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Adolescent and Young Adult Substance Use. A Theoretical Review of Internal and External Factors

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ABSTRACT. This theoretical review investigates various cognitive factors, personality variables and external influences in the development of adolescent and emerging adults substance use. It summarizes results of existing literature on key personality traits (sensation seeking, impulsivity and sensitivity to reward, neuroticism), with an emphasis on their implication in shaping risk behaviors in the form of drug consumption. This review also explores how cognitive variables like familiarity with substances and risk perception interact in order to influence substance use decisions. Additionally, this article considers the pivotal role of external factors such as family and peer influence on these relationships. By integrating various theoretical and empirical studies, this review aims to provide a comprehensive understanding of the psychological, but also social aspects of substance use of individuals within this age group, offering insights for possible future research directions, treatment interventions and prevention strategies.

Keywords: adolescent, personality, cognitive factors, risk behavior, external factors

INTRODUCTION

Substance use represents a global multifaceted issue that is influenced by different and complex cognitive, personality and external factors. Theoretical models and results from empirical studies consistently provide support for the association between sensation seeking, impulsivity and neuroticism and adolescence, as well as emerging adult substance consumption. Sensation seeking

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is a personality trait that involves a predisposition toward seeking novel, intense experiences (Zuckerman, 1994). It is strongly associated with increased risk-taking, including involvement with drugs. Impulsivity, particularly as described in Dawe, Gullo, and Loxton's (2004) Two-Factor Model, highlights the significance of rash decision-making and reward sensitivity in the propensity for substance use. Neuroticism (i.e., tendency towards emotional instability; Kang et al., 2022) is also consistently associated with substance use.

Cognitive factors, including knowledge about substances, familiarity, and risk perception, further shape the decision to engage in substance use. Adolescents who are more familiar with substances or who have more misperceptions about the risks of substance use are more likely to consume. For example, Bhatia et al. (2023) discuss how increased exposure to substances can reduce perceived risks, thereby facilitating substance use.

External factors such as parents and peers influence the decision to consume substances. For example, disapproval and norms can either mitigate or facilitate substance behaviors depending on the context. For example, Yang et al. (2022) found that parental disapproval increases adolescents' risk perception of cannabis use, reducing the likelihood of engagement, while peer acceptance of substance use lowers perceived risks, particularly among sensation-seeking adolescents.

This review integrates findings from various theoretical perspectives to provide a comprehensive overview of how personality traits, cognitive processes, and external factors collectively influence adolescent substance use. By synthesizing these insights, the review aims to guide future research and inform more effective prevention and intervention strategies.

I. PERSONALITY FACTORS AND TEMPERAMENT

1. Sensation Seeking

Sensation seeking (SS; see also novelty seeking / thrill-seeking), as defined by Zuckerman (1994), involves a natural inclination toward seeking out diverse, new and intense sensations. Essentially, individuals with high levels of sensation seeking actively seek out thrilling and exhilarating experiences, needing stimulation. This personality trait also involves a tendency toward taking risks and a readiness to embrace them (Zuckerman, 1994; Cloninger et al., 1993). It is often seen as a facet of the broader concept of disinhibition, which implies challenges in controlling impulses and restraining behavioral tendencies (Zuckerman, 1994; Finn et al., 2000). Consequently, sensation seeking is consistently linked with substance use, particularly during adolescence, making this developmental stage

more susceptible to the onset of substance use disorders (SUDs) (Harden et al., 2008; Steinberg, 2008).

Mirnics et al. (2021) emphasized the importance of sensation seeking in predicting risky behaviors, particularly the potential direct impact on adolescent drug use patterns. In this sense, Shen et al., (2023) conducted a longitudinal three-year study, where participants' ages ranged from 15-18 (mean age at the first measurement was 16.90 years). Results indicated that, for individuals with higher baseline sensation seeking levels, SS trait reached the peak more closely and displayed a slower rate of increase after adolescence. Moreover, they indicated that both sensation seeking and the frequency of substance use increased simultaneously, with no discernable gender differences. Higher sensation seeking levels tended to precede consumption, but also increased even more following substance use. Consequently, the authors propose a bidirectional relationship between these two variables.

The findings from Brumback et al., (2021) indicate that sensation seeking is associated with increased cannabis use as early as age 15. For young adults, sensation seeking was linked to higher frequency of alcohol consumption after reaching 18 years of age, with positive expectations regarding the effects of alcohol also exerting a significant influence. Authors suggest that sensation seeking may have a more pronounced influence on cannabis use during the earlier developmental stages, as early as age 15, while its impact on alcohol consumption becomes more prominent after reaching age 17. Higher sensation seeking and its accelerated growth were directly linked to cannabis/marijuana use, whereas only elevated sensation seeking was associated with alcohol consumption. A family history of substance use was directly associated with heightened impulsivity, which, in turn, correlated with levels of sensation seeking. Wasserman et al., (2020) findings suggest that substance use among family members indirectly influences an individual's own substance use through increased impulsivity (see next section devoted to this construct).

2. Impulsivity and Sensitivity to Reward

2.1. Theoretical considerations

Impulsivity is a multifaceted construct that encompasses a predisposition toward rapid, unplanned reactions without due consideration of potential negative outcomes (The International Society for Research on Impulsivity, 2016). It involves both trait and state aspects, influencing behavior across various situations (Stamates & Lau-Barraco, 2020). Impulsivity as a trait suggests relative stability throughout life, while state models focus on impulse action and choice (Stamates &

Lau-Barraco, 2020). Impulsivity is theoretically associated with behavioral disinhibition (i.e., common genetic liability associated with substance use and externalizing psychopathology, also affecting control and sensitivity to reward; Iacono, Malone, & McGue, 2008) and is linked with impairments in behavioral regulation (see next section on Regulation and Self-Control; Brown, Fite & Bortolato, 2022, Defoe et al., 2022). It serves as a predictor for externalizing disorders and is significantly related to adolescent antisocial behavior and substance use (Defoe et al., 2022).

Different models address this construct from the perspective of different dimensions. In this review, we will be discussing The Two-Factor Model (Dawe, Gullo, & Loxton, 2004; Gullo & Dawe, 2008), and the model derived from the factor analyses conducted by Whiteside and Lynam (2001), including Urgency, Premeditation, Perseverance and Sensation Seeking (UPPS-P Impulsive Behavior Scale).

2.1.1. The Two-Factor Model

The Two-Factor Model proposed by Dawe and colleagues (Dawe, Gullo, & Loxton, 2004; Gullo & Dawe, 2008) is grounded in behavioral and neurobiological research and it points towards the existence of two different traits – rash impulsivity and a distinct reward drive (Stamates & Lau-Barraco, 2020).

In the context of impulsivity and substance use, reward drive refers to the tendency to seek out and be motivated by rewarding stimuli or experiences (Gullo, Loxton, and Dawe, 2014). Originally, the concept of reward drive is derived from the work of Gray (1987), where he proposes the existence of two system - Behavioral Activation System (BAS), linked to sensitivity to reward, and Behavioral Inhibition System (BIS), linked to sensitivity to punishment. According to Gray (1987), BAS regulates approach motivation and directs behavior towards potential and actual reward stimuli. Individuals high in this trait are more likely to engage in seeking positive outcome behaviors. In the work of Dawe, Loxton, and Gullo (2004), Sensitivity to Reward is discussed in the context of impulsivity and their implication in risk-taking behaviors, such as substance dependence. They propose that individuals higher in reward sensitivity are more driven by the potential for immediate gratification. Regarding Sensitivity to Punishment, Gray (1987) proposes that the Behavioral Inhibition System is responsible for detecting signals of punishment, non-reward, or novel stimuli, and it is often associated with avoidance of potential and actual punishment cues, leading to cautious and risk-averse behaviors. In the work of Dawe, Loxton, and Gullo (2004), sensitivity to punishment is discussed in the context of impulsivity and substance use. They propose that individuals high in punishment sensitivity tend to avoid potentially negative outcomes behaviors.

Regarding rash impulsivity, Gullo, Loxton, & Dawe (2004) propose that it is a form of impulsivity characterized by making quick decisions without considering the consequences, often in response to emotional or rewarding stimuli, hence its connection to reward drive and addictive behaviors, including substance use eating disorders. Rash impulsivity often reflects poor control, meaning high trait individuals are more likely to act on immediate urges, even when those actions might lead to negative outcomes. This happens because of valuation of short-term rewards over long-term outcomes.

In summary, heightened levels of reward drive (or reward sensitivity) and rash impulsivity can significantly impair an individual's ability to resist rewarding stimuli, even when they are aware of the costs of their behavior. These traits contribute to a greater vulnerability towards taking risks, as the immediate appeal of reward may override long-term outcomes.

2.1.2. The UPPS factors

To elucidate the nature of impulsivity, Whiteside & Lyman (2001) performed a series of factor analyses in order to distinguish between several aspects of impulsivity (see also Verges et al., 2019). Overall, impulsivity is presented as a multidimensional construct defined by rapid decision-making, resulting in inadequate behaviors that carry an increased probability of unfavorable consequences. However, Whiteside and Lyman's research helped identify four main dimensions of impulsivity, namely Urgency (i.e., tendency to act impulsively in the context of emotional distress), Premeditation (i.e., consideration before implementing behaviors; lack of premeditation indicates a proneness towards taking rash decisions), Perseverance (i.e., the ability to remain focused in a task, especially when confronted with boredom or frustration), and Sensation Seeking. Regarding Urgency, it was later divided into two subtypes: positive urgency (PU; i.e., acting on impulse in a positive affect situation) and negative urgency (NU; i.e., acting on impulse in a negative affect situation), which differ based on the emotional valence triggering impulsive behavior (Cyders et al., 2007). Regarding the latter dimension, there is a great conceptual overlap between what Whiteside and Lyman define as sensation seeking and what Zuckerman originally proposed. Shortly, Whiteside and Lyman propose that sensation seeking is a subordinate dimension of impulsivity, referring to pursuing novel and intense experiences. In contrast, Zuckerman proposed it as a superordinate dimension of personality that involves distinct dimensions – thrill and adventure seeking, experience seeking, disinhibition and boredom susceptibility.

2.2. Empirical Data

The findings from Verges et al. (2019) indicated that the Two-Factor Model of impulsivity outperformed the UPPS-P measures in predictive accuracy. Despite the connection with various substance use outcomes, only rash impulsivity and reward drive remained unique predictors of substance use initiation in the multivariate model. In contrast, Riley et al., (2021) found a significant main effect on current marijuana use observed for a facet of the UPPS-P, namely lack of premeditation. This association was observed specifically for this substance, with higher scores on lack of planning linked to increased reports of current marijuana use.

The main effects of the Felton et al. (2019) study revealed that adolescents with increased impulsivity levels at baseline and lower initial depressive symptoms demonstrated more intense substance use increases. Moreover, their findings suggest that adolescents with depressive symptoms and lower impulsivity levels exhibited slower increases in substance use over time. This points to a stronger positive association between depressive symptoms and substance use among adolescents with higher levels of impulsivity. Regarding negative affect and depression, elevated impulsivity may act as a vulnerability factor, leading youth to adopt more impulsive coping strategies in response to increased distress and in the absence of more optimal regulatory mechanisms.

According to Defoe et al.'s results (2022), transitions in impulsivity from early to mid-adolescence but not from mid-adolescence to late adolescence were predictive of shifts in antisocial behavior and alcohol consumption. Early adolescent impulsivity predicted late-adolescent Alcohol Use Disorder through mid-adolescent antisocial behavior.

In addition, the outcomes of Brown, Fite & Bortolato (2022) indicate that impulsivity is a mediating factor in the relation between emotional maltreatment and past-month marijuana, alcohol, and tobacco use. This type of abuse, as the form most significantly associated with impulsivity, is consistently observed in other studies as well. Emotional abuse may give rise to a disinhibited response style, potentially aggravating impulsive use behaviors. This is consistent with functional neuroimaging studies (e.g., Hogsted et al., 2024, Yang et al., 2023, Brown, Fite & Bortolato, 2022), pointing to the impact of child maltreatment on the prefrontal cortex, a central region for inhibitory control, involved in substance use behaviors. The mediation role of impulsivity extends previous conclusions that highlighted urgency as an important facet of impulsivity in the connection between emotional abuse and alcohol consumption outcomes.

3. Temperament

Child temperament refers to inherent and relatively stable predispositions that modulate children's activity and reactivity, emotionality, and sociability (Goldsmith et al., 1987, Waddell et al., 2024). There are multiple models explaining temperament, but we focus on definitions by Goldsmith at al. (1987) and Rothbart et al. (1994).

As per its dimensions, activity refers to the level of movement and general energy exhibited by an individual; children characterized by high activity often seek out play and exploration (Goldsmith et al., 1987). Reactivity refers to the speed and intensity of one's response to stimuli from the environment; children high in reactivity respond quickly and intensely. Emotionality refers to the frequency, but also intensity of emotional responses; children high in emotionality often experience profound joy, anger, sadness etc. Sociability refers to a tendency to seek out and feel good in social contexts; children high in sociability are often outgoing and active in social settings (Goldsmith et al., 1987).

According to Rothbart's model (1981) **t**here are two main dimensions of child temperament: emotional reactivity and self-regulation or effortful control. The former involves child reactions to changes in their environment, and the latter pertains to a child's ability to manage these reactions (Rothbart et al., 1994, Waddell et al., 2024). Children with higher emotional reactivity often struggle with self-regulation, pointing to the intertwining nature of these two constructs (Waddell et al., 2024).

Within this framework, one temperament dimension strongly associated with substance use, particularly marijuana consumption, is negative emotional reactivity (i.e., intensity and persistence of emotional responses to negative stimuli or stressors). This trait may increase adolescents' vulnerability to marijuana consumption, as they may use it as a mechanism to regulate negative emotions (Tache et al., 2020). The relationship between temperament traits like negative emotional reactivity and marijuana use may be influenced by environmental factors. For adolescents with higher negative emotional reactivity in low-problem neighborhoods, there was an increased marijuana use pattern, but this relationship remained unaffected by exposure to high-problem neighborhoods (Tache et al., 2020).

Another dimension associated with substance use is positive emotional reactivity. Strickhouser, Terracciano & Sutin (2020) suggested that children exhibiting greater sociability (i.e., a sub dimension of surgency/positive emotional reactivity) at ages 4-5 were more likely to start using substances during adolescence. Those displaying higher reactivity were more prone to initiate cigarette or cannabis use, though not alcohol or other drugs.

In terms of effortful control/self-regulation, children with higher levels of persistence (i.e., one of its subdimensions) exhibited a reduced risk of smoking initiation, but not alcohol, marijuana, or other drugs use. These temperament effects persisted over a span of ten years and remained significant even after adjusting for major risk factors, such as gender, parental substance use, family and neighborhood socioeconomic status (Strickhouser, Terracciano & Sutin, 2020).

4. Neuroticism

Neuroticism (N) is among the most widely known personality traits, typically associated with negative affectivity (Grevenstein, Bleumke & Kroeniger-Jungaberle, 2016). It is often conceptualized as a predisposition towards emotional instability (Kang et al., 2022), encompassing feelings of heightened anxiety, depression, emotional volatility, usually accompanied by an ineffective coping mechanism in the face of various stressors. Research suggests that individuals high in neuroticism engage in dysfunctional substance use patterns to manage or alleviate feelings of instability inherent to their baseline negative emotional state (Davies, Harty & Boden, 2024).

For example, elevated levels of neuroticism, coupled with low agreeableness (i.e., personality trait characterized by politeness and cooperativeness) and low conscientiousness (i.e., personality trait associated with task orientation and orderliness), were associated with an increased likelihood of having recently used illegal drugs (Kang, 2022). It was suggested that neurotic individuals may start using drugs as a form of self-medication to alleviate discomfort (Khantzian, 1987, Kang, 2022). Additionally, increased neurotic tendencies were strongly involved in the relationship between childhood adversities and symptoms of substance use disorder (Davies, Harty & Boden, 2024). Higher levels of neuroticism, but also openness, independently predicted myopic relief, which refers to a temporary escape from existing stressors (Lac & Donaldson, 2019).

Neuroticism is also strongly related to negative affectivity, a sub dimension of temperament (also see the section on Temperament). Kendler et al. (1993) examined the genetic and environmental influences on the development of major depression and its association with personality traits, particularly neuroticism, in a female twin population. This study proposes a continuity between early negative affectivity and later neuroticism, highlighting the interplay between genetic and environmental factors in the development of depressive disorders.

II. REGULATION AND SELF-CONTROL

The dual system model of self-regulation proposes that the human mind operates in two systems – a reflexive lower-order (i.e., reactive system that includes reward and punishment sensitivity; see previous section on Impulsivity and Sensitivity to Reward) and a reflective higher-order system (Khan et al., 2018). The latter is based on strategical and deliberate operations and is associated with cognitive control. It involves intentional top-down processes – self-regulation and self-control (Khan et al., (2018).

Self-regulation is usually defined as a set of interconnected thoughts, feelings, and actions employed to adjust to shifting circumstances of life (Shin, Ksinan Jiskrova & Wills, 2019). Self-control refers to the deliberate action of inhibiting impulses and prioritizing long-term objectives over immediate gratification (Duckworth & Steinberg, 2015, Sutherland, Sutherland & Trucco, 2022). Self-regulation involves processes such as monitoring and adjusting emotional experiences (emotional regulation), behaviors (behavioral regulation), and cognitions (cognitive regulation) to take control over actions (Cooper et al., 2023). The regulation processes integrate various resources, such as neuro-physiological and social cues, to guide goal-oriented actions (Cooper et al., 2023). Temperamentally, self-regulation involves effortful control (Rothbart, Derryberry, & Posner, 1994, Khan et al., 2018; see also previous section on temperament), which is based on executive functions. It encompasses three subcomponents: inhibitory, attentional, and activation control. Inhibitory control suppresses behavior, attentional control is responsible for attention shifting and focusing, and activation control facilitates performing an action despite wanting to avoid it (Rothbart et al., 2000, Khan et al., (2018). Effortful control is considered mainly responsible for inhibiting prepotent responses in favor of potentially better long-term results, detecting errors, and planning behavior. In this dynamic framework of the dual systems model and temperament, effortful control governs the operation of the reflexive system to support goal-directed behavior (Khan et al., (2018).

As it was mentioned previously, self-control primarily refers to the ability to regulate one's emotions, thoughts, and behaviors in the face of impulses. It is crucial for achieving long-term goals and maintaining behavioral consistency. This has been studied from various angles, including its cognitive, behavioral, and emotional aspects. Some key conceptualizations of self-control involve; Baumeister and colleagues's view (1998), who proposed that cognitive control represents a limited resource that can be depleted with use; Mischel and Ayduk's perspective (2004); where they focused on the cognitive aspects of self-control and its role in delaying gratification; and Duckworth and Seligman's

work (2005), where self-control was highlighted in relation with persistence and goal achievement in academic settings.

Irrespective of the conceptualization, self-control has an important role in restraining behaviors, and recent research underscores the critical role of this cognitive factor in substance use. For example, Kim et al. (2022) conducted a longitudinal study noting that increased self-control contributes to reduced substance use in adolescents in a direct way. This result suggest that those adolescents with higher self-control are less likely to get involved in substance use behavior over time. Additionally, Smith, Davis & Thompson (2020) investigated the direct influence of self-control on drug use in both adolescents and young adult populations. Their study corroborates the findings of Kim et al (2022), indicating that high control is a predictor of low substance abuse.

Furthermore, longitudinal research by Lee et al. (2020) revealed that low self-control, peer drug use, and parent-child attachment are strong predictors of heavier alcohol, tobacco, and cannabis use. In a study by Sutherland, Sutherland & Trucco (2022), low levels of self-control and high internalizing symptoms demonstrated the strongest association with the intent to use e-cigarettes and a higher likelihood of actually using e-cigarettes later on. Adolescents with higher self-control along with anxiety and depression demonstrated decreased intentions of current use, and are thought to be less likely to engage in future use of e-cigarettes, suggesting a protective effect of this factor variable.

In a study by Martz et al. (2021) investigating substance use using the Go/No-Go paradigm, individuals characterized by moderate inhibitory brain-related activation combined with low reward brain-related activation displayed lower substance use levels. In contrast, individuals characterized by high inhibitory activation and high reward activation interestingly emerged as the highest risk group. During the Go/No-Go task, these individuals displayed the highest inhibitory activation, but also the highest reward activation. Notably, the authors propose that stronger inhibition doesn't necessarily cause better impulse control (a resilience factor in substance use), but this result could suggest a compensation for the deficits in overall cognitive control (Martz et al., 2021).

Anton-Torro et al. (2021) and colleagues identified higher levels of dysexecutive traits, as measured by the Dysexecutive Questionnaire (DEX; Simblett & Bateman, 2011) and impulsivity traits, as measured by the Barratt Impulsivity Scale (BIS-11; Patton, Stanford, & Barratt, 1995) in alcohol-naïve adolescents who transitioned to more problematic alcohol use patterns (binge drinking), using magnetoencephalography (MEG) functional networks. A distinct pattern of hyperconnectivity in main regions of inhibitory control networks was found. These correlated positively with behavioral traits and later predicted future alcohol consumption rates. In this study, hyperconnectivity in inhibitory

control networks is associated with increased risk-taking and impulsive behaviors, suggesting that it is maladaptive in this context. In the case of inhibitory control networks, hyperconnectivity might reflect an inefficient or disrupted regulation of impulses. Normally, these networks help in suppressing inappropriate behaviors and controlling impulses. Increased connectivity in these networks could indicate that the brain is compensating for, or struggling with, regulating these functions effectively. Rather than facilitating better control, it may reflect underlying difficulties in managing impulses, potentially contributing to problematic behaviors such as binge drinking.

According to Cooper et al., (2023), emotional and behavioral dysregulation acted as a mediator between child maltreatment and subsequent substance use. In contrast, results by Shin et al., (2019) indicate that behavioral dysregulation serves as a mediator in the association of childhood emotional maltreatment and problematic patterns of alcohol use, emerging in young adulthood (binge drinking, alcohol-related problems, Alcohol Use Disorder). These findings suggest that a history of childhood emotional abuse might make an individual more susceptible to alcohol use and related disorders, due to tendencies towards impulsivity and distractibility.

In the relation between BIS/BAS (see previous section on Impulsivity and Sensitivity to Reward), substance use, and effortful control, the only factor of effortful control that acted as an important moderator was inhibitory control (Kahn et al., 2018). The findings indicate moderate but significant interactions, pointing to the role of low inhibitory control and punishment sensitivity (see previous section on Impulsivity and Sensitivity to Reward) on alcohol and cannabis use. Another predictive factor that is worth mentioning here is activation control, which emerged as a significant negative correlate of alcohol and cannabis use. Effortful control, alongside implicit attitudes and expectancies of use, interacted in predicting adolescents' cannabis use. Among adolescents with low levels of self-regulation and reduced negative expectancies, positive implicit attitudes toward marijuana were indeed associated with increased cannabis use one year later (Egerton, Colder & Lee, 2021).

Together, these studies underscore the critical role of regulation and control in influencing substance use behaviors, both in a direct and indirect way. Fostering self-control as a preventive measure against substance abuse could be a key factor, having a critical role in managing and reducing risky behaviors. In conclusion, improving self-control and emotional regulation can significantly reduce the risk of substance abuse, emphasizing the need for targeted interventions to enhance these skills.

III. COGNITIVE FACTORS

1. Knowledge and familiarity

Knowledge about different substances or substance use, as well as familiarity with them, have been considered as important risk factors for the actual substance consumption, particularly in adolescence.

Knowledge is included in the concept of familiarity and it can be derived from information about a stimulus (Wang et al., 2018), direct exposure or experience with it (Klein, 2008; Liao et al., 2011), or unconscious priming to it (Kahneman, 2003; Corrigan and Nieweglowski, 2019, Bhatia et al., 2023). In relation to substance use, familiarity could act as a risk factor, because of its potential of diminishing the perception of risk. For example, increased exposure to advertising correlates with perception of the presented information as trustworthy and reliable, thus not as risky (Bhatia et al., 2023).

In the study of Bhatia et al. (2023), results revealed that age might be the most influential factor in the association of familiarity with substances. Notably, familiarity with substances during the ages of 9 to 10 serves as a predictor for substance use during early adolescence. On average, individuals are familiar with around 5 substances at age 11 and approximately 7 substances by age 13. After adjusting for other predictors, the probability of reporting use increased by 1.27 times for each additional substance with which an individual was familiar.

2. Misperceptions and risk

Amialchuck, Ajilore & Egan (2019) investigated misperceptions about peer substance norms. For the three substances considered – alcohol, tobacco, and cannabis – heightened levels of misperceptions about the group-using norm significantly increased an adolescent's own use. This effect is substantial but slightly smaller when compared to the effect of actual peer behavior. The impact of misperceptions seemed to be most pronounced in the case of cannabis.

Regarding risk perception and substance use, several key points are highlighted by Mennis, McKeon & Stahler (2023). After recreational cannabis legalization, cannabis use escalated among both adolescents and young adults. The association between risk perception, cannabis use, and its prevalence increased post-legalization. One mechanism that could explain this is increased accessibility and societal acceptance, particularly important for individuals with lower risk perceptions. There was also a potential decrease in the proportion of marijuana users seeking professional treatment following recreational legalization, a concerning trend given the already low treatment rates even prior to legalization.

3. Motives

Cox and Klinger (1988) proposed the substance use motivational model, initially devised to elucidate alcohol consumption (Poelen, Schijven & Otten, 2022). This influential model has found applicability in understanding motivations for using other substances, such as cannabis. This model posits that involvement in substance use behavior is motivated by a complex interplay of individual characteristics with situational contexts and expectations regarding benefits and costs of use (Conway et al., 2020). These motives are directed by an individual's tendency to pursue or avoid outcomes. According to Cooper (1994), motives can be differentiated based on two factors – the source, which can be internal or external, and valence, consisting of positive or negative reinforcement.

Further work on the two broad goal categories (approach and avoidance) included in Cox and Klinger's model led to the emergence of four substance motives: coping (to reduce internal negative consequences), conformity (to escape from negative external or social outcomes), social (to acquire social or positive external rewards), and enhancement (for positive internal rewards) (Cloutier et al., 2019).

Conway et al. (2020) found that positive effects and social motives were concurrently associated with more frequent simultaneous alcohol and marijuana use (SAM) and prospectively predicted SAM use, surpassing baseline levels of use over a 3-month follow-up period. Moreover, positive effects were associated with outcomes at baseline, possibly indirectly influenced by high levels of use. Social motives showed changes in SAM outcomes from baseline to follow-up, whilst enhancement motives had a pronounced effect in predicting SAM use and consequences. Calm or coping motives were correlated with initial SAM levels, but did not predict outcomes at either assessment point.

King, Mrug & Windle, (2020) found a correlation between higher levels of depressive symptoms and a propensity to use marijuana as a coping mechanism, leading to more frequent marijuana use within the past year. Association with peers who use substances was linked to a higher inclination towards using marijuana for enhancement and social reasons. Expansion motives were associated with increased marijuana use over the past 12 months, while conformity motives were linked to less frequent consumption.

Results by Glodosky & Cuttler (2019) study consolidate the moderating role of coping motives in the relationship between stress and depression. Coping motives, but not other motives for cannabis use, moderated the link between stress and depression. This implies that individuals with high levels of stress who use substances as a coping mechanism may experience elevated levels of depression. Additionally, expansion and conformity motives significantly moderated the relationship between stress and anxiety.

IV. EXTERNAL FACTORS

1. Parents

Undisclosed use by adolescents at home has a significant impact on substance outcomes. Individuals who exclusively engaged in such behavior demonstrated elevated alcohol and substance consumption and more adverse outcomes compared to their counterparts who abstained or consumed with parental awareness (Fay et al., 2020). Conversely, those who never engaged in substance use without their parents' knowledge demonstrated fewer substance-related outcomes, even after adjusting for other factors (Fay et al., 2020). Both parents' disapproval significantly increased youth risk perception of cannabis, consequently reducing use (Yang et al., 2022). Perceiving risk played a mediating role in the relationship between parental disapproval and youth cannabis consumption. Parental disapproval had a significant direct effect on youth cannabis use. Moreover, the greater the adolescents' perception of beer consumption as acceptable because of their parents' habits, the more likely they were to drink beer themselves (Bergagna & Tartaglia, 2019).

2. Peers

Peers also significantly influence adolescent substance use. Peer disapproval demonstrated a stronger indirect effect on youth marijuana use through youth risk perception (Yang et al., 2022). Many adolescents anticipated positive outcomes from alcohol consumption and perceived binging as acceptable due to frequent engagement by their peers, underscoring the perception of social norms as a key factor in adolescent alcohol use (Bergagna & Tartaglia, 2019).

V. INTERACTIONS BETWEEN INTERNAL AND EXTERNAL FACTORS

Waddell et al., (2024) found that parental substance use indirectly influences adolescent drinking through childhood temperament and later negative urgency. Parental substance use disorder correlated with dysregulated irritability temperament during childhood (i.e., an aspect of emotional reactivity, encompassing reactivity to anger, which overlaps with low effortful control; Waddell et al., 2024), which was linked to adolescent negative urgency (see previous section on Impulsivity and Sensitivity to Reward), subsequently associated with adolescent drinking behaviors. Consequently, parental substance use disorder exhibited a sequential indirect connection with adolescent drinking, operating

through both childhood dysregulated irritability and subsequent adolescent negative urgency. This association was moderated by above-average maternal support (i.e., emotional and physical support and availability to the child; Furman & Burmeister, 1985, Waddell et al., 2024).

Using Cloninger's framework on temperament (Cloninger, 1987), Kapetanovic et al. (2019) found that adolescent disclosure appears to be a protective factor for adolescents with difficult temperaments. Both unstable and detached-fearless temperaments share a propensity towards risk, albeit in distinct manners. Adolescents in the detached and fearless cluster demonstrate low levels of harm avoidance (i.e., tendency toward caution and avoidance of potentially unpleasant contexts) and reward dependence (i.e., the extent to which individuals seek out positive reinforcement), embracing novelty-seeking (i.e., tendency to seek out new and exciting stimuli) despite associated risks. Conversely, those with an unstable temperament show high novelty-seeking tendencies and even higher levels of harm avoidance. This results in a pronounced inner conflict between searching for excitement and expecting punishment, with limited opportunities for regulating this tension through social interaction (Kapetanovic et al., 2019).

The impact of parental knowledge on adolescent substance consumption appears to be moderated by adolescent temperament. Specifically, parental solicitation (i.e., parents actively seeking information from their children) is linked to elevated engagement with substances among adolescents within the detached-fearless temperament cluster, but not among those in other clusters. This cluster comprises individuals with moderate and elevated novelty-seeking tendencies, low levels of harm avoidance, and low reward dependence. When parents actively solicit information from their adolescents, this behavior may lead to increased adolescent use over time. Authors have proposed that parental solicitation may be perceived as intrusive, thereby amplifying adolescents' sense of being excessively controlled (Kapetanovic et al., (2019) et al., 2017).

Parental knowledge was associated with decreased levels of substance use among adolescents exhibiting the detached and fearless temperament. When adolescents with this temperament communicated with their parents, their substance involvement decreased. However, when engaging in substance consumption, especially adolescents with a detached-fearless temperament tended to withdraw.

Kapetanovic et al. (2019) propose that parental solicitation may carry drawbacks, while fostering open communication between parents and adolescents is more likely to promote optimal psychosocial adolescent development. This is particularly advantageous for adolescents exhibiting high levels of thrill-seeking and fearlessness (Padilla-Walker & Nelson, 2010), coupled with low sociability (Grusec, 2011, Kapetanovic et al., 2019).

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