



RESEARCH HIGHLIGHT

Comment on Vandaele and Ahmed: Rethinking habits in addiction

Kent C. Berridge ¹*Neuropsychopharmacology* (2021) 46:687–688; <https://doi.org/10.1038/s41386-020-00932-0>

Vandaele and Ahmed provide a thought-provoking reevaluation of habits [1], which joins other recent critical reassessments of the role of habits in addiction [2, 3]. Vandaele and Ahmed consider evidence from both humans and animals, and conclude “habits alone cannot account for the development of compulsive drug use and that drug habits are not necessary, nor sufficient to explain the transition to addiction.”

Debates over habit start with definition. Everyone agrees that addicts take drugs again and again. Habit thus might be applied as a purely descriptive label for any frequently repeated action. But habit typically is meant to be explanatory in neuroscience theories of addiction [4]. So, the question becomes: how can habit be defined in a way that rises to the level of explanation?

The oldest explanatory definition of habit is the clearest: an automatic response, mediated by Stimulus-Response (S-R) associations, often arranged in a chain. Vandaele and Ahmed adopt this classical definition, writing “Habits are defined as automatic responses elicited by antecedent stimuli without deliberation or representation of the consequences of one’s action.”

That definition of habit as ‘automatic S-R reflexes’ would have been recognized a century ago by the early psychologist William James. In 1890 James similarly described habits: “habit soon brings it about that each event calls up its own appropriate successor... until at last the whole chain, A, B, C, D, E, F, G, rattles itself off as soon as A occurs”.

Behaviorists throughout the first half of the 20th century used automatic S-R habits to explain addiction and relapse. For instance, in 1935 Edwin Guthrie described relapse in smoking: “We resolve to stop smoking. We substitute for a few of our conditioned responses inhibitory responses, a grim closing of the mouth, a tendency to push away the pipe... substituting chewing gum, or nails, or pencil. We suddenly find ourselves smoking. Some cue... has taken us unawares and had its usual response”. Yet by the 1960s the explanatory appeal of S-R habit chains had dimmed, so that the learning psychologist O.H. Mowrer could write, “it is clear that the mechanism here posited is the old, familiar, and relatively barren one of reflex chaining. This is a notion which was popular in the heyday of Behaviorism but which finds few contemporary advocates.”

Modern addiction habit theorists today often adopt a somewhat different definition of habit, drawing on a dichotomy between action as either cognitively goal-directed or not [5]. Goal-directed here means tracking current goal value by integrating together different sources of learned information. Habits are not goal directed, in the sense that they persist after devaluation of a goal, especially if tested in extinction [4].

But to define habit as “not goal-directed” is essentially a *negative feature definition*: it defines habit by what it is not, rather than by any identifying *positive feature*. “Not goal-directed” is a large grab-bag category that contains many other potential explanations besides habits for why a devalued outcome might still be persistently pursued despite adverse consequences. One alternative is motivational compulsion, such as sensitized incentive salience or excessive ‘wanting’ [6]. Thus, Vandaele and Ahmed note, “It could be argued that behavioral persistence toward a devalued goal results from an excessively strong motivation for the goal rather than from an action executed “out of habit”.”

The dichotomy between ‘non-goal-directed habits’ vs ‘goal-directed actions’ sprang originally from foundational studies by Dickinson and Balleine [5]. Dickinson adopted procedures and dichotomy logic from earlier analyses by Edward Tolman. However, despite pioneering the dichotomy, Tolman did *not* define pursuit persistence after goal devaluation as *habit*. Instead Tolman posited such persistence to be due to *distorted cognitive expectations* induced by over-training that in Tolman’s words would “narrow the rat’s ‘cognitive maps’”. So is overly-persistent pursuit a habit, a narrowed cognitive map, compulsive motivation, or something else? Ideally, this should be decided by empirical verification of positive features of the underlying habit or compulsion, not by investigator predilection.

One positive feature sometimes suggested to identify habits is expansion of neural control from nucleus accumbens to dorsolateral neostriatum (DLS) [4]. However, although DLS does indeed contribute to habits and related stereotyped patterns of action [7], DLS also mediates motivational enhancement of incentive salience [8]. Recognizing multiple DLS functions leaves open the question of whether DLS recruitment in addiction reflects automatic habit or greater cue-triggered “wanting”.

Procedural test details may also influence whether or not drug seeking seems goal-directed. Vandaele and Ahmed suggest that habit-like persistence of drug seeking in some addiction neuroscience studies is partly an artifact of a single response option. By contrast, they note, “If we consider that behavior remains goal-directed when there is a simple choice between two options, the hypothesis that drug habits contribute to compulsive drug use and ultimately addiction is difficult to reconcile with real-world scenarios, in which drug addicts typically face a multitude of drug and non-drug alternatives”. Also, though there are valid reasons why the Dickinson procedure employs extinction conditions, Vandaele and Ahmed note, “However, extinction conditions rarely occur in real-world drug use scenarios”.

¹Department of Psychology, University of Michigan, Ann Arbor, MI 48109-1043, USA
Correspondence: Kent C. Berridge (berridge@umich.edu)

Thus, a rethink may be needed regarding both the nature of habits and how to identify them. Still, after their quote noted in opening paragraph, Vandaele and Ahmed write “However, this does not preclude a role for habits in addiction. Then, to what extent are drug habits actually involved?”. The answer to that question, they suggest, may require sophisticated modeling of hierarchical decision-making processes underlying drug pursuit and consumption.

It might also be valuable to explore alternative concepts for the role of actions in addiction. One early neuroscience observation that influenced modern habit theory was a classic demonstration that psychostimulant drugs caused aberrant perseveration on instrumental responses for reward [9]. An early reinforcement hypothesis suggested that some actions themselves are rewarding to perform [10]. Similarly, my colleagues and I have often wondered whether incentive salience can be attributed onto an action by mesostriatal systems, as “action salience”, which would give motivational attraction and urgency to performing it. Perhaps Everitt and Robbins’ use of the term “must do!” in their addiction habit theory connotes similar motivational urgency [4]? In any case, whether the motivational target were drug stimuli or actions,

addictively motivated ‘wanting’ to take drugs would be quite different from the ‘automatic performance without deliberation’ that characterized a century of thinking about habits.

FUNDING AND DISCLOSURE

This was an invited commentary. Kent Berridge’s research is supported by NIH grants MH063649 and DA 015188.

REFERENCES

1. Vandaele Y, Ahmed SH. Habit, choice, and addiction. *Neuropsychopharmacology*. 2020. <https://doi.org/10.1038/s41386-020-00899-y>.
2. Hogarth L. *Neuropsychopharmacology*. 2020;45:720–35.
3. Singer BF, Fadanelli M, Kawa AB, Robinson TE. *J Neurosci*. 2018;38:60–73.
4. Everitt BJ, Robbins TW. *Annu Rev Psychol*. 2016;67:23–50.
5. Dickinson A, Balleine B. *Anim Learn Behav*. 1994;22:1–18.
6. Robinson TE, Berridge KC. *Brain Res Brain Res Rev*. 1993;18:247–91.
7. Smith KS, Graybiel AM. *Dialogues Clin Neurosci*. 2016;18:33–43.
8. DiFeliceantonio AG, Berridge KC. *Eur J Neurosci*. 2016;43:1203–18.
9. Robbins TW. *Nature* 1976;264:57–9.
10. Glickman SE, Schiff BB. *Psychological Rev*. 1967;74:81–109.