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Authors
Gumport, Nicole
Harvey, Allison

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Memory and Learning for Sleep and Circadian Treatment in Serious Mental Illness Treated in a Community Mental Health Setting

Nicole B. Gumport,
Allison G. Harvey
University of California, Berkeley

Abstract

Objective: Existing research has demonstrated that patient memory and learning of treatment contents are poor and poorer learning is associated with worse treatment outcome. Most prior studies have included individuals from only a single diagnostic group, offer limited data on possible contributors to poor memory and learning, and have included small samples recruited in university settings. This study sought to describe patient recall of treatment contents, describe patient learning of treatment contents, examine contributors to patient recall and learning of treatment contents, and examine the association of patient recall and learning of treatment contents with treatment outcome.

Methods: Adults with serious mental illness and sleep and circadian dysfunction (N=99) received the Transdiagnostic Intervention for Sleep and Circadian Dysfunction in a community mental health setting. Measures of recall, learning, age, years of education, symptom severity, and treatment outcome were collected at post-treatment and 6-month follow-up.

Results: Recall and learning were poor, fewer years of education was associated with worse recall and learning, and recall and learning were not associated with treatment outcome.

Conclusions: The findings offer evidence that poor patient memory for, and learning of, treatment contents extends to community settings and are transdiagnostic concerns.

Keywords

memory; learning; serious mental illness; sleep; circadian

Memory for the contents of a treatment session is poor. In the physical health literature, patients recall approximately one third of the recommendations of a physician visit (Bober, Hoke, Duda, & Tung, 2007; Jansen et al., 2008; Laws, Lee, Taubin, Rogers, & Wilson, 2018). In the mental health literature, patients with insomnia forget about two thirds of treatment recommendations, with recall as low as 13% for some recommendations (Chambers, 1991). More recently, following the receipt of treatment for insomnia, patients with bipolar disorder recalled 36% of recommendations (Lee & Harvey, 2015). In a study of

Corresponding author: Allison G. Harvey, Ph.D., Department of Psychology, University of California, Berkeley, 2121 Berkeley Way #1650, Berkeley, CA 94720-1650, 1-510-642-7138, aharvey@berkeley.edu.

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couples treatment, recall was as low as 3% for some recommendations and 50% of patients could not recall any treatment skills (Hahlweg & Richter, 2010). Taken together, these findings are concerning for two reasons. First, recent research indicates that poor memory for treatment is associated with worse treatment outcome and lower adherence in studies of depression treatment (Dong, Zhao, Ong, & Harvey, 2017; Harvey, Lee, et al., 2016; Lee & Harvey, 2015; Zieve, Dong, & Harvey, 2019). Second, as many evidence-based treatments focus on the presentation of novel skills (Hundt, Mignogna, Underhill, & Cully, 2013), it seems unlikely that patients will use skills presented during treatment if they are unable to remember them.

Learning of treatment contents is also poor. For example, in a study of computer-based treatment for depression, only 50–65% of patient thoughts of treatment content were accurate and less than half of patient applications of treatment content were accurate (Gumport, Williams, & Harvey, 2015). Emerging evidence also indicates that learning is associated with treatment outcome. Using these same measures in a randomized controlled trial of treatment for depression, patients' accurate thoughts of, and applications of, treatment contents were significantly associated with better treatment outcome at post-treatment (Gumport, Dong, Lee, & Harvey, 2018).

While the field has made progress in understanding memory and learning for psychosocial treatment contents, gaps still remain. First, most prior research has focused on memory and learning for treatment among single diagnostic groups, such as depression (Gumport et al., 2018, 2015), bipolar disorder (Lee & Harvey, 2015), or insomnia (Chambers, 1991). However, problems with declarative, episodic, working, and prospective memory are common across many mental illnesses including depression (Gotlib & Joormann, 2010; Hertel, 1998), bipolar disorder (Torres, Boudreau, & Yatham, 2007), anxiety (Airaksinen, Larsson, & Forsell, 2005), schizophrenia (Boyer, Phillips, Rousseau, & Ilivitsky, 2007; Henry, Rendell, Kliegel, & Altgassen, 2007; Saykin et al., 1991), posttraumatic stress disorder (Isaac, Cushway, & Jones, 2006), and substance use (Rendell, Mazur, & Henry, 2009; Serper et al., 2000). Second, samples were small, ranging from 20–48 participants. Third, there is limited prior research evaluating patient factors that may contribute to worse memory or learning of treatment contents. For example, healthy aging is associated with general declines in memory functioning (Glisky, 2007; Grady & Craik, 2000; Li et al., 2016; Reuter-Lorenz, Festini, & Jantz, 2016), although greater education has been shown to be a protective factor for age-related memory loss (Angel, Fay, Bouazzaoui, Baudouin, & Isingrini, 2010; Cabeza et al., 2018). Additionally, at times, greater symptom severity has been associated with greater memory problems in serious mental illness (SMI; McDermott & Ebmeier, 2009; Reichenberg et al., 2009), although there are non-replications (e.g., Woon, Farrer, Braman, Mabey, & Hedges, 2017). A greater understanding of these contributors to patient memory and learning of treatment contents may allow for the targeted dissemination of interventions known to improve patient memory for treatment (e.g., the Memory Support Intervention, Harvey, Lee, et al., 2016). Fourth, the prior studies that focused on mental health were conducted in university research settings, which limits the generalizability of findings to routine care settings.

The present study focuses on a sample of adults with SMI and sleep and circadian dysfunction in a community mental health setting. SMI was operationalized according to Public Law 102–321 and previous research (Wang, Demler, & Kessler, 2002) as the presence, for at least 12 months, of at least one Diagnostic and Statistical Manual-defined (American Psychiatric Association, 2013) mental disorder that leads to substantial inference with major life activities, such as depression, bipolar disorder, schizophrenia spectrum and other psychotic disorders, posttraumatic stress disorder, and substance use disorders. Sleep and circadian problems such as insomnia, hypersomnia, advanced and delayed phase, and irregular schedules are often are comorbid with SMI (Baglioni et al., 2016). These problems regularly persist after treatment is provided for SMI (López, Lancaster, Gros, & Acierno, 2017) and can predict the onset and worsening of SMI symptoms (Hertenstein et al., 2019). Also, independent of SMI, sleep and circadian problems impair memory and learning processes (Walker & Stickgold, 2006; Yoo, Hu, Gujar, Jolesz, & Walker, 2007). Community mental health settings are major, publicly-funded providers for SMI in the United States. They offer services for the most socioeconomically underserved members of the community (Kim et al., 2020). Within these settings, individuals with a SMI often experience high rates of comorbidity and complexity. Hence, data on how individuals diagnosed with SMI and sleep and circadian dysfunction, who receive care in community mental health settings, recall and learn treatment contents may offer relatively generalizable findings given the focus on a representative, real-world sample compared to previous research. In sum, to the best of our knowledge, no prior studies have examined patient memory and learning in this population or in this setting.

The overall goal of this study is to examine memory and learning for the contents of the Transdiagnostic Intervention for Sleep and Circadian Dysfunction (TranS-C; Harvey & Buysse, 2017) among adults with a SMI in a community mental health setting at post-treatment and 6-month follow-up. Initial results of a clinical trial demonstrated that TranS-C improves sleep and SMI outcomes relative to usual care at post-treatment and 6-month follow-up (Harvey et al., under review). The first aim is to describe the extent of patient recall of treatment contents. We expected that patients would accurately recall approximately one third of treatment contents, based on prior work conducted in university settings (e.g., Lee & Harvey, 2015). The second aim was to describe the extent of patient learning of treatment contents. Three hypotheses were tested based on prior research (Gumport et al., 2018, 2015). We expected that (a) patients will report thinking about treatment contents one to two times in the past week, (b) patients will report applying treatment contents one to two times in the past week, and (c) approximately 60% of thoughts would be accurate and that under 50% of applications would be accurate. The third aim was to examine contributors to patient memory and learning of treatment contents. Based on prior studies (Angel et al., 2010; Harvey et al., 2014; Salthouse, 2009), we expected that greater symptom severity, older age, and fewer years of education would be associated with poorer memory and learning for treatment contents at post-treatment and at 6-month follow-up. The fourth aim was to examine the association of patient recall and learning of treatment content with treatment outcome. The hypothesis tested was that better recall and better learning of treatment contents would be associated with improved treatment outcome at post-treatment and 6-month follow-up (Gumport et al., 2018, 2015; Harvey, Lee, et al., 2016; Lee & Harvey, 2015).

Methods

Participants

The 99 participants included in this study were drawn from a National Institute of Mental Health-funded randomized controlled trial that included adults who met criteria for SMI and sleep and circadian disturbance and who were recruited from multiple sites within Alameda County Behavioral Health Care Services (ACBHCS; Alameda County, CA, USA) (Harvey, Hein, et al., 2016). The primary trial from which the data were drawn included 121 participants. However, 22 participants were excluded from the present study as they either did not complete the post-treatment and 6-month follow-up ($n = 19$) or the memory and learning measures at post-treatment and at 6-month follow-up were missing from their assessments due to administrative error ($n = 3$). Participant characteristics are displayed in Table 1.

Individuals were eligible if they met the following inclusion criteria: (a) 18 years of age or older; (b) English language fluency; (c) presence of at least one DSM-5 mental disorder for 12 months; (d) having a guaranteed bed to sleep in for the next three months; (e) receiving care for SMI at ACBHCS and consenting to regular communication between the research team and their ACBHCS psychiatrist and/or case manager; and (f) presence of one or more of the following problems, on three or more nights per week, for three months assessed via the Sleep and Circadian Problems Interview: taking 30 minutes or longer to fall asleep, waking in the middle of the night for 30 minutes or longer, obtaining less than six hours of sleep per night, obtaining nine or more hours of sleep per 24 hour period (i.e., nighttime sleep plus daytime napping), maintaining a bedtime later than 2:00am, or having more than 2.78 hours of variability in sleep-wake schedule across one week.

Individuals were excluded if they met any of the following criteria: (a) presence of an active and progressive physical illness or neurological degenerative disease and/or substance use that would make participation in the study unfeasible; (b) current serious suicide risk or homicide risk (both assessed by study staff and a case manager or psychiatrist); (c) night shift work two or more nights per week in the past three months; (d) pregnancy or breastfeeding; or (e) unable or unwilling to participate in and/or complete the pretreatment assessments.

Treatment

Treatment was delivered by nine therapists hired by the University of California, Berkeley system. The therapists traveled between the ACBHCS clinic sites to deliver treatment. Clinicians attended a one-day workshop, used a treatment manual, and received weekly supervision.

TranS-C (Harvey & Buysse, 2017), which was administered in eight weekly 50-minute sessions, is grounded in basic sleep and circadian science and the sleep health framework (Buysse, 2014). TranS-C is derived from several sources. It draws from cognitive behavioral therapy for insomnia, which is the frontline treatment for insomnia (CBT-I) (Edinger et al., 2021).There is a great deal of literature indicating the efficacy of CBT-I for SMI (Morin et al., 2006; Qaseem et al., 2016; Riemann et al., 2017). TranS-C also incorporates principles from Interpersonal and Social Rhythms Therapy (Ehlers, Frank, & Kupfer, 1988), chronotherapy (Wirz-Justice, Benedetti, & Terman, 2009), and motivational enhancement (Miller & Rollnick, 2002). TranS-C includes four cross-cutting modules featured in every session (functional analysis, education, behavior change and motivation, and goal-setting), four core modules that apply to the vast majority of participants (establishing regular sleep-wake times including learning a wind-down and wake-up routine, improving daytime functioning, correcting unhelpful sleep-related beliefs, and maintaining behavior change), and seven optional modules used less commonly, depending on the needs of each participant (improving sleep efficiency, reducing time in bed, dealing with delayed or advanced phase, reducing sleep-related worry/vigilance, promoting compliance with CPAP/exposure therapy for claustrophobic reactions to CPAP, negotiating sleep in a complicated environment, and reducing nightmares). Core and optional modules can be delivered in any sequence and are customized to the participant based on their presentation and goals for treatment.

Measures

Patient Recall Task.—The Patient Recall Task (Lee & Harvey, 2015) is a free recall task. Participants were asked to "Take a moment to think back to your sleep coaching. Can you tell me everything you have learned? We have 5 minutes for this task so please take your time." Participants responses were recorded and then transcribed. In the few cases where participants declined audio recording, the trained assessor wrote notes. Trained coders evaluated the transcript of each Patient Recall Task. The transcripts of responses were coded for "treatment points." A treatment point is defined as a main idea, principle, or experience that the treatment provider wants the patient to remember or implement as part of the treatment (Lee & Harvey, 2015). Each treatment point was scored based on a list of 31 possible treatment points that were drawn from a review of the TranS-C treatment manual ("Correctly Recalled"). In addition, recalled items were categorized within the list of 31 possible treatment points. Coders also coded patients responses for inaccurate items ("Incorrectly Recalled"), or items that were inaccurate yet related to TranS-C content (e.g., adults need 4 hours of sleep/night). For a list of all possible treatment points, see the first column of Table 2.

Learning measures.

Thoughts.: Thoughts about treatment contents was adapted from prior studies (Gumport et al., 2018, 2015). Thoughts about treatment contents were assessed via a questionnaire that asked the participant, "In the last week, did information discussed with your sleep coach come to mind?," and "If yes above, how many times?" and "What came to mind?" To determine if thoughts accurately reflected the treatment content, responses to "What came to mind?" were coded for treatment points. This data was collected at post-treatment and 6-month follow-up.

Application.: Application of treatment contents was adapted from prior studies (Gumport et al., 2018, 2015). Application of treatment contents was assessed via a questionnaire that asked the participant "Did you get to apply anything discussed with your sleep coach in the past week?", and "If yes, what did you apply?" These responses were coded for accuracy using the method described above. This data was collected at post-treatment and 6-month follow-up.

Advice.: Advice about treatment contents was assessed via a questionnaire asking, "If you had a close friend with sleep problems, what advice would you give him/her?" Participant responses were coded for accuracy. This data was collected at post-treatment and 6-month follow-up.

Contributors to treatment outcome.

Demographic characteristics.: A demographics form, which assessed age and years of education, was completed by participants at the baseline assessment.

DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure – Adult (DSM-5 Cross-Cutting Measure).: The DSM-5 Cross-Cutting Measure is used as a measure of disorder-focused symptoms. It contains 23 questions that assess symptoms in the most recent two weeks across 13 psychiatric domains: depression, anxiety, mania, psychosis, substance use, anger, somatic symptoms, suicidal ideation, sleep problems, memory, repetitive thoughts and behaviors, dissociation, and personality functioning. Items are rated on a 5-point Likert scale (0=none, 1=slight, 2=mild, 3=moderate, 4=severe). Preliminary psychometric data indicates that this measure is highly correlated with other symptoms measures for each of the 13 psychiatric domains (r = 0.20–0.70) (Bravo, Villarosa-Hurlocker, Pearson, & Protective Strategies Team, 2018). A total score on this measure assessed at baseline were evaluated as contributors to memory and learning for the contents of treatment.

Outcome measures.—Descriptive statistics and change over the course of treatment on each of these outcome measures are presented in Table 3.

Patient-Reported Outcomes Measurement Information System – Sleep Disturbance (PROMIS-SD).: The PROMIS-SD was developed as a part of the NIH Roadmap initiative and designed to improve patient-reported outcomes using state-of-the-art psychometric methods. It assesses sleep disturbance. The 8-item measure is scored 1 (*not at all; never; very poor*) to 5 (*very much, always, very good*), and the items are summed. Patients rate items for the past 7 days (e.g., "My sleep was restless," "I had trouble sleeping," "I got enough sleep.") The scale has established reliability and validity with other established sleep measures (e.g., r = 0.30–0.83) (Buysse et al., 2010; Yu et al., 2011).

Patient-Reported Outcomes Measurement Information System – Sleep-Related Impairment (PROMIS-SRI).: The PROMIS-SRI was developed as a part of the NIH Roadmap initiative and designed to improve patient-reported outcomes using state-of-the-art psychometric methods. It assesses impairment related to sleep. The 16-item measure is scored 1 (*not at all; never*) to 5 (*very much; always*), and the items are summed. Patients rate items for the past 7 days (e.g., "I felt tired," "I felt irritable because of poor sleep," "I was sleepy during the daytime.") The scale has established reliability and validity with other established sleep measures (e.g., r = 0.46–0.68) (Buysse et al., 2010; Yu et al., 2011).

DSM-5 Cross-Cutting Measure.: The DSM-5 Cross-Cutting Measure administered at post-treatment and 6-month follow-up was used as a measure of symptom severity and treatment outcome. This measure is described in more detail in the "contributors to treatment outcome" section above.

Sheehan Disability Scale (Sleep) (SDS).: The SDS assessed functional impairment. The SDS evaluates the extent to which work/school, social life, and home/family responsibilities are impaired on a 0–10 (*not at all* to *extremely*) scale. Its psychometric properties are well established (e.g., Cronbach's alpha = 0.89, test-retest reliability = 0.73, correlations with similar measures = 0.27–0.59) (Arbuckle et al., 2009; Sheehan, Harnett-Sheehan, & Raj, 1996). The three items were averaged to assess global functional impairment (0 [*not impaired*] to 10 [*highly impaired*]).

Procedure

All procedures were approved by the University of California, Berkeley, Committee for the Protection of Human Subjects. All participants provided informed consent. Participants completed a baseline assessment in which they completed a demographics form and all outcome measures. Participants were randomly assigned to receive TranS-C immediately plus usual care (TranS-C-UC), or to Usual Care followed by Delayed Treatment with TranS-C (UC-DT). The latter group was on a waitlist for eight months and then received TranS-C. At post-treatment immediately following treatment and again at 6-month follow-up, participants completed outcome measures. At post-treatment and 6-month follow-up, participants completed the Patient Recall Task, the learning measures, and the outcome measures.

Data coding

Two independent raters coded a subset of the data for the Patient Recall Task (22.22% of the data) and each of the learning measures (36.31% of the data). The remainder of the dataset was coded independently. There was 84.21% inter-rater agreement for the Patient Recall Task, 81.97% inter-rater agreement for Thoughts, 88.52% inter-rater agreement for Application, and 83.61% inter-rater agreement for Advice.

Data analysis

All analyses were conducted in Stata15 (StataCorp, 2017). A significance level of 0.05 was used throughout. For the first and second aims, means and standard deviations or frequencies and percentages are presented. For the third aim, linear regression was used. For the fourth aim, hierarchical linear modeling with restricted maximum likelihood estimation was used. The random part of the model included a random intercept for participant, assumed to have a bivariate normal distribution with a mean of zero and an unstructured covariance matrix. Baseline scores of each outcome measure were included in the fixed part of the model. For aims three and four, all variables were standardized with a mean of 0 and standard deviation of 1. Standardized coefficients were calculated, as these are interpretable as effect sizes (Lorah, 2018).

For the third and fourth aims, to maintain a family-wise error rate of .05 across all tests conducted for a single predictor (e.g., age), we applied Holm's Bonferroni method (Shaffer, 1995). This involves ordering a series of tests according to their associated p values (smallest to largest) and comparing each p value against a sequentially calculated cutoff. For the third aim, because eight tests were conducted for each predictor, the smallest p value must be less than .006 (.05/8), whereas the largest p value must be less than .05 to meet criteria for statistical significance. For the fourth aim, because eight tests were conducted for each predictor, the smallest p value must be less than .001 (.05/4), whereas the largest p value must be less than .05 to meet criteria for statistical significance. Holm's Bonferroni method controls family-wise error without the marked loss of power associated with the traditional Bonferroni correction (Shaffer, 1995).

Results

Recall of treatment contents

As displayed in Table 4, on average, participants correctly recalled 5.51 treatment points at post-treatment based on the list of 31 treatment points (17.78% of possible treatment points). As evident in Table 2, based on a list of 31 treatment points, the top four treatment points recalled at post-treatment were: "I use techniques to reduce worry or thinking interfering with my sleep" (42.39% of participants), "Wind down routine before bedtime" (41.30% of participants), "RISEUP or wakeup routine" (41.30% of participants), and "Consistent bedtime" (35.87% of participants).

As displayed in Table 4, on average, participants correctly recalled 3.92 treatment points (12.65% of possible treatment points) at 6-month follow-up. As evident in Table 2, the top four treatment points recalled at 6-month follow-up were: "Consistent waketime" (32.91% of participants), "Consistent bedtime" (31.65% of participants), "Reducing light exposure in the evening or importance of darkness" (30.38% of participants), and "RISEUP or wakeup routine" (29.11% of participants).

As evident in Table 4, on average, at post-treatment participants incorrectly recalled on average 0.26 treatment points. At 6-month follow-up, participants incorrectly recalled on average 0.20 treatment points.

Learning of treatment contents

Results are displayed in Table 4.

Thoughts.—At post-treatment, 98.65% of participants at post-treatment reported thinking about the treatment contents on average 5.39 times in the past week. On average, participants reported thinking about 0.96 treatment points at post-treatment. At 6-month follow-up, 92.16% of participants at 6-month follow-up reported thinking about treatment contents on average 5.23 times in the past week. On average, participants reported thinking about 1.06 treatment points at 6-month follow-up. At post-treatment, 100% of participants who reported thinking of treatment contents (*n* = 74) accurately thought about at least one treatment point. At 6-month follow-up, of the 69 participants who reported thinking about their treatment contents in the past week, only 51 participants (73.91%) accurately thought about at least one treatment point.

Application.—At post-treatment, 83.13% of participants at post-treatment reported applying the treatment contents in the past week. On average, participants correctly applied 1.43 treatment points at post-treatment. At 6-month follow-up, 65.22% of participants reported applying the treatment contents in the past week. On average, participants applied 1.38 treatment points at 6-month follow-up. At post-treatment, of the 83 participants who reported applying treatment contents in the past week, only 69 of these participants accurately applied at least one treatment point (83.13%). At 6-month follow-up, of the 69 participants who reported applying treatment contents in the past week, only 45 of these participants accurately applied at least one treatment point (65.22%).

Advice.—On average, participants recommended 1.29 treatment points at post-treatment and 1.30 treatment points at 6-month follow-up.

Contributors to recall and learning

Results are presented in Table 5. Years of education significantly predicted participant recall, thoughts, application and advice at post-treatment, and recall and advice at 6-month follow-up, with more education being associated with increased memory and learning. Symptom severity and age were not significantly associated with the recall or the learning measures.

Recall, learning, and treatment outcome

Results are presented in Table 6. Patient recall was not associated with treatment outcome. None of the learning measures were significantly associated with treatment outcome.

Discussion

The overarching goal of the present study was to examine memory and learning for the contents of TranS-C among adults with a SMI who received treatment in a community mental health setting. The first aim was to describe the extent of patient recall. Prior research across patient groups fairly consistently suggests participants recall about one third of treatment contents (Bober et al., 2007; Lee & Harvey, 2015). In the present study, the recall rates observed were lower: 17.78% at post-treatment and 12.65% at 6-month follow-up. This finding is consistent with prior research showing that recall is as low as 3–13% for some recommendations (Chambers, 1991; Hahlweg & Richter, 2010). Prior research suggests that patients recall incorrect information from a treatment session. For example, in a study of physician visits, 25% of patients recalled recommendations that were not made (Bober et al., 2007). Encouragingly, in the present study, on average, participants incorrectly recalled less than a single treatment point at both post-treatment and 6-month follow-up. In other words, while participants may not recall a majority of treatment recommendations, the information they do recall is usually accurate. In terms of specific treatment points, at both assessments, treatment elements from the module promoting regular sleep schedule (e.g., maintaining consistent bedtimes, maintaining consistent waketimes, RISE UP, Wind Down) were among the most frequently recalled treatment elements. On the one hand, this is unsurprising as promoting a regular sleep schedule is one of the TranS-C core modules (Harvey & Buysse, 2017). As such, most participants received this treatment module and learned about these treatment elements. On the other hand, approximately only one third of participants recalled this content at either time point. This finding raises the possibility that interventions designed to improve memory for treatment, such as the Memory Support Intervention, may be helpful to integrate alongside TranS-C (Harvey, Lee, et al., 2016). Alternatively, perhaps participants previously knew treatment content that was more readily recalled. Future research should include a baseline measure of knowledge to address the possibility.

The second aim was to describe the extent of learning of treatment contents. Prior research in patients with depression suggests that participants think about treatment contents one to two times in a week and only 50–65% of patient thoughts of treatment content are accurate (Gumport et al., 2018, 2015). In the present study, participants reported thinking about treatment contents more frequently than expected, on average five times per week. Thoughts were more accurate than expected, with 100% and 73.91% of participants who reported thinking about treatment contents reporting at least one accurate treatment element at post-treatment and 6-month follow-up, respectively. Prior research in patients with depression also indicates that participants report applying treatment contents one to two times in the past week and that under 50% of applications are accurate (Gumport et al., 2018, 2015). Consistently, in the present study, participants reported applying treatment contents 1.43 and 1.38 times per week at post-treatment and 6-month follow-up, respectively. Promisingly, participants applied treatment contents more accurately than expected, with 83.13% and 65.22% of participants applying at least one accurate treatment element at post-treatment and 6-month follow-up, respectively. Perhaps the frequency of thoughts and applications and accurate thoughts and applications were higher in this study than in prior research because the prior study used a much briefer intervention, was computer-based, and included treatment content that was not personalized (Gumport et al., 2015), whereas the present study included eight 50-minute in-person treatment sessions with a modularized treatment tailored to each patient’s individual needs. The final measure of learning, advice for a friend with sleep problems, followed a similar pattern to the thoughts and application findings. Overall, these results demonstrate that learning was better than expected, perhaps because sleep is such a salient issue for the patient group studied. However, learning for treatment contents across the three indices was not optimal. Ideally, we would hope that patients learn and continue to use the vast majority of treatment contents. This is not surprising when considering that TranS-C covers a large amount of information across the course of treatment, the transfer of learning problem (Thorndike, 1932), and that impairments in memory are common across SMI (e.g., Henry et al., 2007; Isaac et al., 2006; Torres et al., 2007).

The third aim was to examine if symptom severity, older age, and fewer years of education were associated with patient memory and learning for treatment contents. In partial support of our hypothesis, more years of education were significantly associated with greater memory and learning at both post-treatment and 6-month follow-up. These results are in line with prior research demonstrating that more years of education are associated with fewer age-related memory declines (Angel et al., 2010; Cabeza et al., 2018). Inconsistent with our hypothesis, older age was not significantly associated with patient recall or with learning of treatment contents at multiple time points. However, the results were all in the expected direction given previous research (Glisky, 2007; Li et al., 2016), with older age being associated with poorer recall and learning. It is noteworthy that there were not enough older adults in this sample to fully power these analyses ($n = 8$ were 65+ years old and $n = 25$ were 55–64 years old). Also inconsistent with our hypothesis, greater symptom severity was not associated with memory and learning at any time point. These results contribute to the mixed findings on the relationship between symptom severity and challenges in memory and learning (e.g., McDermott & Ebmeier, 2009; Woon et al., 2017).

The final aim was to examine if patient recall and learning of treatment content was associated with treatment outcome. Neither patient recall nor the learning measures were associated with treatment outcome. These findings are inconsistent with prior studies that have demonstrated that patient recall is associated with improved treatment outcome for treatment for depression and bipolar disorder (Harvey, Lee, et al., 2016; Lee & Harvey, 2015) and that patient learning is associated with improved depression treatment outcomes (Gumport et al., 2018, 2015). These findings are also surprising given that the receipt of TranS-C resulted in improvement across all primary outcome measures. Several other factors come into play in between the process of remembering the contents of treatment and using these contents effectively in an appropriate situation. For example, while patients may remember the contents of treatment, they may not use the skills due to other habitual behavior, a lack of motivation, or a myriad of other possibilities. Therefore, it may be valuable to evaluate if recall and learning of treatment contents are associated with a more proximate contributor to behavior change, such as intention to use a treatment element (Schwarzer, Lippke, & Luszczynska, 2011) or adherence to treatment recommendations (Dong et al., 2017; Gumport, Dolsen, & Harvey, 2019).

This study had several limitations. First, this study focused only on patient recall and learning for only one treatment, TranS-C. Hence, generalizability of the results to other treatments is not known. Second, although it has been used in prior studies, the learning measure included in this study is not psychometrically validated. Future research should focus on evaluating its psychometric properties. Third, the memory and learning tasks used in this study primarily assess verbal memory and learning for the contents of treatment and do not evaluate primacy or recency effects. Future research may consider focusing on other metrics of memory and learning such as role playing and modeling (Kurtz, 2011). Future studies should consider additional assessments of patient memory and learning in order to examine the association of treatment point presentation during treatment with memory and learning. Fourth, we did not assess baseline knowledge of the treatment contents provided in TranS-C so we cannot account for prior knowledge in the assessments of learning and memory. Fifth, the memory and learning assessments relied on retrospective self-report in the five minutes given for the Patient Recall Task. Future research using an ecological momentary assessment approach may provide a more nuanced picture of patient memory and learning for treatment contents. However, using these methods with a community mental health based sample with SMI will pose challenges as most of the participants included in this sample did not have access to a regular cellphone or other technology. In addition, although anecdotally most participants finished the Patient Recall Task in under five minutes, it is possible that the length of the task put a ceiling on how much participants could recall at each assessment. Finally, this study included a heterogenous sample of adults with SMI and sleep and circadian problems. As both SMI and sleep and circadian problems are associated with cognitive impairment (Moffitt et al., 2009; Wardle-pinkston, Slavish, & Taylor, 2019), it is possible that cognitive impairment contributed to these findings. Further research is needed to see if the results replicate in other samples and mental health systems, as well as in larger samples.

Overall, the present study offers additional evidence that patient recall and learning for treatment contents are poor. This study extends prior research on patient memory and learning beyond university settings to examine treatment delivered within a community mental health setting and beyond single diagnostic groups to patients with a range of SMI. The specific treatment elements that adults with SMI recall from TranS-C are identified. These findings offer additional evidence that poor patient memory for, and learning of, treatment contents are not a problem unique to university treatment settings and are transdiagnostic concerns. Hence, integrating interventions designed to improve memory for treatment, such as the Memory Support Intervention (Harvey, Lee, et al., 2016), may be helpful in community settings treating patients with SMI. This study offers data on the treatment points that stand out the most to patients. Treatment developers and treatment providers may consider further testing and simplifying TranS-C—and other complex interventions—into core elements that patients are most likely to remember and that are associated with change during and following treatment (e.g., Gumport et al., 2019).

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Table 1.

Participant Characteristics

Characteristic	Mean or N	SD or %
Age (years)	47.38	12.00
Female	51	51.52
Race		
African-American or Black	41	41.41
American Indian/Alaskan Native	2	2.02
Asian	7	7.07
Caucasian	37	37.37
Native Hawaiian or Other Pacific Islander	2	2.02
Mixed Race	6	6.06
Not specified	4	4.04
Ethnicity		
Hispanic or Latino	14	14.14
Not Hispanic or Latino	84	84.85
Not specified	1	1.01
Employment		
Full-time	2	2.02
Part-time	12	12.12
Unemployed	79	79.80
Other	5	5.05
Missing	1	1.01
Education (years)	13.83	3.68
Highest level of education completed		
High school or below	28	28.28
Vocational school	10	10.10
Some college or completed college	56	56.57
Graduate school	5	5.05
Annual personal income ($)	11254.10	7651.56
Annual household income ($)	23016.52	22682.56
Receiving government assistance	95	95.96
DSM diagnoses at pre treatment[1]		
Schizophrenia spectrum disorder	51	51.52
Bipolar disorder[2]	25	25.25
Major depressive disorder[3]	21	21.21
Any anxiety disorder[4]	47	47.47
Obsessive compulsive disorder[4]	19	19.19
Post-traumatic stress disorder	13	13.13
Substance use disorder	30	30.30
Psychotic symptoms/features[5]	73	73.74

Characteristic	Mean or N	SD or %
Sleep and circadian diagnoses at pre treatment[1]		
Insomnia	80	80.81
Hypersomnolence (provisional)[6]	25	25.25
Delayed sleep phase	4	4.04
Advanced sleep phase	2	2.02
Irregular sleep-wake disorder	1	1.01
Restless leg syndrome	5	5.05
Periodic limb movements (provisional)[7]	4	4.04

[1] Participants could meet diagnostic criteria for multiple problems.

[2] Bipolar disorder with psychotic features is listed in this category, not in the schizophrenia spectrum or psychotic disorders category.

[3] Depression with psychotic features is listed in this category, not in the schizophrenia spectrum or psychotic disorder category.

[4] No participants were solely diagnosed with an anxiety disorder or obsessive compulsive disorder – all also received a comorbid schizophrenia spectrum, bipolar disorder, major depressive disorder, post-traumatic stress disorder, and/or substance use disorder diagnosis.

[5] Psychotic symptoms/features includes depression with psychotic features, bipolar disorder with psychotic features, a schizophrenia spectrum or psychotic disorder diagnosis.

[6] A hypersomnolence diagnosis requires a multiple sleep latency test (American Academy of Sleep Medicine, 2014).

[7] A periodic limb movement diagnosis requires a polysomnography assessment (American Academy of Sleep Medicine, 2014).

Table 2.

Accurate recall of each treatment point at post-treatment and 6-month follow-up

Treatment Point	Post-Treatment (*N*=92)		6-Month Follow-Up (*N*=79)	
	Frequency	%	Frequency	%
1. Consistent bedtime: going to bed at about the same time each night or same bedtime on weekdays and weekends.	33	35.87	25	31.65
2. Consistent waketime: waking up at about the same time each day or same waketime on weekdays and weekends.	30	32.61	26	32.91
3. Early waketime: waking up early or not sleeping in.	11	11.96	4	5.06
4. Social jetlag: going to bed and waking up about the same time on weekends relative to weekdays	4	4.35	0	0
5. Sufficient sleep: 7–8 hours of sleep per night. Must refer to specific amount.	6	6.52	6	7.59
6. Moving bed or wake time by 20–30 minutes each week.	2	2.17	0	0.00
7. It isn't possible to compensate for lost sleep ("sleep debt") by sleeping in.	0	0.00	0	0.00
8. Wind down routine (30–60 minutes) before bedtime. May also refer to bedtime routine or sleep routine Examples of wind down routine: showering before bed, drinking decaf tea, reading a book, not watching TV, drawing, knitting, puzzles	38	41.30	19	26.03
9. Not napping or avoiding naps. If napping does occur, they are best when short (less than 30 minutes) and earlier in the day (late morning or early afternoon).	29	31.52	20	25.32
10. Any mention of the circadian rhythm or internal body clock. May also refer to the suprachiasmatic nucleus (SCN) as the central conductor of sleep.	7	7.61	3	3.80
11. Any mention of sleep homeostasis, sleep appetite, or sleep drive.	2	2.17	1	1.27
12. Reducing light exposure in the evening or importance of darkness.	29	31.52	24	30.38
13. Have an "electronic curfew" such as turning off cell phone or computer or TV at a certain time.	25	27.17	20	25.32
14. Melatonin or any reference to hormones that help you fall asleep	21	22.83	7	8.86
15. RISEUP or wakeup routine. RISEUP acronym: Refrain from snoozing, Increase activity upon awakening, Shower or wash face and hands (with cold water), Expose yourself to sunlight, Upbeat music in the morning, Phone a friend, or any mention of social activity in the morning.	38	41.30	23	29.11
16. Being active or doing activities or "generating energy" when feeling tired. May also be referred to as "energy experiment" or "energy generating experiment"	8	8.70	3	3.80
17. I use techniques to reduce worry or thinking interfering with my sleep via savoring, worry time earlier in the day, journaling, gratitude practice. May also refer to "relax the mind" as the overarching concept	39	42.39	20	25.32
18. I get out of bed if I am not able to sleep (within 20–30 minutes). May also refer to sleep restriction or stimulus control. May also refer to not trying to force self to sleep ("trying to fall asleep").	12	13.04	10	12.66
19. I keep my bed for sleeping only (I do not work in bed or watch TV in bed).	14	15.22	12	15.19
20. Caffeine is found in coffee, soda, and energy drinks. Some medications like cold medicine also have caffeine. Can also refer to avoiding caffeine in the afternoon or evening.	31	33.70	22	27.85
21. Alcohol and other substances (e.g., tobacco, cocaine) can impact my sleep. I avoid these in the evening.	6	6.52	6	7.59
22. I make a point of trying to eat healthy. Note, can include any mention of diet, appetite, or hunger hormones (e.g., ghrelin and leptin), or eating on a regular schedule.	8	8.69	8	10.13
23. Referring to health or mentioning health and sleep.	2	2.17	1	1.27
24. Getting enough sleep can affect your health. Your immune system is influenced by the amount of sleep you get. Pain levels are influenced by the amount of sleep you get.	0	0.00	1	1.27

Treatment Point	Post-Treatment (*N*=92)		6-Month Follow-Up (*N*=79)	
	Frequency	%	Frequency	%
25. Not getting enough sleep can make it harder to remember things (sleep as related to cognitive functioning)	2	2.17	0	0.00
26. Sleep can improve your physical appearance (or make you more attractive)	0	0.00	0	0.00
27. Sleep is divided into stages and includes REM (rapid eye movement) and non-REM (NREM) sleep.	3	3.26	1	1.27
28. Avoiding going to sleep with the TV or radio on.	9	9.78	3	3.80
29. Sleep inertia: it is normal to feel groggy for the first hour upon waking up.	9	9.78	2	2.53
30. Changing the details and then repeating/rehearsing my dreams during the daytime can reduce my nightmares.	0	0.00	0	0.00
31. I keep my bedroom comfortable for sleep: cool, dark, quiet. May mention wearing earplugs or using a sound machine to block out sounds. May mention using an eye mask to keep dark. May mention asking roommate not to speak to them in the middle of the night or asking roommate to turn off lights too.	19	20.65	11	13.92

Table 3.

Means and change across treatment for primary outcome measures

Outcome Measure	Baseline[a]	Post-Treatment[a]	6- Month Follow-Up[a]	Baseline-Post Change[b]				Baseline to 6-Month Follow-Up Change[b]			
	Mean(SD)	*Mean(SD)*	*Mean(SD)*	*Beta*	*SE*	*p*	*95% CI*	*Beta*	*SE*	*p*	*95% CI*
PROMIS-SD	28.70 (6.22)	21.08 (8.18)	22.37 (8.02)	−0.90	0.09	.00	−1.07, −0.72	−0.79	0.09	.00	−0.96, −0.61
PROMIS-SRI	49.40 (12.86)	35.63 (13.57)	38.52 (14.00)	−0.90	0.09	.00	−1.08, −0.71	−0.74	0.09	.00	−0.92, −0.56
DSM-5 Cross Cutting	24.11 (10.48)	16.69 (11.08)	19.63 (11.10)	−0.63	0.09	.00	−0.81, −0.46	−0.41	0.09	.00	−0.58, −0.24
SDS	13.24 (7.51)	6.59 (6.72)	7.65 (6.45)	−0.86	0.10	.00	−1.05, −0.67	−0.75	0.10	.00	−0.94, −0.57

*** $p<0.001$.

[a] Raw scores are presented.

[b] All variables were standardized with a mean of 0 and standard deviation of 1.All models presented are hierarchical linear models with restricted maximum likelihood estimation was used. The random part of the model included a random intercept for participant, assumed to have a bivariate normal distribution with a mean of zero and an unstructured covariance matrix.

Table 4.

Memory and Learning of Treatment Contents

Indices of Memory and Learning		*N*	Mean	Standard Deviation
Recall: Correctly Recalled				
	Post-treatment	92	5.51	3.93
	6-month follow-up	79	3.85	3.16
Recall: Incorrectly Recalled				
	Post-treatment	93	0.26	0.49
	6-month follow-up	79	0.20	0.46
Thoughts: average number of times in past 7 days				
	Post-treatment	70	5.39	5.83
	6-month follow-up	47	5.23	3.56
Thoughts: accurate number of treatment points				
	Post-treatment	74	0.96	1.04
	6-month follow-up	51	1.06	1.01
Application: accurate number of treatment points				
	Post-treatment	69	1.43	1.31
	6-month follow-up	45	1.38	1.04
Advice: number of treatment points				
	Post-treatment	86	1.29	1.61
	6-month follow-up	74	1.30	1.58
		N	Frequency	%
Thoughts: number of participants who reported thinking about treatment contents in the past week				
	Post-treatment	74	73	98.65
	6-month follow-up	51	47	92.16
Application: number of participants who reported applying treatment contents in the past week				
	Post-treatment	83	69	83.13
	6-month follow-up	69	45	65.22

Table 5.

Linear regressions evaluating the contributions of symptom severity, age, and years of education to memory and learning of treatment contents

Memory or Learning Measure	Post-Treatment				6-Month Follow-Up			
	Coeff.	*SE*	*p*	*95% CI*	*Coeff.*	*SE*	*p*	*95% CI*
Symptom Severity (DSM-5 Cross-Cutting Measure at baseline)								
Recall	−0.01	0.01	0.32	−0.03, 0.01	−0.01	0.01	0.51	−0.02, 0.01
Thoughts (# accurate)	−0.00	0.01	0.91	−0.02, 0.02	0.01	0.01	0.29	−0.01, 0.04
Applications (# accurate)	0.00	0.01	0.85	−0.02, 0.03	−0.00	0.01	0.93	−0.03, 0.02
Advice	−0.00	0.01	0.87	−0.02, 0.02	−0.01	0.01	0.63	−0.03, 0.02
Age								
Recall	−0.01	0.01	0.14	−0.03, 0.00	−0.01	0.01	0.47	−0.02, 0.01
Thoughts (# accurate)	−0.00	0.01	0.99	−0.02, 0.02	−0.01	0.01	0.41	−0.03, 0.01
Applications (# accurate)	−0.01	0.01	0.42	−0.03, 0.01	−0.02	0.01	0.05[c]	−0.04, −0.00
Advice	−0.00	0.01	0.61	−0.02, 0.01	−0.01	0.01	0.50	−0.02, 0.01
Years of Education								
Recall	0.09	0.03	**0.00**	0.03, 0.15	0.10	0.03	**0.00**	0.04, 0.16
Thoughts (# accurate)	0.11	0.03	**0.00**	0.05, 0.17	0.06	0.04	0.18	−0.03, 0.14
Applications (# accurate)	0.09	0.03	**0.01** [b]	0.03, 0.15	0.08	0.04	0.05[c]	0.00, 0.15
Advice	0.08	0.03	**0.01** [a]	0.02, 0.14	0.09	0.03	**0.01**	0.02, 0.16

[a] p value = 0.006.

[b] p value = 0.005.

[c] p value = 0.048. DSM-5 Cross Cutting Measure = DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure – Adult. Table displays standardized values. Bold values indicate statistical significance after Holm's Bonferroni correction (Shaffer, 1995).

Table 6.

Multilevel models examining the relationship between memory and learning measures on treatment outcome

Outcome Measure	Effect of learning/memory on outcome measure at post-treatment					Effect of learning/memory on change in outcome measure between post-treatment and 6-month follow-up			
	N	***Beta***	***SE***	***p***	***95% CI***	***Beta***	***SE***	***p***	***95% CI***
					Recall (correct)				
PROMIS-SD	99	−0.04	0.02	0.14	−0.08, 0.01	0.03	0.03	0.33	−0.03, 0.10
PROMIS-SRI	99	−0.01	0.17	0.49	−0.06, 0.03	0.00	0.03	0.89	−0.05, 0.06
DSM-5 Cross Cutting	99	−0.01	0.02	0.50	−0.06, 0.03	0.01	0.03	0.81	−0.05, 0.07
SDS	98	−0.02	0.02	0.33	−0.06, 0.02	−0.01	0.03	0.66	−0.07, 0.04
					Thoughts (# accurate)				
PROMIS-SD	81	0.04	0.09	0.64	−0.22, 0.14	0.16	0.14	0.26	−0.12, 0.44
PROMIS-SRI	81	0.01	0.08	0.91	−0.15, 0.74	−0.07	0.12	0.54	−0.16, 0.31
DSM-5 Cross Cutting	81	0.01	0.09	0.92	−0.17, 0.19	−0.08	0.14	0.59	−0.36, 0.21
SDS	80	0.01	0.09	0.87	−0.15, 0.18	−0.14	0.14	0.30	−0.41, 0.13
					Application (# accurate)				
PROMIS-SD	81	−0.03	0.08	0.65	−0.18, 0.12	−0.15	0.13	0.26	−0.41, 0.11
PROMIS-SRI	81	−0.09	0.18	0.18	−0.22, 0.04	0.03	0.11	0.81	−0.12, 0.24
DSM-5 Cross Cutting	81	−0.02	0.08	0.75	−0.17, 0.02	−0.14	0.13	0.29	−0.40, 0.12
SDS	80	−0.09	0.07	0.20	−0.22, 0.05	−0.10	0.12	0.39	−0.33, 0.13
					Advice				
PROMIS-SD	95	−0.04	0.06	0.46	−0.15, 0.10	0.05	0.07	0.52	−0.10, 0.19
PROMIS-SRI	95	−0.06	0.05	0.23	−0.17, 0.04	0.03	0.07	0.64	−0.10, 0.16
DSM-5 Cross Cutting	95	−0.02	0.05	0.65	−0.12, 0.08	−0.11	0.07	0.10	−0.24, 0.02
SDS	94	−0.05	0.05	0.38	−0.15, 0.05	−0.05	0.07	0.44	−0.18, 0.08

Note. PROMIS-SD = Patient-Reported Outcomes Measurement Information System – Sleep Disturbance. PROMIS-SRI = Patient-Reported Outcomes Measurement Information System – Sleep-Related Impairment. DSM-5 Cross Cutting = DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure – Adult. SDS = Sheehan Disability Scale (Sleep). Table displays standardized values.