Scarcity begets addiction

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Abstract: As prototypical incentive with biological meaning, food illustrates the distinction between money as tool and money as drug. However, consistent neuroscience results challenge this view of food as intrinsic value and opposite to drugs of abuse. The scarce availability over evolutionary time of both food and money may explain their similar drug-like non-satiability, suggesting an integrated mechanism for generalized reinforcers.

In their discussion of the reinforcement power of money, Lea & Webley (L&W) use the biological value of food to distinguish between tools (useful to eventually obtain a biological incentive) and drugs (parasitizing the biologically meaningful incentive system). This opposition between intrinsically valuable food and addictive drugs of abuse, however, may be less innocuous than it appears on the surface.

As a source of metabolic energy, regulation of food intake could be expected to be controlled by the hypothalamus, the brain region that monitors and manages the neuroendocrine system, ultimately modulating the blood concentration of glucose. Instead, the subjective feeling of "hunger," as meant in the industrialized world, does not seem to correlate primarily with hypothalamic activity. Brain imaging showed that, in human subjects craving food after skipping one or two meals, it is instead the dopamine system that lights up (along with the orbitofrontal cortex), with an activation pattern similar to that recorded in drug addicts awaiting their fix (e.g., Pelchat et al. 2004; Volkow & Wise 2005). However, in subjects fasting for 36 hours, the hypothalamus does show increased activation (Tataranni et al. 1999). This protracted fasting period correlates with considerable metabolic changes and subjective reports nearly opposite to the feelings of people waiting to be seated at restaurants (depressed state as opposed to unrest).

A converging (if on the face unrelated) line of evidence indicates that caloric restriction significantly increases longevity in laboratory animals. In particular, rats whose daily caloric intake is limited to approximately 60% of ad libitum controls have a life expectancy about 30% longer (Hadley et al. 2001; Mattson 2005). If confirmed in humans, these findings would complement the recent recognition of obesity as one of the most lethal preventable diseases in the United States (Allison et al. 2001; Goldin 2005; Volkow & Wise 2005). Moreover, irregular diet (normal meals alternated with fasting periods) is more beneficial in rats than regular feeding (consistently light meals). Several mechanisms have been proposed to explain these observations, including reduction of oxidative stress, strengthening of the shock-absorber systems, and stimulation of growth factors (Mattson 2002; 2005; Mobbs et al. 2001). Taken together, brain imaging and caloric restriction studies invite the provocative hypothesis that humans with virtually unlimited access to food do not normally eat to gain a biological advantage, but rather because they are addicted to food.

Now let us consider barter, which operates on the principle of mutual advantage (McCabe 2003): each party has something the other wants, and, by trading, both parties can be made better off. The tool theory of money emerges from the observation that the value from barter can be greatly expanded by using money to (1) reduce the search costs of finding a potential trading partner, (2) reduce the default risk of trading with a partner by getting money in return, (3) define the relative value of goods and services by pricing them in terms of money, and (4) allow greater specialization of human activity (North 1990). However, money can lose value either through oversupply, as when governments print money to cover their debts, or in competition with other monies, as seen in international exchange rate fluctuations.

In experiments, people continue to trade money (McCabe 1989) even when it is losing value, thus providing evidence that money itself is seen as valuable (consistent with the money as drug hypothesis). A plausible explanation is that even as money itself loses value, the barter it is producing continues to be valuable. So the built-in desire for money may be a secondary reinforcer for barter. The anticipation and realization of earning money is known to activate the same dopaminergic pathways as drugs and other rewards (Knutson et al. 2001b), and contingent management strategies use monetary rewards as a substitute for drugs in drug treatment programs (Higgins et al. 2000).

Food and barter exchange have interesting correlates in that both were scarce (meaning hard to obtain) over evolutionary time, and yet both contributed strongly to the inclusive fitness of humans. Because they were scarce, it is reasonable to assume that the biological system would recognize them as rewarding. As suggested by reinforcement learning models (Sutton & Barto 1998), it is important to encode these rewards (including money as a secondary reinforcer for barter) as values, which can then act as inputs into the actor-critic circuitry in order to learn experientially about better action sequences. Since the ecology makes the future availability of these rewards uncertain, it seems advantageous that the value systems associated with seeking behavior would evolve as non-homeostatic and non-satiable (i.e., linear or non-depreciated) and thus have drug-like properties.

Paradoxically, then, the dopaminergic system underlying drug addiction might have evolved precisely to incentivize mammals, whenever possible, to eat above and beyond the minimal, and in fact ideal, amount of food. Offsetting this impulse must then be inhibitory systems of control, which seem to be more variable across humans. Scarcity thus constitutes a powerful evolutionary explanation for the addictive feature of money, food, and in fact any scarcely available generalized reinforcer.

Research suggests that there are two systems competing for behavioral control. The first system locks in behavioral responses to predicted rewards using temporal difference learning (Shultz et al. 1997). This system allows for habituation and may be the primary route for a drug theory of money. Much of the processing in this system involves the dopaminergic neurons in the striatum (O'Doherty et al. 2004). The second system uses contingent goals to build the value of representative pathways for decision-making, and may be the primary route for a tool theory of money. Much of this processing occurs in the prefrontal cortex (Cohen et al. 2000). Recent theories attempt to explain the arbitration of these two reinforcement learning systems (prefrontal and striatal) in terms of the cost/benefit ratio of each system in different circumstances. Such models can help clarify the neurobiological bases of the tool–drug distinction (or at this point, integration), and at the same time extend it to the broader domain of reinforcement learning with scarce resources.

The desire to obtain money: A culturally ritualised expression of the aggressive instinct

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Abstract: Social behaviour is but an expression of instinctive mechanisms whereby the aggressive instinct is of particular importance, having given rise to most of the complexity of social behaviour through processes of phylogenetic and cultural ritualisation. The role of the aggressive