Tanning as an addictive behavior: a literature review

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Summary

Background: Recent studies have identified reinforcing properties associated with tanning and suggest a possible physiologic mechanism and addiction driving tanning behavior.

Objective: This article attempts to synthesize the existing literature on tanning and addiction to investigate possible associations.

Methods: We investigated a variety of substance dependence models to define what constitutes dependence/addiction and to determine how current studies on tanning meet these criteria.

Results: In some individuals, tanning has met Diagnostic and Statistical Manual criteria for a substance-related disorder or tanning-modified Cut Down, Annoyed, Guilt, Eye-opener criteria. Trial studies have demonstrated the induction of withdrawal symptoms in frequent tanners.

Limitations: Additional studies are needed to investigate the associated dependency and addiction more fully and to elucidate its similarities to other better-known addictive syndromes.

Discussion: Tanning is a problem behavior, both as a health risk and as a possible dependency. Future studies, especially in the area of cognitive mapping and cue-related stimuli are needed. Imaging studies may be important in elucidating whether the same areas of the brain are involved in tanning addiction as in other addictive syndromes.

Tanning as a problem behavior

The incidence and prevalence of skin cancer exceeds all other types of human cancer and is rising at an alarming rate (1). Exposure to ultraviolet (UV) radiation, particularly during childhood, is the primary preventable risk factor for the development of melanoma and non-melanoma skin cancer (2). Despite ongoing efforts to educate the public on health risks associated with exposure to UV radiation (such as sunburns, skin cancer, photodamage/photaging, alteration of the immune system, photoinduced medication reactions, and ocular disorders), recreational exposure to UV radiation continues to increase (3, 4). Frequent tanners are more knowledgeable about skin cancer risks than are non-frequent tanners (5, 6). It appears that other factors may contribute to people’s tanning behavior.

Studies suggest physiological preference for UV and suggest dependency

Many tanners maintain that their motivation for tanning relates to their esthetic preference for a tanned appearance (6). However, a number of recent studies suggest that tanning behavior may be motivated, at least in part, by a type of UV light substance-related disorder (SRD). That is, repeated use of UV light may lead to a behavior pattern characteristic of other types of substance use disorders. One recent study used a double-blind, controlled study to determine whether a physiologic preference for UV light compared with non-UV light exists. Frequent tanners were found to exhibit an overwhelming preference (95%) for UV-emitting tanning beds, suggesting that UV tanning might have reinforcing properties (7). A recent survey study which aimed at determining whether indoor tanning leads to dependency revealed that factors related to other addictive behaviors, such as age of initiation and frequency of use, correlated with difficulty quitting tanning (1). These parallels are thought to support the hypothesis that indoor tanning can lead to dependency.

UV light-induced production of cutaneous endorphins, a form of endogenous opioids, may be involved in the reinforcing property of tanning (8). A study on the effect of opioid antagonism, in the form of naltrexone, revealed diminished preference for UV light and the induction of withdrawal symptoms in frequent tanners (8). Other studies failed to substantiate these results, showing no discernable association...
between exposure to UV light and the induction of cutaneous endorphins (9–11). Further investigation into this area may be necessary.

Recent studies involving the role of tumor-suppressor protein p53 in stimulating α-melanocyte-stimulating hormone and pro-opiomelanocortin (POMC) provide a potential biochemical mechanism for tanning dependence (12). UV light-induced p53 expression stimulates the POMC promoter, thus increasing levels of two POMC derivatives: the endogenous opioid, β-endorphin, and adrenocorticotropic hormone (ACTH) (12). These molecules may contribute to tanning behavior by exerting an anti-inflammatory effect, thus alleviating irritation and local inflammation associated with exposure to UV light (12). Other studies demonstrate that UV light tanning relieves pain (13). The accumulated evidence suggests that there may be a physiological basis, dependence on opioids, for tanning behaviors.

Another study used American Psychiatric Association Diagnostic and Statistical Manual (DSM-IV-TR) (14) modified criteria and a modified Cut Down, Annoyed, Guilt, Eye-opener (CAGE) (15) Questionnaire to evaluate whether UV light tanning constitutes a type of SRD (15). Of the 145 beachgoers interviewed and evaluated, 26% met the modified CAGE criteria for tanning SRD and 53% met modified DSM diagnosis for tanning SRD, suggesting that repeated exposure to UV may result in the development of SRD (15).

The purpose of this review is to synthesize existing literature on SRDs to identify what constitutes dependence and addition, what types of assessments are required to diagnose addiction, and how the current data on tanning meet those criteria, in order to facilitate dermatologists understanding and further study of UV tanning and its relation to addictive behavior. ‘Addiction’ is a complicated phenomenon that is not simply defined. We will first describe various models defining addiction, then we will describe studies used to assess whether a substance is addictive. Finally, we will assess the current evidence of the addictive properties of tanning and what additional studies may be helpful.

**Methods**

**Drug dependence models**

Existing models defining drug dependence fall into four main categories: social learning and cognitive models, pharmacological models, behavioral models, and DSM-related models. Social learning and cognitive models investigate how certain concepts, such as outcome expectancy, situational factors, coping skills, and self-efficacy, relate to drug dependence. Pharmacological models utilize tolerance, withdrawal, and physiological and psychological dependence to define drug dependence. Behavioral models emphasize substance-seeking behavior and pathological use patterns associated with drug dependence. The DSM model is focused on providing a pragmatic dichotomous assessment on whether an individual has a SRD.

**Social learning and cognitive models**

Outcome expectancy refers to the belief that a given behavior will lead to a certain positive outcome. The development of expectancy networks is unconscious and automated and can be viewed as contributing to the loss of control, experience of cravings, and difficulty quitting associated with drug dependence (16). Thus, the nature of an individual’s expectations and the pattern of expectancy activation (automaticity) might provide a useful measure of substance dependence. The use of implicit memory tasks and placebo tests may be useful in assessing the unconscious, automatized component of cognitive expectancy networks and in differentiating between pharmacological and expectancy-based effects of substance use (16).

Self-efficacy refers to the perception of whether an individual can execute a given behavior or attain a certain goal (16). In the context of substance abuse, self-report measures of self-efficacy usually assess an individual’s confidence in their ability to abstain from substance use (abstinence self-efficacy) (16). There should be an inverse relationship between abstinence self-efficacy and development of substance dependence (as one becomes more dependent on substance use their confidence in ability to abstain decreases) (16). Coping models of substance abuse maintain that individuals use substances to deal with the stress of their lives (16). In fact, stress has been identified as a major risk factor for all phases (initiation, escalation, maintenance, and relapse) of substance use (16). Drug use may help individuals cope by enhancing positive affect, diminishing negative affect, providing distraction or escape, and increasing performance (16). Additionally, avoidant coping mechanisms and lack of self-control are risk factors for substance abuse.

An observation common to many types of drug use and abuse is that environmental stimuli, such as drug-paraphernalia, frequently evoke feelings of craving in addicts. Self-report and physiological studies of cue-reactivity of drug-related stimuli in cigarette smokers, alcoholics, and heroin and cocaine addicts support this finding (17). Other models emphasize the ease with which certain drugs are obtained as playing a role in the development of patterns of drug use. Such models maintain that drug use can become automatized if easily obtained or as a function of repeated use (16).

**Pharmacologic model**

According to the pharmacologic model of substance there are two distinct concepts used to describe substance dependence: physical and psychological. Physical dependence refers to the physiological need for a drug, which results due to alteration of homeostatic set-points that adjust to compensate subsequent to multiple episodes of drug use (18). Withdrawal symptoms and tolerance are two hallmarks of most physical dependencies. Tolerance is a form of neuroadaptation, which develops after repeated drug use and in which increasingly larger doses, or concentrations, of a drug are required to achieve the desired effect (19). Withdrawal symptoms refer adverse, physical effects opposite those induced by the drug that result when a drug is...
withheld (or the quantity is reduced) (16). Psychological dependence involves the affect of a drug on the brain’s reward system and is a more subjective measure (20). This interaction typically produces pleasurable sensations or well-being that encourage the user to repeat drug use (18, 20). Discontinuation of drug use may lead to intense cravings and dysphoria due to alteration and compensation in the brain’s reward system subsequent to repeated exposure (18).

Historically, it has been thought that addiction and dependence result from the desire to avoid unpleasant effects of physical and psychological withdrawal. However, recent observations have suggested that repeated drug use produces measurable changes in the brain’s reward system or memory system related to experience of rewards (19). The development of physical dependence is usually associated with mechanisms that produce pharmacodynamic tolerance, such as changes in drug-receptor interactions or alterations in cellular signaling pathways (19).

The mechanism of psychological dependence is thought to revolve around the interaction of a tonically inhibitory GABAergic system and a reward-producing dopaminergic system (18). Under normal circumstances, GABAergic neurons tonically inhibit dopaminergic neurons that originate in the ventral tegmental area and project to the nucleus accumbens (20). Exposure to various drugs results in an increase in the amount of dopamine in the nucleus accumbens, and this mechanism is responsible for the rewarding property many drugs of abuse. The mechanism of opioid-induced reward is of specific interest to this study, because endorphins are a type of endogenous opioids and it is hypothesized that their production during UV tanning is responsible for the rewarding properties of tanning. Opioids exert their rewarding effect by inhibiting inhibitory GABAergic neurons that synapse in the ventral tegmental area thus increasing release of dopamine in the nucleus accumbens (18).

Behavioral model

Not all substances of addiction are associated with the development of physical dependence, so a behavioral model emphasizing substance-seeking behavior and pathologic use patterns may add further depth to defining and understanding SRDs. Currently accepted behavioral models of substance abuse identify the presence of positive reinforcing properties, the ability to discriminate the substance of abuse from other substances, and the association of substance-related cues with substance-use (19). A variety of psychodynamic, genetic, and neurochemical factors also play a role in substance abuse and dependency. The broader biopsychosocial model of addiction defines it as a “complex, progressive behavior pattern having biological, psychological, sociological, and behavioral components” (21). What differentiates addiction from other behaviors is the pathological involvement with it and/or inability to exert control over it, which results in the continuation despite adverse impact on the individual (21).

DSM criteria for SRDs

According to the DSM-IV (14), substance dependence is diagnosed by the presence of three (or more) of the following symptoms in a 12-month period: tolerance (identified by markedly increased amount of substance to achieve desires effect or significantly diminished effect with repeated use of the substance), withdrawal (defined by the presence of substance-specific withdrawal syndrome or the administration of a similar substance to avoid such symptoms), substance use greater in quantity or for longer duration than intended, repeated or unsuccessful efforts to decrease substance use, inappropriate or excessive allocation of time to obtain substance or to recover from effects of substance, and reduction of social, occupational, or recreational activities due to substance use, and use of the substance despite knowledge of harm (14). The DSM allows for the distinction of whether physiological dependency is present. Desired or unsuccessful efforts to decrease substance use may be particularly relevant to tanning, because many tanners tan in excess of what is needed to achieve or maintain a tanned appearance. Use of the substance despite harm is also especially relevant to tanning, because knowledge (and, in many cases, experience) of adverse health consequences associated with tanning do not seem to deter individuals from engaging in this behavior. Withdrawal may be of specific interest, because initial studies on tanning suggest that withdrawal symptoms occur in some frequent tanners, though a relationship of tanning to avoidance withdrawal has not been established.

Other models

There are a variety of other models, including those related to body dysmorphic disorder (BDD), obsessive-compulsive disorder (OCD), impulse control disorders, and seasonal affective disorder (SAD), which may offer an explanation for or insight into tanning behavior.

BDD

For a certain subset of individuals who tan, indoor tanning may constitute a form of BDD. According to the DSM-IV-TR, BDD is defined as a pre-occupation with a perceived defect in appearance causing clinically significant distress or impairment (14). That is, these individuals may be motivated to tan/darken their skin color due to a pre-occupation with an imagined defect in appearance (or being too pale or of not being tan enough). In a study examining the association between tanning and BDD, it was found that 25% of subjects engaged in BDD-related tanning and that for 84% of these individuals, the skin was the most common area of concern/pre-occupation (22). Additionally, all tanners reported experiencing functional impairment related to BDD; 26% of these individuals attempted suicide and the overall quality of life was poor (22). In another study of patients seeking dermatology treatment, 11.9% of patients screened positive for BDD (23). These findings offer an alternative explanation for tanning motivation and behavior in some
individuals and may suggest possible therapeutic interventions. Screening tests, such as the Body Dysmorphic Disorder Questionnaire-Dermatology Version or the Dysmorphic Concern Questionnaire, may be helpful in identifying these individuals and in guiding their treatment (SSRIs and cognitive behavioral therapy) (24, 25).

OCD
In some circumstances, tanning practices may represent a form of OCD. OCD is characterized by obsessive, intrusive thoughts, and associated compulsions, which are carried out in an attempt to reduce anxiety related to the obsession. Thus, tanning practices may represent obsessions, compulsions, or both (14). It would be important to recognize individuals for which tanning is a form of OCD, as there may be different implications for effective treatment. Instruments such as the Yale-Brown Obsessive-Compulsive Scale, National Institute of Mental Health Global Obsessive-Compulsive Scale, could be used to evaluate such individuals (26).

Impulse control disorders
Frequent tanning could also be considered within the realm of impulse control disorders. Individuals with impulse control disorders suffer from inability to resist the impulse to perform an action that is harmful to oneself or others (14). Further investigation into this area may be needed.

SAD
SAD refers to a pattern of major depressive episodes that occurs in conjunction with the change of seasons. The most common form of SAD is the fall-onset or ‘winter depression’ type, which is treated with light therapy (27). Recent studies investigating the relationship between indoor tanning and affective disorders have demonstrated a positive relationship between frequent indoor tanning and SAD symptoms. Therefore, these individuals may be utilizing indoor tanning for its mood-enhancing properties and could perhaps be viewed as a form of self-medication (28). Future studies investigating tanning behavior/motivation should attempt to identify and control for individuals suffering from SAD. Instruments such as the Seasonal Pattern Assessment Questionnaire could be used to screen for such individuals (27). Additional studies on mood and anxiety may identify individuals suffering from other mood-related disorders and this differentiation may provide insight into motivation for tanning behavior.

Results
To assess how research might be used to better our understanding of tanning dependence, we reviewed studies that assess dependence in other forms of substance abuse. Previous studies on substance abuse and addiction fall into three categories: surveys, trials, and imaging.

Definitions

Substance abuse
Substance abuse is a pattern of abnormal substance use that interferes with successful occupational, physical, or social functioning (14).

Dependence
Substance dependence is defined as substance abuse, in addition to the presence of withdrawal symptoms, tolerance, or a pattern of repetitive use, despite significant substance-related problem (14). Dependence is further differentiated into physiological (physical) and psychological subtypes. Dependency is a physiological need for a drug, characterized by adverse physical symptoms in the absence of a drug (withdrawal symptoms). Psychological dependence is more subjective and relates to activation of the brain’s reward system that produces pleasurable feelings (18).

Addiction
The medical definition of addiction has seven criteria. This definition is based on the criteria of the American Psychiatric Association (DSM-IV) (14) and the World Health Organization (ICD-10) (29). According to these two organizations, addiction is any behavior that meets at least three of the seven criteria during the same 12-month period:

1. Tolerance
2. Withdrawal
3. Difficulty controlling use
4. Negative consequences
5. Significant time or emotional energy spent
6. Put off or neglected activities
7. Desire to cut down

Studies on substance abuse

Survey studies
Survey studies such as the CAGE (30) questionnaire are often utilized to obtain information on the epidemiology of substance abuse disorders, such as alcohol abuse, in the United States. Outcome expectancy surveys have been administered for alcohol to assess the strength of individual’s expectations for a variety of drinking situations and are effective due to their high degree of reliability and predictive validity (31, 32). Self-efficacy surveys, which ask individual about their ability to resist an urge to use a substance in a variety of challenging settings, have been used for smoking (33–35).

A number of survey studies suggest that many individuals tan for its relaxing properties and can be viewed as a form of psychological dependence (1, 6–8, 10, 13, 36, 37). These findings suggest that there may be a physiological basis for...
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There is a vast array of literature on the consequences associated with indoor tanning and the adverse effects associated with exposure to artificial UV light. An overwhelming majority of past (93%) and current (91%) tanners believe that skin cancer was a possible consequence of the use of tanning beds (6). It was also found that a majority of past (81%) and a large proportion of current (52%) did not believe that tanning beds are safe (6). These data, in addition to other measures which assessed students’ knowledge about skin cancer and pigmented lesions, suggest that the dangers of tanning are well known (6, 55, 56).

In a large study of French adults, it was found that indoor tanning is associated with other behavioral risk factors for the development of cancer, such as smoking, and that individuals who tan seemed to be unconcerned about the risks of photoaging and skin cancer (57). Thus increased knowledge of the dangers associated with exposure to UV is not sufficient to alter risky behavior. As a side note, we were not able to find information relating to patients undergoing UV therapy and whether they show signs of dependence or addiction.

**Targets for future research**

**Survey studies**

Future survey studies, specifically outcome expectancy and self-efficacy questionnaires, may provide additional insight into the development of tanning dependence. In studies of drug use and drug dependence, it has been found that outcome expectations evolve/change in relation to the level of substance dependence. Specifically, the magnitude of expectancy becomes more strongly positive and the structure of the dependency network becomes more specific and automatic. A study of self-efficacy might ask subjects to rate how confident they are in their ability to quit or abstain from tanning. With drugs of dependence, there is an inverse relationship between abstinence self-efficacy and the level of dependence. Such studies could determine the extent to which different individuals or different tanning behavior patterns constitute dependence.

**Trials**

Additional trial studies, involving the cue-reactivity of drug-related stimuli and cognitive mapping of expectancy activation networks, would increase the current understanding of tanning by providing a social learning and cognitive component. The cue-reactivity paradigm may be a valuable tool in the study of potential tanning addiction. It produces significant, reliable, measurable, physiological effects, and self-report of craving in frequent tanners (8).
addicts presented with drug-related stimuli. Individuals with drug addictions/dependences have been found to have increased sensations of craving (from self-report) and increased heart rate and sweat gland activity when presented with drug-related stimuli. It would be interesting to investigate whether a similar mechanism operates during tanning. The physiologic response to the presentation of tanning related stimuli, such as tanning lotions, certain smells (i.e. coconut-scented tanning lotions), or beaches, compared with neutral stimuli, such as a plain wooden table with nothing on it, should be measured and analyzed. Further placebo studies should be carried out with the goal of differentiating between pharmacological and expectation-based effects of tanning. As described in the Goldman expectancy model, the magnitude of a response to smoking a denicotinized cigarette may serve as an indirect measure of expectancy content (which correlates with dependence). Cognitive mapping studies of expectancy activation might also serve to differentiate between individuals who tan intermittently and individuals who are addicted to tanning.

Imaging studies

There is no evidence of previous imaging studies on tanning in the literature. A variety of imaging studies that reveal structural and functional changes in the brain may be helpful in achieving a more thorough understanding of the addictive properties of tanning (58–75). Structural MRI would be helpful in investigating what brain changes (volumetric and compositional) occur in individuals identified as potentially tanning dependent. In structural MRI studies carried out in drug users, smaller prefrontal lobe size has been linked with decreased executive function and therefore decreased ability to control impulses (53). Functional MRI studies of potentially tanning dependent individual would be useful to determine whether there is increased activity in the nucleus accumbens, one of the brain’s reward/pleasure centers, during the act of tanning, the presentation of tanning-related stimuli, or the imagination/contemplation of tanning. MRS studies would test for evidence of tanning-induced biochemical changes in the brain, such as neuronal damage or inflammation. PET and SPECT studies could be used to determine whether tanning results in the alteration of molecular signaling pathways, cell–cell communication, receptor–ligand interactions. PET could be used to assess whether dopamine increases in the nucleus accumbens in response to tanning. PET could also be used to determine whether some tanners have genetic basis for their observed tanning practices, such as a lower number of receptors thereby increasing their susceptibility to developing a tanning addiction.

Tanning is a problem behavior, in that it poses both a health risk and a possible dependence. Dermatologists have recently recognized that many tanners abuse UV light and that many utilize UV light in excess of what is necessary to achieve or maintain the desired tanned appearance. A variety of survey and trial studies provide evidence that some tanners exhibit psychological and physiological dependence on tanning. The adverse health risks associated with over exposure to UV light are well known and do not seem to deter tanners. The accumulated evidence suggests that tanning is addictive. Additional studies are needed to more fully investigate the associated dependency and addiction and to elucidate its similarities to other better-known addictive syndromes.

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