Music Therapy to Regulate Arousal and Attention in Patients With Substance Use Disorder and Posttraumatic Stress Disorder: A Feasibility Study

Laurien Hakvoort, PhD, RMTh, NMT-F
ArtEZ University of the Arts, Enschede, The Netherlands

Sirik de Jong, BSW, RMTh, NMT-F
ArtEZ University of the Arts, Enschede, The Netherlands

Maartje van de Ree, MA, RMTh, NMT-F
ArtEZ University of the Arts, Enschede, The Netherlands
Tactus, Addiction Care Twente, Enschede, The Netherlands

Tim Kok, PhD
Tactus, Addiction Care Twente, Enschede, The Netherlands

Clare Macfarlane, MA, RMTh, NMT-F
Penitentiary Psychiatric Center Institution Vught, VU University, Amsterdam, The Netherlands

Hein de Haan, MD, PhD
Tactus, Addiction Care Twente, Enschede, The Netherlands

Patients diagnosed with both substance use disorder (SUD) and posttraumatic stress disorder (PTSD) often experience hypervigilance, increased fear, and difficulties regulating emotions. This dual diagnosis...
increases treatment complexity. Recently, a short-term music therapy intervention for arousal and attention regulation (the SMAART intervention) was designed based on neurobiological findings. Twelve patients with SUD and PTSD (50% females) in outpatient treatment participated in six weekly one-hour sessions of the SMAART intervention. Six patients completed the study. PTSD symptom severity was evaluated with the Posttraumatic Stress Disorder Symptom Scale Interview for DSM–5 (PSSI-5) pre- and post-intervention, and sustained attention was evaluated with the Bourdon–Wiersma (BW) test. A significant difference in measurements for the PSSI-5 overall symptom severity was found pre- and post-intervention. Furthermore, participants showed significant improvement on subscales of hyperarousal, mood and cognition, and attention. The BW test completion time decreased significantly. Two participants dropped out before the end of the intervention due to craving. Concerning future research, it is recommended to define the role of the music more explicitly and to change the design to a randomized controlled trial. A risk for future larger studies is a high dropout rate (50%). Several limitations of the study are discussed.

**Keywords:** substance-related disorders; music therapy; stress disorders; post-traumatic

According to the World Health Organization (n.d.), approximately 31 million people worldwide are assumed to be dependent on one or more narcotic substances. The lifetime prevalence of any substance use disorder (SUD) is estimated to be 14.6% (Kessler et al., 2007). Substance Abuse and Mental Health Services Administration (SAMHSA) numbers show that 2.7% of the adult population have a current drug use disorder and 7.2% have a current alcohol disorder (SAMHSA, 2013). A substantial number of these people do not receive treatment. Among those people who are diagnosed with a SUD, the estimated prevalence of posttraumatic stress disorder (PTSD) comorbidity varies between 11% and 61% depending on the different populations under study and which assessment procedure is used (Gielen, 2015; Ouimette, Read, & Brown, 2005; Van Dam, Vedel, Ehring, & Emmelkamp, 2012). These studies suggest that symptom severity and the risk of relapse in substance use are higher in patients with SUD and PTSD than in
those without PTSD. Patients diagnosed with PTSD experience several disrupting symptoms that have a profound negative impact on their life. Often-reported symptoms are nightmares, insomnia, feelings of numbness, or extreme emotional and physical reactions to stressors and trauma-related stimuli (Van der Kolk, 2014). People with a dual diagnosis of SUD and PTSD are more difficult to treat (Najavits, Weiss, & Shaw, 1999).

In a systematic review on SUD and music interventions (N = 40 studies), Hohmann, Bradt, Stegemann, and Koelsch (2017) reported positive effects of music therapy on the mood and emotion regulation of patients with SUD in studies with multiple music therapy sessions. Five studies observed a decrease in anxiety, stress, depression, and anger. However, the data were too limited to draw any firm conclusions, and the study did not focus on treatment goals such as arousal or attention. Megranahan and Linskey (2018) reported in their systematic review of studies on the use of creative arts therapies in the treatment of substance misuse “a strong positive effect for music therapy to enhance contemplation (0.9), treatment readiness (0.76), motivation (0.54) and reduction of cravings (−0.54)” (p. 50), but they mentioned that the studies reviewed were low- to moderate-quality studies. Ghetti et al. (In review) reported in their meta-analysis on music therapy and SUD that music therapy interventions had a positive impact on treatment readiness, motivation for change, craving, and specific mood regulation (depression and anxiety). However, the primary outcomes (the severity of substance dependence and the reduction of substance use) were not addressed in the included studies.

Imaging studies in patients with SUD have identified an important involvement of the prefrontal cortex (PFC) in higher-order executive function, leading to problems with salience attribution and self-control (Goldstein & Volkow, 2011). Emotion regulation disturbances in patients with SUD may derive from impairments in prefrontal functions rather than from excessive reactivity to emotional stimuli. Treatments for emotion regulation that normalize prefrontal functioning seemed to offer greater efficacy for SUD than treatments that dampen reactivity (Wilcox, Pommy, & Adinoff, 2016). As cognitive problems, such as attention problems, are supposed to undermine successful recovery and induce relapse, Rezapour, DeVito, Sofuoglu, and Ekhtiar (2016) and Sofuoglu,
DeVito, Waters, and Carroll (2016) advocated for a neurocognitive rehabilitative approach for patients with SUD.

Hyperarousal and an inability to self-regulate are a problem not only for patients with SUD but also for patients with PTSD. Hyperarousal and an inability to self-regulate are associated with increased amygdala activity and decreased activity in the PFC (Hayes, Hayes, & Mikedis, 2012; Rauch et al., 2003). The decreased PFC activation might prevent the PFC, including the anterior cingulate cortex, from regulating amygdala activity, which leads to increased fear responses, attentional bias toward threat, hypervigilance, and problems in emotion regulation (Pitman et al., 2012). The abnormalities in these areas might correspond with deficits in sustained attention for patients with PTSD (Aupperle, Melrose, Stein, & Paulus, 2012; Scott et al., 2015; Shucard, McCabe, & Szymanski, 2008).

Even though research indicates that hyperarousal, impaired cognitive functioning, and deficits in sustained attention can interfere with the cognitive and verbal treatment of SUD and PTSD (Van der Kolk, 2014), the regulation of arousal levels or sustained attention skills is not addressed in most common evidence-based treatment protocols for these disorders. Cognitive behavioral therapy (CBT; Foa, Hembree, & Rothbaum, 2007; McGovern et al., 2009; Mills et al., 2012; Triffleman, Carroll, & Kellogg, 1999) focuses mainly on exposure to triggering situations and challenging dysfunctional thoughts, beliefs, and behavioral aspects. Eye movement desensitization and reprocessing (EMDR; Shapiro, 2014) aims to desensitize traumatic memories. Integrative approaches for SUD and PTSD, such as Seeking Safety, focus on developing adaptive cognitive, emotional, and behavioral coping skills and include grounding techniques (Najavits, 2002; Roberts, Roberts, & Bisson, 2016). However, hyperarousal and disrupted attentional functions are only partly addressed.

The brain of a traumatized person acts as if the person’s life is continuously threatened (Perry, 2009). The regulation of the hyperactivity of brain regions is recommended, starting with the earliest affected and disturbed brain regions. Patterned, repetitive somatosensory input could provide the affected brain regions with patterned neural activation and could support these brain regions in calming down. Once these areas are regulated and calmed
down, hyperarousal and impulsivity can decrease, and attention and self-regulation might increase (Perry, 2009). In this context, music might be a possible facilitator.

Music is intrinsically rhythmic patterned and can influence brain patterns through somatosensory input. Moreover, rhythm has the ability to connect the auditory neural system with the motor system and drive movement patterns. This is an automatic mechanism called rhythmic entrainment, which explains why people often unconsciously tap along with music (Thaut & Hoemberg, 2014). Rhythmic entrainment occurs involuntarily and on a nonconscious level in the brain (Nozaradan, Peretz, & Mouraux, 2012). By changing the tempo of the pulse, music has the ability to either reduce hyperarousal or increase it by provoking a stress response. Therefore, the use of rhythm in music therapy could be clinically relevant in the treatment of individuals with SUD and PTSD. Music therapy exercises can function as a tool to regulate hyperarousal, and music therapists can simultaneously instill self-regulation skills. However, a literature review indicated no results for music therapy as a treatment for SUD and co-occurring PTSD to date.

Considering the previously described effects of music and specifically rhythm on hyperarousal and attention, Macfarlane (2019) designed a short-term music therapy arousal and attention regulation treatment (SMAART) intervention to support people with PTSD in regulating their arousal and attention levels. Macfarlane, Masthoff, and Hakvoort (2019) conducted a pilot study to examine the feasibility of the SMAART intervention in people with PTSD who were incarcerated in a psychiatric prison center. All participants were dual diagnosed (i.e., PTSD and a personality disorder or psychotic disorder). Promising results were found regarding the decrease in PTSD symptom severity, such as hyperarousal, and the improvement in sustained attention. The present study aims to replicate this study to examine the feasibility of the SMAART intervention in people with SUD and co-occurring PTSD. The study was conducted with participants who were in an outpatient treatment for SUDs. For most of the participants, the SUD was under control. We decided to conduct the SMAART intervention in an outpatient treatment population of individuals with SUD and PTSD to observe possible risks of the protocolled intervention for this vulnerable population.
The following feasibility question was formulated: could the six-session music therapy arousal and attention regulation treatment protocol be applied to decrease hyperarousal (and other PTSD symptoms) and improve sustained attention for patients dual diagnosed with SUD and PTSD? Furthermore, the researchers sought to determine which features of the treatment protocol might need to be adjusted to allow future studies.

Methods

Research Design

To date, this is the first study on a manualized, short-term music therapy intervention targeting hyperarousal and attentional functioning in people with SUD and PTSD. A pre-/posttest design with repeated measures was used to determine whether any effects of the intervention could be observed. The short-term design of the music therapy intervention (six weeks) allowed the potential demonstration of an immediate impact of the intervention.

A scientific ethical committee of the addiction treatment center approved the study (IRB approval). Dutch law requires an additional approval of a medical ethical committee in cases of (medical) interventions. Due to the noninvasive nature of the study, the approval of a medical ethical committee (as defined in the Medical Research Involving Human Subjects Act [WMO]) was waived by the Ethical Committee of the VU University, Amsterdam.

Population

In this study, participants (N = 12) were recruited from an outpatient treatment center for addiction in the Netherlands. Table 1 provides an overview of the participant’s characteristics. Patients were eligible for the study if diagnosed with SUD by the Composite International Diagnostic Interview-Substance Abuse Module (Cottler, Robins, & Helzer, 1989) and with PTSD by the DSM-5 criteria (American Psychiatric Association, 2013), confirmed by the Clinician-Administered PTSD Scale (CAPS [Dutch version]; Boeschoten et al., 2014). To enroll in the research program, a minimum score of 23 (range 0–80) on the Posttraumatic Stress Disorder Symptom Scale Interview for DSM–5 (PSSI–5; Foa
et al., 2016) at pretest was required ($N = 12$). Foa et al. (2016) quote 23 as the cutoff score for a PTSD diagnosis. Participants with psychotic and severe mood disorders were excluded. All participants lived independently and visited the center for addiction for one or two half-day treatment meetings per week. They received a special program for people with comorbid PTSD. Their outpatient treatment included a personalized combination of different treatment interventions, such as Seeking Safety (Najavits, 2002), CBT, pharmacological treatment, and motivational interviewing, and some received EMDR and/or case management. Most participants were abstinent, and some were in “controlled use.”

Patients enrolled in outpatient treatment, who met the inclusion criteria, were contacted and informed about the research project by their clinician. After receiving their written consent, these patients were included in the research. Participation was voluntary, and participants did not receive any financial reward.

**Sampling Techniques**

Due to the treatment complexity of the population and the explorative nature of this study, a convenience sampling method was used based on the formulated inclusion criteria. The generalization of results is limited because the sample was not representative of the entire population. Participants were considered dropouts if the treatment was terminated before the sixth session.

**Table 1.**

*Participants’ Characteristics*

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Total $N = 12$</th>
<th>DSM-5 Diagnose SUD Main Substance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Age (SD)</td>
<td>44 (12.9)</td>
<td>Alcohol 50% ($N = 6$)</td>
</tr>
<tr>
<td>Gender</td>
<td>50% ($N = 6$) female</td>
<td>Cannabis 17% ($N = 2$)</td>
</tr>
<tr>
<td>PTSD</td>
<td>92% ($N = 11$)</td>
<td>Cocaine 8% ($N = 1$)</td>
</tr>
<tr>
<td>Complex PTSD</td>
<td>83% ($N = 10$)</td>
<td>Amphetamines 17% ($N = 2$)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sedatives 8% ($N = 1$)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Polydrug use 50% ($N = 6$)</td>
</tr>
</tbody>
</table>

*Note. DSM-5 = Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM–5; American Psychiatric Association, 2013); PTSD = Post-traumatic Stress Disorder; SUD = Substance Use Disorder; SD = Standard Deviation.*
Intervention

In addition to their outpatient treatment, participants received weekly one-hour manualized, protocolled individual music therapy sessions (the SMAART intervention) as designed by Macfarlane (2019) for six consecutive weeks, delivered by one of the two qualified music therapists. One interventionist was a qualified music therapist with a bachelor’s degree, studying for a master’s degree, with one year of clinical expertise after graduation. The other interventionist had both a bachelor’s and a master’s degree in music therapy and had over four years of clinical expertise after graduation. Both were trained in neurological music therapy. The SMAART intervention protocol (Macfarlane, 2019) was followed carefully. To ensure that both therapists administered the in-between measures identically, both music therapists received supervision. Videotapes of the therapy sessions were evaluated twice during the research process for treatment fidelity.

The sessions took place uninterrupted in an almost empty room in the basement of the clinic, with little ambient sound (Robb et al., 2018). The music therapists started each session with an assessment of PTSD symptoms with the PSSI-5, reviewed the homework log (15 min), and provided psychoeducation (5 min) (see Figure 1). This was followed by three music therapy interventions: (a) breathing/singing (5 min), (b) body percussion (15 min), and (c) musical attention control training (20 min). Psychoeducation focused on the neurobiological and psychological effects of trauma, the stress response, and how the therapeutic mechanisms of the music therapy intervention can contribute to the recovery.

The main goal of the SMAART intervention was to calm and regulate brain areas such as the amygdala (Perry, 2009) and thereby reduce hyperarousal. After assessment and a short (recall of) psychoeducation by the music therapist, the participants began with breathing and singing exercises that focused on mastering abdominal breathing (exhaling longer than inhaling). Next, the therapist initiated the body-percussion intervention. A metronome provided an external pulse to which the participant played rhythmical patterns. This intervention enabled the brainstem and amygdala to synchronize to an external pulse and thereby promoted patterned, organized activity. This intervention aimed to reduce hyperarousal. If the participant succeeded in following the rhythm
while breathing calmly, the tempo of the metronome or the complexity of the rhythmical pattern was expanded. By increasing the tempo and difficulty of the task, a basic, but small, stress response was provoked. The therapist observed the (physical) reactions of the participant, such as changes in the breathing pattern or muscle tension, as a result of the stress response. If a stress response occurred, the participant’s attention was redirected to the breathing pattern. The participant was prompted to recognize and regulate the occurring stress response or hyperarousal. Participants received daily homework assignments to integrate the breathing and body-percussion skills into everyday life situations to maximize the learning effect. Participants were requested to keep a log of the times they performed the homework assignments.

The second goal of the SMAART intervention was to promote sustained attention and the ability to maintain focus on a task. For this purpose, Music Attentional Control Training (MACT) was applied (Thaut & Gardiner, 2014). To improve sustained attention, musical exercises were focused on administering changes in the attentional system. The participant was asked to play along while maintaining focus on auditory stimuli played by the music therapist. The participant followed these musical changes constantly while joining the musical improvisation of the therapist. Music triggered attention by changes in structure, timing, and melody, enabling increased sustained attention (Juslin, 2019; Thaut & Gardiner, 2014). Another benefit of training attention skills with music was that the participants (and therapist) easily noticed any attention shifts. During this study, attention shifts were immediately audible in, for example, rigid patterns of the participant. The musical exercises were executed with voice, xylophones, djembes, and body percussion.

**Measures**

To measure the initial treatment outcomes, PTSD symptoms were assessed pre- and post-intervention as well as at the beginning of each of the six SMAART intervention sessions (see Figure 1). The CAPS (Boeschoten et al., 2014) was used to assess PTSD diagnosis pretreatment. The (Dutch) PSSI-5 (Foa et al., 2016) was used to evaluate changes in PTSD symptoms. The PSSI-5 measures PTSD-related symptoms over the past
month for four domains: re-experiencing, avoidance, changes in cognition and mood, and increased arousal and reactivity. An abbreviated version of the PSSI-5 was used for repeated
measurements. This abbreviated version is almost identical to the PSSI-5, missing the trauma screening questions, two questions regarding distress and interference, and two questions about the symptom onset and duration. This way it requires less time to assess but allows a direct comparison for the four domains. Repeated measurements were obtained by the music therapists according to the instruction manual of Foa et al. (2016). According to Foa et al. (2016), the PSSI-5 is a reliable measure for PTSD symptoms with good test–retest reliability ($r = .87$) and excellent interrater reliability (intraclass correlation = .98) for total scores of PTSD symptom severity. Furthermore, the PSSI-5 had convergent validity with the CAPS ($rs > .72$) (Foa et al., 2016).

The Bourdon–Wiersma (BW) test, also known as the dot cancellation test (Bourdon et al., 1977), was administered by the clinician for the assessment of sustained and selective attention. The BW test is a pencil-and-paper test with an additional limited time element to demand and measure sustained and selective attention. The participant has to sustain attention in reviewing 50 lines of dot-groups, circling four-dot-groups while looking past the groups of three and five dots. The time to complete the BW test, overlooked and incorrectly identified dot-groups, and mistakes are calculated. No psychometric properties of the BW test are available for adults (e.g., see Vos, 1998 for properties for teenagers). More modern alternatives were debated but were rejected to ensure the replication of the Macfarlane et al. (2019) study.

To gain insight into actual withdrawal symptoms, the Dutch Subjective Withdrawal Scale (SOS) (De Jong, Van Hoek, & Jongerhuis, 2004) was administered for psychoactive substances. The Dutch version of the Obsessive Compulsive Drinking Scale (OCDS) for alcohol use (Schippers et al., 1997) was used to measure craving symptoms. The SOS and OCDS are both self-administered scales and are primarily used to measure the signs and symptoms of substance withdrawal and craving, respectively. The SOS or OCDS was administered to participants if they reported that they had used substances in the week prior to participation in a session. The SOS is derived from the Subjective Opiate Withdrawal Scale (Dijkstra, Krabbe, Riezebos, Van der Staak, & De Jong, 2007), and the psychometric properties of
the Dutch SOS are not yet established (De Haan, van der Palen, Wijdeveld, Buitelaar, & De Jong, 2014). The psychometric properties of the OCDS are moderate for adults (Kranzler, Mulgrew, Modesto-Lowe, & Burleson, 1999) and good for young adults (Connor, Feeney, Jack, & Young, 2010). The validated and adjusted (to also measure craving for other substances) Dutch version was used (Schippers et al., 1997).

**Data Collection**

Data (PSSI-5, BW, and SOS/OCDS) were collected prior to the SMAART intervention by a trained, independent psychologist of the treatment center. At the beginning of each session, the music therapist discussed the homework logs and administered the shortened PSSI-5 to assess PTSD symptoms. Music therapists who conducted these in-between measurements were blinded regarding the results of the pretest. The SOS or OCDS was administered when applicable. If a participant indicated substance use eight hours prior to the intervention, the session was postponed. To prevent instrumentation bias, the researchers used the SMAART protocolled intervention. Posttests were administered by the same psychologist who conducted the pretests one week after concluding the music therapy intervention. The same measurement tools were used for pretests and posttests.

**Data Analyses**

Data were anonymized before analysis. The homework logs were not taken into account, since adhering to the homework, as well as logging it, differed greatly among participants. After exploratory analyses, appropriate statistical tests were conducted in IBM SPSS 24. Differences in the pretest and posttest results and tendencies over time are displayed in graphs. Due to the small sample size, measures of the PSSI-5 were analyzed using nonparametric statistical tests. For pre-/posttest analyses, the Wilcoxon signed-rank test (a nonparametric variant of the dependent t-test) was performed. A significance level of .05 was established, and z-scores were calculated. We computed a standardized effect size $r$ by dividing the $Z$-statistic by the square root of the total number of incorporated cases ($N=6$), as suggested by Pallant (2016). Using Cohen and Cohen (2013) criteria, we defined $r=.1$ = small effect, $r=.3$ = medium effect, and $r=.5$ = large
effect. An inspection of the difference between the pretest and posttest medians provided further insight into the size of the effect.

**Results**

In total, 6 out of the 12 participants completed the music therapy intervention (dropout rate 50%). The data of those six participants were analyzed. All but one participant was diagnosed with PTSD with childhood/adolescence onset. The first participant to enroll unexpectedly did not meet the PSSI-5 criterion of a score of 23 (PSSI-5 score was 20) but was included due to the subjective experience of the participant and the intensity and frequency of symptoms as suggested by Foa et al. (2016). Three of the six participants completed the SMAART intervention and had a PSSI-5 score beneath the cutoff score (23) for PTSD after the six SMAART intervention sessions.

**PTSD Symptoms—Group Analyses of Treatment Completers**

The differences in outcomes of PTSD overall symptoms, measured with PSSI-5, are displayed in Figure 2. There was a significant difference in pretest outcomes (Mdn = 34.00, IQR = 20.25) (Mdn stands for median and IQR standing for interquartile range) compared with posttest outcomes, indicating a decrease in the overall experienced symptoms after the intervention (Mdn = 21.00, IQR = 13.00–37.00), $Z = -2.49, p = .012$. The effect size was large as defined by Cohen and Cohen (2013; $r > .5$) ($r = -.56$ with a substantive decrease in the median score of 13 points).

Second, comparisons were made of outcomes per PTSD symptom cluster (re-experiencing, avoidance, mood/cognition, and arousal) (see Figure 3). The graph displayed in Figure 3 revealed an overall PTSD symptom reduction after the first session. At the start of session 3, hyperarousal and re-experiencing increased slightly. However, at the next sessions, re-experiencing, arousal, and avoidance started to decrease and continued to do so. At session 5, there was an increase in the decay of mood and cognition, but in all other clusters, the symptoms continued to decrease. Re-experiencing symptoms and avoidance were the least affected by the music therapy intervention. Concerning re-experiencing symptoms and avoidance, no significant differences were seen.
Figure 2.
Median scores of PTSD symptom changes per session measured by PSSI-5 (for the six participants who completed the study). Note. The Y-axis represents the scores on PSSI-5 (maximum score is 80), the X-axis represents the scores from pre- to posttest with repeated measures before each music therapy session. The bars show the median scores of participants per measure and the error bars represent the 95% confidence interval for the median.

Figure 3.
PSSI-5 Median scores per symptom cluster per treatment session (N = 6) as assessed by the music therapist at the beginning of each session and an independent assessor for pre- and post-treatment. Note. The Y-axis represents the median scores on PSSI-5, and the X-axis represents the number of the session.
from pretest to posttest. Analyses of mood and cognition showed a significant decrease in median score from pretest outcomes (Mdn = 13.50, IQR = 6.75) to posttest outcomes (Mdn = 7.50, IQR = 5) Z = −2.41, p = .016, r = −.54 (large effect). A similar decrease was observed in arousal as an outcome, from pretest outcome (Mdn = 10.00, IQR = 8.25) to posttest outcome (Mdn = 5.50, IQR = 7.5), Z = −2.81, p = .05, r = −.63 (indicating a large effect).

Attention—Group Analyses of Treatment Completers

To explore whether the intervention improved sustained attention among participants, the BW test was performed before and after the six-week intervention. An analysis at the group level revealed a small but significant decrease in completion time between pretest scores in minutes (Mdn = 11:30, SD = 02:02) and posttest scores in minutes (Mdn = 10:39, SD = 02:03), (Z = −2.29, p = .022, r = −.51). Nonsignificant results were found for the number of mistakes and misses.

Relapse and Abstinence

Five of the participants who completed the study were abstinent, varying between two days and eight months, prior to the research. Not one of them relapsed or reported to experience craving or withdrawal during the study. One participant was in “controlled use” and did not report more frequent use or increased severity of the SUD. Therefore, the OCDS and SOS data were not analyzed. However, two other participants dropped out due to mild to severe craving symptoms.

Case Studies

To gain a better understanding of the perspectives of individuals who completed the treatment, we provide an additional case description of the completing participants, providing background information. An overview of the main results per participant is provided in Figure 4.

Participant 1. The participant was a female in controlled use of cannabis during the intervention. Although PTSD symptoms were officially below the cutoff score of 23, participant 1 was included due to the severity of the trauma and the specific characteristics. This decision was justifiable since the first assessment by the music therapist revealed a higher PTSD symptom score of 27.
The overall symptom severity of participant 1 improved from 20 to almost 0 symptoms (Figure 4; see the solid line). The participant improved on all PTSD symptoms but avoidance. Avoidance mildly increased during the intervention. The participant was diagnosed with avoidant personality disorder, which might be a confounding factor. The participant declared that a dear pet had died one week prior to the peak of week 3, which provided an explanation for the sudden increase in symptoms. Performance on the sustained attention test improved by 14.5%.

Participant 3. The participant was a male who was 16 weeks abstinent of alcohol and 2 days abstinent of cannabis prior to the intervention. No substance use was reported during the intervention, and no craving or withdrawal symptoms were observed. PTSD overall symptom severity decreased during the intervention (Figure 4; dotted line) by 55%. At sessions 4 and 5, a mild increase in avoidance symptoms was measured, accompanied by increased scores on arousal symptoms, while re-experiencing and mood/cognition remained the same. The participant attributed this to the stress surrounding the Christmas holidays. From session 6 to posttreatment, overall scores remained below the cutoff score. Performance on the sustained attention test improved by 19%.

Figure 4. PSSI-5 sum-score for symptoms per session for treatment completers. Note. The Y-axis represents the sum-score on PSSI-5 (maximum score is 80), and the X-axis represents moments of assessment. For each individual participant, the sum-score of the pretest was compared with session and the post-score (re-experiencing, avoidance, cognition, mood, and arousal symptoms) and graphed per session.
Participant 4. This participant was a female with an alcohol use disorder. Although she declared to the music therapist that the urge to drink alcohol was overwhelming (score of 14 [out of 20] on the OCDS at the start of session 5 and a score of 12 on OCDS at the start of session 6), the participant reported to the psychologist that no craving had occurred during the study (as measured four days after the last SMAART intervention). Overall, PTSD symptoms decreased by 25.5% but remained above the cutoff score post-intervention (Figure 4; dot-space line). Over time, there was a slight increase in arousal symptoms, with a peak at session 5. The participant reported no substance use during the intervention, except in the week prior to session 5. From pretest to posttest, there was no improvement in re-experiencing symptoms. Although there was a reduction in the overall severity of symptoms, the participant still experienced PTSD symptoms every day, which had a profound negative impact on everyday functioning. Arousal symptoms decreased by 23% and sustained attention improved by 13% from pretreatment levels.

Participant 5. This female participant with an alcohol use disorder in early remission did not report any substance use and was abstinent in the four months prior to enrollment in the study. The total PTSD symptom severity decreased by 42.2%, and the posttest results were below the cutoff score (Figure 4; line-space line). Avoidance and mood, cognition, and arousal improved (50%) compared with pretreatment, but re-experiencing symptoms remained the same. Sustained attention improved by 37.5%.

Participant 7. The participant was a male who reported no substance use and was abstinent from amphetamines for approximately nine months. Overall, symptom severity seemed to increase from pre- to posttest, but arousal symptoms decreased by 33%. The pattern of the graph (Figure 4; line-dot line) is rather unpredictable. Re-experiencing and avoidance symptoms seemed to decrease and increase simultaneously over time, with an explicit increase from session 6 to posttest. This increase was possibly due to an exposure visit to the trauma site just prior to the assessment. Performance on the attention span test also did not improve.

Participant 10. This male participant was nine months abstinent from alcohol and maintained this during the intervention. Symptom severity seemed to decrease gradually over time (Figure 4; line-dot-space line) by 18%. At session 2, there was a
sudden decrease in avoidance symptoms, accompanied by higher scores on mood and cognition. The participant reported that the focus on the trauma symptoms increased stress levels at first. After treatment, the arousal symptoms diminished by 22%, and the performance on the sustained attention test improved by 13%.

**Discussion**

The aim of this study was to determine whether the SMAART protocol could be applied for patients dual diagnosed with SUD and PTSD to decrease hyperarousal (and other PTSD symptoms) and improve sustained attention. To answer this question, the 12 participants diagnosed with SUD and PTSD enrolled in this study received six weekly one-hour music therapy sessions. Since most participants were in control of their SUD, the main focus was on controlling PTSD symptoms.

Symptom severity was measured pre- and post-intervention with the PSSI-5 by an independent psychologist, and, at the start of each SMAART intervention session, an abbreviated version of the PSSI-5 was administered by a qualified music therapist for in-between measurements. The diagram displayed in Figure 2 revealed an increase in PTSD symptoms from pretest to first assessment with the music therapist. An explanation for this finding might be a higher arousal level due to the unfamiliarity of the first session of music therapy. The graph displayed in Figure 3 revealed an overall PTSD symptom reduction after the first session, almost back to the level of the pre-assessment. This might be a result of the psychoeducation combined with relaxation/deep belly breathing and (body) percussion or the fact that the participant was now familiar with the music therapy intervention. When reviewing the development of the overall PSSI-5 results throughout the intervention (see Figure 3), an increase in symptom severity was measured in the first three to four sessions. Subsequently, the symptoms decreased from session 4 to posttest. In addition to external causes, the ascending trend might be attributed to the reduction in avoidance and increased attentional functioning. A second explanation could be a more open sharing of PTSD symptoms with the music therapist due to a developing therapeutic relationship. Therefore, it was assumed to be even more important to have the pre- and post-assessment performed by an independent, trained psychologist.
Sustained attention was measured pre- and post-intervention with the BW test and showed good improvements in sustained attention. The improvement in attention is even more remarkable since research in psychotherapy provides no evidence that psychotherapy improves attention in patients with PTSD (Devineni, Blanchard, Hickling, & Buckley, 2004; Walter, Palmieri, & Gunstad, 2010). Whether these changes in attention have any long-lasting consequences for SUD is still unclear, although attention deficit disorder is assumed to be an eliciting factor in substance use (Van der Burg, Crunelle, Matthys, & Van den Brink, 2019). Although there were too few participants to draw any firm conclusions, these initial results suggest that the regulation of arousal levels and sustained attention skills, essential for decreasing PTSD symptoms according to Van der Kolk, (2014), is possible through the short-term music therapy treatment focused on arousal and attention regulation as protocolled in the six sessions with patients with SUD and PTSD. Despite the symptom severity and the risk of relapse in the addictive behavior of patients with SUD with PTSD when exposed to trauma treatment (Gielen, 2015; Najavits et al., 1999; Van Dam et al., 2012;), only some treatment completers reported increased relapse or craving problems during the SMAART intervention. Most of the participants shared in their anecdotal feedback that they perceived the body-percussion and singing/breathing exercises to be very helpful tools to regulate moments of rising arousal, even in their home situations.

This study had a considerable number of treatment dropouts (six, equaling 50%). There seemed to be no differences in gender or the dependent substance used that could distinguish the dropouts from the completers (at least not with a small N = 12). Four of the patients to drop out were alcohol dependent, one was speed dependent, and one was cannabis dependent. The dropout rate among treatment seekers for SUD and PTSD is generally high. Numbers vary between 35% and 62% (Belleau et al., 2017). Researchers suggested that exposure to traumatic stimuli may be a cause of early dropout (Szafranski et al., 2017), as well as increased sensitivity for anxiety (Belleau et al., 2017) or hyperarousal (Garcia, Kelley, Rentz, & Lee, 2011). Dropout occurred for various reasons. Two participants who dropped out improved substantially with regard to overall PTSD symptoms after three to four SMAART intervention sessions and, therefore, stopped participating in
the program. Two others dropped out due to moderate to severe craving during the intervention period. One participant quit because of different expectations of what the music therapy would entail. The last participant who dropped out did not provide any reason. Most dropouts occurred around session 4. In future studies, we might offer participants additional psychoeducation surrounding difficult moments in the treatment process.

The second aim of the feasibility study was to determine which features of the treatment protocol might need to be adjusted to allow future studies. Participants who dropped out in the current study provided valuable input for adjustment for future SMAART intervention and research. The majority of the participants who dropped out reported different expectations with regard to the musical part of the music therapy. Playing with a metronome was reported to be boring. The xylophone was not very interesting either; other instruments could have made participation more appealing. Potential solutions include the following: (a) clearly explaining the music therapy intervention before obtaining consent, (b) using relaxing personalized music as an alternative for the metronome, and (c) allowing other musical instruments than the xylophone to be utilized during the MACT intervention.

Limitations

As previously mentioned, we cannot draw any substantial conclusions, since this study has multiple limitations. The first is the study design, which bears threats to external validity since no comparison or control group was examined. Because a control group is lacking, factors outside the research might have influenced the outcome of the study. A second important limitation is the small number of participants in the study. It turned out to be difficult to schedule SMAART intervention meetings outside the regular treatment days. Therefore, fewer patients could participate than estimated at the start of the study. Due to the small number of participants, the feasibility findings must be interpreted with caution.

A confounding factor that should be addressed before starting future studies is the simultaneous exposure of participants to other treatments during the study in their outpatient treatment. Another confounding factor we found was that the PSSI-5 was experienced as quite a confronting assessment tool throughout all sessions.
According to the participants’ feedback, that effect did not wear off over the course of the six sessions. With regard to the BW test, we could not rule out a learning effect, though it is unlikely because of the relatively large interval between the pretest and posttest. All in all, the limitations demonstrate that, at least for now, it is not possible to attribute our findings solely to the music therapy intervention.

**Conclusion**

To our knowledge, this is the first study that investigated the effects of a protocolled, short-term music therapy intervention to reduce hyperarousal and increase sustained attention in patients with SUD and PTSD. Despite the limitations of the study design, we identified (significant) differences in pretest and posttest outcomes concerning sustained attention, hyperarousal, and overall PTSD symptom severity scores. The measured changes, supported by the statistical and theoretical analyses of our findings, enabled us to provide recommendations for clinical practice and further research.

This study was a replication of the study by Macfarlane et al. (2019) and a first attempt to evaluate and explore the feasibility of implementing the SMAART intervention protocol for patients with SUD and PTSD. Future research can continue in this direction and investigate possible treatment effects of the SMAART intervention for people with a dual diagnosis of SUD and PTSD. In preparation for more large-scale experiments, further research could investigate the intervention as an initial treatment program and evaluate the effects of SMAART in addition to other treatment interventions, such as Seeking Safety, exposure therapy or EMDR, and the treatment results. Topics of interests would be, for example, whether any delayed effects occur and how the intervention affects treatment dropout and outcomes in later therapies such as EMDR.

**Statement of Ethics**

All participants gave their written informed consent. The study protocol was approved by the Scientific Committee on Human Research of Tactus.
Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Authors’ Contributions

L. Hakvoort conceptualized and directed this study and revised all of the subsequent drafts; S. de Jong collected and analyzed the data and wrote the first draft of the manuscript (L. Hakvoort and S. de Jong are shared first author); and M. van de Ree developed the initial research design and collected data. T. Kok recruited participants, collected pre/post measures, and facilitated the necessary conditions for the research; H. de Haan contributed to the conception and design of the study; and C. Macfarlane supervised music therapists and provide basic structure and foundation of the study. All authors contributed to manuscript revisions, read, and approved the submitted version.

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