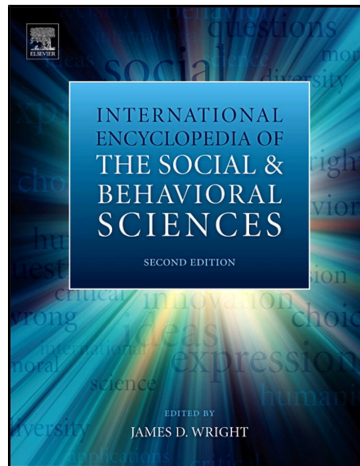


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Wanting vs Needing

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Abstract

Wanting (incentive salience) is a psychological process, triggered by rewards and their cues or imagery, which normally provides an 'oomph' that spurs motivation for objects of desire. Typically 'wanting' is in conformity with significant needs. But 'wanting' can sometimes dissociate from needs and from deliberative plans in maladaptive ways. Most dramatically in drug addiction, when amplified excessively by changes in brain reactivity, 'wanting' can have pathological intensity. Other impulse control disorders, such as gambling and overeating, may possibly share a similar compulsive 'wanting.' And even in ordinary daily life, occasional dissociations of 'wanting' from needs might occur. Selective surges in 'wanting' may explain why under these conditions, rewards can be 'wanted' much more than they are needed or even 'liked.'

Want versus Need

In a classic study of delayed gratification, Mischel and colleagues (Mischel et al., 1972, 1989) examined the ability of young preschool-aged children to patiently refrain from consuming a tasty marshmallow placed in front of them, when promised that if they could wait, a second marshmallow would additionally be received when the experimenter returned later. Some children succeeded in resisting the tempting marshmallow in order to earn the extra one, whereas others succumbed to the immediate temptation. Subsequent findings revealed that children who displayed the greatest amount of patience later went on to have better life outcomes as measured by SAT scores, educational attainment, body mass index, and other life measures.

What happens at such moments of temptation? What is the nature of the temptation process that self-control must wrestle with? Why is a marshmallow one can see and smell more difficult to resist than one in the next room? We suggest that one important psychological process in temptation is incentive salience, also known as 'wanting.' Incentive salience is typically triggered by encounters with reward-related cues (or related vivid imagery), and experienced as surges of motivation to obtain and consume the reward that can last even beyond the presence of the cues or imagery. Incentive salience is generated by brain 'mesolimbic' systems that react to reward cues, involving dopamine and other signals that converge on the nucleus accumbens. The intensity of the 'wanting' surge is determined by the reactivity of brain mesolimbic systems at the moment of cue reencounter. This motivation intensity may reach heights that become nearly compulsive if the brain systems are especially highly reactive, which can happen in certain states (e.g., in stress, emotional excitement, relevant appetites) and especially in some individuals (e.g., addicts). Incentive salience is an adaptive psychological response that is crucial to normal life. But sometimes it can go awry, in ways small or large, with consequences for well-being.

The ability to delay gratification in the face of temptation is thought to reflect the sensitivity of an individual's reward system. There frequently are moments of temptation in life for everyone, where temptations can sometimes drive individuals

to act in ways that may not best fit their needs. The brain's reward system is designed to make people usually want what they need, but given the right conditions they are prone to wanting in the absence of any need.

Most commonly, intense dissociations between wants and needs may occur when brain reward systems and the attribution of 'wanting' (incentive salience) become hypersensitive. This can happen to moderate degrees temporarily in ordinary life under conditions of appetite, stress, or emotional arousal. Greater degrees of hypersensitivity can occur in more extreme conditions, the most dramatic case perhaps being drug addiction. This is referred to as incentive sensitization and results from repeated assaults to our reward system by addictive substances such as drugs of abuse, highly palatable foods, repetitive gambling, or even chronic stress. Following sensitization of their reward system, an individual may be more vulnerable to the magnetic properties of reward cues, such as the smell of brownies or coffee brewing, the sight of a regular watering hole or a needle for an addict, or the flashing lights of a slot machine in a compulsive gambler. All of these cues will trigger powerful wants that are often separate from an individual's needs, and require the exertion of regular cognitive control to maintain behavior on an appropriate course. In most individuals this may mean merely having a second brownie when you know one was enough, or having another drink at the end of the night. In recovering drug addicts however, this may mean undermining the intention to stay drug free and potentially lead to relapse.

Drug Addiction, Recovery, and Relapse

Addiction may provide a potent example of how incentive salience can rise to compulsive levels in some individuals. Relatively few individuals are susceptible to the degree of elevation in 'wanting' high enough to produce compulsive addiction under typical conditions. For example, most adults have used a potentially addictive drug at least once in their lifetime, if caffeine, alcohol, and nicotine are included in addition to illicit drugs. Yet most do not become addicts. For those who do, none of these drugs satisfy a true need except

when an individual is in pronounced state of withdrawal. Addiction is characterized by compulsive drug seeking, an impairment of social and psychological functions, and/or damage to one's health. Addiction typically involves overwhelming involvement with the addictive reward, a loss of control, and a narrowing of interests. According to a 2010 survey, less than 10% of the US population met the criteria for chronic alcohol or drug abuse disorder, and an even smaller proportion suffered from chronic addiction (Substance Abuse and Mental Health Services Administration, 2011).

A chief problem in treating addiction is chronic or repeated relapse among those who are trying to quit. Even after prolonged periods of withdrawal and abstinence, a high percentage of addicted individuals in treatment programs eventually relapse to drug-taking. For example, in the case of a study of heroin users, relapse rates to reuse after cessation were approximately 60% within 3 months and at least 75% within 12 months (Hunt et al., 1971). For this reason, drug addiction is characterized as a chronic relapsing disorder; relapse is the rule rather than the exception, and often occurs repeatedly.

There are three conventional reasons frequently suggested in psychology and neuroscience to explain addiction and relapse: (1) *Drug Euphoria* – that addicts resume drug-taking to experience the intense pleasure (euphoria) they remember the drug producing; (2) *Overlearning Habits or Predictions* – drug-taking becomes such a well-entrenched habit that relapse is almost inevitable, or that learning becomes distorted in other ways to create false predictions about drug rewards (Everitt et al., 2008; Hyman et al., 2006); and (3) *Withdrawal Escape* – that the withdrawal syndrome that accompanies the cessation of drug intake is so unpleasant an addict would do anything to stop it, and so relapse occurs as an escape from withdrawal (Koob and Volkow, 2010). All three of these explanations certainly play a role in relapse. However, we believe they are insufficient to explain the central problem underlying relapse in addiction, for several reasons.

First, drug pleasure or euphoria certainly accounts for the initial pattern of drug use and abuse, but may have more difficulty accounting for relapse as tolerance can develop to the pleasure. Even addicts who do not find their drugs particularly pleasant anymore may experience increases in drug craving that persist a long time.

It also has been suggested by some learning-oriented scientists that the repeated use of drugs creates a learning disorder, such as making drug-taking an overly ritualized habitual act or creating false expectations of exaggerated reward. Ritualization may be true of the act of drug-taking, but cannot explain the preceding flexible acts of drug seeking during craving. And there is little reason to believe that addicts mispredict the reward value of their drugs, or the consequences of their actions. Learned habits or mispredictions alone cannot account for the excessive motivational attraction of addiction.

Finally, many addictive drugs surely do induce tolerance (when drug is present) and withdrawal (when drug is absent). Withdrawal is typically described as an intense negative emotional state accompanied by dysphoria, anxiety, and irritability, and may indeed be a potent reason why many addicts relapse and take drugs, at least while the withdrawal lasts. Yet withdrawal is a relatively short-lived phenomenon, and

decays substantially within days to weeks. By contrast, relapse frequently occurs even after withdrawal is no longer reported, and even in fully 'detoxified' addicts, months after 'recovery.'

In contrast to these suggestions, the Incentive Sensitization Theory (Robinson and Berridge, 1993) originally proposed an alternative explanation that can account for the persistence of relapse, and the independence of addiction from pleasure, withdrawal, or faulty expectations. It may also have applications to some addictions that extend beyond drugs, and proposes an explanation for the dichotomy that sometimes exists between wants and needs. The Theory proposes that relapse frequently occurs as a result of brain changes that lead to intense incentive motivation for drugs. These brain changes generate pulses of incentive salience or 'wanting,' often triggered by encountering drug cues, which may be experienced as feelings of drug craving or may even control behavior implicitly without need of strong conscious feelings. Craving occurs when the process of incentive salience (or core 'wanting'), mediated primarily by subcortical mesolimbic brain systems that use dopamine as an important neurotransmitter, is translated into conscious awareness. At its core, the motivation to take drugs is due to the overattribution of incentive salience to drug-related stimuli. It is important to note that incentive salience is a distinct psychological process from withdrawal and drug pleasure. In some cases, attribution of incentive salience to reward-predicting cues may make the cues 'wanted' as much as the reward itself, irrespective of whether the reward constitutes an actual need. Such cues become motivational magnets, sometimes prompting irrational behavior, such as interactions with the cue specific to those previously seen only during interactions with the reward itself (Davey and Cleland, 1982). As example of irrational cue attraction, crack cocaine addicts can be found inspecting the floor for a white speck that is more likely to be an ordinary pebble than crack cocaine, and can be attracted to pick it up, inspect, and put it in the pipe and even try to light or smoke the noncocaine pebble (a phenomenon that has been called 'chasing ghosts') (Rosse et al., 1993).

Incentive Salience and Utility

In applying incentive salience to daily life choices, it can be useful to consider such explanations in terms of forms of reward utility that are important to decision-making: predicted utility, decision utility, experienced utility, and remembered utility (Kahneman et al., 1997). All these forms of utility are critical in the process that determines whether a reward is truly needed, or if it is simply wanted. Predicted utility is an expectation of how much a future drug reward will be liked. Decision utility is the valuation of the drug manifest in choice and pursuit. Experienced utility is how much the pleasant drug is liked when actually taken. Remembered utility is the memory of how pleasant the drug was in the past. Experienced utility is considered the end point of the decision process. It is the state reached after successful attainment of a particular outcome, pertaining to the hedonic evaluation of that outcome. Experienced utility informs to some degree both remembered and predicted utility. However, other signals are needed in order for decisions to actually be made. The incentive sensitization theory suggests that only one of these, decision utility, of which incentive salience is one constituent, need to be distorted to create

a compulsive addiction. If decision utility fails to clearly distinguish between what is wanted and what is actually needed, then addictive and compulsive behavior is given the opportunity to proliferate, with behavior that is persistently guided by urges and cravings rather than cognitive goal-directed action.

Typically, decision utility is determined by predicted and remembered utility. However, predicted and remembered utility may fail to be a perfect representation of experienced utility, because hedonic memories can become distorted, such as when peak-end averages of a hedonic experience outweigh in memory the actual amount of pain or pleasure that was experienced (Kahneman et al., 1997). Drug addicts are also believed to often fail to accurately translate experienced utility into decisions (Bechara, 2005). In general, any distortion in memory or prediction that leads to faulty predictive utility will likewise affect decision utility, producing decisions that fail to maximize experienced utility of chosen outcomes.

However problems in excessive decision utility for addicts and some others facing strong cue-triggered temptations may remain even when their remembered utility and predicted utility for drug consequence are quite accurate. This is where there is a special role for incentive salience, because of the ability of brain mesolimbic systems to become especially highly reactive under some conditions (Berridge, 2012; Berridge and Robinson, 1998). Although 'wanting' typically coheres with 'liking' (hedonic impact) for the same reward, 'wanting' and 'liking' can be dissociated in certain circumstances and by some manipulations, especially those that specifically involve dopamine. Finally, 'wanting' can also be distinguished from learning and predictions about the same reward. For example, 'wanting' triggered by a Pavlovian reward cue can dramatically increase motivation for the reward, even if its previously learned value has not changed (e.g., in hunger, satiety, stress, or drug-related states). Abstinence from smoking for only 24 h can dramatically potentiate neural responses to smoking-related cues (McClernon et al., 2009). This also means that in instances where needs have been satisfied, wants may still occur, particularly when triggered by reward- or drug-related cues.

In this framework, incentive salience 'wanting' is a pure form of decision utility, which is distinct from other forms of utility and in some conditions can decouple from all the others (Berridge and Aldridge, 2008). That is, 'wanting' for an outcome is distinguishable from both experienced utility (hedonic impact or 'liking' the outcome), remembered utility of how nice the outcome was in the past, and anticipated or predicted utility of how nice it will be in the future. For incentive salience, under conditions of dopamine-related stimulation, situations exist where cue-triggered decision utility > remembered utility from the past, and similarly decision utility > predicted utility for future reward value. In other words, it is possible to addictively 'want' what is not expected to be liked, nor remembered to be liked, as well as what is not actually liked when obtained. All of these situations apply to rewards that are needed but become infinitely more problematic when they relate to rewards that satisfy no need and are purely wanted.

Such intense 'wants' may be triggered especially at particular moments, on particular encounters with addictive cues but not on other encounters with the same cues. According to the

incentive sensitization theory of addiction (Robinson and Berridge, 1993), attribution of incentive salience to a reward cue becomes exaggerated in addicts due to mesolimbic brain changes that are very long lasting (Paulson et al., 1991). Exaggeration can happen because incentive salience, which makes up part of decision utility, always results from the synergy between two sources: previously learned associations about the reward cue and the current brain state at the time of cue encounter (Berridge, 2012; Zhang et al., 2009). In the case of needs, that brain state can be driven by hunger, thirst, or even salt deficiency, but where drugs are concerned, the presence of drug-related cues or small amounts of the drug itself can spur powerful wants in the form of craving.

How dramatically can raising brain mesolimbic reactivity make 'wanting' detach from, and soar above, memories or learning-based predictions of value? So much so that even a repulsive learned cue for unpleasant sensations can become suddenly and intensely 'wanted' via the activation of mesocorticolimbic circuitry. This can sometimes be useful and meet adaptive needs, which is why the psychological process and brain mechanism of incentive salience evolved. For example, we have shown that rats which learned a revulsion toward a Pavlovian cue for unpleasant Dead Sea saltiness, will on their first reencounter with that cue in a novel salt-need state activate their mesolimbic circuitry in a way that generates intense 'wanting,' instantly transforming the cue into an attractive and powerful motivational magnet that is jumped on and gnawed (Robinson and Berridge, 2013). While adaptive in that case, similar powerful brain transformations may be recruited to varying degrees by addictive drugs, other motivational consumption disorders, and even ordinary emotional states that heighten mesolimbic reactivity to reward cues (including marshmallows). This cue/state transformation helps define what it means to say that addiction hijacks brain limbic circuits of natural reward. Finally, different individuals may be differentially vulnerable to such mesolimbic transformations that generate such moments of intense 'wanting.' Fluctuations in the temptation power for cues, which illustrates the difference between decision utility and predicted utility, hinge on the current neurobiological state factors related to dopamine at the moment of cue encounter. In particular, incentive sensitization suggests that craving and relapse are magnified by a sensitized neural system (mesocorticolimbic dopamine and related systems), which can flip into a super-reactive mode under several conditions. Those include especially states of stress, or if a person tries to 'just take one' hit of their addictive drug (that primes mesolimbic systems to react more powerfully to cues), or in other emotional states that heighten mesolimbic reactivity. At such moments, ordinary stimuli, such as cues associated with rewards, are transformed into potent incentive stimuli, making them attractive and able to trigger an urge to pursue and consume their reward. Under these situations, an individual is the most vulnerable to expressing wants that are most distally removed from true needs.

This type of synergistic modulation of 'wanting' is not limited to addicts. Everyone has experienced at least moderate pulses of incentive salience in their lives that are generated by similar rules. For example, advertisements that pop up on a Web page may prompt the finger to click onto the product. The smell of food as you walk down the street may make you

suddenly feel quite hungry, even if you were not feeling that way moments earlier. But the smell of food as a cue is not constant in its temptation power: if you really have not eaten all day you might find the aroma extremely tempting, whereas you would not if you have recently eaten. The essence of incentive sensitization suggests that addicts encounter fluctuations like this in the temptation power of their drug-associated cues, but that their maximal peaks of temptation are much higher than other people are liable to experience in daily life because of the enduring sensitization of their mesolimbic systems.

The basic mechanisms of the excessive attribution of incentive salience to drugs and drug-related stimuli can even occur as a mostly automatic and unconscious process, creating urges to take drugs whether or not a strong subjective feeling of craving is simultaneously present. Such dissociation between acted-on motivation and confusing subjective feelings is what often renders the compulsive quality of an addict's own behavior astonishing even to him or her. Here, unconscious wants would have the ability to override our cognitive pursuit of needs, sometimes emerging as a sense of loss of control.

Only 'wanting,' not 'liking,' becomes sensitized and consequently more intense on its own, as addiction develops. That is because 'liking' or pleasure has separable, and more restricted brain mechanisms (Berridge and Kringelbach, 2013; Smith et al., 2010). Thus elevated 'wanting' can detach from normal 'liking.' For example, in animal studies, sensitization increases neuronal firing in pathways that code incentive salience as well as the behavioral ability of reward cues to trigger frenzied bursts of effort to obtain the reward (Tindell et al., 2005; Wyvell and Berridge, 2001). Yet sensitization does not increase 'liking' reactions that reflect the hedonic impact of the reward when it actually arrives. Similarly, in humans who are becoming drug-tolerant addicts, incentive motivation to take the drug can grow as they become addicted, so that a single hit of drug can provoke intense urges to take more, even if the person reports the dose of drug no longer gives as much pleasure as initially.

Other Forms of Excessive Wanting Beyond Drugs

Binge Eating and Food Addiction

Beyond purely drug addiction, consequent incentive sensitization may also manifest itself by food bingeing, pathological gambling, hypersexuality, and other compulsive motivations. Unlike drugs, food fulfills a bodily need, yet it can still be wanted to excessive levels. Overeating is a chief cause of growing obesity trends. Could exaggerated 'wanting' or 'liking' play a role in some individuals? Excessive hedonic reactions to food would magnify both 'liking' and 'wanting' above that of a regular individual, thus contributing to binge eating and obesity (Berridge et al., 2009; Davis et al., 2009). Alternatively, changes in 'wanting' alone could be responsible for overeating. Sensitization of mesolimbic dopamine systems by exposure to cycles of bingeing alternating with dieting has been suggested to occur (Avena and Hoebel, 2003a,b). Enhanced sensitivity of the mesolimbic reward system could attribute high levels of incentive motivation to the sights and smells related to food and drive excessive consumption, without necessarily producing comparable levels of 'liking' when the food is itself consumed.

A different set of problems may face some other individuals, who have been suggested to have elevated 'liking' as well as 'wanting' that drives binge eating and overconsumption, and possibly deserve the label of food addicts (Davis et al., 2009; Davis and Carter, 2009). Notably Davis and colleagues have found that certain individuals who are both obese and binge eaters are far more likely to carry both alleles for a gene that codes a gain of function for mu-opioids, and another allele for a gene that may be associated with higher binding for the dopamine D2 receptor. Together these genetic traits have been suggested by Davis and colleagues to combine to simultaneously increase 'liking' and 'wanting' for foods in a manner that strongly promotes binge eating and gives rise to addictive like features, including loss of control and relapse. This may be a rare example where 'wanting' and 'liking' increase in tandem, making it exceptionally hard to adhere to levels of food intake that conform to physiological needs. Similarly, it has been suggested that individuals who carry genes promoting elevated dopamine function might experience stronger cue-triggered urges in response to food cues, making them more liable to develop obesity (Campbell and Eisenberg, 2007).

Conversely, it has been suggested that anorexia nervosa, involving a failure to eat, is related to a reward dysfunction that suppresses the 'wanting' for food despite leaving the 'liking' portion intact (as well as developing an abnormal 'wanting' for body perceptions of self as thin) (Keating et al., 2012). This could be interpreted as a case of insufficient 'want' that fails to achieve the motivation required to fulfill basic needs.

Gambling

Gambling might also involve special recruitment of incentive salience brain systems. Uncertainty may especially promote incentive salience under some conditions, which mirror many of the hallmarks of gambling (Anselme et al., 2013; Linnet et al., 2012; Lobo et al., 2010; van Holst et al., 2010). It has even been shown that not knowing how hard one must work to be rewarded may even sensitize the brain in ways similar to addictive drugs (Singer et al., 2012). This may produce a further example of the dissociation between experienced or remembered utility and decision utility. Individuals sometimes seem driven by cues to gamble, in all cases at a global monetary loss, for only a moderate experience utility. It seems that despite a conscious awareness that, for example, slot machine gambling will repeatedly end with a loss, showing a cognitive awareness that playing will fail to fulfill any monetary need, players want to gamble, sometimes expressly to satisfy an urge to play. Compulsive gamblers may also show other addictions (Zhang et al., 2009).

Consumer Behaviors

Even beyond addiction, situations may arise in everyday life in which incentive salience becomes particularly high to induce moments of strong decision utility to pursue or consume an incentive. Consumer goods can similarly be strong incentives influenced by powerful cues. Some situational factors, like being

in a store, might possibly increase how much consumer goods are 'wanted' while the extent to which they are 'liked' remains unchanged (Litt et al., 2010). Purchasing a product without actually 'liking' the product sufficiently to make the purchase under normal circumstances is likely to induce regret. Accordingly, Litt et al. (2010) suggested that 'wanting' and 'liking' for consumer goods can be driven in opposite directions, almost mimicking reports of drug addiction. When people experienced failure in pursuing desired outcomes (e.g., a 5\$ gift card), individuals showed increased willingness to pay for this reward, i.e., 'wanted' the reward more. However, these individuals also happened to 'like' the reward less in the sense that they were likely to more often trade it away for an equivalent prize (5\$ gift card from a similar store). Such instances show how consumer goods can be wanted more than they are needed. In cases of excessive consumerism or for people who display hoarding behavior, motivation to possess becomes tantamount and need becomes entirely irrelevant.

Summary

'Wanting' as a process and incentive sensitization helps explain fundamental problems such as addiction and, compulsive pursuits, as well as more mundane temptations such as a dangling marshmallow. In such moments of temptation, cognitive needs and intentions may be set aside either momentarily or sometimes more permanently, to satisfy intense cravings for incentives that are often more 'wanted' than they are needed. Incentive salience operates alongside more cognitive processes of planning and goals that may be aligned to meet major life needs. Often incentive salience operates in congruence with those needs, but not always. When 'wants' and needs diverge, temptations can arise of varied intensities. While temptation can be controlled, that control presents a challenge. Even an addict remains in principle capable of resisting temptation on any single trial, but in practice is likely to succumb to relapse if required to encounter a series of repeated temptations.

Powerful levels of 'wanting,' often in the absence of equivalent 'liking,' are not restricted to addictive drugs. The incentive sensitization theory potentially provides an explanation for why consumer goods and certain foods can also become excessively compelling incentives. In turn, ever-present cues, such as those incorporated in advertisements, can trigger potent 'wanting' peaks that propel susceptible individuals toward overconsumption of material goods and addiction-like disorders such as binge eating or gambling.

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