The Multiple Facets of Cigarette Addiction and What They Mean for Encouraging and Helping Smokers to Stop

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ABSTRACT

Addiction involves powerful motivation to engage in an activity repeatedly to an extent that is harmful often accompanied by impaired capacity for self-control. To effectively combat addiction to cigarettes requires an understanding that there are several mechanisms underlying it. The PRIME Theory of motivation aims to provide a model that can encapsulate these mechanisms. It recognises that evolution has led to multiple levels of motivation from basic impulses and inhibitions, through 'motives' (feelings of want and need), to 'evaluations' (beliefs about what is good or bad), and plans (intentions regarding future actions). Self-control involves self-consciously generating motives from evaluations or plans; it requires and depletes mental energy. Nicotine from cigarettes generates the motivation to smoke and undermines self-control by interacting with all of the level of motivation. It: creates stimulus-impulse associations resulting in cue-driven urges; impairs inhibitory control; gives enjoyment resulting in 'wanting' to smoke; it leads to 'nicotine hunger', withdrawal symptoms and beliefs about benefits of smoking (e.g. stress relief) all of which can result in a 'need' to smoke. Evidence is emerging that wanting to smoke (because of enjoyment) is a major deterrent to making quit attempts but does not influence success, while cue-driven impulses to smoke, nicotine hunger and adverse mood and beliefs about the benefits of smoking are important in relapse. Combating cigarette addiction requires attention to all of these factors.

INTRODUCTION

It is now widely acknowledged that cigarette smoking is addictive and that the main reason for this is that it delivers nicotine to the brain in a convenient, flexible way that allows smokers to control the dose they receive (1). However, this addiction has many facets and understanding these is important when determining how best to encourage and help smokers to stop. This paper examines these various facets and their implications.

UNDERSTANDING HUMAN MOTIVATION: PRIME THEORY

Understanding the multiple aspects of addiction requires an understanding of human motivation. Many people conceptualise human motivation in terms of decisions to do or not do things based on an analysis of their costs and benefits (2). However, it is clear that much behaviour is driven by habit or instinct in which one just responds without thinking about the consequences (3) and often our actions are driven by feelings of desire rather than judgements about what would be the best option (3).

Moreover, it is apparent that we sometimes do things because we planned to do them or have rules about them and do not have to weigh up the costs and benefits each time (3). Our capacity and skills at achieving self-regulation based on rules we impose on ourselves is a major factor in achieving life goals (4). We need
a model of human motivation that encapsulates these different aspects of motivation: automatically generated impulses and inhibition, feelings of desire, beliefs about what is for the best, pre-specified plans, rules or intentions and our capacity for self-regulation. This model should be usable by non-academics to explain and predict behaviour and to generate and test ideas for interventions.

The PRIME Theory of motivation aims to provide such a model, using concepts and terms that are as close as possible to those in everyday use (5). It proposes that evolution has led to a multi-level motivational system in which new, higher levels of flexibility have been added on to older ones but have to work through the latter to influence behaviour.

Thus, at the lowest level, all animals, including humans, have built-in systems for generating reflex responses to particular stimuli. These responses are fixed and cannot take account of competing demands. For increased flexibility and adaptation a second level has evolved for most species in which stimuli generate ‘impulses’ to act in particular ways and ‘inhibitions’ to stop the animal from doing things that are harmful or which conflict with other activities. Thus an animal faced with competing impulses and inhibitions responds according to which of these is strongest. The links between stimuli and these impulses and inhibitions may be hard-wired (in what we call instincts) or learned (in what we call habits). This second level of motivation provides more flexibility and potential for adaptation than simple reflexes, but behaviour is still driven by stimuli without any regard to the possible future outcomes—it is automatic. This response system is fast but responses are relatively fixed in response to specific stimuli.

The development of the mammalian cerebral cortex has evolved to permit a further level of flexibility and a third level in the motivational system: the capacity to form mental representations of possible future outcomes and for these to act as stimuli generating impulses and inhibitions. It is clear that many, if not all, mammals (and certainly humans) have the capacity to experience positive and negative feelings and they show every evidence of being able to respond flexibly to achieve or avoid these. As humans we talk in terms of pleasure or satisfaction and pain or discomfort. Being able to form such mental representations provides the opportunity for ‘goal directed’ behaviour. The mental representation of a goal, and feelings of anticipated pleasure or satisfaction on the one hand and relief from discomfort on the other generates what may be called ‘motives’: feelings of ‘wanting’ (in the case of anticipated pleasure or satisfaction) or ‘needing’ (in the case of anticipated relief). In everyday language we often use the term ‘desire’ to refer to these feelings of want or need.

Wants and needs seem to be central to goal directed behaviour. We want things that we imagine will give us pleasure or satisfaction and we need things that we imagine will give us relief. Like other mammals, we do not have to be able to verbalise these feelings to act on them—they simply act as triggers for impulses and inhibitions. These feelings come about through stimuli that, through association, bring to mind the images of the goals concerned.

The fourth level of motivation is intimately tied up with our capacity for language. Uniquely among species, humans have developed this symbolic form of mental representation that involves propositions. This gives us the capacity to form ‘beliefs’ which adds yet a further level of flexibility to our motivational system. Beliefs have two advantages: 1) they can be communicated and 2) they can form the basis for reasoning. Some of these beliefs involve value judgements: notions of ‘beneficial versus harmful,’ ‘pleasing versus displeasing,’ ‘morally right versus morally wrong,’ etc. These can be called ‘evaluations’.

Thus we can be told about, or use reasoning to arrive at, evaluations which can then influence our actions. It appears to be the case, however, evaluations can only motivate behaviour if they generate wants or needs. In other words, just believing that something is good or bad is not motivating—it has to generate feelings. It does this by creating a mental image that involves anticipated pleasure or satisfaction or anticipated relief. So the belief that smoking can lead to lung cancer will have no influence on our actions unless it generates an image in our minds that causes discomfort and another of a course of action that relieves this feeling.

Thus far, four levels of motivation have been identified: responses, impulses and inhibitions, motives, and evaluations. Humans have also evolved the capacity to plan ahead; we can form mental representations of possible actions and develop an intention to undertake them. These ‘plans’ add a further level of flexibility and adaptability to our behaviour. Thus, we can anticipate future demands or opportunities. When confronted with competing demands or opportunities that are not time critical we can also attend to the one that we judge to have the greatest immediate priority and form a plan to undertake competing actions later.

Because humans usually have many competing priorities and occupy an environment in which pre-specification and timing of actions is critical, plans govern our lives to a considerable degree. They form an overarching structure for our day-to-day activities. Degree of commitment to a plan appears to be important in whether it is executed. This can be thought of in terms of the extent to which it generates sufficiently strong wants or needs to overcome any others that might conflict with it when the time for action arises.

It appears, therefore, that to understand human motivation we have to recognise that it involves multiple levels of varying flexibility, with the more flexible levels having to operate through less flexible ones. Figure 1 shows this schematically.

A common feature of human motivation is the exercise of ‘self-control’ (4). In terms of PRIME Theory, this involves a sense of self or identity that creates ‘rules’ (types of plan) which can generate motives (wants and needs) from evaluations (beliefs about what is good or bad). Thus, the belief that smoking is harmful does not usually in itself stop someone from smoking but occasionally it causes the smoker to want or need self-consciously to form a rule not to smoke (‘I must not smoke’) or to cut down on smoking (‘I must reduce the amount I smoke’) which then generates the want or need not to smoke. An important feature of the exercise of self-control is that it requires and
that structure. The nucleus accumbens consists of a core and shell. Dopamine release in the core appears to act to generate stimulus-impulse associations (10, 11).

The stimuli preceding the behaviour that led to the dopamine release generate the impulse to repeat this action. This does not require any positive feelings to be experienced. Thus nicotine taps directly into one of the most basic levels of human motivation generating the impulse to smoke in the presence of smoking cues (12). This impulse does not require any anticipated pleasure, satisfaction or relief. Thus smokers can feel urges to smoke in the presence of smoking cues that seem to arise without any obvious reason or anticipation of pleasure from smoking.

There is also emerging evidence that during nicotine withdrawal smokers have impaired functioning of the low-level brain mechanisms that underlie inhibition (13). This means that smokers trying to stop, not only experience the impulse to smoke in the presence of smoking cues, but also have a reduced capacity to inhibit this action. This increases the likelihood that smoking cues will lead to a lapse and then relapse.

**Motives**

The binding of nicotine to receptors in the ventral tegmental area (VTA), aside from generating the impulse to smoke by virtue of dopamine release in the core of the nucleus accumbens, results in pleasant sensations because of dopamine release in the nucleus accumbens shell (11). This makes the act of smoking enjoyable, hence makes smokers want to smoke. It appears that this rewarding effect is enhanced by the fact that other stimuli such as the sensation of smoke in the throat are closely paired in time with the nicotine reward (14).

Recent research has also found that nicotine can act as what might be termed a ‘pleasure amplifier’. It can make mildly pleasurable stimuli more rewarding (15). Thus the sweet smell of the tobacco, the aesthetics of the cigarette pack and even the other activities associated with smoking become more pleasant with nicotine present in the brain. This in turn can make smoking more rewarding and lead smokers to want to smoke.

Chronic nicotine ingestion from cigarettes also leads to chronic functional changes in several parts of the brain that lead smokers to feel a need to smoke—to relieve a kind of ‘nicotine hunger’. Thus while nicotine acutely increases the release of dopamine in the nucleus accumbens, after chronic use there appears to be abnormally low levels of dopamine released when central nervous system (CNS) nicotine concentrations are depleted (16). This low level of dopamine release appears to underlie a feeling of needing to smoke. It creates an acquired drive to smoke. The strength of this can be usefully assessed by recording how soon after waking the smoker first lights up a cigarette (17, 18).

In addition to this, chronic changes in the CNS lead to unpleasant withdrawal symptoms (irritability, depressed mood, anxiety, restlessness, difficulty concentrating and increased appetite) that make the experience of not smoking aversive and generate the need to smoke (19, 20). Of these, depressed mood early on in the quit attempt appears to be the one most strongly
associated with relapse (19) but persistence of many of the adverse symptoms also appear to lead to relapse (21). Smokers also experience a reduced capacity to gain enjoyment from and be rewarded by other stimuli, which probably results from a rebound of the effect of nicotine in acting as a pleasure amplifier, as described earlier (22).

**Evaluations**

Smokers readily form beliefs about the benefits of smoking. In particular, they believe that it helps to control stress (23). They also believe that it is enjoyable, helps with weight control and aids concentration (23). These beliefs will lead the smoker to want or need to smoke at times when circumstances make them relevant (e.g., at times of stress). Thus, a smoker who feels miserable and wants to be 'cheered' up, or who is stressed and needs to feel better will on those occasions experience a want or need to smoke (24). This may occur many months and sometimes years after having stopped smoking. If, at the same time, that individual has low reserves of mental energy or a weakened motivation for self-protection, the self-imposed rule of not smoking may not be sufficient to prevent the behaviour.

When this occurs, clinical experience suggests that the individual often does not intend to resume smoking permanently but only long enough to address the particular need at that time. However, once the cigarette is smoked, it rekindles the other sources of motivation, including the stimulus-impulse associations and the ‘nicotine hunger’, this leads over a period of time to full resumption of smoking.

**Self-control**

Stopping smoking almost always requires the exercise of self-control. There are many occasions on which the urge, want or need to smoke must be countered by want or need to follow the self-imposed rule that smoking is not permitted. Having attempted to stop and failed in the past few weeks or even months is strongly associated with failure of a subsequent quit attempt, even controlling for other measures of addiction (25). Although there may be a number of reasons for this, one obvious one is that it often requires a long period of recuperation during which reserves of mental energy is restored. It has also been found that chronic financial stress (26) and depression (19), which deplete mental energy are associated with greater risk of relapse. On the other hand one study has found that successfully overcoming urges to smoke may build capacity for self-control (27).

**OVERCOMING ADDICTION TO CIGARETTES**

**The process of smoking cessation**

Overcoming addiction to cigarettes involves a) making a serious quit attempt and then b) maintaining abstinence in the face of motivation to smoke coming from multiple sources. In terms of PRIME Theory, the process of smoking cessation therefore involves: forming a personal rule not to smoke followed by self-conscious implementation of that rule in the face of impulses, wants and needs to smoke.

Smokers will form that rule when at the precise moment they:

- have the idea of making the rule and
- this idea feels more attractive than the idea of continuing to smoke.

In approximately half the cases where this occurs, there is no pre-planning: the smoker implements the quit attempt as soon as the decision is made (28). In other cases, the smoker defers implementation, usually for just a few days, for example to give time to prepare mentally or practically for what is ahead.

The intention to stop is quite variable and stimulus dependent (29). This means that smokers can be prompted to make quit attempts who were not thinking of doing so beforehand (30). They will also accept the oﬀer of help and many will go on to succeed (30).

PRIME Theory predicts that the nature of the not-smoking rule may have a major bearing on the outcome of the quit attempt. If the rule is that the smoker will ‘try not to smoke’, it would be expected that it would not generate sufficiently strong motivation on all relevant occasions to prevent smoking. On the other hand, if the rule is that smoking is not permitted at all, the boundaries are more clearly defined and the inhibition of smoking will be more powerful and consistent. However, for the rule to be able to generate sufficiently strong wants or needs to inhibit smoking, it needs to be linked to what might be termed ‘deep identity’: self-ascribed labels and attributes to which the individual is emotionally attached.

According to PRIME Theory, therefore, the process of smoking cessation can be encapsulated in a simple 4-state model in terms of the rule that is in operation (Figure 2):

1. Smoking (no rule),
2. Not smoking (I do not smoke),
3. Attempting to stop (I am trying not to smoke), and
4. Planning to stop (I have made a definite plan to stop in the near future)

Transitions can occur suddenly between any state and any other state, depending on the momentary balance of wants and needs. There is evidence emerging that wanting to smoke (enjoyment of smoking) deters quit attempts while needing to smoke (anticipated relief from nicotine hunger) and cue driven impulses to smoke (experienced as ‘urges’) lead to relapse after the quit attempt has been started (18, 24). Enjoyment of smoking, leading to ‘wanting’ to smoke does not appear to be a major factor in relapse (31). If the would-be ex-smoker is able to maintain complete abstinence cue-driven impulses to smoke, nicotine hunger and withdrawal symptoms decline, presumably as the brain recovers its normal functioning. The effect is substantially reduced risk of relapse with each week of abstinence that passes (32).

Very commonly, the momentary motivation to smoke exceeds the motivation not to and a lapse occurs. Anecdotal evidence
suggests that usually the smoker does not decide to go back to smoking permanently but merely to suspend the rule. However, in practice the lapse does usually lead eventually to full relapse. There is some evidence that this is mediated by the extent to which the cigarette is found to be satisfying (33). In the early stages following the quit attempt, cue-driven urges to smoke and the need to smoke will dominate. Late relapse may involve continuing impulses and needs in a minority of heavily addicted smokers, but it also appears that beliefs that smoking helps relieve stress can provoke relapse, presumably in response to stressful events (24).

**Principles underpinning effective smoking cessation interventions**

Given all of the above, one can begin to build a more comprehensive set of principles for clinical interventions to help smokers to overcome addiction to cigarettes. These would include:

1. generating repeated quit attempts by offering help with stopping to all smokers and not preceding this by asking smokers whether they are interested in stopping;
2. spacing quit attempts at least a few months apart;
3. specifying the quitting process as a clear ‘not a puff’ rule after a definite quit point, and emphasising the importance of, and rationale for, this rule at every opportunity;
4. being prepared to provide assistance to smokers who have quit without planning and who subsequently need support;
5. using nicotine replacement therapy (NRT) prior to a quit attempt partially to extinguish associations between smoking and nicotine reward (34). With nicotine from the NRT competing with nicotine from cigarettes for the receptors, one would expect a partial dissociation between the act of smoking and its effects in the nucleus accumbens. This would explain why using nicotine patches for 2 weeks prior to the quit date appears to improve long-term abstinence rates (34);
6. using medication (35) to address the need to smoke arising from ‘nicotine hunger’ and to block the rewarding effect of nicotine if a lapse occurs. Medications that have been shown to substantially improve smokers’ chances of achieving long term abstinence are nicotine replacement therapies (NRT), bupropion, varenicline and nortriptyline (36–38). These appear to work by reducing the need to smoke and cue driven impulses. Bupropion and varenicline also reduce the satisfaction from the cigarette smoked if a lapse occurs (35);
7. using medication such as fast acting forms of nicotine replacement therapy (12, 39) to reduce cue-driven impulses to smoke;
8. using strength of, and time spent with urges to smoke (as measures of nicotine hunger and cue driven impulses), and time to first cigarette prior to the quit point as pre-quit measures of the strength of addiction to help guide choice of treatment (18);
9. using strength of, and time spent with, urges to smoke and presence of withdrawal symptoms and self-efficacy after the quit point to gauge progress and assess whether treatment is still required (40–42);
10. using behavioural support to sustain motivation not to smoke, to develop a strong identity that excludes smoking, to develop skills for avoiding, escaping from or coping with urges to smoke, to maximise self-regulatory capacity and skills, and to optimise use of medication.

**CONCLUSIONS**

Bearing in mind the multiple levels at which human motivation can operate, we can think of addiction to cigarettes as involving multiple sources of motivation to smoke:
1. wanting to smoke for the enjoyment acting to deter quit attempts;
2. cue-driven impulses to smoke, needing to smoking because of ‘nicotine hunger’ and adverse withdrawal symptoms, reduced self-regulatory capacity, and functional beliefs about smoking (particularly its capacity to reduce stress) leading to lapse and then relapse.

Helping smokers to overcome their addiction then involves:

1. prompting quit attempts by offering help to all smokers without necessarily asking whether they are interested in quitting;
2. assessing each of the factors undermining success before and during the quit attempt and adjusting treatment parameters to take account of continuing problems of motivation to smoke and self-regulatory capacity;
3. using medication and behaviour support to address all levels of the motivational system: countering motivation to smoke, maximising motivation not to smoke, and maximising self-regulatory capacity and skills;
4. applying this for as long as is necessary in a given quit attempt and in the event of relapse, reapplying the treatment after a period which allows for recovery of reserves of mental energy.

Declaration of interest

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