0=not at all useful; 1 = somewhat useful; 2 = moderately useful; 3 = very useful; 4 = extremely useful). A Total Usefulness Treatment Score was created by calculating the mean of all 14 items on the scale at 6-month and at 12-month follow-up individually. Cronbach's alpha for this scale is 0.91, which is considered excellent.

Utilization Scale.—A Utilization Scale listing each of the 14 treatment elements from TranS-C was administered at 6-month and 12-month follow-up. Each treatment element is rated on a 5-point Likert scale (0=I never use it; 1 = I rarely use it; 2 = I occasionally use it; 3 = I often use it; 4 = I always use it). A Total Utilization Treatment Score was created by calculating the mean of all 14 items on the scale at 6-month and at 12-month follow-up individually. Cronbach's alpha for this scale is 0.84, which is considered good.

Data Analysis

Data analyses were conducted in Stata15 (StataCorp, 2017). Means and standard deviations were calculated to identify Usefulness Scores and Utilization Scores. Treatment outcome measures (TST, bedtime, and CMEP) were standardized within each time point. Hierarchical linear modeling using maximum likelihood estimation was used to address the other aims of this study, specifically looking at change in Usefulness Scores or Utilization Scores predicting outcomes measures from 6-month to 12-month follow-up. Standardized post-treatment scores of the treatment outcome measures (TST, bedtime, and CMEP), age, sex, and text messaging condition were included as covariates in the fixed part of the model. The random part of the model included a random intercept, assumed to have a bivariate normal distribution with a mean of zero and an unstructured covariance matrix. A significance level of 0.05 was used throughout. We elected to only examine the relationship between the

treatment outcome measures that were significantly associated with the Total Usefulness Treatment Score with the Usefulness Scores of specific treatment elements and to examine only the relationship between treatment outcome measures that were significantly associated with the Total Utilization Score with the Utilization Scores of specific treatment elements.

Results

Usefulness and Utilization at 6-month and 12-month follow-up

The Total Usefulness Treatment Score was 2.03 at 6-month follow-up and 1.92 at 12-month follow-up. Usefulness Scores of each treatment element at 6-month and 12-month follow-up are displayed in Table 2. Each treatment element was rated above a 1 (somewhat useful). The treatment elements with the highest Usefulness Scores at both 6-month and 12-month follow-up were “I try to wake up about the same time each morning on weekdays,” “I avoid napping after school and in the evening”, and “I try to go to sleep about the same time each night on weeknights.”

The Total Utilization Treatment Score was 2.15 at 6-month follow-up and 1.99 at 12-month follow-up. Utilization Scores of each treatment element at 6-month and 12-month follow-up are also displayed in Table 2. Each treatment element was rated above a 1 (rarely utilized). The treatment elements with the highest Utilization Scores at both 6-month and 12-month follow-up were identical to the elements with the highest Usefulness Scores.

Total Usefulness Treatment Score, Total Utilization Treatment Score, and Treatment Outcome

As evident in Table 3, the Total Usefulness Treatment Score was significantly associated with TST at 6-month follow-up such that greater Total Usefulness was related to longer TST. The Total Usefulness Treatment Score did not significantly predict TST at 12-month follow-up nor did it predict a change in TST between 6-month and 12-month follow-up. There was no association between Total Usefulness Treatment Score with bedtime or with CMEP.

Also evident in Table 3, the Total Utilization Treatment Score was significantly associated with bedtime at 12-month follow-up and with a change in bedtime between 6-month and 12-month follow-up such that greater Total Utilization was related to an earlier bedtime. The Total Utilization Treatment Score was not associated with bedtime at 6-month follow-up. The Total Utilization Treatment Score was not significantly associated with TST or CMEP.

Usefulness Scores, Utilization Scores, and Treatment Outcome

Further analyses examined the relationships between the usefulness of the 14 individual treatment elements as they related to TST (Table 4). We conducted these analyses with TST, but not bedtime and CMEP, as TST was the only outcome significantly associated with the Total Treatment Usefulness Score. Usefulness of “I try to get about 9 hours of sleep per night” was significantly associated with longer TST at 6-month follow-up and at 12-month follow-up. Usefulness of “I avoid napping after school and in the evening” was significantly associated with longer TST at 12-month follow-up. At 6-month follow-up, greater usefulness of the following treatment elements was significantly associated with longer TST:

"If my bedtime gets too late, I bring it forward by about 20-30 minutes each week," "I have an electronic curfew to reduce light exposure via cell phones or computers before my bedtime," "I use techniques to reduce worry interfering with my sleep via savoring or 'worry time' earlier in the day etc.," and "I keep my bed for sleeping only (I do not work in bed or watch TV in bed)." These effects were small for all treatment elements and time points *(Standardized Betas* = 0.20-0.37), except for the usefulness of "I try to get about 9 hours of sleep per night" was significantly associated with longer TST at 6-month follow-up *(Standardized Beta* = 0.03). None of the Usefulness Scores of other treatment elements were significantly associated with TST or a change in TST at either time point.

The relationship between the utilization of individual treatment elements and bedtime is displayed in Table 5. We conducted these analyses on bedtime, not TST and CMEP, as bedtime was the only outcome significantly associated with the Total Treatment Utilization Score. Greater utilization of "I try to go to sleep about the same time each night on weeknights" was significantly associated with an earlier bedtime at 6-month follow-up. Greater utilization of "I engage in a wind-down before bedtime" was significantly associated with a change in to an earlier bedtime from 6- to 12-month follow-up. Utilization of "I have an electronic curfew to reduce light exposure via cell phones or computers before my bedtime" was significantly associated with an earlier bedtime at 12-month follow-up and with a change to an earlier bedtime between 6- and 12-month follow-up. At 12-month follow-up, greater utilization of the following treatment elements was significantly associated with an earlier bedtime: "I use a brisk wake up routine to help wake up in the morning (eg., try to refrain from snoozing, increase activity, shower or wash face and hands, expose yourself to sunlight, upbeat music, phone a friend)," "When I feel sleepy in the day I purposively generate energy," and "I use techniques to reduce worry interfering with my sleep via savoring or 'worry time' earlier in the day etc." The effects were small for all treatment elements and time points *(Standardized Betas* = 0.18-0.25).None of the Utilization Scores of the other treatment elements were significantly associated with bedtime or a change in bedtime at either time point.

Discussion

The present study was designed to examine which elements of TranS-C, a manualized psychosocial intervention targeting sleep and circadian problems, were identified as useful and utilized at 6-month and 12-month follow-up by evening circadian preference adolescents. Our first aim was to determine the Total Usefulness Treatment Score and the Total Utilization Treatment Score and to report the ratings of the usefulness and utilization of each individual treatment element. In support of our hypotheses, the Total Usefulness Treatment Score was rated as at least "somewhat useful" (with a mean score of 1 or above) and the Total Utilization Treatment Score was rated on average as used at least "rarely" (a mean score of 1 or above). All of the treatment elements were rated as "somewhat useful" and were rated as utilized at least "rarely." Consistent with Harvey et al. (2002), we found that engaging in a wind-down was one of the most highly rated treatment elements and reducing sleep related worry was rated as "somewhat to moderately useful" and "rarely to occasionally utilized" by adolescents. Also in support of our hypothesis, avoiding naps was the most highly rated treatment element, which is encouraging given that avoiding naps is

known to be effective (Bootzin, 1972; Harvey et al., 2002; Morgenthaler et al., 2006). This finding is consistent with previous research reporting that stimulus control, the element of CBT for insomnia from which this TranS-C element was adapted, has been well-accepted by adolescents participating in randomized controlled trials (Blake et al., 2017). Together, these results indicate that youth are finding TranS-C elements useful and they are utilizing them.

The second aim was to examine if the Total Usefulness Treatment Score and the Total Utilization Treatment Score were associated with treatment outcome. In partial support of our hypothesis that total usefulness and total utilization would be associated with improved outcome, the Total Usefulness Treatment Score predicted longer TST, whereas the Total Utilization Treatment Score predicted an earlier bedtime. These findings are consistent with previous research demonstrating that patient ratings of the usefulness and utilization of CBT skills are associated with improved outcomes (Gallagher-Thompson et al., 2008; Hundt et al., 2013). Inconsistent with our hypothesis, neither the Total Usefulness Treatment Score nor the Total Utilization Treatment Score were associated with the CMEP. This finding is surprising given that TranS-C has been shown to decrease an evening circadian preference (Harvey et al., 2018). It is possible that ratings of the usefulness and utilization of TranS-C simply do not contribute to a shift in self-described circadian preference, yet may still contribute to a change in circadian preference assessed using other methods. Taken together, the results expand the literature to include that adolescent patient ratings of the usefulness and utilization of a sleep and circadian treatment are associated with improvement in TST and earlier bedtime six and twelve months after treatment completion.

The third aim was to evaluate if the usefulness and utilization of individual treatment elements were associated with treatment outcome. Encouragingly, ratings of the usefulness of several elements were associated with an increase in TST, although these effects were small. First, trying to get about 9 hours of sleep each night was associated with longer TST at both follow-ups and shifting sleep 20-30 minutes earlier if bedtime is too late was associated with longer TST at 6-month follow-up. Second, patient ratings of the usefulness of having an electronic curfew were also associated with TST at 6-month follow-up. This finding is consistent with prior research indicating that technology use is a risk factor for shorter TST among adolescents (Bartel, Gradisar, & Williamson, 2015; Harbard, Allen, Trinder, & Bei, 2016). Third, avoiding naps and keeping the bed for sleep only, both of which are components of stimulus control, were rated as useful and were associated with increased TST at the 12-month follow-up and the 6-month follow-up, respectively. As highlighted earlier, this finding adds to the prior literature indicating that adolescents find stimulus control acceptable.

Finally, ratings of the utilization of several other treatment elements were associated with an earlier bedtime at 6-month and 12-month follow-up with small effects. Specifically, the utilization of a wind down routine and maintaining a consistent bedtime were associated with an earlier bedtime at both follow-ups. In TranS-C, the rationale for the wind down routine was to assist with bedtime consistency. Consistent bedtimes, along with other routines (e.g., mealtimes, exercise), have been shown to be essential for stabilizing the circadian rhythm (Stepanski & Wyatt, 2003). The utilization of worry reduction techniques were associated with an earlier bedtime at 12-month follow-up. This is consistent with prior

research showing that worry prior to sleep contributes to difficulties falling asleep (Harvey, 2002) and that cognitive strategies are effective at reducing worry (Harvey, Sharpley, Ree, Stinson, & Clark, 2007). Furthermore, ratings of the utilization of an electronic curfew were also associated with a shift to an earlier bedtime between the 6-month and 12-month follow-ups and at the 12-month follow-up, which is consistent with prior literature linking technology use in the evening to a later bedtime (Bartel et al., 2016; Hale & Guan, 2015). Utilization of a rise up routine was associated with an earlier bedtime, aligned with research indicating that daytime behaviors can contribute to nighttime functioning (Kaplan, Talavera, & Harvey, 2018; Richardson, Gradisar, Short, & Lang, 2017). Last, we found that engaging in activities to generate energy, or being more active, during the day was associated with earlier bedtimes at the 12-month follow-up. This treatment element targets unhelpful beliefs about daytime energy and assists with daytime impairment (Harvey, 2015; Harvey & Buysse, 2017). In addition, this element is presented as an alternative to napping, so utilizing it may help adolescents maintain a consistent, earlier bedtime. Taken together, these results provide encouraging data about which elements adolescents utilize that contribute to earlier bedtimes.

There are several limitations. First, the Usefulness Scale and Utilization Scale were given at 6-month follow-up and 12-month follow-up, not immediately post-treatment. These findings would be even more informative if we could assess if patient ratings predicted change from treatment termination to one year later. Future research in this domain would also contribute to our understanding of behavior change maintenance (Kwasnicka et al., 2016). Second, objective assessments of sleep and circadian functioning were not used. However, the sleep diary is a validated subjective measure of sleep (D. Buysse et al., 2006; Carney et al., 2012). Third, participants received the text messaging intervention between the two assessment points were included in this study. Research indicates that receipt of text messages following treatment supports the maintenance of behavior change (Schlicker et al., 2018), thus these text messages may have increased the utilization of treatment elements for participants in this study. Hence, we re-ran the analyses without including the text messaging intervention as a covariate and obtained the same significant results as reported in this manuscript. Nonetheless, future research should examine the long term effects of ratings of usefulness and utilization on treatment outcome without these additional potential facilitators of behavior change. Fourth, the Usefulness Scale and Utilization Scale have not yet been validated. Future studies are needed to validate these scales. Fifth, analyses were conducted using a treatment-completing rather than an intent-to-treat sample, which may limit generalizability. Sixth, pubertal data was not included, although age and sex are correlates of pubertal status. Future research could include a measure of adolescent pubertal development (Michaud, Suris, & Deppen, 2006). Finally, the sample size was relatively small and multiple comparisons were used. Future research with a larger sample is needed. Based on Nakagawa and Cuthill (2007), corrections for multiple corrections (e.g., Bonferroni) further reduce power, increase the likelihood of a type II error, and may also contribute to publication bias (Nakagawa & Cuthill, 2007). We therefore included effect sizes as suggested by Nakagawa and Cuthill (2007) rather than correct for multiple comparisons. Partially standardized coefficients, as we presented above, are interpretable as effect sizes (Ferron et al., 2008; Lorah, 2018; Snijders & Bosker, 2012).

In sum, higher patient ratings of the usefulness of TranS-C treatment elements are associated with longer TST and higher patient ratings of the utilization of TranS-C treatment elements are associated with an earlier bedtime at 6-month and 12-month follow-up. These findings are particularly relevant to clinicians delivering TranS-C. Specifically, during the delivery of the treatment, it may be important to emphasize the treatment elements that adolescents find useful and actually utilize, and that are more closely related to outcomes. The present study extends previous research on patient ratings of usefulness and utilization to adolescents, highlighting that patient ratings of several TranS-C treatment elements are associated with improvement in selected outcome measures for adolescents.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Adolescents received a sleep and circadian intervention
- Patient ratings of usefulness and utilization of treatment elements are examined
- Ratings of usefulness were associated with longer sleep duration
- Ratings of utilization were associated with earlier bedtimes
- Results have implications for understanding mechanisms of change after treatment

Table 1

Participant Characteristics

Characteristic	M or N	% or SD
Age (years)	14.45	1.93
Female	35	54.69
Race		
Caucasian	39	60.94
African-American or Black	3	4.69
Asian	9	14.06
Native Hawaiian or Other Pacific Islander	2	3.13
Mixed Race	11	17.19
Ethnicity		
Hispanic or Latino	10	15.63
Not Hispanic or Latino	54	84.38
Family Annual Income ($)		
≤ 20,000	1	1.56
20,001-50,000	8	12.50
50,001-100,000	20	31.25
100,000	34	53.13
Refused to answer/missing	1	1.56
Current Grade (at baseline)		
5	3	4.69
6	4	6.25
7	5	7.81
8	10	15.63
9	11	17.19
10	14	21.88
11	11	17.19
12	6	9.38
Post-treatment		
TST	482.22	83.86
Bedtime	22.72	0.93
CMEP	25.25	4.89
6-month follow-up		
TST	436.97	59.24
Bedtime	22.91	1.11
CMEP	25.58	4.60
12-month follow-up		
TST	458.58	72.37
Bedtime	23.01	1.10
CMEP	26.03	5.24

Note. $N = 64$. TST = total sleep time. CMEP = Children's Morningness-Eveningness Preference Scale.

Table 2

Mean Usefulness Scores and Utilization Scores at 6-month follow up and 12-month follow-up

	6-month follow-up		12-month follow-up	
	Usefulness	**Utilization**	**Usefulness**	**Utilization**
1. I try to go to sleep about the same time each night on weeknights	2.38(0.97)	2.63(0.99)	2.31(1.03)	2.63(1.01)
2. I try to wake up about the same time each morning on weekdays	2.53(1.02)	2.79(0.99)	2.40(0.97)	2.85(1.17)
3. I try to reduce 'social jetlag' – which means I try to go to bed and wake up about the same time on weekends relative to weekdays	2.24(1.01)	2.38(1.05)	2.06(1.12)	2.31(1.31)
4. I try to get about 9 hours of sleep per night	2.27(1.04)	2.29(1.19)	2.24(1.13)	2.31(1.06)
5. If my bedtime gets too late, I bring it forward by about 20-30 minutes each week	1.75(1.23)	1.41(1.10)	1.74(1.14)	1.37(1.02)
6. I engage in a wind-down before bedtime	2.09(1.18)	2.29(1.18)	2.08(1.15)	2.03(1.16)
7. I avoid napping after school and in the evening	2.43(1.28)	2.95(1.24)	2.38(1.20)	2.94(1.20)
8. I have an electronic curfew to reduce light exposure via cell phones, computers etc before my bedtime	1.81(1.30)	1.87(1.25)	1.72(1.15)	1.62(1.41)
9. I use a brisk wake up routine to help wake up in the morning (e.g., try to refrain from snoozing, increase activity, shower or wash face and hands, expose yourself to sunlight, upbeat music, phone friend)	2.14(1.19)	2.33(1.22)	1.98(1.15)	1.89(1.16)
10. When I feel sleepy in the day I purposively generate energy	1.89(1.26)	1.74(1.20)	1.65(1.05)	1.46(1.00)
11. I use techniques to reduce worry interfering with my sleep via Savoring or 'worry time' earlier in the day etc.	1.80(1.21)	1.71(1.31)	1.45(1.29)	1.38(1.21)
12. I get out of bed if I am not able to sleep within about 20 minutes	1.25(1.56)	1.24(1.32)	1.29(1.14)	1.12(1.15)
13. I keep my bed for sleeping only (I do not work in bed, watch TV in bed etc)	1.81(1.39)	1.95(1.33)	1.57(1.37)	1.82(1.36)
14. I avoid caffeine and energy drinks	1.94(1.45)	2.49(1.47)	1.98(1.46)	2.17(1.50)
Total Treatment Score	2.03(0.81)	2.15(0.67)	1.92(0.79)	1.99(0.65)

Note. Means (Standard Deviation) presented. The rating scale for the Usefulness Scale is: 0=not at all useful; 1 = somewhat useful; 2 = moderately useful; 3 = very useful; 4 = extremely useful. The rating scale for the Utilization Scale is: 0=I never use it; 1 = I rarely use it; 2 = I occasionally use it; 3 = I often use it; 4 = I always use it.

Table 3

Multilevel models examining the relationship between the Total Usefulness Treatment Score and Total Utilization Treatment Score with sleep and circadian outcomes at 6-month and 12-month follow-up

	Total Treatment Score effect at 6-month follow-up			**Total Treatment Score effect at 12-month follow-up**			**Total Treatment Score effect on change from 6-month follow-up to 12-month follow-up**		
Sleep and Circadian Measures	***Beta***	***SE***	***p***	***Beta***	***SE***	***p***	***Beta***	***SE***	***p***
Usefulness									
TST	0.42	0.16	0.01*	0.19	0.19	0.31	−0.22	0.23	0.34
Bedtime	0.17	0.14	0.58	−0.12	0.15	0.27	−0.18	0.16	0.27
CMEP	0.06	0.12	0.63	0.24	0.03	0.08	0.18	0.14	0.23
Utilization									
TST	0.28	0.18	0.12	0.23	0.20	0.25	−0.06	0.25	0.81
Bedtime	−0.03	0.15	0.84	−0.37	0.16	0.02*	−0.35	0.18	0.04*
CMEP	0.03	0.13	0.84	0.24	0.13	0.08	0.21	0.16	0.19

Note.

*p<.05.

All models include post-treatment outcome measure score, age, sex, and text messaging condition as fixed effects. All outcome variables are standardized with a mean of 0 and standard deviation of 1.

Table 4

Multilevel models examining Usefulness Scores of individual treatment elements and their relationship to Total Sleep Time (TST)

	Individual Treatment Elements' Usefulness Score effects on TST at 6-month follow-up			**Individual Treatment Elements' Usefulness Score effects on TST at 12-month follow-up**			**Individual Treatment Elements' Usefulness Score effects on change in TST from 6-month follow-up to 12-month follow-up**		
	Beta	***SE***	***p***	***Beta***	***SE***	***p***	***Beta***	***SE***	***p***
1. I try to go to sleep about the same time each night on weeknights	0.24	0.03	0.06	0.12	0.12	0.33	−0.12	0.17	0.47
2. I try to wake up about the same time each morning on weekdays	0.18	0.13	0.15	0.15	0.13	0.25	−0.03	0.17	0.88
3. I try to reduce 'social jetlag' – which means I try to go to bed and wake up about the same time on weekends relative to weekdays	0.01	0.13	0.94	0.05	0.12	0.70	0.04	0.16	0.82
4. I try to get about 9 hours of sleep per night	0.03	0.12	0.01*	0.37	0.12	0.00**	0.07	0.15	0.64
5. If my bedtime gets too late, I bring it forward by about 20-30 minutes each week	0.22	0.12	0.04*	0.09	0.11	0.44	−0.13	0.14	0.36
6. I engage in a wind-down before bedtime	0.12	0.11	0.28	0.07	0.11	0.54	−0.05	0.14	0.72
7. I avoid napping after school and in the evening	0.15	0.10	0.13	0.20	0.10	0.04*	0.15	0.04	0.72
8. I have an electronic curfew to reduce light exposure via cell phones, computers etc before my bedtime	0.23	0.09	0.02*	−0.01	0.12	0.93	−0.23	0.03	0.08
9. I use a brisk wake up routine to help wake up in the morning (e.g., try to refrain from snoozing, increase activity, shower or wash face and hands, expose yourself to sunlight, upbeat music, phone friend)	0.14	0.10	0.18	0.12	0.11	0.21	−0.01	0.14	0.97
10. When I feel sleepy in the day I purposively generate energy	0.17	0.10	0.11	−0.08	0.12	0.49	0.36	0.14	0.08
11. I use techniques to reduce worry interfering with my sleep via Savoring or 'worry time' earlier in the day etc.	0.22	0.10	0.03*	0.05	0.10	0.64	−0.08	0.13	0.18
12. I get out of bed if I am not able to sleep within about 20 minutes	0.04	0.11	0.421	−0.05	0.11	0.67	−0.19	0.15	0.20
13. I keep my bed for sleeping only (I do not work in bed, watch TV in bed etc)	0.21	0.09	0.02*	0.12	0.09	0.19	−0.09	0.12	0.44
14. I avoid caffeine and energy drinks	0.12	0.09	0.16	0.10	0.08	0.22	−0.02	0.12	0.87

Note.

*p<.05.

**p<.01.

All models include post-treatment outcome measure score, age, sex, and text messaging condition as fixed effects. All outcome variables are standardized with a mean of 0 and standard deviation of 1.

Table 5

Multilevel models examining Utilization Scores of individual treatment elements and their relationship to bedtime

	Individual Treatment Elements' Utilization Score effects on bedtime at 6-month follow-up			**Individual Treatment Elements' Utilization Score effects on bedtime at 12-month follow-up**			**Individual Treatment Elements' Utilization Score effects on change in bedtime from 6-month follow-up to 12-month follow-up**		
	Beta	***SE***	***p***	***Beta***	***SE***	***p***	***Beta***	***SE***	***p***
1. I try to go to sleep about the same time each night on weeknights	−0.20	0.10	0.04*	−0.04	0.10	0.67	0.15	0.12	0.20
2. I try to wake up about the same time each morning on weekdays	−0.08	0.10	0.44	−0.09	0.10	0.36	−0.01	0.13	0.92
3. I try to reduce 'social jetlag' – which means I try to go to bed and wake up about the same time on weekends relative to weekdays	0.03	0.09	0.78	−0.10	0.09	0.18	−0.07	0.11	0.52
4. I try to get about 9 hours of sleep per night	0.04	0.09	0.67	0.01	0.09	0.94	−0.03	0.11	0.77
5. If my bedtime gets too late, I bring it forward by about 20-30 minutes each week	0.03	0.09	0.72	−0.14	0.10	0.17	−0.17	0.12	0.72
6. I engage in a wind-down before bedtime	0.05	0.08	0.55	−0.15	0.10	0.08	−0.20	0.12	0.04*
7. I avoid napping after school and in the evening	−0.06	0.08	0.43	−0.06	0.08	0.47	0.00	0.12	0.97
8. I have an electronic curfew to reduce light exposure via cell phones, computers etc before my bedtime	0.06	0.08	0.46	−0.20	0.09	0.02*	−0.25	0.11	0.02*
9. I use a brisk wake up routine to help wake up in the morning (e.g., try to refrain from snoozing, increase activity, shower or wash face and hands, expose yourself to sunlight, upbeat music, phone friend)	−0.09	0.08	0.24	−0.21	0.08	0.01*	−0.13	0.10	0.22
10. When I feel sleepy in the day I purposively generate energy	−0.05	0.08	0.52	−0.23	0.10	0.02*	−0.17	0.11	0.14
11. I use techniques to reduce worry interfering with my sleep via Savoring or 'worry time' earlier in the day etc.	−0.06	0.08	0.46	−0.18	0.08	0.03*	−0.02	0.10	0.19
12. I get out of bed if I am not able to sleep within about 20 minutes	0.12	0.07	0.10	−0.06	0.08	0.45	−0.18	0.10	0.07
13. I keep my bed for sleeping only (I do not work in bed, watch TV in bed etc)	0.11	0.07	0.13	0.02	0.07	0.80	−0.09	0.09	0.30
14. I avoid caffeine and energy drinks	0.03	0.07	0.70	−0.12	0.07	0.07	−0.14	0.08	0.08

Note.

*p<.05.

All models include post-treatment outcome measure score, age, sex, and text messaging condition as fixed effects. All outcome variables are standardized with a mean of 0 and standard deviation of 1.