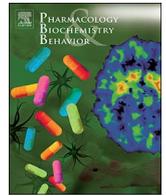




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## Review

## Addiction as a BAD, a Behavioral Allocation Disorder

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## ABSTRACT

Addiction is continued drug use despite its harm. As one always has alternatives, addiction can be construed as a decision to allocate behavior to drug use. While decision making is commonly discussed and studied as if it resulted from deliberative, evaluative processes, such processes are actually only rarely involved in behavior allocation. These deliberative processes are too slow, effortful and inefficient to guide behavior other than when necessary. Rather, most actions are guided by faster, more automatic processes, often labeled habits. Habits are mostly adaptive, and result from repeated reinforcement leading to over-learned behavior. Habitual behavior occurs rapidly in response to particular contexts, and the behavior occurring first is that which occurs, *i.e.*, the behavior that is decided upon. Thus, as drug use becomes habitual, drug use is likely to be chosen over other available activities in that particular context. However, while drug use becoming habitual is necessary for addiction to develop, it is not sufficient. Typically, constraints limit even habitual drug use to safer levels. These constraints might include limiting occasions for use; and, almost always, constraints on amount consumed. However, in a minority of individuals, drug use is not sufficiently constrained and addiction develops. This review discusses the nature of these constraints, and how they might fail. These failures do not result from abnormal learning processes, but rather unfortunate interactions between a person and their environment over time. These accumulate in the maladaptive allocation of behavior to drug use. This Behavior Allocation Disorder (BAD) can be reversed; occasionally easily when the environment significantly changes, but more often by the arduous application of deliberative processes generally absent from decision making. These deliberative processes must continue until new more adaptive habits become the most probable behavior in the contexts encountered. As alternatives to drug use become the most probable behavior, relapse risk diminishes.

## 1. Introduction

Addiction is a Behavior Allocation Disorder (BAD). This means that instead of some more adaptive behavior, drug seeking and taking occur at rates harmful to the individual or others. This choice is most often not deliberative, but rather results from automatic Type I thinking, just like most of the other decisions each of us make every day (see [Kahnemann, 2011](#) for a discussion of Type I and II thinking). The habitual nature of drug seeking and taking is likely necessary, but it is not sufficient for addiction to occur. Numerous constraints limit even habitual drug use to less dangerous levels, and only when these constraints are surmounted does a BAD occur. While overcoming these constraints is maladaptive, these constraints are overcome as a result of normal learning processes, and BADs like addiction are best understood within this framework.

## 2. Addiction as a Behavioral Allocation Disorder

Addiction is continued drug use despite harm to oneself or others ([Lamb et al., 2016](#)). This simple definition includes all the essential characteristics of addiction. The harm that results from addiction can take on many faces. Some are stark and clear, like death from opioid overdose ([Chen et al., 2014](#)). Others are more contextually dependent, such as the legal consequences of marijuana use ([Banys, 2016](#)). Still others are not readily apparent until revealed by epidemiologic study, *e.g.*, increased fatalities following a myocardial infarction in smokers ([Kaufman et al., 1983](#)). Addiction is when use continues despite these consequences to the individual. Addiction can also be characterized by harm to others, *e.g.*, drunk driving deaths, fetal alcohol syndrome, lost productivity and the destructions of families ([Boutress and Chassin, 2015](#); [NHTSA, 2012](#); [Berman et al., 2014](#); [Roozen et al., 2016](#));. Continued drug use in the face of such harms is clearly undesirable.

Though sometimes not enticing, alternatives to this continued drug use always exist. Thus, this continued drug use represents a choice of

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drug use over these alternatives. This choice, like all choices, involves the allocation of behavior among activities: drug seeking and taking instead of other activities. Framing choice as behavior allocation shifts our usual thinking about choice as a deliberative, evaluative process, to a different framework, one concentrating upon identifying the determinants of behavior allocation. This is a useful framework when the allocation is harmful or disordered. It avoids the judgmental attitude that comes when talking about someone's choices. It also avoids the intellectual missteps that come when viewing this harmful behavior allocation as necessarily the result of deliberative, evaluative choices. Viewing addiction as a Behavior Allocation Disorder, a BAD, thus, provides a useful framework for understanding the behavioral processes operating to cause a maladaptive allocation of behavior and what can be done to correct this.

### 3. Behavior allocation is more often a function of habit than of deliberation

The role decision-making plays in addiction, is easier to study if we make several admissions we often hesitate to make. First, decision-making is studied by observing the behavior allocation occurring when a particular situation is encountered. This allocation is the decision resulting from whatever “decision making” happened. Second, this decision making can be usefully discussed as either (1) habitual behavior resulting from a rapid, automatic process that has been called Type I thinking or (2) goal directed behavior resulting from a slower, more deliberative process that has been called Type II thinking<sup>1</sup> (Dickinson, 1985; Kahnemann, 2011). Third and last, it is almost automatic to assume that what we study when we study decision-making is the slower, more deliberative process, Type II thinking. This is mistaken and is a result of our Type I, rapid, automatic thinking. When we use our more deliberative Type II thinking, we realize that more often the decisions we study are the result of rapid, automatic, habitual, Type I thinking.

To understand why this is so, consider how many decisions are made in a day. Remember each of these decisions results in emission of one of many possible behaviors, – behavior allocation. So starting to walk down the hall by putting your right foot forward rather than your left is a decision; as is extending it 45 rather than 47 cm; and following this by extending your left foot 45 cm involves more decisions. If much deliberation went into this, the trip to the end of the hall would take a very long time. While most can accept that routine, overlearned everyday acts are habitual and automatic, what is more difficult to accept is that more meaningful and important decisions might also be largely habitual. Yet the boundaries between meaningful and important, and trivial and inconsequential can be difficult to foretell. Further, years of training has often equipped us with a repertoire of habits leading to the correct behavior occurring in the appropriate circumstances: we look left and right when crossing the street, and stop at red traffic lights; we do not cheat or steal; we treat others as we would like to be treated; and we randomize our subjects to treatments. If we do these, we likely do them automatically, without thinking, yet deciding to do otherwise could have important consequences. In these cases, this automaticity is good and adaptive.

When an automatic response is not available, is ineffective, or something alerts us to the desirability of not responding automatically, more deliberative, effortful Type II thinking occurs. However, often when this seems to occur, habits reinforced in other similar circumstances actually occur. For instance, Kahnemann (2011) recounts how instead of answering the question asked, people often answer a similar,

but simpler, question they can readily answer. It is not that slower, deliberative, effortful decision-making cannot occur, but rather that faster, more automatic and less effortful decision making occurs instead. This is most likely a result of these automatic behaviors occurring more rapidly, *i.e.*, the behavior occurring first is the behavior that occurs.

Kacelnik et al. (2011) propose that behavior allocation reflects a race between behaviors rather than a comparison of outcomes because “when two options are simultaneously available, animals do not explicitly deliberate between two options, but instead rely on the same process as when facing independent sequential opportunities. ...each option sets in motion a process that would normally generate a latency and then action, but the option that generates the shorter latency ‘censors’ the alternative(s) so that one of them is expressed behaviorally.” This view is supported by findings that choices between two options can be predicted from the response latency when each option is available in isolation and that latencies in choice trials tend to actually be shorter than when each option is available in isolation, as would be expected from censored data, but the *opposite* of what would be expected if the subject was to weigh the value of each option (see Kacelnik et al., 2011).

Similar to Kacelnik et al.'s hypothesis that behavioral allocation reflects a race between behaviors, Bickel et al. (2000) hypothesize the option with the greater demand when available alone is chosen when both are available simultaneously, a hypothesis supported by several of their earlier studies. In other words, the behavior having the greatest momentary probability, the behavior that would occur most rapidly under the circumstances, is the behavior that occurs, not necessarily the behavior that results in the most valued outcome. This would explain the paradox of preference reversals, *i.e.*, when more behavior is allocated to the consumption of A than B when their price is low, but when their price is high, more behavior is allocated to the consumption of B than A. Such preference reversals would occur when the consumption of A is high at low prices, but falls rapidly as price increases; and the consumption of B is moderate at low prices, but falls slowly as price increases. Thus at low prices the probability of A  $P(A)$  is greater than  $P(B)$  and A is chosen over B. However, at high prices,  $P(A) < P(B)$  and B is chosen over A.

### 4. Habitual drug use is necessary, but not sufficient, for development of a BAD

Habits result from overtraining and the reduced variation in behavior that comes with overtraining. Such overtraining can lead to a behavior being the predominant behavior in a context, which results in a tight coupling between the context and the emission of the behavior. This tight coupling of context-response-outcome eventually results in the context reliably leading to the emission of the response. This type of tight control of the stimulus over the response (S-R behavior) can result in a seeming insensitivity of the response to changes in the outcome value. For example, a rat, which has repeatedly earned food for responding when food deprived, will make more responses than a rat with a shorter history of this, when responses no longer result in food delivery and the rats are no longer food deprived (Dickinson et al., 1995). In other words, longer training results in habitual behavior that appears insensitive to outcome devaluation when tested in extinction. The relevancy of this type of devaluation insensitivity to the development of a BAD is unclear, as, when responses do result in food delivery, responding between the two groups is more similar (Dickinson et al., 1995). However, the rapidity and automaticity of habitual behavior is likely to play an important role in the development of a BAD and a different way in which habitual behavior may seem insensitive to outcome value. The rapidity or high probability of habitual behavior increases the likelihood that habitual behavior occurs first and is chosen. As the most probable behavior may not be the most valued behavior, this can lead to seemingly irrational choice and

<sup>1</sup> As CP Snow (1959) notes in the *Two Cultures*: “The number 2 is a very dangerous number: that is why the dialectic is a dangerous process. Attempts to divide anything in two ought to be regarded with suspicion.” However, like for the purposes of Snow's lectures this dangerous division serves the purpose of this paper.

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