Running Head: IMPLICIT ATTACHMENT AND SUBSTANCE USE

Mummy, Daddy, and Addiction: Implicit Insecure Attachment is Associated with Substance
Use in College Students

Wilfried Serra¹, Armand Chatard^{1,2}, Nina Tello^{1,2},
Ghina Harika-Germaneau¹, Xavier Noël³, & Nemathollah Jaafari¹

¹ Université de Poitiers, Unité de recherche clinique Pierre Deniker du Centre Hospitalier
Henri Laborit, France

² Université de Poitiers, Centre de Recherches sur la Cognition et l'Apprentissage, CNRS
7295, France

³ Université Libre de Bruxelles, Faculté de Médecine

Experimental and Clinical Psychopharmacology (in press)

© 2019, American Psychological Association. This paper is not the copy of record and may not exactly replicate the final, authoritative version of the article. Please do not copy or cite without authors' permission. The final article will be available, upon publication, via its DOI: 10.1037/pha0000266

Correspondence

Armand Chatard, Université de Poitiers, Centre de Recherches sur la Cognition et
l'Apprentissage, UMR CNRS 7295, MSHS, Bat A5, 5 rue Théodore Lefebvre, TSA 21103,
86073 Poitiers CEDEX, France. Email: armand.chatard@univ-poitiers.fr

Abstract

Indirect measures of cognition have become an important tool in research on addiction. To date, however, no research has examined whether indirect measures of parent attachment relate to substance use. To examine this issue, a sample of college students ($N = 121$) was asked to complete two measures of explicit attachment (the Relationship Questionnaire; Bartholomew & Horowitz, 1991, and the Adult Attachment Styles; Collins & Read, 1990), and a measure of implicit attachment (the Single Category Implicit Association Test, Karpinski & Steinman, 2006). The indirect attachment measure assessed the strength of automatic mental association between the concepts *parents* and *secure*. Participants also completed different measures of tobacco, cannabis, and alcohol use. Results showed that, for most of the participants, the parents were considered a source of security at both the explicit and implicit levels. Direct and indirect attachment measures were not related to each other. Overall, explicit attachment was not related to substance use. However, implicit attachment was significantly associated with the use of licit (tobacco) and illicit (cannabis) drugs. We also found some evidence that polydrug use is especially common among students with an insecure implicit attachment. This is the first study to examine how implicit attachment processes relate to addictive behaviors. The results suggest that implicit attachment, thought to reflect unconscious traces of past experiences, is a better predictor of substance use in college students than direct, self-reported measures of attachment. Further studies should examine whether implicit attachment is associated with severe substance use disorders in clinical populations.

Keywords: Attachment processes, implicit associations, parents, insecure, substance use

Public Significance Statement

This study shows that implicit attachment (i.e., the strength of a person's automatic association in memory between the concepts *parents* and *secure*) is significantly associated with substance use in college students. In contrast, explicit attachment (self-reported measures of parent-child emotional bond) was not associated with substance use. This study is important because this is the first to examine how implicit attachment processes relate to addictive behaviors.

Disclosure and Acknowledgments

Funding for this study was provided by the University of Poitiers, the Centre de Recherches sur la Cognition et l'Apprentissage (CNRS 7295), and the Centre Hospitalier Henri Laborit (CHL). The University of Poitiers, the Centre de Recherches sur la Cognition et l'Apprentissage (CNRS 7295), and the Centre Hospitalier Henri Laborit (CHL) had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication. The funding sources had no other role other than financial support.

This work was part of W. Serra's M.Sc. thesis, conducted under the supervision of A. Chatard. W. Serra and A. Chatard developed the study concept and materials. N. Tello collected the data. W. Serra and A. Chatard analyzed the data and wrote the manuscript. N. Tello, G. Harika-Germaneau, X. Noël, and N. Jaafari commented on the manuscript. All authors approved the final version of the manuscript for submission.

All authors declare that they have no conflicts of interest.

All persons who contributed to this study are listed as coauthors on the paper.

A poster of the data and main ideas reported in the paper was presented at the 12^{ème} *Congrès International d'Addictologie de l'ALBATROS*, Paris, France, 6-8 Juin 2018.

A preprint of the manuscript has been posted online:

A supplementary online material (SOM), the dataset and code for reproducing the findings are publicly available on the Open Science Framework page: <https://osf.io/xrhbs/>

Mummy, Daddy, and Addiction: Implicit Insecure Attachment is Associated with Substance Use in College Students

Research and theorizing on attachment processes suggests that an insecure attachment style may be a risk factor for psychological disorders, including those associated with substance use and misuse (Mikulincer & Shaver, 2012). Although some studies support this prediction, both at biological and behavioral levels, other studies have failed to show a link between attachment and substance use. In this paper, we propose that inconsistent findings in this literature may be explained, in part, by the measurement techniques employed. While the influence of attachment processes is supposed to be automatic and unconscious, attachment styles have most often been assessed using direct measures such as questionnaires. This is potentially problematic, we argue, because such direct measures are inappropriate for accessing automatic and unconscious processes, which are not accessible through introspection (Stacy, 1997; McCusker, 2001). In an effort to address this limitation, in the current study we examine whether an indirect measure of secure versus insecure attachment (the implicit association test or IAT; Greenwald, McGhee, & Schwartz, 1998) might contribute to shedding new light on how attachment processes relate to substance use in college students.

A recent review of the literature provides empirical evidence for a general link between insecure attachment and substance use disorders in adolescence (Schindler & Bröning, 2015). Given the strong associations between insecure attachment and emotional distress, adolescents with a maladaptive attachment style may use and abuse substance in order to relieve stress and negative affect (Kassel, Wardle, & Roberts, 2007). Using a large sample of 1989 adolescents, Cooper, Shaver, and Collins (1998) found that the association between insecure attachment and substance use is at least partially accounted for by distress symptoms. Insecure attachment is also correlated with substance use disorders among students (Brennan & Shaver, 1998; Burge et al., 1997; Lindberg & Zeid 2016) and in the

general population (Mickelson, Kessler, & Shaver, 1997; Vungkhanching, Sher, Jackson, & Parra, 2004). In the same way, insecure attachment appears to be overrepresented in patients with severe alcohol-use disorders (De Rick, Vanheule, & Verhaeghe, 2009; Thorberg & Lyvers, 2006; Wedekind et al., 2013) and among people who use illicit drugs (Finzi-Dottan, Cohen, Iwaniec, Sapir, & Weizman, 2003; Schindler et al., 2005).

At the biological level, research indicates that oxytocin, a peptide hormone and neuropeptide strongly related to the quality of parent-child relationships (Feldman et al., 2012), is related to substance use and abuse. For example, repeated oxytocin supplementations have been linked to changes in behaviors associated with attachment (Bernaerts et al., 2017). In animal studies, oxytocin supplementations have also been found to successfully attenuate the observed negative emotional consequences of opioid withdrawal (Zanos et al., 2014). Similar results have been reported for cocaine (Georgiou et al. 2014), amphetamines (Ferland, Reichel, & McGinty, 2016), cannabis (McRae-Clark, Baker, Maria, & Brady, 2013), tobacco (Manbeck, Shelley, Schmidt, & Harris, 2014), and alcohol (Peters, Bowen, Bohrer, & McGregor, 2016). In rats, oxytocin supplementations during adolescence have been found to reduce alcohol intake (Bowen et al., 2011) and amphetamine consumption at adult age (Hicks, Cornish, Baracz, Suraev, & McGregor, 2016).

Although some studies support the idea of addiction as an attachment disorder, both at biological and behavioral levels, other studies have failed to show a link between attachment and substance use. In particular, several investigations have found that insecure attachment is not associated with alcohol use disorders (e.g., Kassel et al., 2007; Reis, Curtis, & Reid, 2012; Ahrens, Ciechanowski, & Katon, 2012; Caspers, Yucuis, Troutman, & Spinks, 2006). In some studies (Olsson et al., 2013), alcohol use was positively related to a secure, rather than an insecure, attachment style. Given the heterogeneous findings and the well-documented problem of publication bias in science (Open Science Collaboration, 2015), there are reasons

to believe that the link between attachment and addiction may not be as strong as expected on the basis of attachment theory (Bowlby, 1982/1969).

In this paper, we propose that inconsistent findings in this literature may be explained, in part, by the measurement techniques employed. In prior studies, researchers have mainly relied on direct, self-reported measures of attachment styles, such as the Relationship Questionnaire (RQ; Bartholomew & Horowitz, 1991) or the Adult Attachment Styles (AAS; Collins & Read, 1990). These self-report instruments may not be the most appropriate tools for assessing attachment styles. Within the framework of attachment theory, the secure and insecure attachment styles are expected to exert their influence automatically and unconsciously (Gillath et al., 2006). Thus, a self-report measure may be ill suited to capture attachment styles. This is why some researchers have sought to develop more indirect measures (George, Kaplan, & Main, 1996; George & West, 2012). These measures are supposed to capture automatic processes, such as implicit emotion regulation (Jacobvitz, Curran, & Moller, 2002). However, these instruments have been criticized because of their low reliability (low inter-coder agreement) and lack of convergent validity (Baldoni et al., 2018). Thus, further research is needed to develop and test more reliable and convenient measures of implicit attachment.

The implicit association test (IAT; Greenwald et al., 1998) is a reaction-time measure that is widely used to assess implicit cognitions. A great deal of work has shown that the IAT is a reliable tool for measuring a variety of implicit attitudes, with high test-retest correlations after several months (Egloff & Schmukle, 2002; Greenwald, Poehlman, Uhlmann, & Banaji, 2009; Karpinski, & Steinman, 2006; Nosek, Greenwald, & Banaji, 2007; Rae & Olson, 2018; Rudman, 2008). As a new measure, the IAT has been the target of some skepticism and critics (Bosson, Swam, & Pennebaker, 2000; Blanton, Jaccard, Klick, Mellers, Mitchell, & Tetlock, 2009). However, its psychometric reliability and predictive validity are now well established

(for a recent meta-analysis, see Kurdi et al., 2018). The IAT has been found to prospectively predict many criterion variables above self-report measures, including political voting behavior (Galdi, Arcuri, & Gawronski, 2008), change in marital satisfaction (McNulty, Olson, Meltzer, & Shaffer, 2013), and even suicide attempts (Nock et al., 2010; Tello, Harika-Germaneau, Serra, Jaafari, & Chatard, 2018), sometimes after several months. At the neuronal level, performance on the IAT is associated with activation in the amygdala (Phelps et al., 2000) and in the striatum (Ames et al., 2013), involved in emotion conditioning and implicit memory, respectively.

The IAT was initially developed to assess implicit cognition, reflecting “*introspectively unidentified (or inaccurately identified) trace of past experience*” (Greenwald & Banaji, 1995, p. 5). As such, it may be especially adapted to measuring implicit attachment. Recently, some variants of the IAT have been developed to measure implicit attachment by assessing associations of Mother/Father (versus others) with positive (versus negative) words (Zayas & Shoda, 2005; Dewitte et al., 2007; Venta, Jardin, Kalpakci, & Sharp, 2016) or associations of Partner (versus others) with positive (versus negative) words (Banse & Kowalick, 2007; Faure, Righetti, Seibel, & Hofmann, 2018; Zayas & Shoda 2005). These initial studies indicate that the parents and the partners are more strongly associated in memory with positive words than with negative words, consistent with the notion that most individuals have a secure attachment style. In line with the idea that individuals may be unaware of their implicit attitudes, implicit attachment measured with some variants of the IAT is often weakly (and not significantly) correlated with explicit attachment (Venta et al., 2016). Previous studies have also suggested that implicit attachment could predict relationship satisfaction and stability (Banse & Kowalick, 2007). To date, however, no studies have examined whether implicit attachment is a significant predictor of substance use among college students.

Is a deficit in implicit attachment a risk factor for substance use in college students? Can an indirect measure of attachment contribute to better predict substance use? In the present study, we assessed for the first time both explicit and implicit attachment to test their relative contribution to predicting alcohol, cannabis, and tobacco use in college students. We used a narrowly focused IAT variant to examine implicit associations between parents and secure vs. insecure concepts. In line with the idea that attachment is best conceptualized as an implicit process, we expected implicit attachment measured with this variant of the IAT to be associated with substance use among college students.

Method

Participants

One hundred and twenty-one undergraduate college students (95 females, $M_{\text{age}} = 19.62$ years) took part in this study in exchange for course credits. The characteristics of the sample are presented in Table 1. The participants were treated in accordance with the French national ethics laws and regulations. The local ethics committee declared this study exempt from an IRB approval because it was only behavioral and non interventional. However, the study was carried out in accordance with the provisions of the World Medical Association Declaration of Helsinki, and participants provided their written informed consent.

Measures

Explicit attachment. The participants completed two direct measures of attachment: the Relationship Questionnaire (RQ; Bartholomew & Horowitz, 1991) and the Adult Attachment Styles (AAS; Collins & Read, 1990). The RQ is a 4-item questionnaire designed to measure the secure, fearful, preoccupied, and dismissing attachment styles. Each attachment style is assessed with a single item (e.g. "It is easy for me to become emotionally close to others"; "I am comfortable depending on them and having them depend on me"; "I don't worry about being alone or having others not accept me"). Participants indicated how

much they agree or disagree with each statement using a 7-point Likert scale (1 = Strongly disagree to 7 = Strongly agree). The AAS is a three-category model. It distinguishes close, dependent, and anxious attachment styles. The different attachment styles are assessed with 6 items each (e.g. "I do not worry about being abandoned"). The Cronbach's alpha of the close, dependent, and anxious attachment styles was .73, .86, and .61, respectively.

Implicit attachment. A Single Category IAT (SC-IAT, Karpinski & Steinman, 2006) was used to measure implicit attachment using reaction time data. Positive scores on this measure indicate that participants automatically associate parents with secure, whereas negative scores indicate that they automatically associate parents with insecure. Due to space limitation, we report a detailed description of the SC-IAT used in this study, a table depicting the target words (Table S1), a table depicting the different blocks (Table S2), and the scoring procedure in the supplementary online material (<https://osf.io/xrhbs/>).

Alcohol use. The Alcohol Timeline Followback (TLFB), a daily drinking estimation method, was used to measure total alcohol consumption (TAC) over the past week. The participants also completed the Alcohol Use Disorder Identification Test (AUDIT; Saunders, Aasland, Babor, De La Fuente, & Grant, 1993) to measure potentially problematic alcohol use (continuous variable).

Tobacco use. The participants indicated whether they currently smoke (binary variable – coded with 1 as actual tobacco users), and if they did, they completed the Heaviness of Smoking Index (HIS; Etter, Duc, & Perneger, 1999) to measure nicotine dependence (continuous variable).

Cannabis use. The participants reported whether they had consumed cannabis during the last month (binary variable – coded with 1 as actual cannabis users). They also completed the Cannabis Use Screening Test (CAST; Legley, 2017) to provide a continuous measure of the severity of addiction to cannabis.

Polydrug use. The measures of alcohol (per week), tobacco (per day), and cannabis (per month) use were then combined to form an index of polydrug use (binary variable – coded with 1 as polydrug user).

Data analysis. Statistical analyses were performed using JASP 0.8.0.1 (<https://jasp-stats.org>). Correlations analyses were conducted to examine how the different attachment measures relate to each other and to test the relations between the attachment measures and substance use. Because substance use measures often deviate from normality, we used non-parametric rank correlations (Spearman's rho or r_s) to test our main hypothesis. The α level was set at .05 (two-tailed) for all analyses, and p-values were adjusted for multiple comparisons using Benjamini and Hochberg's (1995) procedure.¹

Results

As shown in Table 1, most participants reported a secure rather than an insecure parent attachment on both the direct and indirect attachment measures.

The correlations between explicit and implicit attachment are depicted in Table S3 of the supplementary online material (<https://osf.io/ehnvvr/>). As shown in this table, the direct measures were strongly related to each other. However, as in previous research (Venta et al., 2016), the direct measures were not related to the indirect measure (SC-IAT secure). The two measures may assess different aspects of attachment, and they may contribute to predicting addictive behaviors independently from each other.

The adjusted correlations between direct and indirect attachment measures, on one hand, and substance use, on the other hand, are depicted in Table 2. Close inspection of this table reveals that the direct measures of attachment fail to predict substance use. None of these correlations were significant after correction for multiple comparisons.

A different picture emerges with regard to implicit attachment. As Table 2 shows, implicit attachment was consistently related to substance use. Five out of the 7 correlations

tested here reached significance. Compared to participants with a more insecure implicit attachment, those with a more secure implicit attachment were less likely to be actual tobacco smokers ($r_s = -0.199, p = .043$). Participants who smoked and had a more secure implicit attachment were less dependent on nicotine than those with a more insecure implicit attachment ($r_s = -0.326, p = .043$). In the same way, participants with a more secure implicit attachment were less often actual cannabis users ($r_s = -0.255, p = .028$) and had lower CAST scores ($r_s = -0.198, p = .043$) than those with a more insecure implicit attachment. Overall, implicit attachment was not related to alcohol use ($r_s = -0.137, p = .161$, with TAC) or abuse ($r_s = -0.063, p = 0.497$, with AUDIT). However, participants with a more secure implicit attachment were less likely to engage in polydrug use ($r_s = -0.243, p < .028$) than those with a more insecure implicit attachment.²

To take another look at our data, we conducted Bayesian correlation analyses to test the hypothesis that implicit attachment is related to substance use. As shown in Table S4 of the SOM, implicit attachment was related to actual tobacco use ($b = -0.163, BF_{10} = 3.717$), nicotine dependence ($b = -0.253, BF_{10} = 4.105$), actual cannabis use ($b = -0.209, BF_{10} = 33.978$), and polydrug use ($b = -0.200, BF_{10} = 20.207$). Accordingly with the Jeffreys' (1963) convention, the data provided substantial evidence for our hypothesis on these four indices of substance use. On the three other measures of substance use, the data were inconclusive ($b = -0.103, BF_{10} = 0.464$, for TAC, and $b = -0.155, BF_{10} = 2.66$, for CAST) or yielded support for the null hypothesis ($b = -0.033, BF_{10} = 0.138$, for AUDIT). The results of these analyses provided converging evidence for our hypothesis.

Discussion

The aim of the present study was to revisit the relation between parent attachment and substance use using a sample of college students. Most of the studies conducted so far on this issue have suggested that a deficit in attachment (i.e., an insecure attachment) is a risk factor

for addiction. Our results do not support this conclusion when considering explicit attachment alone. We found no significant relation between explicit attachment and the use of licit (alcohol and tobacco) and illicit (cannabis) drugs. This finding is in line with some prior studies in which no relation was found between explicit attachment and alcohol use (Ahrens et al., 2012; Reis et al., 2012) or between explicit attachment and cannabis use (Kassel et al., 2007). Thus, the present findings add to a growing body of failed studies that suggest that the relation between explicit attachment and addictive behaviors is difficult to replicate and somewhat exaggerated in the extant literature.

In this paper, we argued that direct measures of attachment, which involve some forms of meta-cognition, might not be the most appropriate approach to studying attachment. Because attachment has often been conceptualized as an automatic and unconscious process, indirect measures may better capture this construct and its relation with substance use and misuse. The present study provided a first test of this reasoning using a single category implicit association test to assess implicit attachment. As expected, implicit attachment was significantly related to substance use, especially tobacco and cannabis use. Implicit attachment was also a significant predictor of polydrug use. The present findings suggest that students with an insecure implicit attachment are at a higher risk for cannabis and tobacco use, nicotine dependence, and polydrug use. Collectively, the present findings contribute to the extant literature by providing the first evidence to suggest that implicit attachment is a better predictor of substance use than explicit attachment.

There are at least three limitations of the present findings that deserve to be addressed in future studies. First, we relied on a convenience sample of college students to test our hypothesis. Our sample included mainly female participants. Thus, it is possible that gender effects influenced the main findings. Also, our study was conducted on a non-clinical population. Because substance use alone is not a strong predictor of developing a severe

substance use disorder, it is possible that implicit attachment is associated with substance use in college students but not with the severity of substance use disorders in clinical populations. However, we found that implicit attachment is related to polydrug use among college students. Because polydrug use in early adulthood may increase the risk of developing a severe substance use disorder later in life, implicit attachment may actually be a risk factor for substance use disorders. Further studies are needed to examine these issues.

Second, we did not include controls for early childhood trauma, sexual abuse, early emotional neglect, depression, or anxiety. Research indicates that maladaptive attachment styles are often associated with aversive life events in early childhood (Van Ijzendoorn, Schuengel, & Bakermans-Kranenburg, 1999; but see Fraley, 2019). In the same way, there is substantial evidence that depression and anxiety are related to maladaptive attachment styles (Cooper et al. 1998; Kassel et al., 2007). Indirect measures are often weakly related to self-reported measures of depression and anxiety. However, it might be important in future studies to control for a number of predictors of maladaptive attachment styles and substance use to more directly gauge the incremental validity of implicit attachment in predicting substance use.

Relatedly, future studies are needed to examine which psychological and biological variables carry over the influence of implicit attachment on substance use. One potential mediator is the motivation to relieve distress (Kassel et al., 2007). Individuals with an insecure implicit attachment may be especially motivated to consume alcohol and other drugs to escape from negative affects and external problems. This hypothesis could be advantageously tested using experimental designs (Mikulincer, Birnbaum, Woddis, & Nachmias, 2000; Mikulincer, Gillath, & Shaver, 2002). Another potential candidate is oxytocin. Implicit attachment may be associated with substance use via its links with oxytocin. Further studies

are needed to test whether oxytocin supplementation may change the link between implicit attachment and substance use.

Despite these limitations, the present findings are important because they contribute insights into the underlying processes in substance use in college students. According to attachment theory, the secure and insecure attachment styles are automatic and unconscious relational systems that develop from the repeated interactions with the mother and the father during infancy. The strength of implicit associations between *parents* and *secure*, assessed with reaction time data, may reflect unconscious traces of past experiences with the parents or caregivers. As such, indirect measures of attachment appear to be a promising new tool with which to explore the link between attachment and addiction. Such measures may contribute to better identifying at-risk individuals and offer new avenues of prevention.

References

- Ahrens, K. R., Ciechanowski, P., & Katon, W. (2012). Associations between Adult Attachment Style and Health Risk Behaviors in an Adult Female Primary Care Population. *Journal of Psychosomatic Research* 72(5), 364–70.
doi:10.1016/j.jpsychores.2012.02.002
- Ames, S. L., Grenard, J. L., Stacy, A. W., Xiao, L., He, Q., Wong, S. W., ... & Bechara, A. (2013). Functional imaging of implicit marijuana associations during performance on an implicit association test (IAT). *Behavioural brain research*, 256, 494-502. doi: 10.1016/j.bbr.2013.09.013
- Baldoni, F., Minghetti, M., Craparo, G., Facondini, E., Cena, L., & Schimmenti, A. (2018). Comparing Main, Goldwyn, and Hesse (Berkeley) and Crittenden (DMM) coding systems for classifying Adult Attachment Interview transcripts: an empirical report. *Attachment & Human Development*, 1-16. doi: 10.1080/14616734.2017.1421979
- Banase, R., & Kowalick, C. (2007). Implicit Attitudes towards Romantic Partners Predict Well-being in Stressful Life Conditions: Evidence from the Antenatal Maternity Ward. *International Journal of Psychology*, 42(3), 149–57.
doi:10.1080/00207590601067037
- Bartholomew, K., & Horowitz, L. M. (1991). Attachment styles among young adults: a test of a four-category model. *Journal of Personality and Social Psychology*, 61(2), 226-244.
- Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society. Series B (Methodological)*, 289-300.

- Bernaerts, S., Prinsen, J., Berra, E., Bosmans, G., Steyaert, J., & Alaerts, K. (2017). Long-term oxytocin administration enhances the experience of attachment. *Psychoneuroendocrinology*, 78, 1-9. doi: 10.1016/j.psyneuen.2017.01.010
- Blanton, H., Jaccard, J., Klick, J., Mellers, B., Mitchell, G., & Tetlock, P. E. (2009). Strong claims and weak evidence: Reassessing the predictive validity of the IAT. *Journal of applied Psychology*, 94(3), 567.
- Bosson, J. K., Swann Jr, W. B., & Pennebaker, J. W. (2000). Stalking the perfect measure of implicit self-esteem: The blind men and the elephant revisited?. *Journal of personality and social psychology*, 79(4), 631.
- Bowen, M. T., Carson, D. S., Spiro, A., Arnold, J. C., & McGregor, I. S. (2011). Adolescent Oxytocin Exposure Causes Persistent Reductions in Anxiety and Alcohol Consumption and Enhances Sociability in Rats. *PLoS ONE* 6(11). e27237. doi:10.1371/journal.pone.0027237.
- Bowlby, J. (1982/1969). *Attachment and loss. Vol. 1, Attachment* (2nd ed), New York : Basic Books.
- Brennan, K. A., & Shaver, P. R. (1995). Dimensions of Adult Attachment, Affect Regulation, and Romantic Relationship Functioning. *Personality and Social Psychology Bulletin*, 21(3), 267–83. doi:10.1177/0146167295213008
- Burge, D., Hammen, C., Davila, J., Daley, S. E., Paley, B., Lindberg, N., ... Rudolph, K. D. (1997). The Relationship between attachment cognitions and psychological adjustment in late adolescent women. *Development and Psychopathology*, 9(1), 151–67.
- Caspers, K. M., Yucuis, R., Troutman, B., & Spinks, R. (2006). Attachment as an organizer of behavior: implications for substance abuse problems and willingness to seek

- treatment. *Substance Abuse Treatment, Prevention, and Policy*, 1(1), 32.
doi:10.1186/1747-597X-1-32
- Chatard, A. (2018, October 19). Implicit attachment and substance use. Retrieved from
osf.io/xrhbs
- Collins, N. L., & Read, S. J. (1990). Adult attachment, working models, and relationship
quality in dating couples. *Journal of Personality and Social Psychology*, 58(4), 644-
663.
- Cooper, M. L., Shaver, P. R., & Collins, N. L. (1998). Attachment Styles, Emotion
Regulation, and Adjustment in Adolescence. *Journal of Personality and Social
Psychology*, 74(5), 1380–97. doi:10.1037/0022-3514.74.5.1380
- De Rick, A., Vanheule, S., & Verhaeghe, P. (2009). Alcohol Addiction and the Attachment
System: An Empirical Study of Attachment Style, Alexithymia, and Psychiatric
Disorders in Alcoholic Inpatients. *Substance Use & Misuse* 44(1), 99–114.
doi:10.1080/10826080802525744
- Egloff, B., & Schmukle, S. C. (2002). Predictive validity of an implicit association test for
assessing anxiety. *Journal of personality and social psychology*, 83(6), 1441-1455.
- Etter, J. F., Duc, T. V., Perneger, T. V. (1999). Validity of the Fagerstrom test for nicotine
dependence and of the Heaviness of Smoking Index among relatively light smokers.
Addiction, 94, 269–281.
- Faure, R., Righetti, F., Seibel, M., & Hofmann, W. (2018). Speech is silver, nonverbal
behavior is gold: How implicit partner evaluations affect dyadic interactions in close
relationships. *Psychological Science*, 29, 1731-1741.
- Feldman, R., Zagoory-Sharon, O., Weisman, O., Schneiderman I., Gordon I., Maoz, R., ...
Ebstein, R. (2012). Sensitive Parenting Is Associated with Plasma Oxytocin and

- Polymorphisms in the OXTR and CD38 Genes. *Biological Psychiatry*, 72(3), 175–181. doi:10.1016/j.biopsych.2011.12.025
- Ferland, C. L., Reichel, C. M., & McGinty, J. F. (2016). Effects of oxytocin on methamphetamine-seeking exacerbated by predator odor pre-exposure in rats. *Psychopharmacology*, 233(6), 1015–1024. doi:10.1007/s00213-015-4184-7
- Finzi-Dottan, R., Cohen, O., Iwaniec, D., Sapir, Y., & Weizman, A. (2003). The Drug-User Husband and His Wife: Attachment Styles, Family Cohesion, and Adaptability. *Substance Use & Misuse*, 38(2), 271–292.
- Fraley, R. C. (2019). Attachment in adulthood: recent developments, emerging debates, and future directions. *Annual Review of Psychology*, 70, 401-422
- Galdi, S., Arcuri, L., & Gawronski, B. (2008). Automatic mental associations predict future choices of undecided decision-makers. *Science*, 321(5892), 1100-1102. doi: 10.1126/science.1160769
- George C, & West, M. (2012). *The Adult Attachment Projective Picture System: attachment theory and assessment in adults*. Guilford Press, New York.
- George, C., Kaplan, N., & Main, M. (1996). *The adult attachment interview*. University of California, Berkeley.
- Georgiou, P., Zanos, P., Ehteramyan, M., Hourani, S., Kitchen, I., & Maldonado, R. (2015). Differential regulation of mglu r and muopr by priming- and cue-induced reinstatement of cocaine-seeking behaviour in mice. *Addiction Biology*, 20(5), 902-912. doi: 10.1111/adb.12208
- Gillath, O., Mikulincer, M., Fitzsimons, G. M., Shaver, P. R., Schachner, D. A., & Bargh, J. A. (2006). Automatic activation of attachment-related goals. *Personality and Social Psychology Bulletin*, 32(10), 1375-1388. doi : 10.1177/0146167206290339

- Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: attitudes, self-esteem, and stereotypes. *Psychological Review*, 102(1), 4-27.
- Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring Individual Differences in Implicit Cognition: The Implicit Association Test. *Journal of Personality and Social Psychology*, 74(6), 1464–1480.
- Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the implicit association test: I. An improved scoring algorithm. *Journal of Personality and Social Psychology*, 85(2), 197.
- Greenwald, A. G., Poehlman, T. A., Uhlmann, E. L., & Banaji, M. R. (2009). Understanding and using the Implicit Association Test: III. Meta-analysis of predictive validity. *Journal of Personality and Social Psychology*, 97(1), 17-41.
- Hicks, C., Cornish, J. L., Baracz, S. J., Suraev, A., & McGregor, I. S. (2016). Adolescent Pre-Treatment with Oxytocin Protects against Adult Methamphetamine-Seeking Behavior in Female Rats: Oxytocin and Methamphetamine. *Addiction Biology*, 21(2), 304–315. doi:10.1111/adb.12197
- Jacobvitz, D., Curran, M., & Moller, N. (2002). Measurement of adult attachment: the place of self-report and interview methodologies. *Attachment & Human Development* 4(2), 207-215.
- Jeffreys, H. (1963). Review of the foundations of statistical inference. *Technometrics*, 3, 407-410.
- Karpinski, A., & Steinman, R. B. (2006). The single category implicit association test as a measure of implicit social cognition. *Journal of Personality and Social Psychology*, 91(1), 16-32.

- Kassel, J. D., Wardle, M., & Roberts, J. E. (2007). Adult attachment security and college student substance use. *Addictive Behaviors*, 32(6), 1164–1176.
doi:10.1016/j.addbeh.2006.08.005
- Kurdi, B., Seitchik, A. E., Axt, J., Carroll, T., Karapetyan, A., Kaushik, N., ... Banaji, M. R. (2018, in press). Relationship between the Implicit Association Test and intergroup behavior: A meta-analysis. *American Psychologist*. doi:10.31234/osf.io/582gh
- Legley S. (2017). The Cannabis Abuse Screening Test and the DSM-5 in the general population: Optimal thresholds and underlying common structure using multiple factor analysis. *International Journal of Methods in Psychiatric Research*, 27(2), 1597. doi: 10.1002/mpr.1597.
- Lindberg, M. A., & Zeid, D. (2017). Interactive Pathways to Substance Abuse. *Addictive Behaviors*, 66, 76–82. doi:10.1016/j.addbeh.2016.11.016
- Manbeck, K. E., Shelley, D., Schmidt, C. E., & Harris, A. C. (2014). Effects of Oxytocin on Nicotine Withdrawal in Rats. *Pharmacology Biochemistry and Behavior*, 116, 84–89. doi:10.1016/j.pbb.2013.11.002
- McCusker, C. G. (2001). Cognitive biases and addiction : an evolution in theory and method. *Addiction*, 96, 47–56.
- McDonald, J.H. (2014). *Handbook of Biological Statistics* (3rd ed.). Sparky House Publishing, Baltimore, Maryland.
- McNulty, J. K., Olson, M. A., Meltzer, A. L., & Shaffer, M. J. (2013). Though they may be unaware, newlyweds implicitly know whether their marriage will be satisfying. *Science*, 342(6162), 1119–1120. doi : 10.1126/science.1243140
- McRae-Clark, A. L., Baker, N. L., Maria, M. M., & Brady, K.T. (2013). Effect of oxytocin on craving and stress response in marijuana-dependent individuals: A pilot study. *Psychopharmacology*, 228(4), 623–631. doi:10.1007/s00213-013-3062-4

- Mickelson, K. D., Kessler, R. C., & Shaver, P. R. (1997). Adult Attachment in a Nationally Representative Sample. *Journal of Personality and Social Psychology*, 73(5), 1092–1106. doi:10.1037/0022-3514.73.5.1092
- Mikulincer, M., & Shaver, P. R. (2012). An attachment perspective on psychopathology. *World Psychiatry: Official Journal of the World Psychiatric Association (WPA)*, 11(1), 11–15.
- Mikulincer, M., Birnbaum, G., Woddis, D., & Nachmias, O. (2000). Stress and accessibility of proximity-related thoughts: exploring the normative and intraindividual components of attachment theory. *Journal of Personality and Social Psychology*, 78(3), 509–523. doi: 10.1037/0022-3514.78.3.509
- Mikulincer, M., Gillath, O., & Shaver, P. R. (2002). Activation of the attachment system in adulthood: threat-related primes increase the accessibility of mental representations of attachment figures. *Journal of Personality and Social Psychology*, 83(4), 881–895.
- Nock, M. K., Park, J. M., Finn, C. T., Deliberto, T. L., Dour, H. J., & Banaji, M. R. (2010). Measuring the suicidal mind: Implicit cognition predicts suicidal behavior. *Psychological Science*, 21(4), 511–517. doi: 10.1177/0956797610364762
- Nosek, B. A., Greenwald, A. G., & Banaji, M. R. (2007). The implicit association test at age 7: A methodological and conceptual review. In Bargh, J. A. (Ed.), *Social psychology and the unconscious: The automaticity of higher mental processes* (pp. 265–292). New York: Psychology Press.
- Olsson, C. A., Moyzis, R. K., Williamson, E., Ellis, J. A., Parkinson-Bates, M., Patton, G. C., ... Moore, E. E. (2013). Gene-environment interaction in problematic substance use: Interaction between DRD4 and insecure attachments. *Addiction Biology*, 18(4), 717–726. doi:10.1111/j.1369-1600.2011.00413.x

- Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science*, 349(6251), aac4716. doi: 10.1126/science.aac4716
- Peters, S. T., Bowen, M. T., Bohrer, K., McGregor, I. S., & Neumann, I. D. (2016). Oxytocin inhibits ethanol consumption and ethanol-induced dopamine release in the nucleus accumbens: Oxytocin, ethanol and dopamine. *Addiction Biology*, 22(3), 702-711. doi:10.1111/adb.12362
- Phelps, E. A., O'Connor, K. J., Cunningham, W. A., Gatenby, J. C., Funayama, E. S., Gore, J. C., et al. (2000). Amygdala activation predicts performance on indirect measures of racial bias. *Journal of Cognitive Neuroscience*, 12, 729–738.
- Rae, J. R., & Olson, K. R. (2018). Test–retest reliability and predictive validity of the Implicit Association Test in children. *Developmental Psychology*, 54(2), 308. doi:10.1037/dev0000437
- Reis, S., Curtis, J., & Reid, A. (2012). Attachment Styles and Alcohol Problems in Emerging Adulthood: A Pilot Test of an Integrative Model. *Mental Health and Substance Use* 5(2), 115–131. doi:10.1080/17523281.2011.619503
- Rudman, L. A. (2008). The validity of the implicit association test is a scientific certainty. *Industrial and Organizational Psychology*, 1(4), 426-429. doi:[10.1111/j.1754-9434.2008.00081.x](https://doi.org/10.1111/j.1754-9434.2008.00081.x)
- Saunders, J. B., Aasland, O. G., Babor, T. F., De la Fuente, J. R., & Grant, M. (1993). Development of the alcohol use disorders identification test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption-II. *Addiction*, 88(6), 791-804.
- Schindler, A., & Bröning, S. (2015). A review on attachment and adolescent substance abuse: empirical evidence and implications for prevention and treatment. *Substance Abuse*, 36, 304–313. doi: 10.1080/08897077.2014.983586

- Schindler, A., Thomasius, R., Sack, P. M., Gemeinhardt, B., Küstner, U., & Eckert, J. (2005). Attachment and substance use disorders: A review of the literature and a study in drug dependent adolescents. *Attachment & Human Development* 7(3), 207–28.
doi:10.1080/14616730500173918
- Stacy, A. W. (1997). Memory activation and expectancy as prospective predictors of alcohol and marijuana use. *Journal of Abnormal Psychology*, 106, 61–73.
- Tello, N., Harika-Germaneau, G., Serra, W., Jaafari, N., & Chatard, A. (2018, December 3). Does the Implicit Association Test Predict Suicidal Behavior? Direct Replication of Nock, Park, Finn, Deliberto, Dour, & Banaji (2010).
<https://doi.org/10.31234/osf.io/esgf5>
- Thorberg, F. A., & Lyvers, M. (2006). Attachment, Fear of Intimacy and Differentiation of Self among Clients in Substance Disorder Treatment Facilities. *Addictive Behaviors*, 31(4), 732–737. doi:10.1016/j.addbeh.2005.05.050
- Van Ijzendoorn, M. H., Schuengel, C., & Bakermans-Kranenburg, M. J. (1999). Disorganized attachment in early childhood: Meta-analysis of precursors, concomitants, and sequelae. *Development and psychopathology*, 11(2), 225-250.
- Venta, A., Jardin, C., Kalpakci, A., & Sharp, C. (2016). The Development and Preliminary Psychometric Evaluation of an Attachment Implicit Association Task. *Bulletin of the Menninger Clinic*, 80(3), 255–280. doi:10.1521/bumc.2016.80.3.255
- Vungkhanching, M., Sher, K. J., Jackson, K. M., & Parra, G. R. (2004). Relation of Attachment Style to Family History of Alcoholism and Alcohol Use Disorders in Early Adulthood. *Drug and Alcohol Dependence*, 75(1), 47–53.
doi:10.1016/j.drugalcdep.2004.01.013
- Wedekind, D., Bandelow, B., Heitmann, S., Havemann-Reinecke, U., Engel, K. R., & Huether, G. (2013). Attachment Style, Anxiety Coping, and Personality-Styles in

Withdrawn Alcohol Addicted Inpatients. *Substance Abuse Treatment, Prevention, and Policy* 8(1). doi:10.1186/1747-597X-8-1

- Zanos, P., Georgiou, P., Wright, S. R., Hourani, S. M., Kitchen, I., Winsky-Sommerer, R. (2014). The oxytocin analogue carbetocin prevents emotional impairment and stress-induced reinstatement of opioid-seeking in morphine-abstinent mice, *Neuropsychopharmacology*, 39, 855–865. doi: 10.1038/npp.2013.285
- Zayas, V., & Shoda, Y. (2005). Do automatic reactions elicited by thoughts of romantic partner, mother, and self relate to adult romantic attachment?. *Personality and Social Psychology Bulletin*, 31(8), 1011-1025. doi : 10.1177/0146167204274100

Footnotes

¹ The Benjamini–Hochberg (BH) procedure was used to adjust the false discovery rate (FDR) to 5% in the present study. We used the BH procedure instead of the classical Bonferroni correction because the latter is very extreme and it may lead to a very high rate of false negatives when the different tests are not independent (Benjamini, & Hochberg, 1995), which is obviously the case in our study (for instance, nicotine dependence entails smoking). The BH procedure is less extreme and ensures a more reasonable tradeoff between Type II (false negative) and Type I (false positive) errors. Readers interested in learning more on the BH procedure, and how to compute the BH adjusted p-values, may refer to McDonald (2014).

² In this study, the Benjamini and Hochberg (1995) corrected significance level was 0.0357. The Bonferroni corrected significance level was 0.0071. When the conservative Bonferroni correction was used to adjust for multiple comparison testing, only the correlation between implicit attachment and polydrug use was significant at $p < .05$.