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Critical Review of the Habit Theory in Substance Use Disorder and Application of Moors' Goal-Directed Theory

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Abstract

Purpose of Review Substance use remains a pressing societal concern, imposing significant burdens on public health systems and the economy, while also affecting individual well-being. This review examines the habit theory as an explanation for problematic substance use, highlighting its weak empirical grounding. As an alternative, we apply the goal-directed theory of Moors et al. [1, 2] to substance use and argue that it offers a better explanation for the heterogeneity in substance use behaviors.

Recent Findings Our review of the main assumptions and predictions of the habit theory emphasizes concerns regarding reliability, interpretability, and ecological validity of the tasks used to measure the habit construct. A major challenge for habit theory is explaining the complexity of substance use, specifically, the heterogeneity of consumption patterns within and between individuals, how epidemiological risk factors confer risk, and how interventions produce beneficial outcomes. We argue that the goal-directed theory by Moors et al. [1, 2] provides a more compelling synthesis of the empirical findings and offers a more nuanced understanding of substance use, accounting for complexities that remain unaddressed by the habit theory. We elaborate on five key factors that contribute to problematic substance use and show how the goal-directed theory extends beyond existing models, providing a more nuanced understanding of substance use and informing more effective intervention strategies.

Summary We propose shifting from the habit theory to the goal-directed theory of Moors et al. [1, 2], which better accounts for the heterogeneity and motivational strength underlying substance use. This perspective has important implications for understanding risk factors and designing more effective interventions.

Keywords Habit · Goal-directed · Substance use · Addiction

Introduction

Understanding the mechanisms underlying substance use is challenging due to considerable heterogeneity both across and within individuals [3]. The range of consumption patterns varies widely including occasional use, binge episodes, and continuous, heavy use. The heterogeneity extends to the clinical diagnosis of substance use disorder (SUD) according to the Diagnostic and Statistical Manual of Mental Disorders (5 th ed.; DSM–5; [4]) in which SUDs are categorized as mild, moderate, or severe, with a total of 2036 possible symptom combinations. Heterogeneity can also be found in risk factors, including the availability of substances in the environment [5], traumatic experiences [6], and stress [7, 8]. Given the range of substance use behaviors and risk factors, it is unsurprising that there is no one-size-fits-all approach

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to treatment [3]. Instead, different treatments are effective for different individuals [9], underscoring the importance of personalized approaches in both research and clinical practice. Despite this heterogeneity, a striking commonality across the wide range of problematic substance use behaviors is their seemingly irrational nature. Many individuals intend to reduce or abstain from substance use due to its known negative consequences, yet they continue to engage in it.

The current paper focuses on such seemingly irrational substance use. A key question in the addiction field is whether substance use reflects the operation of a habit process or a biased goal-directed process. According to the habit theory [10], substance use is initially goal-directed. For instance, people may initially consume substances to attain hedonic effects. However, with repetition, the consumption may become habitual such that it is directly triggered by substance use contexts, independently of the user's stated wishes to abstain. In the early stages of habit formation, the impulse to engage in substance use may still partially be suppressed by goal-directed processes. However, in the later compulsive stage, this is no longer possible because there is a complete loss of goal-directed control. In contrast, goal-directed theories propose that substance use is not due to a loss of goal-directed control but instead to biased goal-directed processes [11–14]. According to these theories, problematic substance use remains goal-directed and is determined by its expected value relative to that of alternative activities. From this perspective, individuals continue using substances because they perceive its benefits—however short-term or distorted—to outweigh the value of other options.

In the first part of the current paper, we describe the habit theory and outline its key assumptions. In the second part, we discuss problems with the habit theory, such as the unreliability, small effect sizes, and ambiguous interpretation of general and substance-use-specific habit effects in experimental tasks. Moreover, we note that common methods to study habits lack ecological validity, thereby limiting generalizability to real-life substance use. In the third part of the paper, we outline the goal-directed theory by Moors et al. [1, 2, 15] and apply it to problematic substance use. We elaborate on five factors that contribute to problematic substance use as predicted by the goal-directed theory. We then outline testable predictions and describe how this theory goes beyond other goal-directed theories and can better synthesize experimental behavioral effects and observational data on substance use.

Habit Theory

The habit theory offers one candidate explanation for problematic substance use in humans. According to this theory, most behavior initially stems from goal-directed processes but transitions to habit processes after repetition. Different mental representations are thought to be involved in these two processes [16, 17]. In a goal-directed process, a choice is made between two or more response options (R_1 vs. R_2; e.g., substance use vs. abstention) given a certain stimulus context (S; e.g., walking into a networking event). This choice is made based on a comparison of the expected utilities of these response options, that is, the subjective value of the outcomes of these response options ($O1^v$; e.g. feeling more confident in social interactions) with the values of the outcomes of the other response options (O_2^v; e.g., remaining sober or avoiding a hangover), weighted by the subjective probabilities that these responses will indeed lead to these outcomes (i.e., the response-outcome expectancies). The contingencies in the goal-directed process can be written in the notation: $S:R_1\text{-}O^v$, $S:R_2\text{-}O^v$ … $S:R_n\text{-}O^v$. Once a choice between response options is made, the intention to engage in the chosen response option is activated and eventually implemented in overt behavior.

Through repetition of a behavior in a specific context, it is assumed that initially goal-directed actions transition into stimulus-driven habits due to the formation and strengthening of direct associations between the context and the response (e.g., after months of regularly drinking at networking events, merely entering such an event automatically triggers the impulse to drink). As a result, the context should be sufficient to trigger the behavior directly without requiring the retrieval of expected outcome values of substance use. This is captured in the notation S-R[1] (in contrast to the goal-directed equivalent $S:R_1\text{-}O^v$).

If an individual intends to abstain from substance use, their behavior under goal-directed control should align with that intention. Thus, it seems difficult to explain irrational substance use (i.e., the intention-behavior mismatch) with a goal-directed mechanism. Habit processes, on the other hand, provide an intuitive explanation for the discrepancy between substance users reporting abstinence intentions at one time point but then subsequently using substances,

[1] It is important to clearly state what is meant by habitual behavior, especially since the term habit is used in different ways [18, 19]. Some authors use "habit" to refer to frequent or routine behavior. They call substance use a habit in the sense that it is done regularly. Others use "habit" to refer to automatic causation. They call substance use habitual because certain contexts automatically trigger it. Still others use "habit" to refer to behavior that is caused by an S-R association. They would call substance use habitual if it is caused by a mental association between a certain context and this substance use. Finally, there are authors who use "habit" to refer to the S-R association itself, rather than the behavior caused by it. They would say that substance use is caused by a habit, understood as the mental association between a certain context and this substance use. Here, we refer to habits as S-R representations (the last usage), and to goal-directed processes as involving $S:R\text{-}O^v$ representations.

because habitual behavior is assumed to occur independently of current expected values and desires [20–22].

Proponents of the habit theory endorse a default-interventionist architecture regarding the interplay between goal-directed and habit processes (see [1]). Habit processes are seen as the default process, which can only occasionally be controlled by goal-directed processes. It is argued that the balance between goal-directed and habit processes is shifted in vulnerable substance users such that the habit process becomes dominant [23]. This may be due to excessive habit strength, impaired goal-directed control, or a combination of both [23, 24]. The dominance of the habit process could develop during acquisition of substance use or could manifest during its expression under conditions that prevent goal-directed control. In the following three sections, we outline how habit processes are thought to be acquired, when they are thought to be expressed, and how they are empirically diagnosed.

Acquisition

A core assumption of the habit theory is that overtraining increases the dominance of habit processes over goal-directed ones. Moderate repetition of an instrumental response is assumed to install goal-directed knowledge of the causal relationship between the response and its outcomes such that behavior can be controlled by the expected value of the outcomes [25]. It is also assumed to initiate habit learning based upon the contiguity between the response and the stimulus context in which it occurs [26]. Once the S-R association is installed, the stimulus acquires the capacity to elicit the response by activating this association, without an expectation of the outcome. Extensive training is assumed to further strengthen the S-R association while simultaneously weakening the goal-directed representations [25, 27]. On this view, the proposed dominance of habits in substance users may arise from repeated substance use.

One problem for this view is that the temporal trajectories from recreational use to problematic use, and from problematic use to abstinence, are highly variable and do not follow a consistent linear progression. For instance, many individuals maintain recreational substance use chronically while others quit spontaneously after years of dependence [12, 28]. It is impossible to reconcile this heterogeneity with a simple, temporally linear, homogenous model of habit formation underpinning addiction. To explain the heterogeneity of problematic use, the habit theory needs to specify how individual differences and/or environmental risk factors explain variation in the habit formation trajectories across individuals, times, and conditions.

Expression

To explain temporal and individual variation in problematic use, as well as its often irrational nature, habit theorists argue that habits tend to dominate under poor operating conditions. These conditions include limited opportunity (e.g., time), reduced capacity (e.g., attention), and/or low motivation (e.g., to engage in goal-directed control), due to factors such as time pressure, stress, distraction, fatigue, or psychiatric symptoms [29, 30]. This proposal of the habit theory squares well with the default-interventionist architecture mentioned earlier. This architecture stems from the idea that habits are computationally simple and therefore automatic (i.e., can operate under poor conditions), whereas goal-directed processes are seen as more complex and therefore non-automatic (i.e., require ample conditions). As a result, habit is the default mechanism to which behavioral control reverts under poor operating conditions. Goal-directed control, on the other hand, is assumed to be the secondary determinant of behavior, which is only recruited under ample operating conditions [1, 31]. The key implication of this view is that goal-directed control of behavior can be hindered under poor operating conditions. By linking individual and situational differences in operating conditions to the dominance of habit versus goal-directed processes, this provides an explanation for the heterogeneity observed in problematic use across individuals, contexts, and time.

Empirical Diagnostics

Habit and goal-directed processes are typically distinguished in studies employing experimental operant conditioning procedures (e.g., [32]). In these studies, the presence of a stimulus (e.g., symbol) followed by a response (e.g., selecting a symbol with a mouse) leads to the delivery of a valued outcome (e.g., chocolate milk). Given that goal-directed processes are based on values and expectancies, behavior that is under goal-directed control should be sensitive to changes in these factors. In contrast, habit processes do not involve values and expectancies, making them insensitive to such changes. Based on these assumptions, behavioral sensitivity to changes in outcome values or expectancies is taken to distinguish between the operation of the two processes. More specifically, sensitivity to these changes is taken as evidence that behavior results from a goal-directed process whereas insensitivity is taken as evidence that it results from a habit process. Researchers commonly assess sensitivity to changes in values with an outcome devaluation test and sensitivity to expectancies with a contingency degradation test, a contingency reversal test, or a contingency omission test [33–36].

Problems with the Habit Theory

The habit theory has an enduring appeal to explain behavior in general and problematic substance use in particular. In the following section, we offer a critical evaluation of the habit theory highlighting (a) unreliable empirical evidence and alternative explanations for the role of habits in substance use and (b) issues of ecological validity. Considering these limitations, our review calls into question the utility of the habit theory as an explanation for substance use.

Unreliable Empirical Evidence and Alternative Interpretations

First, we review general habit effects in studies designed to test predictions about the acquisition and expression of goal-directed and habit processes (not specific to substance use). Specifically, we examine habit effects after overtraining and under poor operating conditions. Then, we review evidence for substance-use-specific habit effects, assessing the prediction that substance users are more prone to rely on habits.[2]

General Habit Effects

Overtraining Initial evidence for the assumption that extended training leads to habit formation comes from a study by Tricomi et al. [27]. In their study extensive training (3 days) led to decreased sensitivity to devalued outcomes compared to moderate training (1 day). However, two multi-study replication attempts failed to replicate this, instead showing that goal-directed control remained intact after overtraining [39, 40]. Although the original study was conducted inside an fMRI scanner whereas the replication studies were not, the potential contribution of the scanner to the original findings has been ruled out in another failed replication attempt [41]. It is worth noting that overtraining effects in animals [42] have also failed to replicate in some studies [43–45]. Taken together, these results suggest that individuals remain sensitive to outcome values after overtraining, thereby providing evidence for goal-directed but not habit processes.

[2] We restrict our review to human experimental work and omit (most) animal studies to simplify the extrapolation of findings to theories of human substance use. The tasks used to test the habit construct in humans are often adapted from animal models [25], which avoid issues of expectations, language, and demand that can complicate human experimental psychology [37]. However, although animal studies may be informative, it can be argued that it is too big a leap of generalization to regard an effect obtained under laboratory conditions in animals as offering direct and plausible insights for substance use observed in natural conditions in humans [38].

Poor Operating Conditions Another prediction of the habit theory is that insensitive behavior should be more readily and reproducibly observed under poor operating conditions (e.g., a lack of opportunity, capacity, and/or motivation) [46, 47]. This could explain why insensitivity is not reliably found after overtraining alone. Habits may be acquired after overtraining, but they may not be expressed under ample operating conditions that allow individuals to engage in goal-directed control. In the following section, we will consider the evidence for habits under time constraints and stress.

Time Constraints Hardwick et al. [48] published a key study claiming evidence for the dominance of habits under time constraints. In this study, participants were initially trained on four stimulus–response-outcome contingencies. When two of these contingencies were switched, participants who received extensive training made a substantial number of actions slips (i.e., responding in line with the old contingency) when tested under time pressure but not when there was ample time to respond. The persistence of responding in line with the old contingencies was interpreted as evidence that overtraining leads to habit formation, with participants relying on these habits when time is scarce but shifting to goal-directed control when time is abundant. However, Buabang et al. [49] proposed an alternative interpretation, positing that insensitivity to contingency reversal under time pressure may reflect reliance on old, goal-directed, contingency knowledge rather than habits. Their conceptual replication showed that participants who received extensive training were not only more likely to commit more action slips under time pressure, but also more likely to report old response-outcome contingencies in line with these action slips. This suggests that action slips could be driven by the persistence of rigid, outdated goal-directed knowledge (see also [50]). Recently, this goal-directed explanation received additional support from a study by Van Dessel et al. [51]. These observations, moreover, challenge one of the key methods used to detect habit processes. They suggest that insensitivity to contingency change is not a process-pure diagnostic of habits but may instead indicate the persistence of goal-directed processes, even under conditions typically thought to favor habits.

Stress Stress is another factor that may contribute to poor operating conditions. The key evidence for the idea that stress promotes outcome-insensitive behavior comes from Schwabe and Wolf [52, 53] who showed insensitivity in stressed participants and sensitivity in control participants. Recently, Smeets et al. [54] failed to replicate these findings in two studies. Similarly, Buabang et al. [55] were unable to conceptually replicate Schwabe and Wolf's [53] results, instead providing evidence for goal-directed

control under stress. Other studies [56, 57] have also not been able to observe differences between stress and control groups, although they have shown that stressed individuals show more insensitive behavior when moderating variables were invoked. For example, Smeets et al. [56] [58] found increased insensitivity only in stressed individuals with heightened cortisol levels, while Quaedflieg et al. [57] observed this effect in stressed individuals with lower baseline working memory. In sum, stress does appear to be related to insensitive behavior in some cases, but further research is needed to determine the exact conditions that favor insensitivity and whether this effect is reliable. However, as previously highlighted, even the positive findings do not necessarily provide evidence for habits because insensitivity to change is not a process-pure diagnostic method [18, 59].

Substance-Use-Specific Habit Effects

A substance-use-specific prediction of the habit theory is that outcome-insensitive behavior should be observed to a greater extent in substance users versus non-users, or as a function of dependence severity across substance users. Hogarth [13, 60] reviewed 15 cross-sectional studies (published across eight papers), which tested whether insensitivity to outcome devaluation is correlated with substance use status, or with dependence severity within the substance user group [20, 58, 61–66]. Only three of these 15 studies (20%) showed impaired sensitivity to devaluation in the user group or the more dependent subsample, whereas the remaining 12 studies (80%) reported comparable sensitivity to devaluation, suggesting intact goal-directed control. Moreover, the insensitivity to devaluation seen in these three studies potentially occurred because participants' learning of the relevant contingencies was impaired rather than because of a shift to habits [67]. In fact, in all studies, participants were questioned about their knowledge of the contingencies between stimuli, responses, and outcomes in the task. As it turns out, impaired contingency knowledge coincided with the absence of a devaluation effect [13, 60]. Taken together, the majority of studies find that outcome devaluation effects in substance users are not significantly different from those in healthy controls, suggesting comparable levels of goal-directed control. Moreover, the small number of studies that have found a propensity toward outcome-insensitive behavior among substance users may be explained by poor contingency knowledge among these individuals.

Issues of Ecological Validity

The experimental paradigms that are optimized to detect habit effects do not appear to model the natural environment of substance users, raising the strong possibility that the theoretical principles derived from these paradigms offer little insight into the processes that are operating in the real world. Three issues are important in this respect.

A first issue is that many of the findings that support the habit theory, in particular in animal studies, are restricted to experimental designs with single response options and disappear when multiple response options are available [68, 69]. Yet substance users in their natural environment typically have a choice between a range of different behavioral options, which have a mixture of short- and long-term rewards and costs. Moreover, substance use is seldom a matter of a single response, but usually involves a complex sequence of responses that requires flexibility [70].

A second issue is that the classic outcome devaluation tests are conducted under extinction, which means that the outcome is no longer delivered. In some studies, the test under extinction is followed by a reacquisition test in which outcomes are again delivered. Results from these reacquisition tests typically demonstrate outcome sensitivity, even when a test under extinction previously indicated outcome insensitivity (e.g., [25]; see also [71]). As pointed out by Bouton [71], the quick return of outcome-sensitivity in reacquisition tests indicates that habits are not stable and therefore not the end stage of behavior. The reacquisition test has greater ecological validity than the extinction test because individuals do experience outcomes of their behavior in real life. In fact, the extinction test does not appear to model any circumstances in the real world that substance users would commonly find themselves in.

A third issue is that the transition of behavior from outcome-sensitive to outcome-insensitive is often constrained to the context in which the behavior was overtrained and does not generalize to other contexts [71]. However, substance use frequently manifests across diverse environments, indicating a broader range of influences beyond habit. For instance, people not only use alcohol during network events but also during family dinners and social gatherings with friends.

A Goal-Directed Account of Problematic Substance Use

The habit theory makes two assumptions relevant to substance use. First, it posits that habits form through extensive repetition. Applied to substance use, this would suggest that repeated substance use leads to habit formation. However, our review finds that behavior remains under goal-directed control even after extensive training [39–41]. Second, the theory assumes that habits emerge under conditions that are thought to impair goal-directed control, such as stress, which is considered a significant risk factor for problematic substance use [7, 72]. However, our review indicates that

goal-directed processes remain effective under stress [54, 55, 73]. Similarly, some researchers propose that substance use itself weakens goal-directed control, making it harder to suppress habitual tendencies [24, 74]. Yet, the majority of evidence suggests that goal-directed control remains intact in individuals who engage in substance use [13, 75], challenging the idea that substance use inherently promotes habitual behavior.

These problems have led some researchers to propose that while some facets of problematic substance use are due to an inability to suppress habitual tendencies, habits are not *necessary* for substance use, and other aspects may instead be driven by biased goal-directed processes (e.g., [23, 76]). These researchers acknowledge that substance use can also result from goal-directed processes when it has the highest expected utility (e.g., the costs of abstinence are considered higher than the benefits of substance use). Here, we go beyond this proposal by arguing that most phenomena related to substance use can be explained by goal-directed processes alone. We, along with others [12–14, 60, 77], contend that substance use may be driven by biased goal-directed processes, where individuals persistently pursue substance-related goals despite negative consequences. This also aligns with recent findings in rodents showing that goal-directed processes can lead to punishment-resistant behavior [78]. This view challenges the idea that substance use is a shift to strong habits or a failure of self-control, and instead emphasizes the powerful, goal-directed nature of substance use behaviors.

We focus on the key question of how problematic substance use can be considered goal-directed if people explicitly acknowledge that it contradicts their goals. In the following sections, we first outline the goal-directed theory by Moors et al. ([1, 15]; see Box 1) and apply it to explain (non-problematic) substance use. After that, we highlight several factors that may contribute to problematic substance use from this perspective. Further, we examine whether the habit theory or the goal-directed theory forms a better account for the diverse consumption patterns and trajectories, risk factors, and intervention strategies present in substance use. Finally, we derive testable predictions that follow from Moors' [1] goal-directed theory and describe how the theory relates to other goal-directed theories of substance use.

Applying the goal-directed theory outlined in Box 1 to substance use (see Fig. 1), a first thing to note is that substance use can fulfill a wide range of goals. These may all serve as a starting point of a goal-directed cycle that results in substance use. The specific goals subserved by substance use may differ across individuals, contexts, and drug classes [79], but often-cited categories are the goals to feel well (i.e., transition from a negative to at least a neutral affective state; affect regulation), to feel great (i.e., transition from a neutral to a positive affective state; recreational use), to fit in (i.e., facilitate social interaction), and to do better (i.e., to improve cognitive or physical performance) [80]. These goals broadly align with motivational theories, in which motives for substance use are categorized into four types: coping, enhancement, conformity, and social motives [81, 82].

Box 1
The Goal-Directed Theory

The goal-directed theory by Moors et al. [1] proposes that action selection operates within a cycle. This cycle is initiated by the detection of a discrepancy between the situation of the agent (a current or anticipated state) and a first goal (a desired or valued state). This cycle repeats continuously, and is updated in real time, as the agent transacts with the environment to achieve the desired state. A unique claim of this model is that the reduction in discrepancy between the current and desired state can be achieved by three strategies. The agent may choose to (a) act in an attempt to align the situation with the first goal (i.e., assimilation), (b) adjust or replace the goal so that it is no longer discrepant with the situation (i.e., accommodation), or (c) reinterpret the situation so that it no longer seems discrepant with the first goal (i.e., immunization). When a person chooses to act, they also have to choose a particular behavior option. The selection of the broad strategy and of the particular behavior are based on an evaluation of the expected utility (values of outcomes weighted by their expectancies) of the strategies and behaviors. The strategy/behavior with the highest expected utility activates its corresponding action tendency or intention, which may then translate into actual behavior. The subsequently changed situation constitutes the input for the next run of the cycle. The cycle is repeated until the discrepancy is effectively reduced or until a new cycle is initiated upon the detection of a discrepancy with another goal. The goal-directed theory further assumes that people have multiple goals. This implies that behaviors must be evaluated in terms of benefits and costs for several goals. The model also assumes that people's goals are organized in a goal hierarchy. This entails that cycles for subordinate goals are embedded into cycles for superordinate goals. The theory not only explains behavior but also proposes an account of affect: While the detection of a (current or anticipated) discrepancy leads to negative affect, the absence or the reduction of a (current or anticipated) discrepancy leads to positive affect [2, 83]

To illustrate how the goal-directed theory could be applied to explain substance use, let us consider the goal to feel well. If an individual perceives a discrepancy between their current negative affective state and their goal to feel well, they may strive to reduce this discrepancy. This can be achieved by one of three broad strategies. First, individuals may engage in overt behavior (i.e., assimilation). Second, they may adjust (lower) the value of the goal to feel well, meaning they may accept their current level of affect (i.e., accommodation). Third, they may also reinterpret the current affective state as not being so bad after all (i.e., immunization). If the person chooses to engage in overt behavior, they compare the different behavior options that are available and choose the option with the highest expectancy to reach the goal to feel well. Thus, a person may choose to

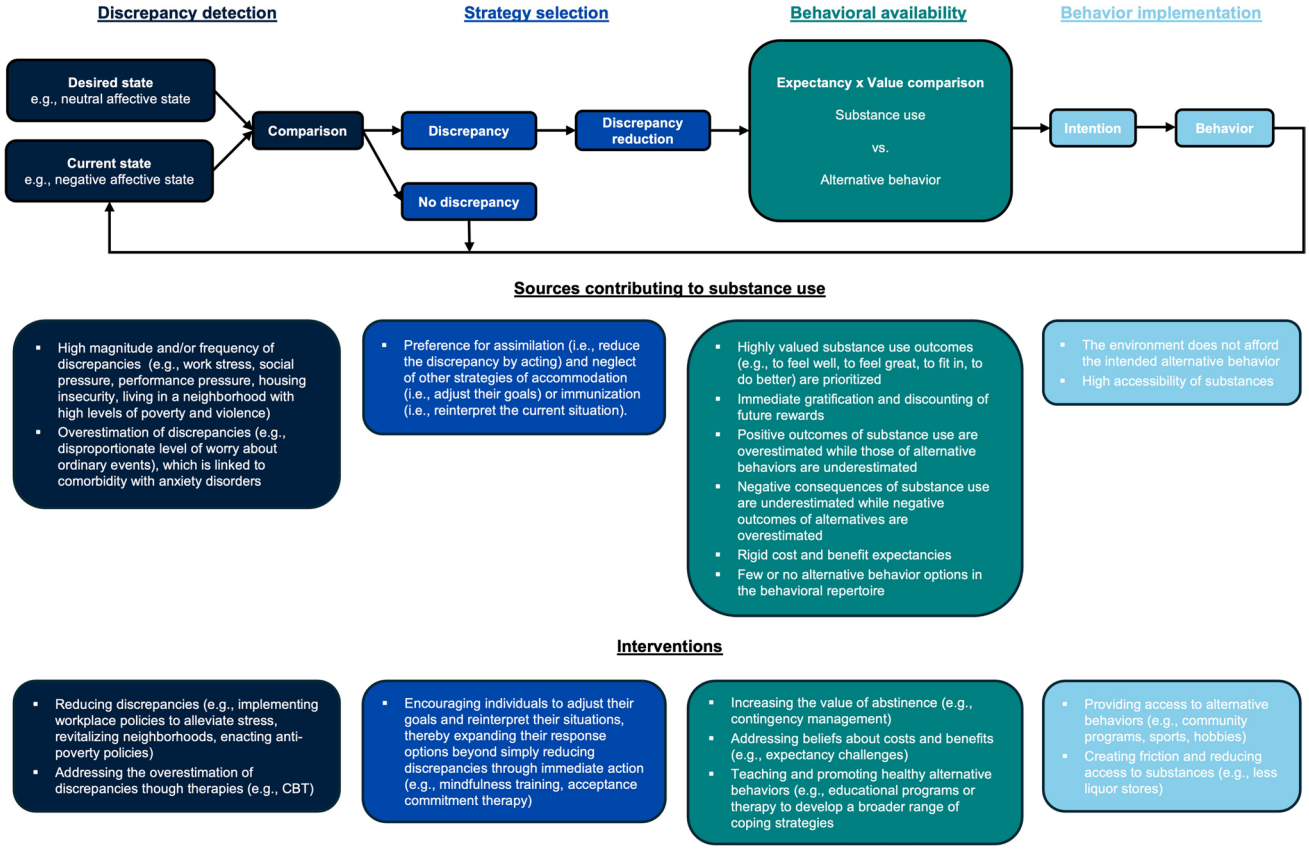

Fig. 1 Illustration of the goal-directed theory applied to substance use. The goal-directed cycle begins by comparing the current state with the desired state. If no discrepancy is detected, the cycle concludes. However, when a discrepancy is identified, efforts are made to reduce it. This may involve taking action (i.e., assimilation), which includes evaluating the expected values of different behaviors that are available. The behavior with the highest expected utility is selected, forming an intention that may then be translated into behavior. Once the behavior is enacted, the current state is updated, completing the feedback-based cycle. Figure adapted from Köster et al. [84]

consume substances rather than to do sports or to meditate if they estimate that consuming substances has the highest expectancy to reach the goal of feeling well. Of course, the person has to weigh the benefits of substance use for the goal to feel well with the costs that this behavior has for other goals, such as the long-term goals to stay healthy and productive.

Factors Contributing to Problematic Substance Use

Now that we have established the theoretical framework and illustrated how it can explain (a single occurrence of) substance use, we turn to specific factors that may contribute to problematic substance use through a goal-directed lens. Substance use can be considered problematic when there is a clear intention-behavior gap between earlier stated intentions to abstain and subsequent substance use and when it becomes excessive according to the individual or others. According to the goal-directed theory, maladaptive behavior, including problematic substance use, occurs when biases or problems arise in one or more steps of the goal-directed cycle. In the following sections, we identify five factors that may contribute to problematic substance use based on this perspective.

Values of Goals

A first factor concerns the goals that are considered and their value relative to that of other goals. Individuals may engage in substance use and fail to adopt alternative behaviors (e.g., sports or meditation) because the goals satisfied by substance use (e.g., to feel well, to feel great, to fit in, to do better) are more likely to be considered or more important than those satisfied by the alternative behavior (e.g., long-term health) at the time of action selection (i.e., economic demand; [11]). This is in line with earlier proposals that some (vulnerable) users may persist in selecting substances because they ascribe greater relative value to the outcomes of substance use compared to those of other behavior in the moment of substance choice [60, 85, 86].

The goals that are satisfied by substance use are usually short-term goals, whereas those satisfied by abstinence are

usually long-term goals. Given that short-term goals are often more vivid [87], they may be more likely to be considered. This ties in with research indicating that individuals discount the value of future rewards to different degrees, and that those who show particularly strong delayed reward discounting are more prone to substance use [11, 88, 89]. Hence, in the moment individuals decide for substance use, this may align with their current goals, offering one potential explanation for the contradiction between earlier stated intentions to abstain and subsequent substance use behavior (i.e., intention-behavior gap).

Stimulus-Goal Discrepancies

A second factor concerns the magnitude and/or frequency of encountered discrepancies between situations and goals. Individuals who engage in substance use may encounter more substantial or more frequent discrepancies than other individuals, thus leading to a stronger or more frequent need for discrepancy reduction. If such individuals also expect substance use to be an effective way to achieve this reduction, they may be more likely to engage in substance use.

This suggestion resonates with research on the risk factors of substance use, showing that substance use is more prevalent amongst individuals facing more goal-discrepant situations. For instance, individuals are more likely to develop substance use problems if they face adverse childhood experiences [90, 91], housing insecurity [92], and neighborhoods with high levels of poverty and violence [80, 93, 94]. These circumstances may constitute discrepancies with important goals (e.g., safety). Discrepancies with fundamental goals are reflected in quality of life, which is an individual's overall well-being, considering their values, environment, and social context [95]. These discrepancies specifically and lower quality life generally increase the likelihood of experiencing negative affect, which in turn may constitute a discrepancy with the goal to feel well. If individuals expect that substance use helps them to reduce this discrepancy, they should be particularly prone to substance use if they are exposed to such circumstances more frequently [96].

Individuals who engage in substance use may not only be subject to larger objective goal-discrepant situations, but they may also overestimate discrepancies. This suggestion is in line with epidemiological research showing a strong comorbidity between substance use and mental disorders [97]. For instance, individuals with anxiety disorder often show a disproportionate level of worry about ordinary events, which may indeed indicate the overestimation of situation-goal discrepancies [98]. Individual differences in discrepancy detection may thus highlight the interplay between mental health and substance use, suggesting that some individuals may be more likely to turn to substances to alleviate distress and seek well-being.

Preferences for Broad Strategies

A third factor concerns individual preferences to engage in the broad strategies of assimilation, accommodation, and immunization. Some individuals may tend to choose assimilation (i.e., reduce the discrepancy by acting) and neglect the other strategies of accommodation (i.e., adjust their goals) or immunization (i.e., reinterpret the current situation). Such a tendency may increase the likelihood that individuals engage in substance use to regulate their affect rather than to accept or reinterpret their current affect. Although research has not directly tested whether individuals with struggling with substance use are more inclined to choose assimilation than accommodation or immunization, this does align with the finding that teaching individuals to accept their current level of affect or to reinterpret their current level of affect can be effective strategies to address substance use in mindfulness training [99] and acceptance commitment therapy [100].

Behavioral Availability

A fourth factor concerns the behavior options that are present and accessible. Substance use becomes more likely if it is easily accessible. In line with this, it has been found that the availability of substances is a reliable prospective risk factor for substance use initiation and maintenance. For instance, research by Shih et al. [5] suggests that young adolescents who grow up in neighborhoods with a higher concentration of liquor stores are more likely to engage in drinking behaviors.

Substance use is also more likely if a person has few or no alternative behavior options available. People may not always know about alternative behavior options, or the environment may not always afford such options. For instance, people can only choose to do sports or meditation instead of substance use if they know about these options and if these options are available in their environment. Reduced engagement in non-substance related activities confers longitudinal risk of substance dependence, which is consistent with the proposal that a lack of attractive alternatives is a causal factor in addiction (i.e., alternative reinforcer hypothesis; [11, 101–103]).

Outcome Expectancies of Substance Use and Alternative Behaviors

A fifth factor concerns the expectancy that substance use will result in desired (benefits) and undesired outcomes (costs) compared to alternative behaviors. A person is more likely to engage in substance use if they overestimate the expectancy that substance use will result in a desired outcome (e.g., regulate negative affect) and/or underestimate the expectancy that alternative strategies (e.g., sports, meditation) result in the same outcome. Substance use is also more likely if a person underestimates the expectancy that substance use results in

undesired outcomes of substance use (e.g., health problems) and/or overestimates the negative outcomes of alternative behaviors (e.g., that sport depletes energy).

Importantly, expectancies about the outcomes of a behavior may be hard to change once they are firmly established [49, 51]. It may be challenging, for instance, to erase a person's long-held expectancy that substance use helps regulate negative affect. In the case of alcohol consumption, research indeed suggests that individuals who form expectancies that alcohol has positive effects early in life are more likely to develop problematic alcohol consumption later on [104–106].The findings by Buabang et al. [49] and Van Dessel et al. [51] furthermore suggest that individuals may be especially likely to rely on such long-held expectancies under poor operating conditions despite knowing that these are inaccurate. This may also be true for long-held expectancies about the positive outcomes of substance use under poor conditions, offering a goal-directed explanation for findings, such as that the risk to relapse into substance use is higher when people are stressed [7].

Understanding Complexities of Substance Use through the Lens of the Goal-directed Theory

It must be acknowledged that problematic substance use is a complex phenomenon. This is reflected in the diverse consumption patterns, risk factors, and intervention strategies that have been identified in previous research. In terms of consumption patterns, some individuals engage in continuous, heavy consumption, whereas others engage in binging and thus in excessive substance use within a short time frame. In terms of risk factors, it has been shown that substance use can be influenced by poverty [80], psychiatric disorders [98], availability of substances [5], availability of alternatives [107], marketing [108], price [109], peers [110], family [111], and early exposure [112]. In terms of intervention strategies, it has been shown that substance use can be partially reduced through contingency management [113], expectancy challenges [114], cognitive-behavioral therapy (CBT; [115, 116]), mindfulness training [99], acceptance commitment therapy [100], and pharmacotherapy [117].

The habit theory reduces problematic substance use to one mechanism, which appears insufficient to account for the wide variability observed in substance use behaviors [118]. In contrast, the goal-directed theory does hold the promise of explaining this variability through a dynamic process comprising a feedback-based discrepancy detection stage and a strategy/action selection stage based on expected utilities (see Box 2 for the relation to other theories). The explanation for substance use put forward by this theory implies that a person consumes substances because they perceive some kind of discrepancy between their current state and a desired state, choose to act to reduce this discrepancy, and choose substance use as the behavior with the highest expectancy to reduce the discrepancy. The five factors identified within the goal-directed theory (see previous section) collectively influence the likelihood of this decision-making process resulting in substance use behaviors. Moreover, the interplay of the identified factors can account for the inherent complexity of substance use behaviors and generate novel predictions concerning the occurrence and prevention of substance use.

The novel predictions can be illustrated with several concrete examples. For instance, individuals who favor assimilation strategies (i.e., actively reducing discrepancies through action) are predicted to report higher rates of substance use than individuals who prefer accommodation (i.e., adjusting goals) or immunization (i.e., reinterpreting situations). Another prediction is that problematic substance use is associated with strong, rigid expectancies regarding the outcomes of substance use (e.g., beliefs about its coping effectiveness) and difficulties adjusting these expectancies. Moreover, such strong expectancies are predicted to be especially likely to be retrieved and determine behavior under conditions such as stress or time pressure. Yet another prediction is that frequent discrepancies between current and desired states (e.g., persistent stress at work due to social exclusion) may increase the likelihood of persistent heavy substance use. In contrast, large but acute discrepancies (e.g., unrealistic work deadline) may elevate the risk of binge-like episodes involving excessive substance use within a short time frame.

Box 2
Relation to Existing Theories

As mentioned above, Moors' [1] theory is part of a broader family of goal-directed theories. This theory differentiates itself from other goal-directed theories by proposing an action control cycle comprising two stages: a feedback-based discrepancy detection stage and a strategy/action selection stage based on expected utilities. Several theories show partial overlap with either of the two stages. Moors' [1] goal-directed theory is a detailed attempt at integrating both strands of theories. In the discrepancy detection stage, individuals identify a discrepancy between their current and desired state, which starts a cycle to address this discrepancy. Discrepancy detection, reduction, and negative feedback is also emphasized in theories from cybernetics [119–124]. The action selection stage in Moors'[1] theory involves choosing the behavior with the highest expected utility, which is determined by two components: expectancy (the likelihood of achieving the desired outcome) and value (the importance or desirability of that outcome). This stage shares elements with expectancy-value theories, which emphasize the role of anticipated positive outcomes in driving behavior, especially regarding positive drug outcomes [125, 126]. It also shares elements with biased choice theories, which highlight how individuals may overvalue immediate, positive substance use outcomes, often prioritizing short-term rewards despite potential long-term consequences [16, 77–84]. Finally, it shares elements with theories of positive and negative reinforcement that focus on substance use either as a means of achieving pleasurable feelings or to alleviate negative emotional states [127]

Another important aspect highlighted by the goal-directed theory is that these predictions should not only be studied in isolation. The theory specifies how the different factors relate to one another, resulting in further predictions based on their interactions. For example, the tendency to choose assimilation as a strategy to reduce discrepancies, may only result in substance use for individuals who also consider substance use a particularly good strategy to reduce the discrepancy with a particular goal (e.g., the goal to feel great). For others, such a tendency may result in other patterns of behavior (e.g., engaging in extreme sports). Another example is, that stress may be identified as a risk factor, but according to this theory, it only leads to substance use if an individual perceives substance use as the behavior with the highest expected utility for reducing stress-related discrepancies. Thus, understanding substance use requires considering how different factors interact within the individual's decision-making process. To empirically test these complex interactions, ecological momentary assessment (EMA) provides a valuable methodological tool for capturing real-time fluctuations that drive substance use [128]. EMA's strength lies in its ability to collect data in natural settings, enabling researchers to closely track shifts across various stages, from experiencing discrepancies to actual substance use and post-use states, while preserving temporal order for stronger causal inference. By capturing these dynamics in real-world contexts, EMA holds the potential to enhance relapse prediction [129], inform personalized interventions [130], and ultimately improve treatment outcomes [131].

Conclusion

The habit theory has been central to the research and intervention agenda in the field of substance use for several decades. The theory postulates that certain contexts or stimuli may directly trigger substance use without the consideration of expected outcomes. This provides an intuitive explanation for the seeming contradiction between individuals' substance use behavior and their intentions to abstain. We reviewed the main assumptions of the habit theory, namely that habits form with overtraining and that they are especially likely to be expressed under poor operating conditions (e.g., due to time constraints or stress). Our review revealed several issues regarding the reliability, interpretability, and ecological validity of this evidence (for a related discussion see [132]). Moreover, there seems to be little compelling evidence that substance use is associated with a stronger reliance on habit processes, and habit theory fails to account for the diverse consumption patterns, risk factors, and intervention strategies that have been identified. This critical evaluation of the habit theory led us to the sobering conclusion that one of the most influential theories on substance use lacks a convincing basis in experimental evidence and cannot account for the observed complexity of substance use behavior.

To move toward a better understanding of substance use, we propose to shift the focus back to goal-directed processes as the potential cause of substance use. Yet, this leaves us with the important question of how substance use can be goal-directed if it does not align with the goal of individuals to abstain. Our explanation builds on the goal-directed theory of Moors et al. [1, 15]). Based on this theory, we identified several factors that may contribute to problematic substance use. These factors include (a) the values of goals satisfied by substance use in the moment of substance use, (b) the objective and subjective frequency and magnitude of discrepancies between situations and goals, (c) the tendency to take action to resolve discrepancies rather than to accept or reinterpret the situation, (d) the limited availability of alternative behaviors, and (e) the reliance on false expectancies about the outcomes of substance use. Taken together, these factors offer a more comprehensive understanding of the complex dynamics of problematic substance use, including consumption patterns, risk factors, and intervention strategies.

When it comes to research on the underlying processes of substance use, it is important to sustain a high level of reliability, interpretability, and ecological validity of the findings because the findings directly impact public health policy planning [133]. Otherwise, research may contribute to the misallocation of treatments, potentially withholding more efficacious treatments to those in need [134]. Based on our review, we advise against using the habit theory to explain problematic substance use. Given the sheer complexity of problematic substance use, we propose shifting the focus away from a univariate explanation, such as habit theory, and instead embrace a more complex syndrome model of problematic substance use (e.g., [135]). The outlook offered by the goal-directed perspective provides a promising path towards such a better understanding of problematic substance use, making it important to test its underlying assumptions and to explore its implications for therapeutic interventions.

Key References

- Hogarth L (2022) The persistence of addiction is better explained by socioeconomic deprivation-related factors powerfully motivating goal-directed drug choice than by automaticity, habit or compulsion theories favored by the brain disease model. In: Evaluating the Brain Disease Model of Addiction. Routledge

This chapter challenges the brain disease model of addiction (BDMA), advocating for a shift in research focus towards socioeconomic and environmental factors that drive drug choice.

- Moors A, Boddez Y, De Houwer J (2017) The power of goal-directed processes in the causation of emotional and other actions. Emot Rev 9:310–318. https://doi.org/10.1177/1754073916669595

  Introducing the goal-directed theory by Moors, which is applied to substance use in this paper.

- Vandaele Y (2024) Interaction Between Habitual and Goal-Directed Processes in Addiction. In: Vandaele Y (ed) Habits: Their Definition, Neurobiology, and Role in Addiction. Springer International Publishing, Cham, pp 337–363

  This chapter highlights the recency of the debate as to whether problematic substance use behavior arises from habitual or goal-directed processes.

- Buabang EK, Köster M, Boddez Y, et al. (2023) A goal-directed account of action slips: The reliance on old contingencies. J Exp Psychol Gen 152:496–508. https://doi.org/10.1037/xge0001280

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  This paper critiques the chronic, relapsing brain disease (CRBD) model's neglect of sociopolitical dynamics and its potential to marginalize drug users, suggesting a need for more socially rooted approaches.

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Declarations

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