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Vulnerabilities to addiction must have their impact through the common currency of discounted reward

Commentary on Redish, A. D., Jensen, S., & Johnson, A. (2008). A unified framework for addiction: vulnerabilities in the decision process. *Behavioral and Brain Sciences*, *31*(4), 415-436

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Abstract
The ten vulnerabilities vary in their likelihood of producing temporary preference for addictive activities, which is the phenomenon that puzzles conventional motivational theory. Direct dopaminergic stimulation, but probably not the other vulnerabilities, may contribute to the necessary concavity of addicts' delay discounting curves, as may factors that the senior author analyzes elsewhere. Whatever their origins, these curves can themselves account for temporary preference, sudden craving, and the "automatic" habits discussed here.

Text
Any or all of the ten vulnerabilities in this innovative analysis may have a role in addicts' decisions. It is an admirable structure, but this rich menu potential mechanisms needs to be seen in perspective. Whatever else is true of them, addictive behaviors are goal-directed and usually effective. The final common path of all these vulnerabilities has to be motivation, even modest changes of which can significantly affect addictive choices (Becker *et.al.*, 1992; Olmstead *et.al.*, 2007). And the best-established property of this motivation is that it is relatively short-term. Each vulnerability needs to be examined as a possible explanation, entire or partial, specifically for the temporary amplification of short-term relative to long-term motivation that induces temporary preference for the addictive activity.

The search for explanations is complicated by the fact that short-term rewards' intermittent dominance of greater long-term rewards extends beyond the identified addictions. Addictions are not a circumscribed set of activities, just the most conspicuous or harmful examples of a broad human tendency to develop habits that lure us into

continuing them even while we are trying to break them. Some addictions may indeed be due to the physiological properties of a substance, but these must ride on top of whatever general principle makes any rapidly rewarding activity a mixed blessing. Some serious examples do not involve substances— not only gambling (Appendix F) but credit abuse and various kinds of thrill seeking—and some others involve normal substances that we evolved to ingest: Food is a prevalent example. Both kinds of temptation shade over into trivial but unwelcome habits such as drinking too much coffee (Appendix E) or watching a particular kind of TV show. All such choices must have brain mechanisms, of course—there are no disembodied motives-- and associated brain processes are being observed in increasing detail; but the brain processes that are observed during addictions are not necessarily different from the processes that govern every choice we make. Even opiates may not "mimick" rewards (vulnerability #5, section 3.2.1) but *be* rewards, useless as far as adaptivity goes, but for hedonic purposes only different from other rewards in their power, speed, and (consequent?) long-term failure. Which vulnerabilities can explain preference reversal?

Of the eight that the authors discuss, the most likely candidates for explaining short-term amplifications of motivation are #4 and #7, those that involve the distortion of error-prediction, in planning and habit systems respectively, by the direct action of dopaminergic drugs on striatal structures (*e.g.* Robinson & Berridge, 2001). Such action has been observed by several methods, as he reviews. The resulting property of being "wanted but not liked" is clearly an example of temporary preference-- "a motivational magnet" (Berridge, 2007), but this effect has so far been reported for only short periods of time. It is not known whether this effect changes motivation long enough to affect the value of a weekend coke binge, for instance. And this mechanism would govern only agents that directly elevate dopamine.

Vulnerabilities #1 and #2 describe changes in the value of addictive activities and their alternatives as a result of past or current addictive activity. Evidence for a long-lasting attenuation after taking some agents is strong (Volkow *et.al.*, 2002), and addicts often mistake this "grayness" of life for a bleak normality without their drug (my own clinical observation), but this remains a factor both when they are deciding to relapse and when they are deciding not to. By the authors' own account, vulnerability #3 seems to involve the genuine (opioid-mediated) pleasurability of some activities, which does not set them apart from motivated activities in general.

Vulnerabilities #5 and #6 involve selective attention to, or interpretation of, contingencies of reward. This selection is motivated. There is no reason to suppose that this kind of "fooling yourself" occurs differently in addictions than, say, in the overly positive belief in others' approval of you or in feelings of efficacy over random events, which all non-depressed subjects seem to develop (*e.g.* Alloy & Abramson, 1979). As a practice that increases current good feeling at the expense of realism, this selective interpretation is itself a relative of the addictions, and itself needs explanation.

As for vulnerabilities #8 and again #7, the existence of a habit system distinct from a planning system is certainly well established, but "mindless" would have always been a

better term than "automatic" (or "robotic," section 3.3.1) for the behaviors it governs. The latter terms imply an ability to override contrary motivation, whereas this selective principle is actually observed to give way to the planning system whenever a choice is subject to conflicting motives. This mechanism seems likely to be limited to those addictions that cause brain damage. Behaviors that persist despite punishment have elicited similar explanations over the years—*e.g.* Freud's "repetition compulsion" (1920/1956) and Watson's "conditioned responses" (1924)—but a motivational explanation is needed.

Vulnerability #10 is basically a space to be developed. Thus a substantial amount of explanatory work will still have to be done by vulnerability #9. The authors mention only a high rate of discounting (section 3.6), but it is the hyperbolic or at least hyperboloid shape of a person's discount curve that predicts she will overvalue rewards only temporarily (Ainslie, 1992, 2005). The review they cite analyzes possible mechanisms for the hyperboloid shape of people's discount functions (Redish & Kurth-Nelson, in Madden *et.al.*, in press), but makes it clear that the hyperboloid shape itself is robust. Whatever its roots, hyperboloid discounting can account for not only overvaluation of imminent rewards but also for two additional phenomena relevant to addictions. First, the sudden cravings that are evoked by mere reminders of past consumptions, which are inadequately explained by linear applications of either hyperbolic discounting theory or conditioning theories, may come from a recursive self-prediction process in which a random increase in a person's subjective probability of relapse increases craving, increased craving increases the probability of relapse, and so on (Ainslie, in Madden *et.al.* in press, same volume).

Secondly, any complex goal-seeking process involves setting up intermediate goals, which become game-like occasions for an emotional reward such as joy, relief, or self-congratulation (Ainslie, 1992, pp. 339-343). Then the prospect of a great "score" of a drug will have the same rewarding power as a great score in sports, despite a desire to limit consumption, as will the chance for a restrained eater to neatly finish off a container of food. The rewards for any lifestyle consist of much more than the external rewards that the lifestyle has arisen to obtain. The additional emotional or "game-like" rewards can maintain the activities set up by the lifestyle for long after the ostensible rewards have changed in value—hence the big lottery winners who continue to travel by bus and save grocery coupons. Such a process is more likely than mindless automaticity to underlie consciously unwanted drug-copping habits.

The same potential for game-like reward might be the basic motivating principle of the non-substance addictions, which otherwise have scant rationale in the vulnerabilities discussed here. To the extent that people can anticipate occasions for emotion they are apt to have the emotion prematurely—the way that familiar scenarios become mere daydreams—and learn to avoid this mainly by making somewhat unpredictable events the occasions for emotional reward, that is, broadly speaking, by gambling (Ainslie, 2001, pp. 168-174). This tactic is often adaptive when applied to human relationships and attempts at personal accomplishment, but can be diverted into short term rewardingness (addictiveness) by finding bets that are won or lost quickly—bets that

include but are by no means limited to gambling in the sense of the word that the authors use (Appendix F).

Dopaminergic agents possibly aside, temporary preference comes from the universal properties of discounted reward.

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