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The subjective experience of heroin effects among individuals with chronic opioid use: Revisiting reinforcement in an exploratory study

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Abstract

Aims: Consistent with the opponent process theory individuals with chronic opioid use should predominantly endorse the avoidance of aversive negative emotional and/or physiological states as the motivation for continued opioid use (source of reinforcement: reductions in negative states). The primary aim of this study was to explore whether this view is supported by the subjective effects of heroin reported by individuals with opioid use disorder (OUD).

Methods: Responses during in-person interviews of participants to the question "What do you like about heroin? " were categorized as positive, negative, or mixed (positive and negative) reinforcement. In addition, we examined differences between these "reinforcement groups" in sociodemographic and clinical variables.

Results: Participants (N = 307) with OUD were predominantly male (78.1%), with chronic heroin use (M = 15.8 years, SD = 11.5), and 46.1% currently used heroin and were not enrolled in treatment. Agreement between two raters concerning the categorization of participant-reported effects of heroin into reinforcement categories was high, κ= 0.924, p < .0005. Approximately half (49.8%) of participant-reported effects of heroin were categorized as attributable to positive reinforcement. About one-fourth (22.8%) were categorized as negative reinforcement and 9.0% as "mixed ". There were no statistically significant differences between the three reinforcement groups in any of the socio-demographic variables, duration of heroin use, or treatment status/ interest.

Conclusions: The results of this study indicate marked heterogeneity of heroin effects experienced by individuals with OUD and their source of reinforcement, respectively. Better

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Contributors

The authors listed are responsible for the content and preparation of this manuscript. SM, LB, and JDJ designed and conceptualized the study. SM and LB conducted the statistical data. All authors contributed to the writing and have approved this manuscript.

integration of how individuals construe their drug use is important to understand the psychological —and neurobiological—processes in the development and maintenance of OUD.

Keywords

Heroin; Reinforcement; Subjective experience; Surrogate measure; Heterogeneity

1. Introduction

Stimulus-response and reinforcement explanations for addictive behaviors have been offered by psychologists for more than a century. In the 1890s, William James postulated that the development of human behavior is grounded in the idea that behavioral patterns (habits) are formed in response to the motivation to achieve a particular outcome [1]. After repeated practice, the sequence of actions forming a habit becomes “automatic ” and is performed without conscious attention—it is provoked by an event or stimulus. B.F. Skinner’s reinforcement theory, developed almost four decades later, specified that behavioral patterns are strengthened and maintained in relation to a stimulus [2]. Although several competing reinforcement theories emerged during this time, many of these approaches share the idea that stimuli, rewards, and other external forces play a key role in repeating behaviors in animals and humans, rather than conscious and unconscious thoughts or feelings [2–5].

According to some neurobiological and reinforcement perspectives, drug “addiction ” may be conceptualized as a product of neurobehavioral stimulus-response learning in which drug use routines or habits are often performed automatically, with limited or no reflection [6, 7]. Note that we are using the term “addiction ” to refer to the most severe form of a full spectrum of substance use disorders (SUD) which is characterized by an individual’s inability to control the impulse to use drugs despite negative consequences [8]. In contrast, SUD refers to a problematic pattern of substance use leading to clinically significant impairment or distress with 2 or more criteria (depending on the substance) listed in the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5) occurring within 12 months.

The traditional model of the development and maintenance of SUDs emphasizes that individuals initiate drug use for their pleasurable and/or euphorigenic effects (positive reinforcement). However, over time, the motivation for drug use evolves towards the avoidance of withdrawal symptoms and other adverse states in the absence of the drug (negative reinforcement) [6, 9]. Following this model, tolerance (i.e., requiring higher doses to maintain initial drug effectiveness or diminished effect after repeated administration of the same dose of the drug) and dependence (i.e., physiological and/or psychological withdrawal when drug use has ceased) are two key diagnostic criteria for SUDs [10, 11]. However, it is important to note prior research has also suggested variability on why and how individuals initiate and respond to first drug use episodes on several dimensions including subjective self-reported effects and physiological processes [12–15]. Therefore, it is possible for an individual to not have an initially positive effect when first trying a drug but subsequently develop a SUD.

It is also important to acknowledge other theories of addiction which emerged outside of the behavioral tradition. Many models of addiction are centrally grounded within cognitive theories which conceptualize human functioning and behavior as being driven by a complex interaction of thoughts and intellectual processes, giving rise to belief systems and behavioral and emotional patterns [16]. Although there is a multiplicity of cognitive addiction theories, some of the most prominent aspects of these models focus on the underlying mechanisms related to drug use behaviors and craving and the reduction in self-control processes, both automatic and non-automatic [17–19]. There is a large body of literature that suggests that individuals with SUDs often suffer from significant impairment across several cognitive processes including executive functioning, episodic memory, decision-making, and selective attention and attentional biases [20–24]. Therefore, these models highlight cognition as a critical component in the development and maintenance of SUDs and key to improving clinical outcomes [24].

The opponent process theory, later adopted by some neuroscientists, integrated and built on the progressive pleasure/withdrawal view of addictive behavior [25, 26]. One of the theory's central ideas suggests that positive affective and hedonic processes (source of reinforcement: positive) are opposed by negative affective processes (source of reinforcement: negative) through a complex interaction of neurobiological mechanisms [25–28]. In the current scientific literature, SUDs are most commonly described as chronic brain disorders characterized by disruptions in motivational circuits produced by multiple factors including inflated incentive salience and habit formation, reward deficits, impaired stress response, and cognitive functioning discrepancies [29, 30]. This model integrates a neurobiological explanation of opponent processes as a motivational theory for the negative reinforcement driving addiction, and more specifically, the combination of loss of reward function and sensitization of brain stress systems [28].

The strength of an opponent-process model of SUDs is that it recognizes withdrawal and distress as important factors for maintaining drug use and the involvement of a multitude of components in this process. However, the focus on negative-reinforcement mechanisms in the later stages of SUDs has failed to account for the perseverance of vulnerability to relapse months or even years after withdrawal symptoms have dissipated, or after stabilization on opioid agonist or antagonist medications in the case of opioid use disorder (OUD) [31–34]. Though there is extensive neurobiological evidence of hedonic habituation (tolerance), dependence, and withdrawal [35], the extent to which the opponent-process model of SUDs ubiquitously corresponds with the conscious experience of individuals with a history of chronic drug use is largely unknown.

In the current exploratory study, the investigators chose to target OUD because opioids can have initial positive and negative reinforcing effects. When opioids activate mu-opioid receptors (MOR), they reduce the tonic inhibition of dopamine neurons, resulting in increased mesolimbic dopamine release that is thought to produce euphoria [36, 37]. In some studies, MOR activation has been implicated in the moderation of prosocial behavior, anhedonia, and attachment. Therefore, attenuation of "social pain " (e.g., social dysfunction and isolation) has also been implicated as a motivator of opioid use [38–42]. Furthermore,

clinical studies have shown that opioid agonists have anxiolytic effects, attributed to their ability to decrease serum cortisol levels [43–46].

The positive and negative reinforcing effects of opioids may be separate or complementary contributors to their initial and continued use. Yet, the role and relative contribution that reinforcement type plays in OUD have not been extensively investigated clinically. In line with the opponent process theory, we would expect individuals with a history of chronic heroin use to predominantly endorse the avoidance of aversive negative emotional states as the primary reason for using heroin (source of reinforcement: negative). The primary aim of this exploratory study was to explore whether this corresponds with the effects of heroin experienced by individuals with OUD with a history of chronic heroin use. In addition, this study sought to examine associations between reinforcement group (i.e., participant-reported effects of heroin categorized by source of reinforcement) and socio-demographic variables, addiction severity, and treatment status and interest.

2. Method

2.1. Participants and recruitment

This study is a secondary analysis of data collected as part of a 5-year randomized clinical trial (ClinicalTrials.gov Identifier: NCT02535494]; completed October 10, 2019) conducted at New York State Psychiatric Institute (NYSPI)/Columbia University Irving Medical Center (CUIMC). The primary aim of the parent study was to compare the effects of a novel comprehensive and standard overdose education and naloxone distribution (OEND) training on overdose intervention attempts. After receiving one of the two training modules, participants were followed over 12 months to measure the effects of the intervention. For more details of the study and study-related procedures see [47].

This study recruited and enrolled individuals with OUD, confirmed in a clinical interview, between the ages of 21 and 65 years. Following an initial telephone screen, in-person screening procedures were conducted at the Division on Substance Use Disorders at NYSPI/CUIMC. The in-person screening visit included various questionnaires and clinical interviews administered by a team of research assistants, psychologists, nurses, and physicians. Participants were excluded if they had an active psychiatric disorder that might have interfered with participation or made participation hazardous for them or the study staff (e.g., psychotic disorder, active bipolar disorder with mania, or significant history of violent behavior).

Study design and procedures—All study procedures were approved by the NYSPI Institutional Review Board, conducted per the Declaration of Helsinki, and all participants provided written informed consent. As a part of the protocol, participants' drug use severity was assessed with the Addiction Severity Index (ASI) Self-Report Form [48, 49]. Participants also completed a locally developed semi-structured questionnaire [50] assessing current and history of licit and illicit drug use. In addition to questions about the frequency and quantity of various drugs used, this assessment also included questions about motivation/reasons for drug use such as:

- What do you like about heroin?
- Have you ever used heroin for pain control?

Answers to these questions were recorded in writing by the interviewer (a research psychologist trained in interviewing techniques). Of note, interviews were not audio recorded.

2.2. Categorizing participant-reported effects of heroin by source of reinforcement

Only participants who provided a response to the question "What do you like about heroin? " were included in the sample for the current analysis ($n = 307$; total sample of the parent trial $N = 321$). The responses recorded for this question in short sentences were reviewed by two independent raters (SM and LB). The raters categorized the effects of heroin reported by participants in response to this question by their source of reinforcement (henceforth referred to as "reinforcement groups "): positive reinforcement, negative reinforcement, both positive and negative reinforcement (mixed), participant does not like heroin, participant does not use heroin, and other. They used the following standard definitions of positive and negative reinforcement, with examples to categorize each response.

Reinforcement: "The operation of reinforcement is defined as the presentation of a certain kind of stimulus in a temporal relation with either a stimulus or a response. A reinforcing stimulus is defined as such by its power to produce the resulting change. There is no circularity about this; some stimuli are found to produce the change, others not, and they are classified as reinforcing and non-reinforcing accordingly. A stimulus may possess the power to reinforce when it is first presented (when it is usually the stimulus of an unconditioned respondent) or it may acquire the power through conditioning " [2].

Positive reinforcement: Positive reinforcement is defined as the process by which presentation of a stimulus (or a subjectively positive state) increases the probability of a response. An example of positive reinforcement may be: A person using heroin for the euphoric effect [9].

Negative Reinforcement: Negative reinforcement is defined as the process by which removal of an aversive stimulus (or subjectively aversive state) increases the probability of a response. An example of negative reinforcement may be: A person using heroin to alleviate pain [9].

Note. *Negative reinforcement should not be mistaken as punishment. Negative and positive reinforcement increases the probability of a response, whereas punishment decreases the probability of a response*.

Of note, participants were not limited to one response. If a participant provided more than one response to the question "What do you like about heroin? " and responses indicated both negative and positive reinforcing effects of heroin, the participant was assigned to the mixed reinforcement group. In contrast, if all responses indicated the same reinforcement

source, the participant was assigned to the respective reinforcement group (i.e., negative, or positive).

2.3. Statistical analysis

Sample demographics were summarized in terms of arithmetic mean and standard deviation for continuous variables (e.g., ASI drug use composite score, heroin use duration in years, bags of heroin currently used per day) and percentages for count variables (e.g., sex, age, race/ethnicity). Cohen's κ was used to determine the degree of agreement between the two raters' categorization of participant-reported heroin effects by the source of reinforcement.

Analyses of variance (ANOVA) or Pearson chi-square tests were used to compare reinforcement groups (positive, negative, and mixed) in terms of sociodemographic variables, addiction severity, current treatment status and interest in treatment, and use of heroin for pain control. All hypothesis tests were two-sided and a multiple-comparison correction was performed using Bonferroni correction, adjusting the significance level to $p < .005$. Analyses were performed using SPSS Version 25 (IBM).

3. Results

3.1. Sample demographics and categorization of participant-reported heroin effects

Answers to the question "What do you like about heroin? " were available from 307 participants. Agreement between the two raters concerning categorization of participant-reported effects of heroin into different reinforcement categories was high, $\kappa = 0.924$, 95% CI (0.89, 0.96), $p < .0005$. Any outstanding disagreements regarding categorization were resolved through discussion between the two raters, and all participants could be categorized into one of the reinforcement groups.

Sociodemographic and clinical characteristics of the sample are displayed in Table 1. The sample was comprised of primarily individuals with chronic heroin use, with an average duration of 15.8 years (range < 1 year to 50 years) and a mean ASI drug use composite score of 0.25 (range: 0 to 0.88). Mean daily quantity of heroin use was 3.87 bags per day (range: < 1 to 30 bags). Almost half (46.1%) of the sample currently used heroin and were not enrolled in treatment, 43.1% percent were currently receiving medication for OUD (MOUD), and a small proportion (10.8%) had recently undergone detoxification from opioids. Over half of the participants (50.3%) reported having used heroin for the management of physical pain, and more than one-third (36.1%) were still using it for that purpose.

Approximately half (49.8%) of participants' answers to the question "What do you like about heroin? " were categorized as attributable to positive reinforcement. About one-fourth (22.8%) were categorized as negative reinforcement and 9.0% as "mixed " (both positive and negative reinforcement). Twenty participants (6.5%) indicated that they did not like heroin, three (1.0%) responded that they currently did not use heroin, and four answers (1.3%) were categorized as "other " (e.g., "heroin balances the crack high "). The most common participant-reported effects of heroin are shown in Fig. 1. Given the small numbers

of participants included in the “does not use/like heroin ” and “other ” categories, we only included positive, negative, and mixed reinforcement groups in subsequent analyses.

Common answers that were categorized as attributable to positive reinforcement included descriptions of euphoria and the high, a good feeling, and relaxation. Some individuals also mentioned that they like “the drip ”. This refers to the physical sensation of the drug “dripping ” down the throat/nasal passage after snorting it. Other participant-reported effects in the positive reinforcement category ranged from sexual enhancement (e.g., prolonged ejaculation) to energizing effects. The most common participant-reported effect categorized as attributable to negative reinforcement was pain control, followed by continued heroin use to avoid opioid withdrawal. “The nod ” was also commonly mentioned. “Nod ” related to heroin use was categorized as negative reinforcement as this is an opioid-induced state that shifts between wakefulness and various degrees of drowsy or unconsciousness [51]. Therefore, the investigators characterized “nod ” as a state of loss of sensation or awareness. Similarly, participants also referred to the anxiolytic effects of heroin, being able to escape the world around them and entering a state of numbness.

3.2. Socio-demographic and clinical differences between reinforcement groups

Participants who reported heroin effects attributable to both positive and negative reinforcement (i.e., those in the mixed reinforcement group) appeared to have the shortest heroin use history, be less commonly receiving MOUD, and use heroin as a means of pain control less often compared to the other two groups. In addition, participants in the negative reinforcement group seemed to use fewer bags of heroin per day (Table 1). However, none of these differences reached statistical significance (Table 1).

4. Discussion

The results of the current study do not support the hypothesis that individuals with OUD and a history of chronic heroin use would primarily endorse effects of heroin that are attributable to negative reinforcement such as avoidance of withdrawal symptoms. Indeed, only about 12% of individuals in the negative reinforcement group endorsed using heroin to reduce withdrawal symptoms. Even though more than a third of our sample indicated that they were currently using heroin for the management of physical pain, less than one-fourth exclusively endorsed negative reinforcing effects of heroin when being asked what they liked about heroin. Meanwhile, approximately half reported effects attributable to positive reinforcement such as euphoria. These data provide conflicting support for the opponent process theory which purports that the initiation of drug use is primarily driven by positive reinforcing effects of drugs, while the continuation of use and subsequent development of SUDs is primarily characterized by the transition to negative reinforcement—chiefly, the avoidance of withdrawal symptoms [52].

Clinical laboratory studies support the hypothesis that withdrawal symptoms may not be the main driver of drug use during the “addicted ” phase. In one such study, individuals with OUD who did not demonstrate naloxone-precipitated withdrawal (i.e., were not physiologically dependent on opioids) still demonstrated robust operant responding (i.e., motivation) for intravenous morphine [53]. Other clinical studies found that maximal periods

of drug self-administration often do not coincide with periods of maximal withdrawal distress [53–55]. However, one clinical study did reveal that buprenorphine and methadone were self-administered at doses that produced negligible positive subjective effects because those doses alleviated mild withdrawal symptoms [56].

Proponents of the opponent process theory have acknowledged the importance of positive reinforcing effects of drugs, and some utilized the incentive-sensitization theory of addiction [52, 57] to address gaps in understanding the underlying mechanism for compulsive drug use. The incentive-sensitization theory assumes that repeated exposure to drugs can persistently change brain circuits that regulate the attribution of incentive salience to stimuli [58]. This ‘sensitization’ of circuits results in pathological levels of “desire” or “want” (incentive salience) being attributed to drugs and drug-associated cues. Nonetheless, the consensus remained that individuals would eventually shift to primarily endorsing effects of drugs attributable to negative reinforcement[52,55,58,59]. Although the opponent process and the incentive-sensitization theory have greatly contributed to understanding the neurobiological pathways that lead to neurological alterations in addiction, these theories appear to inadequately explain the heterogeneity observed in our sample. Given that the sample consisted of individuals who had been using heroin for approximately 16 years, and in line with the aforementioned theories, we would have expected greater homogeneity in the participant-reported effects of heroin and their source of reinforcement, respectively.

Previous research has demonstrated phenotypic heterogeneity among samples with SUDs and other psychiatric disorders [60, 61]. Within SUD samples, heterogeneity is prominently expressed across multiple dimensions including psychological functioning, pharmacokinetic and pharmacodynamic processes, genetic contributions, psychiatric comorbidities, drug-associated behaviors, and environmental influences [62–64]. To that end, our data seem to suggest clustering into potential “reinforcement phenotypes. ” Better characterizing these suggested phenotypes and understanding their behavioral and psychological underpinnings may not only improve our precision in assessing OUD but may assist in the development of more personalized treatment approaches. For example, a recent study provides preliminary evidence for distinct opioid withdrawal phenotypes (high and low levels of opioid withdrawal), which are associated with differentially meaningful outcomes in pharmacotherapy; i.e., differential response to study medication and retention rates [65].

We did not observe any differences between reinforcement groups in socio-demographic, addiction severity, or treatment variables. However, we were limited to baseline information available from the primary trial, and the available variables to characterize addiction severity (i.e., the ASI and quantity/duration of heroin use) may not fully represent the impairments in psychosocial and behavioral functioning related to OUD [66, 67]. Thus, future studies are tasked with moving beyond these sample characteristics, exploring behavioral and psychological correlates of and differential treatment responses associated with reinforcement phenotypes. Integration with established psychological trait theories, such as the five-factor model of personality, and behavioral models of addiction (e.g., drug administration/choice tasks) may be a promising starting point.

In our study, reinforcement groups were ascertained from a single question about motivation for drug use, specifically “What do you like about heroin?. ” Besides eliciting descriptions of heroin effects experienced by our participants, this question may be accessing several psychological domains including but also extending beyond hedonic responses such as drug liking or craving. For example, the incentive-sensitization theory differentiates between drug “liking ” and “wanting, ” and these two psychological manifestations are thought to have distinct neurobiological mechanisms [68]. Studies have also shown that “liking ” can occur unconsciously in the absence of subjective hedonic reactions while still eliciting goal-directed behavioral responses [69–71]. Additionally, it has been shown that “liking ” can occur in combination with conscious subjective states that are related to specific hedonic pathways and to perceptive ratings and subjective feelings [71–73]. Differentiation is also made between conscious wanting and the neurobiological process of “wanting ” or incentive salience and its observable responses [71]. Furthermore, within the craving domain, a recent study suggested that opioid craving is a multi-dimensional construct with distinct components [74]. This study postulated that heterogeneity in the subjective rating of craving may be due to individual differences in functionality (i.e., severity of opioid use and physiological dependence). Taken together, these findings suggest that it would be advantageous to comprehensively investigate reinforcement phenotypes by differentiating between 1) craving, wanting, and liking, 2) conscious and unconscious processes and motivations, and 3) acute and long-term (retrospective or “remembered ”) drug effects.

Our preliminary findings may also offer the opportunity to incorporate theoretical cognitive constructs such as metacognition to strengthen the validity of traditional reinforcement theories, in addition to providing a structure for further investigation. Metacognition is commonly defined as the self-awareness, knowledge, and cognitive processes involved in decision-making, appraisal, control, or monitoring of thinking (“thinking about thinking ”) [75, 76]. Although still an emerging area, preliminary research in explicit cognitive processes has shown associations between deficits in metacognition and the vulnerability to addiction, however, more research is needed [17, 77–80]. A recent systematic review highlighted evidence that suggests that individuals with SUDs are more likely to display maladaptive general metacognitive beliefs, metacognitive beliefs related to thoughts about addiction, and metacognitive beliefs related to craving [81]. Taken together metacognition appears to contribute to the initiation and perseveration of SUDs. As such, this model may provide an innovative framework to conceptualize and understand our findings related to the subjective understanding of heroin effects.

Several limitations of this study merit comment. First, this was a secondary analysis, and assessing the reinforcing effects of heroin was not the main objective of the primary trial. It would be critical to replicate our findings utilizing a prospective design that comprehensively assesses reinforcement across multiple phenotypical dimensions (biological, psychological/cognitive, and behavioral). These potential reinforcement phenotypes should be examined and validated across multimodal methods of assessments such as self-reports and laboratory models, including self-administration paradigms. Second, cross-sectional data were used to delineate reinforcement groups and as such, our data may only represent a snapshot of an individual’s perception/experience of heroin effects at the time of the study. In addition, we did not assess opioid withdrawal symptoms or

opioid intoxication at the time of the interview, both of which could have influenced participants' responses. Future studies should assess the stability of these potential reinforcement phenotypes over time and as a function of withdrawal/intoxication. Third, given that a clinical interview was used to elicit descriptions of heroin effects experienced by participants, bias arising from social desirability or selective recall cannot be ruled out. Additionally, the question used to ascertain reinforcement groups may not capture the complexity of the subjective experience resulting from heroin use or the motivation for drug use and the phrasing of the question may have biased participants' responses towards positive reinforcement responses. Furthermore, while the agreement between the two independent raters was high and their categorization followed pre-determined definitions of positive and negative reinforcement with examples, it cannot be ruled out that categorizations of participant-reported effects of heroin by source of reinforcement may be subjective or biased [82]. Fourth, while the sex distribution of our sample mirrors the ratio of men to women with OUD in the US [83], future studies should attempt to recruit more women in order to adequately explore potential sex differences. Finally, future research is tasked with exploring potential differences among OUD populations (e.g., individuals from different socioeconomic backgrounds, individuals living in rural versus urban areas, chronic versus short-term opioid use, polysubstance use, and psychiatric comorbidities), in addition to other SUD populations.

In conclusion, the results of this study indicate marked heterogeneity of heroin effects experienced by individuals with OUD and their source of reinforcement, respectively. While imperative for understanding the neurobiological pathways that lead to brain changes in addiction, contemporary reinforcement theories appear to inadequately explain our findings. Within traditional reinforcement theories, drug use routines or habits are thought to be predominantly performed automatically, without conscious reflection. Better integration of how individuals construe, understand, or make sense of their drug use (i.e., their meaning-making) is important to understand the psychological—in addition to the neurobiological—processes in the development and maintenance of SUDs. Systematically incorporating assessments of the subjective experience of drug effects with "objective " measures, such as drug choice tasks, may help address gaps in understanding the underlying mechanism of compulsive drug use and developing a more complete model of reinforcement processes that guide an individual's behavior. [84]. This approach may facilitate the development of a more complete model of addiction which integrates behavioral, cognitive, and psychological mechanisms to assist in the development of more personalized and precise interventions and improve clinical outcomes. For example, tailoring a pharmacological or behavioral SUD treatment to a specific reinforcement phenotype may lead to greater adherence and improved effectiveness [84].

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Role of the funder/sponsor

The funding organization had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Declaration of Competing Interest

Within the past three years Dr. Jones received compensation (in the form of partial salary support) from a study partially supported by Cerecor Inc and has served as a paid consultant to Alkermes and the World Health Organization. Within the past three years, Dr. Comer has received research funding from Alkermes, Braeburn Pharmaceuticals, Cerecor Inc., Corbus, Go Medical, Intra-cellular Therapies, Janssen, and Lyndra. Dr. Comer has also consulted for: Alkermes, Charleston Labs, Clinilabs, Epiodyne, Mallinckrodt, Nektar, Neurolixis, Opiant, Otsuka, and Sun Pharma. She also has received honoraria from the World Health Organization. Dr. Levin receives grant support from the NIDA, SAMHSA and US WorldMeds. She is a consultant for Major League Baseball. She was an unpaid member in the scientific advisory board for Alkermes, Indivior, Novartis and US WorldMeds but did not personally receive any compensation in the form of cash payments (honoraria/consulting fees) or food/beverage (she declined food/beverages in each circumstance) nor receive compensation in the form of travel reimbursement. She also receives medication from Indivior for research. SM and LB have no conflicts to report.

References

[1]. James W, The Principles Of Psychology Volume I By William James (1890), The Principles of Psychology, 1890.

[2]. Skinner BF, The Behaviour of Organisms, 1938 Appleton-Century.

[3]. Pavlov IP, in: A Brief Outline of the Higher Nervous activity. Psychologies of 1930, Clark University Press, Worcester, 1930, pp. 207–220, doi: 10.1037/11017-011.

[4]. Thorndike EL, The law of effect, Am. J. Psychol 39 (1927) 212, doi: 10.2307/1415413.

[5]. Watson JB, in: Proceedings of the unconscious of the behaviorist. The unconscious: A symposium, New York, Alfred A. Knopf, 1927, pp. 91–113, doi: 10.1037/13401-005.

[6]. Bechara A, Berridge KC, Bickel WK, Morón JA, Williams SB, Stein JS, A neurobehavioral approach to addiction: implications for the opioid epidemic and the psychology of addiction, Psychological Science in the Public Interest 20 (2019) 96–127, doi: 10.1177/1529100619860513. [PubMed: 31591935]

[7]. Roberts AJ, Koob GF, The neurobiology of addiction: an overview, Alcohol Health Res. World 21 (1997) 101–106, doi: 10.1016/s0190-9622(83)80200-x. [PubMed: 15704343]

[8]. National Institute on Drug AbuseThe National Institute On Drug Abuse Media Guide: How to Find What You Need to Know About Drug Use and Addiction, 2018 https://www.drugabuse.gov/sites/default/files/media_guide.pdf (accessed June 7, 2021).

[9]. Wise RA, Koob GF, The development and maintenance of drug addiction, Neuropsychopharmacology 39 (2014) 254–262, doi: 10.1038/npp.2013.261. [PubMed: 24121188]

[10]. Saunders JB, Substance use and addictive disorders in DSM-5 and ICD 10 and the draft ICD 11, Curr. Opin. Psychiatry 30 (2017) 227–237, doi: 10.1097/YCO.0000000000000332. [PubMed: 28459730]

[11]. Saunders JB, Substance dependence and non-dependence in the diagnostic and statistical manual of mental disorders (DSM) and the international classification of diseases (ICD): can an identical conceptualization be achieved? Addiction 101 (2006) 48–58, doi: 10.1111/j.1360-0443.2006.01589.x. [PubMed: 16930161]

[12]. de Wit H, Phillips TJ, Do initial responses to drugs predict future use or abuse? Neurosci. Biobehav. Rev 36 (2012) 1565–1576, doi: 10.1016/j.neubiorev.2012.04.005. [PubMed: 22542906]

[13]. Haertzen CA, Hooks NT, Ross FE, Liking of the first drug experience: a comparison of ten drugs in opiate addicts, Psychol. Rep 48 (1981) 647–668, doi: 10.2466/pr0.1981.48.2.647. [PubMed: 7291402]

[14]. Haertzen CA, Kocher TR, Miyasato K, Reinforcements from the first drug experience can predict later drug habits and/or addiction: results with coffee, cigarettes, alcohol, barbiturates, minor and major tranquilizers, stimulants, marijuana, hallucinogens, heroin, opiates and cocaine, Drug Alcohol Depend 11 (1983) 147–165, doi: 10.1016/0376-8716(83)90076-5. [PubMed: 6134605]

[15]. Swadi H, Individual risk factors for adolescent substance use, Drug Alcohol Depend. 55 (1999) 209–224, doi: 10.1016/S0376-8716(99)00017-4. [PubMed: 10428362]

[16]. DiGiuseppe R, David D, Venezia R, Cognitive theories, in: APA Handbook of Clinical psychology: Theory and Research, American Psychological Association, Washington, 2016, pp. 145–182, doi: 10.1037/14773-006. (Vol. 2).

[17]. Copersino ML, Cognitive mechanisms and therapeutic targets of addiction. Current opinion in behavioral, Sciences 13 (2017) 91–98, doi: 10.1016/j.cobeha.2016.11.005. [PubMed: 28603756]

[18]. ST Tiffany A cognitive model of drug urges and drug-use behavior: role of automatic and nonautomatic processes, Psychol. Rev 97 (1990) 147–168, doi: 10.1037/0033-295X.97.2.147. [PubMed: 2186423]

[19]. Skinner MD, Aubin H-J, Craving's place in addiction theory: contributions of the major models, Neurosci. Biobehav. Rev 34 (2010) 606–623, doi: 10.1016/j.neubiorev.2009.11.024. [PubMed: 19961872]

[20]. Potvin S, Stavro K, Rizkallah É, Pelletier J, Cocaine and cognition, J. Addict. Med 8 (2014) 368–376, doi: 10.1097/ADM.0000000000000066. [PubMed: 25187977]

[21]. Leung D, Staiger PK, Hayden M, Lum JAG, Hall K, Manning V, et al. , Meta-analysis of the relationship between impulsivity and substance-related cognitive biases, Drug Alcohol Depend 172 (2017) 21–33, doi: 10.1016/j.drugalcdep.2016.11.034. [PubMed: 28107679]

[22]. Biernacki K, McLennan SN, Terrett G, Labuschagne I, Rendell PG, Decision-making ability in current and past users of opiates: a meta-analysis, Neurosci. Biobehav. Rev 71 (2016) 342–351, doi: 10.1016/j.neubiorev.2016.09.011. [PubMed: 27649645]

[23]. Baldacchino A, Balfour DJK, Passetti F, Humphris G, Matthews K, Neuropsychological consequences of chronic opioid use: a quantitative review and meta-analysis, Neuroscience & Biobehavioral Reviews 36 (2012) 2056–2068, doi: 10.1016/j.neubiorev.2012.06.006. [PubMed: 22771335]

[24]. Verdejo-Garcia A, Garcia-Fernandez G, Dom G, Cognition and addiction, Dialogues Clin. Neurosci 21 (2019) 281–290, doi: 10.31887/DCNS.2019.21.3/gdom. [PubMed: 31749652]

[25]. Solomon RL, Corbit JD, An opponent-process theory of motivation: II. Cigarette addiction, J. Abnorm. Psychol 81 (1973) 158–171, doi: 10.1037/h0034534. [PubMed: 4697797]

[26]. Solomon RL, Corbit JD, An opponent-process theory of motivation: I. Temporal dynamics of affect, Psychol. Rev 81 (1974) 119–145, doi: 10.1037/h0036128. [PubMed: 4817611]

[27]. Koob GF, Stinus L, Le MM, Bloom FE, Opponent process theory of motivation: neurobiological evidence from studies of opiate dependence, Neuroscience & Biobehavioral Reviews 13 (1989) 135–140, doi: 10.1016/S0149-7634(89)80022-3. [PubMed: 2682399]

[28]. Koob GF, Le Moal M, Neurobiological mechanisms for opponent motivational processes in addiction, Philos. Trans. Royal Soc. B 363 (2008) 3113–3123, doi: 10.1098/rstb.2008.0094.

[29]. Koob GF, Volkow ND, Neurobiology of addiction: a neurocircuitry analysis, Lancet Psychiatry 3 (2016) 760–773, doi: 10.1016/S2215-0366(16)00104-8. [PubMed: 27475769]

[30]. Hogarth L, Addiction is driven by excessive goal-directed drug choice under negative affect: translational critique of habit and compulsion theory, Neuropsychopharmacology 45 (2020) 720–735, doi: 10.1038/s41386-020-0600-8. [PubMed: 31905368]

[31]. Fishman M, Vo HT, Burgower R, Ruggiero M, Rotrosen J, Lee J, et al. , Treatment trajectories during and after a medication trial for opioid use disorder: moving from research as usual to

treatment as usual, J Addict Med 14 (2020) 331–336, doi: 10.1097/ADM.0000000000000592. [PubMed: 31972765]

[32]. Strang J, Volkow ND, Degenhardt L, Hickman M, Johnson K, Koob GF, et al. , Opioid use disorder, Nat. Rev. Dis. Primers 6 (2020) 3, doi: 10.1038/s41572-019-0137-5. [PubMed: 31919349]

[33]. Eastwood B, Strang J, Marsden J, Continuous opioid substitution treatment over five years: heroin use trajectories and outcomes, Drug Alcohol Depend 188 (2018) 200–208, doi: 10.1016/j.drugalcdep.2018.03.052. [PubMed: 29778774]

[34]. Sinha R, New findings on biological factors predicting addiction relapse vulnerability, Curr. Psychiatry Rep 13 (2011) 398–405, doi: 10.1007/s11920-011-0224-0. [PubMed: 21792580]

[35]. Jones J, Levin C, Mumtaz M, CSN Opioids, The American Psychiatric Association Publishing Textbook of Substance Use Disorder Treatment, American Psychiatric Association Publishing, 2021, doi: 10.1176/appi.books.9781615373970.kb12.

[36]. Chefer VI, Kieffer BL, Shippenberg TS, Basal and morphine-evoked dopaminergic neurotransmission in the nucleus accumbens of MOR- and DOR-knockout mice, Eur. J. Neurosci 18 (2003) 1915–1922, doi: 10.1046/j.1460-9568.2003.02912.x. [PubMed: 14622224]

[37]. Jalabert M, Bourdy R, Courtin J, Veinante P, Manzoni OJ, Barrot M, et al. , Neuronal circuits underlying acute morphine action on dopamine neurons, Proc. Natl. Acad. Sci 108 (2011) 16446–16450, doi: 10.1073/pnas.1105418108. [PubMed: 21930931]

[38]. Burkett JP, Spiegel LL, Inoue K, Murphy AZ, Young LJ, Activation of μ-opioid receptors in the dorsal striatum is necessary for adult social attachment in monogamous prairie voles, Neuropsychopharmacology 36 (2011) 2200–2210, doi: 10.1038/npp.2011.117. [PubMed: 21734650]

[39]. Cinque C, Pondiki S, Oddi D, Di Certo MG, Marinelli S, Troisi A, et al. , Modeling socially anhedonic syndromes: genetic and pharmacological manipulation of opioid neurotransmission in mice, Transl Psychiatry 2 (2012) e155–e155, doi: 10.1038/tp.2012.83. [PubMed: 22929597]

[40]. Der-Avakian A, Markou A, The neurobiology of anhedonia and other reward-related deficits, Trends Neurosci 35 (2012) 68–77, doi: 10.1016/j.tins.2011.11.005. [PubMed: 22177980]

[41]. Eisenberger NI, The neural bases of social pain, Psychosom. Med 74 (2012) 126–135, doi: 10.1097/PSY.0b013e3182464dd1. [PubMed: 22286852]

[42]. Volkow ND, Wang G-J, Fowler JS, Tomasi D, Telang F, Addiction: beyond dopamine reward circuitry, Proc. Natl. Acad. Sci 108 (2011) 15037–15042, doi: 10.1073/pnas.1010654108. [PubMed: 21402948]

[43]. Delitala G, Grossman A, Besser M, Differential effects of opiate peptides and alkaloids on anterior pituitary hormone secretion, Neuroendocrinology 37 (1983) 275–279, doi: 10.1159/000123558. [PubMed: 6633817]

[44]. Kreek MJ, Koob GF, Drug dependence: stress and dysregulation of brain reward pathways, Drug Alcohol Depend 51 (1998) 23–47, doi: 10.1016/S0376-8716(98)00064-7. [PubMed: 9716928]

[45]. Bershad AK, Jaffe JH, Childs E, de Wit H, Opioid partial agonist buprenorphine dampens responses to psychosocial stress in humans, Psychoneuroendocrinology 52 (2015) 281–288, doi: 10.1016/j.psyneuen.2014.12.004. [PubMed: 25544740]

[46]. Allolio B, Schulte HM, Deuβ U, Kallabis D, Hamel E, Winkelmann W, Effect of oral morphine and naloxone on pituitary-adrenal response in man induced by human corticotropin-releasing hormone, Acta Endocrinol 114 (1987) 509–514, doi: 10.1530/acta.0.1140509.

[47]. Jones JD, Campbell AN, Brandt L, Metz VE, Martinez S, Wall M, et al. , A randomized clinical trial of the effects of brief versus extended opioid overdose education on naloxone utilization outcomes by individuals with opioid use disorder, Drug Alcohol Depend 237 (2022) 109505, doi: 10.1016/j.drugalcdep.2022.109505.

[48]. McLellan AT, Kushner H, Metzger D, Peters R, Smith I, Grissom G, et al. , The fifth edition of the addiction severity index, J. Subst. Abuse Treat 9 (1992) 199–213. [PubMed: 1334156]

[49]. Ljungvall H, Persson A, Åsenlöf P, Heilig M, Ekselius L, Reliability of the addiction severity index self-report form (ASI-SR): a self-administered questionnaire based on the addiction severity index composite score domains, Nord. J. Psychiatry 74 (2020) 9–15, doi: 10.1080/08039488.2019.1666300. [PubMed: 31696752]

[50]. Comer SD, Sullivan MA, Whittington RA, Vosburg SK, Kowalczyk WJ, Abuse liability of prescription opioids compared to heroin in morphine-maintained heroin abusers, Neuropsychopharmacology 33 (2008) 1179–1191, doi: 10.1038/sj.npp.1301479. [PubMed: 17581533]

[51]. Van Hout MC, Nod and wave: an internet study of the codeine intoxication phenomenon, Int. J. Drug Policy 26 (2015) 67–77, doi: 10.1016/j.drugpo.2014.06.016. [PubMed: 25052240]

[52]. Koob GF, Caine SB, Parsons L, Markou A, Weiss F, Opponent process model and psychostimulant addiction, Pharmacol. Biochem. Behav 57 (1997) 513–521, doi: 10.1016/S0091-3057(96)00438-8. [PubMed: 9218276]

[53]. Lamb RJ, Preston KL, Schindler CW, Meisch RA, Davis F, Katz JL, et al. , The reinforcing and subjective effects of morphine in post-addicts: a dose-response study, J. Pharmacol. Exp. Ther 259 (1991) 1165–1173. [PubMed: 1762068]

[54]. Jaffe JH, Current concepts of addiction, Res. Publ. Assoc. Res. Nerv. Ment. Dis 70 (1992) 1–21.

[55]. Wise RA, Bozarth MA, A psychomotor stimulant theory of addiction, Psychol. Rev 94 (1987) 469–492. [PubMed: 3317472]

[56]. Comer SD, Sullivan MA, Walker EA, Comparison of intravenous buprenorphine and methadone self-administration by recently detoxified heroin-dependent individuals, J. Pharmacol. Exp. Ther 315 (2005) 1320–1330, doi: 10.1124/jpet.105.090423. [PubMed: 16144974]

[57]. Bickel WK, Mellis AM, Snider SE, Athamneh LN, Stein JS, Pope DA, 21st century neurobehavioral theories of decision making in addiction: review and evaluation, Pharmacol. Biochem. Behav 164 (2018) 4–21, doi: 10.1016/j.pbb.2017.09.009. [PubMed: 28942119]

[58]. Robinson TE, Berridge KC, The neural basis of drug craving: an incentive-sensitization theory of addiction, Brain Res. Brain Res. Rev 18 (1993) 247–291, doi: 10.1016/0165-0173(93)90013-p. [PubMed: 8401595]

[59]. Stewart J, de Wit H, Eikelboom R, Role of unconditioned and conditioned drug effects in the self-administration of opiates and stimulants, Psychol. Rev 91 (1984) 251–268. [PubMed: 6571424]

[60]. Wong CCY, SG Review, Genetics of addictions: strategies for addressing heterogeneity and polygenicity of substance use disorders, Philos. Trans. R. Soc. Lond. B Biol. Sci 363 (2008) 3213–3222, doi: 10.1098/rstb.2008.0104. [PubMed: 18640915]

[61]. Feczko E, Miranda-Dominguez O, Marr M, Graham AM, Nigg JT, Fair DA, The heterogeneity problem: approaches to identify psychiatric subtypes, Trends Cogn. Sci 23 (2019) 584–601, doi: 10.1016/j.tics.2019.03.009. [PubMed: 31153774]

[62]. Wendt FR, Pathak GA, Tylee DS, Goswami A, Polimanti R, Heterogeneity and poly genicity in psychiatric disorders: a genome-wide perspective, Chronic Stress 4 (2020) 247054702092484, doi: 10.1177/2470547020924844.

[63]. Schuler MS, Dick AW, Stein BD, Heterogeneity in prescription opioid pain reliever misuse across age groups: 2015–2017 national survey on drug use and Health, J. Gen. Intern. Med 35 (2020) 792–799, doi: 10.1007/s11606-019-05559-6. [PubMed: 31792871]

[64]. Strain EC, Hegemony, homogeneity, and DSM-5 SUD, Drug Alcohol Depend 221 (2021) 108660, doi: 10.1016/j.drugalcdep.2021.108660.

[65]. Dunn KE, Weerts EM, Huhn AS, Schroeder JR, Tompkins DA, Bigelow GE, et al. , Preliminary evidence of different and clinically meaningful opioid withdrawal phenotypes, Addict. Biol 25 (2020), doi: 10.1111/adb.12680.

[66]. Quednow BB, Social cognition in addiction, Cognit. Addict (2020) 63–78 Elsevier, doi: 10.1016/B978-0-12-815298-0.00005-8.

[67]. Poudel A, Sharma C, Gautam S, Poudel A, Psychosocial problems among individuals with substance use disorders in drug rehabilitation centers, Nepal, Substance Abuse Treatment, Prevention, and Policy 11 (2016) 28, doi: 10.1186/s13011-016-0072-3. [PubMed: 27528233]

[68]. Berridge KC, Robinson TE, Liking, wanting, and the incentive-sensitization theory of addiction, Am. Psychol 71 (2016) 670–679, doi: 10.1037/amp0000059. [PubMed: 27977239]

[69]. Fischman MW, Foltin RW, Self-administration of cocaine by humans: a laboratory perspective, Ciba Found. Symp 166 (1992) 165–173 discussion 173–80, doi: 10.1002/9780470514245.ch10. [PubMed: 1638911]

[70]. Winkielman P, Berridge KC, Wilbarger JL, Unconscious affective reactions to masked happy versus angry faces influence consumption behavior and judgments of value, Pers. Soc. Psychol. Bull 31 (2005) 121–135, doi: 10.1177/0146167204271309. [PubMed: 15574667]

[71]. Berridge KC, Kringelbach ML, Pleasure systems in the brain, Neuron 86 (2015) 646–664, doi: 10.1016/j.neuron.2015.02.018. [PubMed: 25950633]

[72]. Gilbert DT, Wilson TD, Why the brain talks to itself: sources of error in emotional prediction, Philos. Trans. Royal Soc. B 364 (2009) 1335–1341, doi: 10.1098/rstb.2008.0305.

[73]. Kringelbach ML, Berridge KC, The affective core of emotion: linking pleasure, subjective well-being, and optimal metastability in the brain, Emotion Rev 9 (2017) 191–199, doi: 10.1177/1754073916684558.

[74]. Bergeria CL, Strickland JC, Huhn AS, Strain EC, Dunn KE, A preliminary examination of the multiple dimensions of opioid craving, Drug Alcohol Depend 219 (2021) 108473, doi: 10.1016/j.drugalcdep.2020.108473.

[75]. Flavell JH, Metacognition and cognitive monitoring: a new area of cognitive-developmental inquiry, Am. Psychol 34 (1979) 906–911, doi: 10.1037/0003-066X.34.10.906.

[76]. Spada MM, Caselli G, Nik čevi ć Av, Wells A, Metacognition in addictive behaviors, Addict. Behav 44 (2015) 9–15, doi: 10.1016/j.addbeh.2014.08.002. [PubMed: 25182375]

[77]. Hajloo N, Sadeghi H, Babayi Nadinloei K, Habibi Z, The role of meta-cognition in students' addiction potential tendency, Int. J. High Risk Behav. Addict 3 (2014) e9355, doi: 10.5812/ijhrba.9355. [PubMed: 24971304]

[78]. Balconi M, Finocchiaro R, Campanella S, Reward sensitivity, decisional bias, and metacognitive deficits in cocaine drug addiction, J. Addict. Med 8 (2014) 399–406, doi: 10.1097/ADM.0000000000000065. [PubMed: 25303980]

[79]. Wasmuth SL, Outcalt J, Buck K, Leonhardt BL, Vohs J, Lysaker PH, Metacognition in persons with substance abuse: findings and implications for occupational therapists, Canadian J. Occup. Therapy 82 (2015) 150–159, doi: 10.1177/0008417414564865.

[80]. Toneatto T, Metacognition and substance use, Addict. Behav 24 (1999) 167–174, doi: 10.1016/S0306-4603(98)00126-9. [PubMed: 10336099]

[81]. Hamonniere T, Varescon I, Metacognitive beliefs in addictive behaviours: a systematic review, Addict. Behav 85 (2018) 51–63, doi: 10.1016/j.addbeh.2018.05.018. [PubMed: 29852356]

[82]. Hoyt WT, Kerns M-D, Magnitude and moderators of bias in observer ratings: a meta-analysis, Psychol. Methods 4 (1999) 403–424, doi: 10.1037/1082-989X.4.4.403.

[83]. McHugh RK, The importance of studying sex and gender differences in opioid misuse, JAMA Network Open 3 (2020) e2030676, doi: 10.1001/jamanetworkopen.2020.30676.

[84]. Jones JD, Varshneya NB, Hudzik TJ, Huhn AS, Improving translational research outcomes for opioid use disorder treatments, Curr. Addict. Rep 8 (2021) 109–121, doi: 10.1007/s40429-020-00353-5.

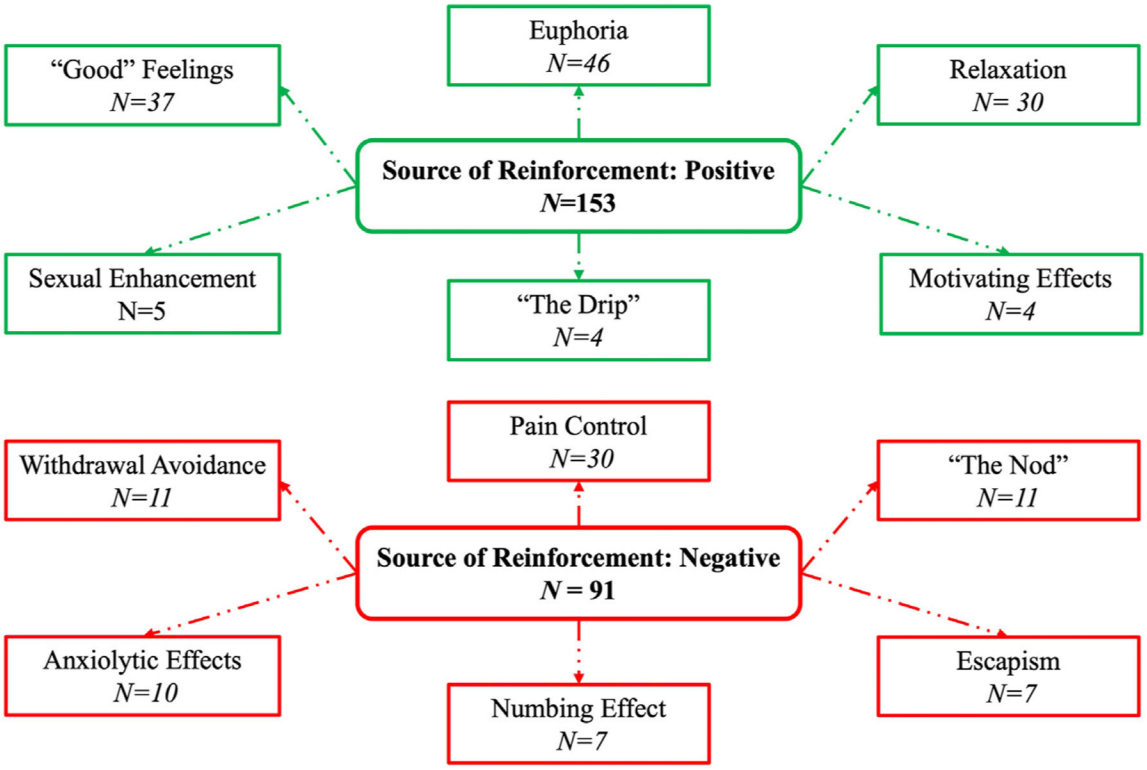

Fig. 1.

Participant-reported effects of heroin (i.e., "What do you like about heroin? ") [1, 2]

[1] Figure only includes responses provided by at least four participants.

[2] A total of 307 participants provided responses to this question.

Table 1

Sample characteristics.

		Reinforcement group			
	Total *N* = 307	**Positive *N* = 153**	**Negative *N* = 91**	**Mixed *N* = 36**	***p***
Sex, *N* (%)					.275
Male	239 (78.1)	124 (81.6)	70 (76.9)	24 (66.7)	
Female	66 (21.5)	27 (17.8)	21 (23.1)	12 (33.3)	
Age, *M* (SD)	46.8 (9.9)	45.8 (9.6)	46.5 (10.0)	44.7 (9.5)	.034
Race/ethnicity					.052
NH Caucasian/White	56 (18.8)	24 (16.1)	15 (16.7)	12 (36.4)	
NH African American/Black	133 (44.6)	74 (49.7)	35 (38.9)	14 (42.4)	
Hispanic/Latino/a	88 (29.5)	43 (28.9)	31 (34.4)	6 (18.2)	
Other/Multiracial	21 (7.1)	8 (5.4)	9 (10.0)	1 (3.0)	
Heroin use in years, *M* (SD)	15.8 (11.5)	16.3 (11.9)	15.2 (10.6)	13.2 (11.5)	.385
Bags of heroin/day, *M* (SD)	3.9 (4.36)	4.2 (4.9)	3.2 (3.14)	4.1 (4.8)	.237
ASI drug use composite score, *M* (SD)	0.25 (0.17)	0.25 (0.16)	0.23 (0.16)	0.27 (0.17)	.543
Severe[1], *N*(%)	79 (26.3)	41 (26.8)	25 (29.1)	7 (20.0)	.591
Treatment status					
Active heroin/illicit opioid use	137 (46.1)	67 (44.4)	39 (45.3)	18 (51.4)	.946
Receiving MOUD	128 (43.1)	68 (45.0)	38 (44.2)	13 (37.1)	
Recently detoxified	32 (10.8)	16 (10.6)	9 (10.5)	4 (11.4)	
Treatment interest (ASI), *M* (SD)	1.72 (1.80)	1.88 (1.84)	1.46 (1.77)	1.92 (1.71)	.177
Use of heroin for pain control (lifetime), *N* (%)	151 (50.3)	74 (50.0)	46 (50.5)	13 (38.2)	.424
Use of heroin for pain control (current), *N* (%)	83 (36.1)	44 (34.6)	22 (36.1)	6 (28.6)	.821

Note. ASI: Addiction Severity Index, MOUD: Medications for Opioid Use Disorder, NH: Non-Hispanic.

[1]ASI drug use composite score ≥ 0.40.