The Influence of an Attachment-Related Stimulus on Oxytocin Reactivity in Poly-Drug Users Undergoing Maintenance Therapy Compared to Healthy Controls

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Background: Substance use disorders (SUDs) have been described as a dysfunctional way to compensate for deficiencies in that person’s underlying attachment system. Furthermore, the neuropeptide oxytocin (OT), which is a critical component of the neurobiology of the attachment system, has been shown to effectively reduce addictive behavior and therefore has been discussed as a potential medication in SUD treatment. This study investigates variation in peripheral OT plasma levels as a function of exposure to an attachment-related stimulus in SUD patients compared to healthy controls (HCs).

Methods: A total sample of 48 men, 24 inpatients in maintenance treatment who were diagnosed with poly-drug use disorder (PUD) and 24 HC, was investigated. A 15-min exposure to the Adult Attachment Projective Picture System (AAP) was used as an attachment-related stimulus and coded for attachment status. Blood samples before and after the AAP-assessment were taken and assayed for OT levels. Variation in baselines level of OT was examined in relation to the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST), the Adult Attachment-Scale (AAS), and the Brief Symptom Inventory (BSI).

Results: Following the AAP stimulus controls showed no significant difference in OT levels elevation from baseline compared to the PUD group’s OT levels. Furthermore, in the PUD group only OT-baseline-levels may be negatively associated with the AAS subscale “Comfort with Closeness” and “Anxiety” and lifetime substance use.
In the context of addiction, beneficial effects of administered OT on drug tolerance, withdrawal and seeking have been proposed across various substance classes (33, 34). Individual differences in the endogenous OT-system may therefore affect the vulnerability to addiction. SUDs have been repeatedly linked to decreased levels of OT (35–37). Furthermore, OT is assumed to modulate the mesolimbic dopamine system (38), a structure which is substantially involved with the process of addiction development and bond formation (2, 39). Similarly, there is considerable evidence suggesting interactions between the OT and endogenous opioid system (40). In line with these observations, a recent review by Zanos et al. (41) concluded that the OT system is not only meaningfully influenced by opioid addiction and abstinence but also might serve as a critical target for pharmacological interventions. Such findings inform the first aim of this study to investigate cross sectional relationships between substance use and OT levels.

Previous research indicated a relationship between the administration of stimuli designed to activate the attachment system of participants and the OT-system. One such measure, the Adult Attachment Projective Picture System (AAP) was shown to significantly increase OT levels (42). This study was conducted with a sample of healthy lactating mothers who might be thought to be especially responsive to attachment cues. Moreover, these authors hypothesized that women with more secure attachment patterns should show higher OT-reactivity. However, in this study, the authors were not able to confirm the proposed association between a larger increase in OT and more securely attached mothers. This experimental paradigm using the AAP as an attachment stimulus is adopted in the current study, while our study is focused on substance users compared to healthy controls (HCs).

What is more, in recent years, several reviews have been published which critically assess methodical flaws frequently observed within the research of the human OT system [e.g., (43–45)]. These contributions specifically emphasize the importance targeted hypotheses, consideration of differences between central processing of OT and its peripheral levels, as well studies focussed on peripheral levels making use of plasma samples, and plasma to be assayed for OT levels after extraction.

With this in mind, this study aimed to enhance the understanding the relationship between attachment and the OT-system in patients with SUD. We sought to address two primary aims. First, using baseline levels of peripheral OT, we examined their associations with substance use (using the ASSIST), attachment (using the Adult Attachment-Scale), and current symptoms (using the Brief Symptom Inventory). In relation to
the first aim, we expected to find OT levels negatively associated with insecure attachment patterns and psychopathological symptom burden in the PUD group. Our second aim follows the experimental study by Krause et al. (42), which focuses on the response of the peripheral OT-system in response to an attachment-related stimulus. In the experimental study, we compared PUD patients undergoing maintenance therapy to HCs. Following Krause, we expected to see a rise in the OT levels of health controls when exposed to an attachment stimulus. We were exploring whether the SUD group would show a different OT response to the same stimulus. However, as this is the first time, this experimental paradigm is investigated in patients undergoing maintenance treatment, this hypothesis remains exploratory.

**SAMPLE AND METHODS**

**Participants**

The study sample consisted of 48 male participants between 19 to 38 years of age (M = 27.42, SD = 4.82), consisting of one clinical (PUD; n = 24) and one non-clinical group (HC; n = 24). Participants in the clinical group met diagnostic criteria for PUD (F19.2), diagnosed according to the International Classification of Diseases version 10 (ICD 10) (46) by a licensed psychiatrist. Due to the haphazard drug use, one of the main characteristics for PUD, the drugs consumed cannot be reported in detail. At the time of the study, all PUDs were currently participating in maintenance therapy as described below. PUDs with fluid psychotic symptoms were excluded. Comorbidities with other diagnoses were distributed as follows: 9.2% Affective disorders (F3.x), 5.8% Neurotic, stress and somatoform disorders (F4.x), 4.6% Personality and behavioral disorders (F6.x), 2.3% Schizophrenia, schizotypal and delusional disorders (F2.x), 1.2% Behavioral and emotional disorders (F5.x) with onset usually occurring in childhood and adolescence.

Before participating in the study PUD patients had been in maintenance therapy for a mean time of 15 weeks (SD = 13.8) and received either Levo-Methasan (n = 21), Bupersan (n = 1), Substitol Retard (n = 1), or Compensan Retard (n = 1) as a substitution agent, with daily doses ranging from 2 to 320 mg, depending on patient and medication. Furthermore, 21 PUD patients received additional psychopharmacological medication: 16 (66.67%) received antipsychotics and 19 (79.17%) received antidepressants. Participants of the non-clinical group, exclusively non-smoking men, reported either none or just a few previous experiences with illegal substances. With the exception of occasional consumption of alcohol, no use of psychoactive substances was reported by HC in the last 30 days prior to the investigation and no use of psychopharmacological medication. HCs were included if they reported no past or present psychiatric disorder or chronic disease.

Exclusion criteria for both groups were insufficient knowledge of the German language. Clinical subjects were assessed at the Johnsdorf therapeutic facility of the Grüner Kreis Society. Non-clinical subjects were recruited through advertising on social networks and via email distribution of the University of Graz. The study was approved by the ethics committee of the University of Graz, Austria and conducted in accordance with the Declaration of Helsinki.

**Procedure and Design**

In order to eliminate any effects due to circadian rhythms the timing of the experiment was standardized. Participants were asked to fast for at least 3 hours before arriving in the laboratory (between 12.00 am and 3.30 pm), avoid caffeinated drinks and to refrain from smoking on the day of participation, before and during the experiment. After written informed consent was obtained and the subjects were notified about the course of the experiment, the first venipuncture and blood collection was performed. Immediately after, the AAP (47) was applied in which participants were asked to tell a story for each of the eight shown pictures with either monadic or dyadic scenes by answering the following questions: “What is happening in the scene?”, “What led up to the scene?”, “What are the characters thinking or feeling?”, and “What might happen next?”. The abstract line drawings indicate scenarios such as illness, separation, and abuse without detailed facial expression, allow a large scope of interpretation (47). The AAP measure is designed around a common assumption in observational and discourse attachment measures that attachment behavior is best observed directly after an attachment related stimulus is delivered or represented such as a separation, loss, illness and so on (48). The interviews lasted on average 16 min (SD = 4.50). The AAP interviews were administered by a trained psychologist in a standardized manner according to the published administration requirements. Following the AAP, and 25 min after the first blood sample a second blood sample was collected, again via venipuncture. The psychometric assessment (described below) took place online via Lime-Survey® before the experiment.

**Measures**

**Addictive Behavior**

The German Version of the Alcohol, Smoking and Substance Involvement Screening Test [ASSIST 3.0; (49), German Version; (50)] is a structured short interview designed to record lifetime consumption behavior and its negative effects from the following substance classes: alcohol, tobacco, cannabis, cocaine, amphetamines, inhalants, sedatives, hallucinogens, and opiates among others. For this study, the interview was adapted as a self-report questionnaire. Questions about the “Frequency of drug use”, “Craving to use the drug”, “Problems”, and “Failed expectations” are rated on a 7-point Likert scale from 0 (never) to 6 (daily). Questions about “Expressed concerns by relatives or friends”, “Failed attempts to cut down drug use”, and “Drug injection” are rated on a 3-point Likert scale (0 = “no never”, 3 = “yes, but not in the past 3 months”, 6 = “yes, in the past 3 months”). By adding the drug specific symptom scores an overall score for every symptom class (mentioned above), as well as a total score was calculated. Subscales ranged in Cronbach’s alpha from 0.79 to 0.89.

**Mental Health Symptoms**

The short version of the Brief Symptom Inventory [BSI-18; (51), German Version; (52)] assesses the amount of psychiatric burden of the last 7 days by means of 6 items on each of the...
three subscales: (1) Somatization, (2) Depression, and (3) Anxiety. It is rated on a 5-point Likert scale from 0 “absolutely not” to 4 “very strong”. A Global Severity Index (GSI) can be generated for a total of the 18 items. Cronbach’s alpha for the subscales ranged from 0.70 to 0.87. The total Global Severity Index score showed a Cronbach’s alpha of 0.87.

Attachment Styles
The German Version of the Adult Attachment Scale [AAS; (53, 54)] is a self-report method measuring attachment dimensions based on attachment theory (55). This questionnaire consists of three subscales: (1) Anxiety about being rejected or unloved, (2) Comfort with Closeness and Intimacy, and (3) Comfort in Depending on others. This questionnaire consists of 18 items rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Cronbach’s alpha for the scales ranged from 0.68 to 0.79.

Oxytocin Assessment
For measuring the plasma OT levels, blood samples were drawn from antecubital veins into 3-ml vacutainer blood vacuette (Greiner Bio-One International GmbH, Austria) containing Aprotinin (500 KIU/ml of blood) (Sigma-Aldrich, Germany). Vacuette were stored at −20°C before use. Vacuette were centrifuged at 4°C at 1,600 g for 15 min. Supernatants were stored at −80°C until analysis. Extraction of samples was undertaken and OT concentrations in the extracts were determined in duplicate by Oxytocin ELISA kit (ADI-900-153A, Enzo Life Sciences, USA), a colorimetric competitive enzyme immunoassay kit at the Center for Medical Research at the Medical University Graz, Austria. The mean intra-assay and inter-assay coefficients of variability were 23.4% and 13.9%, respectively; sensitivity was 15.0 pg/ml. All procedures were performed according to the manufacturer’s instructions by authorized personnel.

Data Reduction and Statistical Analyses
For group comparisons in the experimental design, one-way analyses of variance and $\chi^2$ tests were conducted. To evaluate the reactivity of OT, the amount of the difference value of pre- and post-OT-level was considered. To investigate the relationship between OT and behavioral measures Pearson’s correlation coefficients were calculated separated for the PUD group. Alpha was set to $p < 0.05$ in ANOVAs and Pearson’s correlations. However, with regard to recent critical reviews of OT-literature [e.g., (43, 44)], we additionally corrected for multiple comparisons via the Bonferroni correction. In order to ensure a better evaluation of the results, effect sizes were included.

Hypothesis-Testing Results
Group Differences in OT and Attachment
As depicted in Table 2, group comparisons showed that PUD had higher levels of OT compared to HC at baseline ($F(1, 46) = 7.02; p < 0.05$). No other significant group differences regarding OT were observed (all $p > 0.05$) [for comparative means see (56)]. Following the administration of the AAP as attachment stimuli, the HC seemed to increase in OT levels whereas the PUD group’s OT remained flat. However, this difference was not significant ($F(1, 46) = 3.25; p = 0.08$).

Furthermore, the between group tests for differences in the measures of mental health and attachment the PUD group showed a tendency toward less Comfort with closeness ($F(1, 46) = 3.97; p = 0.05$) and Comfort with Depending on others ($F(1, 46) = 3.61; p = 0.06$) and higher depressive symptom burden ($F(1, 46) = 8.27; p < 0.05$). With regard to the Bonferroni corrected alpha level, no group differences remained significant (all $p > 0.003$)

Intercorrelations of Oxytocin, Attachment, and Personality Characteristics for PUD
Correlations over PUD showed that baseline OT-levels were related to less Comfort with closeness ($r = −0.41, p < 0.05$) and lifetime substance use over all substance classes ($r = −0.48, p < 0.05$). Furthermore, OT-reactivity showed non-significant tendencies with Comfort with closeness ($r = .34, p < 0.10$) and Lifetime substance use ($r = .37; p = 0.07$). Moreover, as shown in Table 3, insecure attachment patterns were related to Depression ($r = −.51−.49; p < 0.05$). No correlation remained significant if corrected for multiple comparisons (all $p > 0.003$).

DISCUSSION
In order to enhance the understanding of the relationship of OT to SUD, we investigated the differences in psychopathology, attachment, and the OT-system between PUD patients undergoing maintenance treatment compared to HC, as well as differences in peripheral OT response to an attachment-related stimulus. Our results suggest that PUD patients were higher OT at baseline compared to a HC group. In response to the attachment stimulus containing the AAP procedure, differences between the PUD and HC groups regarding OT-reactivity remained non-significant. Furthermore, baseline OT-levels showed a significant relationship with decreased Comfort with closeness in PUD patients.

However, these results should be interpreted with caution. In the first instance, the sample size of the study was small and there were numerous significance tests run. Following Nave et al. (44) and McCullough et al. (43), who proposed the necessity for correcting for multiple comparisons, no finding remained significant based on a Bonferroni corrected alpha level. While the Bonferroni correction has been criticized as being overly conservative (57, 58), the findings of this study are tentative and require replication in a larger study.
The finding of increased OT-baseline in the PUD group is in contrast to many other studies (41). The interpretation of this result needs to remain speculative at this point. However, it is conceivable that this finding might be traced back to the characteristics of living in the therapeutic community which is characterized by high social cohesion and an attachment focused treatment approach (59). Furthermore, in contrast to the HC group, PUD participants traveled to the OT measuring in groups, which might have

### TABLE 1 | Group differences in demographic data and conditions prior to investigation.

<table>
<thead>
<tr>
<th>Measure</th>
<th>PUD (n = 24)</th>
<th>HC (n = 24)</th>
<th>T</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Risk of substance use</td>
<td>28.50</td>
<td>5.85</td>
<td>26.33</td>
<td>3.25</td>
<td>-1.59</td>
</tr>
<tr>
<td>Lifetime substance use (incl. alcohol &amp; tobacco)</td>
<td>23.63</td>
<td>4.79</td>
<td>8.63</td>
<td>4.18</td>
<td>-11.56</td>
</tr>
<tr>
<td>Global continuum of substance risk (incl. alcohol &amp; tobacco)</td>
<td>29.04</td>
<td>4.43</td>
<td>13.75</td>
<td>7.04</td>
<td>-9.01</td>
</tr>
<tr>
<td>Conditions day of examination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waking up</td>
<td>467.17</td>
<td>79.61</td>
<td>371.96</td>
<td>138.38</td>
<td>-2.92*</td>
</tr>
<tr>
<td>Caffeine consumption</td>
<td>440.63</td>
<td>178.57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nicotine consumption</td>
<td>103.54</td>
<td>195.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Last meal</td>
<td>272.63</td>
<td>133.84</td>
<td>360.04</td>
<td>258.75</td>
<td>1.48</td>
</tr>
<tr>
<td>Sexual activity</td>
<td>700.43</td>
<td>138.25</td>
<td>621.25</td>
<td>231.45</td>
<td>-1.43</td>
</tr>
</tbody>
</table>

### TABLE 2 | Group differences (ANOVA) in behavioral and biological measures.

<table>
<thead>
<tr>
<th>Measure</th>
<th>PUD (n = 24)</th>
<th>HC (n = 24)</th>
<th>F (1, 46)</th>
<th>η²</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSI-18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Somatization</td>
<td>0.690</td>
<td>2.17</td>
<td>2.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>0.852</td>
<td>6.25</td>
<td>5.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>0.816</td>
<td>4.54</td>
<td>5.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>0.869</td>
<td>12.96</td>
<td>11.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxytocin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre (pg/ml)</td>
<td>60.64</td>
<td>24.87</td>
<td>22</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Post (pg/ml)</td>
<td>60.38</td>
<td>38.73</td>
<td>30.43</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Reactivity</td>
<td>-0.26</td>
<td>17.64</td>
<td>15.72</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>AAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependence</td>
<td>0.731</td>
<td>16.13</td>
<td>4.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closeness</td>
<td>0.786</td>
<td>11.63</td>
<td>3.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>0.678</td>
<td>12.29</td>
<td>3.91</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Bonferroni corrected p = 0.005; *p < 0.05; PUD, Poly-drug use disordered patients; HC, Healthy controls. *Past time in minutes since last consumption on test day.
further contributed to inflated OT baseline levels (60). Another possibility would be an influence of the various medications used for maintenance therapy which interact with the opioid system, or indeed the use of antidepressant or antipsychotic medications in PUD participants. However, while not extensively researched, recent literature indicates no influence of antidepressant pharmacological treatments on OT (61) but there have been some animal studies suggesting a relationship between antidepressants and OT metabolism (62).

OT-reactivity in PUD patients did not significantly differ from variability of HC participants. Based on previous research it might be speculated (29, 42), that an increase in OT in response to an attachment related stimulus is associated with seeking and finding of an internalized positive attachment representation. Furthermore, animal research has shown that the administration of morphine potently inhibits the secretion of OT and depresses the OT-sensitivity of the mammary gland, due to inhibition of the firing of supraoptic OT-neurons (63–66). Considering potential ceiling effects of methadone on the endogenous OT-system, its influence of the various medications used regarding adult attachment attitude using the AAS measure. Nevertheless, the non-significant associations showed there may be important relationships here which the current study was underpowered to detect and are consistent with the pattern observed in previous research (14, 67–69).

In general, the main results in this study may be influenced by several effects brought about by a combination of psychopharmacology, maintenance, and long-term psychotherapeutic treatment.

In addition, our findings designate a negative relationship between baseline OT-level and Comfort with Closeness in PUD patients. Corresponding to recent findings by Torres et al. (70), which suggested a negative correlation between the dose of maintenance therapy and Closeness as well as decreased Anxiety in patients undergoing maintenance therapy. Therefore, the mechanism of maintenance therapy might operate on the surface but helps PUD patients only to a limited extent in the formation of healthy interpersonal relationships and positive attachment representations that can be relied on in times of distress (15, 21).

Moreover, we observed tentative hints toward a link between OT-reactivity and increased Comfort with closeness which, however, did not achieve statistical significance. Similarly, Krause et al. (42) did not find significant associations between attachment security and OT-reactivity in lactating mothers. Hence, while a relationship between attachment and OT-reactivity may be a reasonable premise, more research should be done to further analyse this subject matter.

**Limitations and Future Perspectives**

Findings of the present study are mainly limited by the sample size, the exclusion of the female gender and the use of self-report measures. Furthermore, the measurement of OT is controversially discussed in literature (43, 71).

Furthermore, nicotine abstinence was not given in PUD patients prior to the investigation in this study, which might be seen as a characteristic of PUD patients in maintenance treatment. However, in line with previous research, nicotine abuse was not related to OT (72, 73). Moreover, due to the explorative nature of this study, no control condition was administered, which limits the interpretability of the effects of the AAS on OT-levels. This shortcoming needs to be addressed in future studies. What is more, a recent study by Fuchshuber et al. (74) indicated a medium effect size regarding the difference in attachment security comparing PUD and HC groups (74). With respect to the relatively small sample size employed in this study, future research addressing this subject might take this to an account regarding the estimation of the required sample size. Along, to gain a more complete understanding of the relationship between attachment, OT and maintenance treatment, the investigation of abstinent SUD patients who are not undergoing maintenance therapy is of interest for future studies. Finally, cortisol and vasopressin, both known for their close interrelatedness with OT, should be taken into account (29, 30, 75, 76).

**CONCLUSION**

This study suggests that peripheral OT levels in poly-drug users undergoing maintenance treatment do not show significant

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**TABLE 3 | Intercorrelations for behavioral and biological measures for PUD (n = 24)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSI-18 Somatization</td>
<td>.40</td>
<td>.79**</td>
<td>−.21</td>
<td>−.03</td>
<td>.27</td>
<td>−.11</td>
<td>−.15</td>
<td>.19</td>
<td>.17</td>
<td>.14</td>
<td></td>
</tr>
<tr>
<td>BSI-18 Depression</td>
<td>.48*</td>
<td>−.04</td>
<td>.01</td>
<td>.06</td>
<td>−.51*</td>
<td>−.46*</td>
<td>.49*</td>
<td>.21</td>
<td>.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BSI-18 Anxiety</td>
<td>−.13</td>
<td>−.08</td>
<td>.10</td>
<td>−.02</td>
<td>−.12</td>
<td>.22</td>
<td>.14</td>
<td>.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OT Pre</td>
<td>.70**</td>
<td>−.72*</td>
<td>.05</td>
<td>−.41</td>
<td>−.37</td>
<td>−.48*</td>
<td>.11</td>
<td></td>
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<tr>
<td>OT Post</td>
<td>−.02</td>
<td>.07</td>
<td>−.24</td>
<td>−.33</td>
<td>−.31</td>
<td>−.04</td>
<td></td>
<td></td>
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<tr>
<td>OT Reactivity</td>
<td>.00</td>
<td>.34</td>
<td>.20</td>
<td>.37</td>
<td>−.19</td>
<td></td>
<td></td>
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<tr>
<td>AAS Closeness</td>
<td>.68**</td>
<td>−.36</td>
<td>−.05</td>
<td>−.20</td>
<td></td>
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<tr>
<td>AAS Anxiety</td>
<td>−.02</td>
<td>−.04</td>
<td>−.22</td>
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<tr>
<td>ASSIST Lifetime SU</td>
<td>−.18</td>
<td>.24</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>ASSIST GC of SR</td>
<td></td>
<td>−.16</td>
<td></td>
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</table>

*N = 24; Bonferroni corrected p = 0.004; **p < .01, *p < .05; Pre, baseline OT-levels; Post, OT-levels after confrontation with attachment related cue; GC, global continuum; SU, substance use; SR, substance risk.*
differences regarding responsive to an attachment related stimulus delivered via the Adult Attachment projective task compared to HCs. The meaning of this finding is complicated by a number of confound in the PUD group related to both the pharmacological and psycho-social treatments they are receiving. The current findings which indicate non-significant tendencies however are an important preliminary finding which we hope will motivate more research using an experimental paradigm to further explore this hypothesis.

DATA AVAILABILITY STATEMENT

This article contains previously unpublished data. Datasets are available on request.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the ethics guidelines of the Karl Franzens University of Graz, Austria. The protocol was approved by the ethics committee of the Karl Franzens University of Graz, Austria. Written informed consent in accordance with the Declaration of Helsinki was given by all subjects.

REFERENCES


AUTHOR CONTRIBUTIONS

JT, EW, and HU conceptualized the study. JT, AK, FT, AR, and collected the data. JT, AB, SS, BR, TP, and KL analyzed the data. JT and AB interpreted the AAP data. JT, MH-R, HU, and AL drafted and revised the manuscript. EW, H-PK, AB, MH-R, HU, JF, and AL critically reviewed the manuscript. All authors contributed to the article and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2020.460506/full#supplementary-material


**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.

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