**Research Paper**

# The Role of Anhedonia and Low Arousal in Substance Use Disorder Among Adolescents With Conduct Disorder Symptoms

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## ABSTRACT

**Objective:** During adolescence, transformations in the neural circuitry of the brain's reward system can lead to vulnerabilities that pave the way for involvement in criminal and addictive behaviors. Some mental disorders (e.g., conduct disorder) are more comorbid with substance use disorders because of their unique nature. This study examines the role of anhedonia and low arousal in substance use disorders among adolescents with conduct disorder symptoms.

**Methods:** The present correlational study was conducted in 2021 in Tabriz City, Iran. The participants were 784 adolescents with Conduct Disorder (CD) aging from 13 to 17 years at Juvenile Detention Centers (JDC). After the attrition, 436 adolescents remained. We used convenience sampling for the sampling method. In addition, we utilized the substance abuse scale, the conduct disorder rating scale, the self-assessment anhedonia scale, and the how I feel scale to collect the data. After the ethical approval and signed informed consent, the questionnaires were distributed among participants. After collecting the questionnaires, we entered the data into the SPSS software, version 23, for analysis.

**Results:** The Addiction Potential Scale (APS) had a significant and direct correlation with physical anhedonia (r=0.226, P<0.01), intellectual anhedonia (r=0.221, P<0.01), social anhedonia (r=0.236, P<0.01), and negative emotion (r=0.211, P<0.01). Substance use increases with an increase in anhedonia. On the other hand, APS had a significant and reversal correlation with positive emotion (r=-0.173, P<0.05), and positive and negative emotion control (r=-0.197, P<0.01), i.e., less positive emotion and weak control of positive and negative emotions lead to substance use disorder among adolescents with conduct disorder.

**Conclusion:** Impulsive behaviors (e.g., substance use disorder) respond to low arousal and anhedonia among adolescents with conduct disorder symptoms to relieve their negative emotions and strengthen their low arousal.

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## Highlights

● Adolescents with conduct disorder symptoms are vulnerable to substance use because of low arousal and anhedonia.

● Impulsive behaviors (e.g., substance use disorder) are a response to low arousal and anhedonia among adolescents with conduct disorder symptoms to mitigate their negative emotions and strengthening their low arousal.

## Plain Language Summary

Conduct disorder is a type of disorder that is related to risky and impulsive behaviors. Indeed, given its unique nature, conduct disorder is comorbid with substance use disorders; however, low arousal and anhedonia are not its main symptoms. Recent studies have shown that abnormal low arousal in the cortex of psychopathic subjects is the main reason for antisocial and risk-taking behaviors. Therefore, this study aims to study the role of anhedonia and low arousal in substance use disorder among adolescents with conduct disorder symptoms.

## 1. Introduction

During adolescence, alterations in the neural circuitry of the brain's reward system (e.g., hyperactivity of the nucleus accumbens and the amygdala) can lead to vulnerabilities that pave the way for involvement in criminal and addictive behaviors (Bakhshipour and Karimpour, 2021; Bozzini et al., 2021). Because of their special nature, some mental disorders (e.g., conduct disorder) are more comorbid with substance use disorders. Conduct Disorder (CD) is a DSM-5 (the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders) diagnosis typically assigned to individuals under 18 who habitually violate the rights of others. They behave in ways that do not conform with the law or are not the appropriate social norms for their age.

One of the major symptoms of CD is related to a deficiency in impulse control. This symptom is associated with aberrant pleasure-seeking behaviors such as substance use disorders. In this regard, Michael and David (1991) demonstrated that all types of drug abuse were closely linked with CD. Because of the specific neurobiology of CD, a powerful correlation exists between primary antisocial behaviors and CD with substance use disorders. In addition, CD was found to increase the risk of substance use and abuse in adolescents (Gray and Milin, 2021). Meanwhile, because of the deficiencies in the brain's reward system in CD, people with this disorder suffer from negative emotions, low arousal, and a lack of motivation. However, few studies have examined the relationship between them; therefore, they require more studies to examine them.

Various studies have shown that impulsivity and emotion dysregulation is usual in adolescents with CD (Fairchild et al., 2019; Schoorl et al., 2016). They are related to the bottom-up system. This system involves the subcortical brain areas, including the amygdala and the reward-sensitive dopamine-rich structures in the midbrain. It tends to extend the rewarding and addictive behaviors without paying attention to long-term consequences (Bechara and Van Der Linden, 2005). Impulsive behaviors are a response to motivational and emotional deficiencies (Volkow, Michaelides, & Baler, 2019). In this regard, Galanaki (2012) showed that adolescents with personal fable and those who got high scores in sensation seeking consume more substances and drugs (Hayes et al., 2020).

Based on the reward deficiency syndrome (RDS) theory, substance use is the dire consequence of a deficiency in the midbrain dopamine system (Gondré-Lewis, Bassey, & Blum, 2020). Also, people with RDS suffer from low arousal and anhedonia in the resting state because of the deficiency in the reward and motivational system. These people tend to consume drugs to compensate for such deficiencies (Blum et al., 2021). Furthermore, based on the low arousal theory, the arousal rate of the cortex in psychopathic subjects is abnormally low (Houston and Stanford, 2020). Arousal and performance have a U-shape and reversal relation called the Yerkes-Dodson curve (Nickerson, 2021). According to the Yerkes-Dodson curve, people with high or low arousal experience negative emotions and perform poorly in most situations (Durand and Barlow, 2015). Abnormal low arousal in the cortex of psychopathic subjects is the main reason for antisocial and risk-taking behaviors (e.g., substance use). In other words, psychopathic subjects seek stimuli to reinforce their low arousal (Durand and

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Barlow, 2015). Andrews and Bonta (2010) examined the variables of the autonomic and the central nervous system in a sample of 15-year-old subjects. They found that future offenders had lower skin conduction activity and lowered resting heart rate, and their slow brain-waves activity had more frequency, all of which are indicators of low arousal.

Some studies (Wiesbeck et al., 1996; Zuckerman, & Aluja, 2015; Border et al., 2018) have shown that a hyperactive dopamine system may be the reason for the relationship between sensation seeking and substance use (appetitive motivational system). A strongly activated approach system might be an underlying cause of some addictive behaviors.

Based on the low arousal theory, psychopathic subjects are incapable of earning pleasure from normal stimuli (e.g., watching TV, talking with people, etc.) (Koegl, Farrington, & Raine, 2018). In addition, they suffer from anhedonia and experience negative emotions. The anhedonia hypothesis has majorly impacted biological theories of reinforcement, motivation, and addiction. Anhedonia, a significantly reduced desire or enjoyment of normally rewarding behaviors, is a clinically important symptom for many addicted people (Zhang et al., 2016). Anhedonia can also serve as a pre-existing risk for daily drug use, resulting in the development of addiction (Willemsen, Vanheule, & Verhaeghe, 2011). In other words, anhedonia acts as a fundamental factor in some mental disorders that are comorbid with substance use disorders (e.g., conduct and antisocial personality disorders, borderline personality disorder, bipolarity, and other mental disorders that are related to impulsive behaviors).

Previous studies have only paid attention to the association between CD and drug use; however, in the present study, we aim to investigate the role of two components of anhedonia and low arousal; they are the underlying symptoms of CD and are related to the brain's reward system and addiction. The main difference between the present study and similar studies is that this research focuses on the underlying variables related to the brain's reward system and addiction to CD. Thus, we hypothesize that anhedonia and low arousal play essential roles in substance use disorder among adolescents with CD symptoms.

## 2. Materials and Methods

### Study participants

The present correlational study was conducted in 2021 in Tabriz City, Iran. A total of 784 adolescents (primary sample) aged 13 to 17 with CD symptoms at juvenile detention centers (JDC) participated in this study. We used convenience sampling for choosing the samples. Assessments were performed by a clinical psychologist with a PhD degree and a clinical psychologist with a Master's degree. All participants provided written informed consent after receiving a complete study description. We selected 467 adolescents with Z scores above 1.5 on the CD scale. After the attrition, 436 adolescents remained, and the attrition rate was 4% (n=31). The reasons for attrition were conscious withdrawal from continuing to participate in the study and incorrect completion of the evaluation measures.

The Mean±SD of age in the whole sample was 15.5±4.53 years. Additionally, the following measures were taken into consideration: 13 years old, n=32 (7%); 14 years old, n=87 (20%); 15 years old, n=174 (40%); 16 years old, n=91 (21%); 17 years old, n=52 (12%). Socioeconomic status of participants was low (279 [64%]), middle (83 [19%]), and high (74 [17 %]). The Mean±SD of the CD score was 62.4±5.86. Also, 265 (61%) reported having a familial history of crime and addiction.

The following items were considered as the inclusion criteria: being at the age of 13 to 17 years, wanting to voluntarily participate in this study, and completing the evaluation measures. The exclusion criterion was the presence of other diagnosed serious mental disorders.

The participants were informed about the study's aims and provided signed informed consent. The ethical approval for this survey was obtained by the Ethics Committee of the Research University of Tabriz City, Iran (Ethics Code: IR. UTBZ. REC. 4263. 1730). Following the ethical approval and signed informed consent, the questionnaires were distributed between participants. After collecting questionnaires, the data was entered into the SPSS software, version 23, for analysis.

### Study measures

#### Substance Abuse Scale

The substance abuse scale (SAS) was first developed by Greene et al. (1992) based on MMPI-2, whose content was specifically related to substance abuse. This scale is

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in the form of yes (1) and no (0) questions. A high total score on the SAS scale means high addiction potential and acknowledgment. SAS consists of two parts, namely the addiction potential scale (APS) and the addiction acknowledgment scale (AAS), which respectively contain 13 and 39 items. We used the APS subscale in the present study. The AAS and APS scores are converted to linear T scores using MMPI-2 normative data. In the preparation and standardization of this questionnaire, substance abusers included people who abused one or jointly two different substances (e.g., people who only abused alcohol or abused alcohol and another substance). The key substances were selected according to the choices of substance abusers. Green et al. (1992) reported 0.74 as the internal validity coefficient of the sample consisting of substance abusers, people with mental disorders, and normal subjects. In the present study, the reliability of this scale was obtained at 0.91 using the Cronbach α.

### Conduct Disorder Rating Scale

The conduct disorder rating scale (CDRS) has two versions, namely the parent and the teacher version (Waschbusch and Elgar, 2007). We used the parent version for measuring CD symptoms. This version has 19 items and describes child behaviors in the past 12 months. The responses include 0=never, 1=once, 2=monthly, 3=weekly, and 4=daily. Parent ratings include rule violation, noncompliance, interruptions, complaining or whining, conduct problems, negative verbalizations, unintentional behaviors, and positive behaviors. The parent version of the CDRS showed 78.8% accuracy in identifying CD via a diagnostic interview (Waschbusch and Elgar, 2007). Based on the study by Azimkhani (2010), the validity of this scale was 0.97, 0.85, and 0.97 through calculating the Cronbach α, the split-half method, and the test-retest method, respectively.

### Self-assessment Anhedonia Scale

The self-assessment anhedonia scale (SAAS) is a 27-item, self-report scale that measures the anhedonia variability (Olivares, Berrios, & Bousoño, 2005). SAAS has three sub-scale, including physical anhedonia, intellectual anhedonia, and social anhedonia. Each item has three lines: 1) intensity (a lot - not at all); 2) frequency (always - never); 3) change (the same as before - less than before). Each line is 10 cm long and is scored on a Likert-type scale, ranging from 0 to 10. The higher the score, the greater the anhedonia. To avoid halo effects, the second line polarities were reversed. The Cronbach α coefficient was greater than 0.8; for the composite sample, the α was greater than 0.9. Factor analysis yielded one

factor accounting for a large proportion of the variability (Olivares et al., 2005). In the present study, the reliability of this scale was obtained at 0.86 by the Cronbach α. Additionally, based on Siadatian and Ghamarani (2013), the scale's reliability was obtained in total and substance from 0.59 to 0.86 using the Cronbach α.

### How I Feel Scale

The "how I feel" (HIF) scale is a 30-item self-report scale that measures the emotional arousal and regulation of adolescents and children (Walden, Harris, & Catron, 2003). HIF includes three subscales of frequency and intensity: 1) positive emotion; 2) negative emotion; 3) positive and negative emotion control. HIF has five rating scales: 1=not at all true of me, 2=a little true of me, 3=somewhat true of me, 4=pretty true me, 5=very true of me. the Cronbach α coefficients were 0.75, 0.71, and 0.70, respectively. Also, based on the study by Asem, Khanjani, Mahmood Alilou (2021), the reliability of this scale was equal to 0.88 using the Cronbach α.

### Data analysis

To analyze the data, First, the correlations between the variables were calculated using the Pearson correlation method. Then, we used the stepwise multiple regression analysis to predict the dependent variable.

## 3. Results

Based on Table 1, APS has a significant and direct correlation with physical anhedonia (r=0.226, P<0.01), intellectual anhedonia (r=0.221, P<0.01), social anhedonia (r=0.236, P<0.01), and negative emotion (r=0.211, P<0.01). In fact, with an increase in anhedonia and low arousal subscales, substance use grows. On the other hand, APS has a significant and reversal correlation with positive emotion (r=-0.173, P<0.05) and positive and negative emotion control (r=-0.197, P<0.01), i.e., less positive emotion and weak control of positive and negative emotions lead to substance use among adolescents with CD symptoms.

To examine the correlations between predictor and criterion variables, we used the multiple regression method. In this regard, for examining the collinearity and independence of error sources, we utilized the Durbin-Watson test. Also, to examine the normality, we used the Kolmogorov–Smirnov test. The results of all tests were confirmed.

**Table 1.** Correlation matrix between APS and predictor variables

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1. SAS-APS | 1 | | | | | | |
| 2. Physical anhedonia | 0.226** | 1 | | | | | |
| 3. Intellectual anhedonia | 0.221** | 0.153* | 1 | | | | |
| 4. Social anhedonia | 0.236** | 0.161* | 0.146* | 1 | | | |
| 5. Positive emotion | -0.173* | -0.209* | -0.168* | -0.203** | 1 | | |
| 6. Negative emotion | 0.211** | 0.199** | 0.177* | 0.196** | -0.219** | 1 | |
| 7. Positive and negative emotion control | -0.197** | -0.155* | -0.148* | -0.206** | 0.173* | -0.201** | 1 |
| Mean±SD | 46.7±4.21 | 17.7±3.11 | 15.7±4.4) | 16.7±3.27 | 23.1±5.22 | 26.3±4.01 | 19.7±3.26 |

APS: Addiction potential scale; *P<0.05, **P<0.01.

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Table 2 demonstrates that the calculated F (14.207) in analyzing the variance in components of anhedonia and low arousal is significant at the P<0.01 level. This finding indicates that the components of anhedonia and low arousal explain 32.7% of the variance in APS overall. In addition, based on Table 3, among the components of anhedonia and low arousal, physical anhedonia (β=0.323), intellectual anhedonia (β=0.308), social anhedonia (β=325), and negative emotion (β=0.327) had a significant effect (P<0.01) on APS. In other words, high scores in these components increase the likelihood of substance use. Also, positive emotion (β=- 0.311) and positive and negative emotion control (β=- 0.314) had a significant and reversal effect (P<0.01) on APS. Indeed, low scores in these components increase the likelihood of substance use.

## 4. Discussion

The results of the present study showed that the components of low arousal and anhedonia are related to substance use and predict it among adolescents with CD symptoms. Following our results, Kiluk et al. (2019) demonstrated that a high level of anhedonia was correlated with opioid craving and usage. Also,

Destoop, Morrens, Coppens, & Dom (2019) indicated that anhedonia is linked to drug abuse problems. Anhedonia can also serve as a pre-existing risk for daily drug use and the eventual development of addiction in certain people. Woods and White (2005) showed that direct "pure" bullies had low arousal levels. Nevertheless, clinically, low arousal was not related to either bullying profiles or behavioral problems that were inconsistent with our results. Cheetham et al. (2010) showed compelling evidence that affective dysregulation underpins key aspects of substance use behaviors, including vulnerability, early experimentation, and the production and maintenance of substance use disorders (Cheetham et al., 2010; Parolin et al., 2017).

Based on the RDS theory, because of the deficiency in dopamine agonists (DA) in people with CD, they are incapable of earning pleasure from normal activities (Blum et al., 2017). Thus, these people look for dangerous stimuli, such as substance use and gambling. In contrast, in a normal individual, DA acts in a chain of arousal and inhibition (cascade theory of reward) and leads to positive emotions. In this regard, the results of Lempert et al. (2019) showed that a potential decrease in pleasure experience is related to delay discounting. Consequently, delayed discounting

**Table 2.** Regression and analysis of variance of addiction potential scale prediction based on predictor variables

| Model | SS | df | MS | F | P | R | R² | Adj R² | SE |
|---|---|---|---|---|---|---|---|---|---|
| Regression | 15748.364 | 5 | 3149.78 | 14.207 | 0.01 | 0.580 | 0.338 | 0.313 | 14.890 |
| Residual | 31039.480 | 140 | 221.712 | | | | | | |
| Total | 46788.657 | 145 | | | | | | | |

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**Table 3.** β-coefficients and t in the prediction of APS

| Model | β-Coefficients (Non-standard) | SD | β-Coefficients (Standard) | t | P |
|---|---|---|---|---|---|
| Physical anhedonia | 1.740 | 0.224 | 0.323 | 4.291** | 0.01 |
| Intellectual anhedonia | 1.440 | 0.312 | 0.308 | 3.182** | 0.01 |
| Social anhedonia | 1.799 | 0.298 | 0.325 | 3.741** | 0.01 |
| Positive emotion | -1.602 | 0.301 | -0.311 | 3.196** | 0.01 |
| Negative emotion | 1.584 | 0.317 | 0.327 | 4.299** | 0.01 |
| Positive and negative emotion control | -1.332 | 0.279 | -0.314 | 3.198** | 0.01 |

** $P<0.01$. SD: **Standard Deviation**

leads to a preference for immediate rewards. Marissen, Meuleman, & Franken(2010) suggested that people with high impulsivity, for instance, antisocial, conduct, and borderline, commit dangerous and criminal behaviors to alleviate the negative emotions. Thus, impulsive behaviors are a response to low arousal and anhedonia. Volkow et al. (2019) showed that subjects who are involved in risky behaviors (drug use and parachuting) experience more anhedonia than other people. Dawe et al. (2007) indicated that reduced dopamine release could be linked to less effective inhibitory dopaminergic synapses on striatal neurons in reward-sensitive people. Compared to people with a higher hedonic tone, people with a lower hedonic tone seem more receptive to dopamine activation, which causes them to concentrate on reward signals. Consequently, the lower hedonic tone makes them vulnerable to addiction.

Also, according to the Yerkes-Dodson curve and the arousal theory, people with high or low arousal experience negative emotions (Houston & Stanford, 2020). Indeed, abnormal low arousal in the cortex of psychopathic subjects is the main reason for antisocial and risk-taking behaviors for earning pleasure (e.g., substance use). In other words, psychopathic subjects seek stimuli to reinforce and alleviate their low arousal and anhedonia (Maffei et al., 2020).

In addition, based on Zuckerman's theory, people with high Sensation Seeking (SS) have four features: excitement and adventure, experiences, disinhibition, and boredom susceptibility (Zuckerman and Aluja, 2015). Zuckerman suggested that people with high SS choose novel experiences; however, the initial arousal of these experiences decreases after a short time because of a

- Defect in Dopamine Agonists (DA)
- Sensory Deprivation of the Pleasure or Reward Mechanisms
- Predominance of the Bottom-up System (Impulsive System)

⇩

- Anhedonia
- Low Arousal
- Sensation Seeking
- Emotion Dysregulation
- Chronic Negative Emotions

⇩

- Impulsive and Risky behaviors (e.g., substances use disorders and antisocial behaviors)
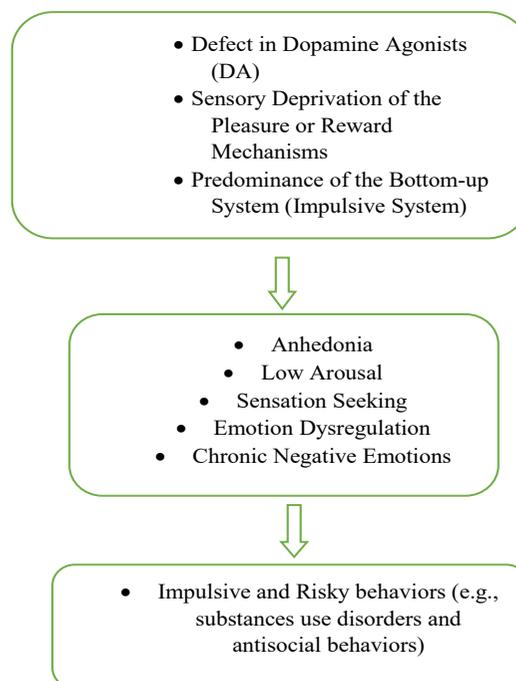
**Figure 1.** The present article at one glance

defect in their arousal system. This outcome is because it no longer provides the optimal stimulation level for thrill-seeking people. Additionally, Zuckerman suggested that high sensation seekers are in a low arousal state; thus, they have more need for powerful stimuli to achieve optimal levels of arousal and eliminate boredom and anhedonia (Zuckerman and Aluja, 2015).

## Limitations and clinical applications

The present study was performed on people with CD symptoms; therefore, it is recommended to generalize the results to clinical groups with caution. Also, we suggest using neurological tools for precise measuring in future studies. Besides, the results of the present study help clinicians in diagnosing and treating the underlying factors (low arousal and anhedonia) associated with impulsivity and substance use disorders in adolescents with CD (Figure 1).

## 5. Conclusion

Because of the deficiency in dopamine agonists (DA) in people with CD, they cannot earn pleasure from normal activities. Thus, these people look for dangerous stimuli, such as substance use. Indeed, risky behaviors (e.g., substance use) are a response to low arousal and anhedonia in adolescents with CD symptoms to relieve negative emotions and strengthen their low arousal.

## Ethical Considerations

### Compliance with ethical guidelines

The participants were informed about the study's aims and provided signed informed consent. The ethical approval for this survey was obtained by the Ethics Committee of the Research University of Tabriz City, Iran (Ethics Code: IR.UTBZ.REC.4263.1730).

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