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Genospirituality: Our Beliefs, Our Genomes, and Addictions

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Abstract

Addictions to smoking, alcohol, illicit drugs, and certain behaviors like gambling, overeating, and sex, are prevalent worldwide. These behaviors are highly destructive and costly to individuals and society due to health consequences, criminality and lost productivity. The genetic vulnerability, environmental exposures, and individual behaviors that contribute to the brain dysfunction and compulsive tendencies that mark addiction make it one of the most complicated diseases to study

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and treat. Although much has been learned about the genetic basis of and biochemical imbalances associated with the addictions, research leading to effective treatments has been slow. Addictions are often accompanied by an inner sense of disintegration, enslavement and meaninglessness that can be viewed in terms of a spiritual craving for wholeness, freedom, and transformation. Arguably, progress towards effective treatment has been retarded by insufficient attention being paid to understanding the role of spirituality in helping to heal addicts. Assuming one accepts the belief that the brain mediates all conscious and unconscious experiences- including spiritually experiences -healing, like addictions, can be related to the processes by which the human brain is organized for controlling pleasure and pain. Here we hypothesize that a healthy spirituality may come more naturally to some individuals because of the unique interaction of their genes and their environments, and we review the evidence in support of this view.

Keywords

Reward Deficiency Syndrome (RDS); Genes; Dopaminergic; Reward dependence; Spirituality; Addiction recovery; Twelve steps

Introduction

Recently, Blum and associates attempted to establish links between molecular neuroscience and each step in the Twelve Steps adopted by self-help groups [1]. It is important to point out that the purpose of this current article is not to support or refute the existence of a higher power, but to provide some evidence that acceptance of the Twelve-Step doctrine may be linked to reward circuitry genetic antecedents.

In their book [1], Blum's group briefly discussed the development of the Twelve Steps and pointed out the struggles of its co-founder William G. Wilson. The concepts developed not only by "Bill W" but by other notables such as "Dr. Bob" (Robert H. Smith) and the Oxford Group have evolved based on empirical experiences of what has worked for the Alcoholics Anonymous (AA) and later Narcotics Anonymous memberships. It is quite remarkable that Bill W along with others fought arduously, against all odds to deliver, the Twelve-Step message and fellowship to alcoholics starting in Ohio, St. Louis, and New York. It is ironic that in 1939, when the Works Publishing Company, owned by a few investors through the purchase of stock, published the "Big Book" (Alcoholics Anonymous: How Thousands of Men and Women Have Recovered from Alcoholism), the response was less positive than expected. The end result was that Bill W and his wife Lois lost just about everything including their house. However, realizing that the Twelve-Step program was indeed saving lives, Bill never gave up!

Bill W continued to smoke throughout his recovery even at 76 years of age, while dying from emphysema in the winter of 1971. From a neurological perspective, nicotine, sugar, and coffee activate and release dopamine in the *nucleus accumbens* (NAc) reward site of the mesolimbic system of the brain [1]. While not minimizing the effect AA also had on his recovery, certainly the depression Bill W suffered during his recovery from alcohol, a 17-year battle, was reduced by the continued use of all these substances. We are also interested in Bill W's effort to combat alcoholism through biology. When he experimented with both

LSD and Vitamin B3 (niacin) therapy, many in the fellowship were dismayed with his hope to biologically assist alcoholics to gain relief from their addiction.

In an effort to expand our scientific understanding of how the Twelve-Step program and fellowship saves lives and assists the people doing the work to better understand the role of neuroscience in addiction, in Blum et al.'s book [1], the authors attempted to link the remarkable benefits of each of the Twelve Steps with the science of molecular neurobiology and neurogenetics. The present paper reviews some of the findings from this expanding attempt to bridge the gap between scientific knowledge and humanity.

Reward Circuitry and Addictive Behaviors

Over a half century of dedicated and rigorous scientific research into the mesolimbic system has provided insight into the addictive brain and the neurogenetic mechanisms involved in the quest for happiness. In brief, a primary site in the brain where one experiences feelings of well-being is called the mesocorticolimbic reward system [1]. This is where chemical messages, including serotonin (5-HT), enkephalin, gamma-aminobutyric acid (GABA), and dopamine (DA), work in concert to provide a net release of DA at the NAc [1]. It is well known that genes control the synthesis, vesicular storage, metabolism, receptor formation, and catabolism of neurotransmitters [2,3]. The polymorphic versions of these genes have certain variations that can lead to an impairment of the neurochemical events involved in the neuronal release of DA. The cascade of these neuronal events has been termed "The Brain Reward Cascade" [4] (Figures 1a,b and 2). A breakdown of this cascade ultimately will lead to the dysregulation and dysfunction of DA. Because DA has been proposed as the pleasure molecule and the anti-stress molecule [4-6], any reduction in function could lead to reward deficiency and result in aberrant substance-seeking behavior and a lack of wellness.

Humans are biologically predisposed to drink, eat, reproduce, and desire pleasurable experiences. Impairments in the mechanisms involved in reward from these natural processes lead to multiple impulsive, compulsive, and addictive behaviors governed by genetic polymorphic antecedents. Although there is a plethora of genetic variants influencing mesolimbic activity, polymorphisms of the following candidate genes are known to predispose individuals to excessive cravings (e.g., for drugs of abuse) and can result in aberrant behaviors [7-11]. The list of genes includes the serotonergic 2A receptor (5-HTT2a), serotonergic transporter (5HTTLPR), DAD2 receptor, DAD4 receptor, DA transporter (DAT1), catechol-O-methyltransferase (COMT), and monoamine-oxidase genes and P400 family of genes [12]. Additional predisposing influences are the genetic transcription factors DeltaFosB, CREB, the extracellular signal-regulated kinase signaling pathway, brain-derived neurotrophic factor, and glutamate transmission.

Gold and colleagues proposed a functional DA deficit to explain cocaine abstinence [13-16] and possibly opioid withdrawal in 1996, Blum's laboratory first coined the term *Reward Deficiency Syndrome* (RDS) [8] as an umbrella term for all conditions that are associated with hypodopaminergic function. Common genetic variants of the DA receptor gene (DRD2) polymorphisms [17,18] have been identified as putative predictors of impulsive, compulsive, and addictive behaviors [19] (Table 1). For example; individuals who possess a

paucity of serotonergic and/or dopaminergic receptors and an increased rate of synaptic DA catabolism because of high catabolic genotype of the COMT gene or high monoamine-oxidase activity are predisposed to self-medicate with any substance or behavior that will activate DA release. Examples include alcohol, opiates, psychostimulants, nicotine, glucose, gambling, sex, and even excessive internet gaming [5,20,21].

The use of most drugs of abuse, including alcohol, is associated with release of DA in the mesocorticolimbic system or reward pathway of the brain [22] (Figure 3). Activation of this dopaminergic system induces feelings of reward and pleasure [15,23,24]. However, reduced activity of the DA system (hypodopaminergic functioning) can trigger drug-seeking behavior [25]. Variant alleles can induce hypodopaminergic functioning through reduced DA receptor density, blunted response to DA, or enhanced DA catabolism in the reward pathway [26]. Cessation of chronic drug use can also induce a hypodopaminergic state that prompts drug-seeking behaviors in an attempt to address the withdrawal-induced state [27].

While acute use of these substances can induce a feeling of well-being, sustained and prolonged abuse unfortunately leads to a toxic “high” and results in tolerance, disease, and discomfort and even a flat affect [28]. Thus, excessive cravings caused by carrying the DRD2 A1 allelic genotype and low DA receptors are compounded by consequential drug seeking behavior. Conversely, normal densities of DA receptors result in low craving behaviors. In terms of preventing substance abuse or excessive glucose craving, one goal would be to induce a proliferation of DA D2 receptors in genetically prone individuals [29]. Experiments *in vitro* have shown that constant stimulation of the DA receptor system via a known D2 agonist in low doses results in significant proliferation of D2 receptors in spite of genetic antecedents [30]. In essence, D2 receptor stimulation signals negative feedback mechanisms in the mesolimbic system to induce mRNA expression, causing proliferation of D2 receptors. This molecular finding serves as the basis for naturally inducing DA release to cause the same induction of D2-directed mRNA and thus proliferation of D2 receptors in humans. This proliferation of D2 receptors in turn will induce the attenuation of craving behavior. In fact, this has been proven with nonhuman animal research showing a form of gene therapy, DNA-directed overexpression of the DRD2 receptors, induces a significant reduction in both alcohol and cocaine craving-induced behavior [31-34].

These observations are the basis for the development of a functional hypothesis of drug seeking and drug use. The hypothesis is that the presence of a hypodopaminergic state, regardless of the source, is a primary cause of drug-seeking behavior. Thus, genetic polymorphisms, which induce hypodopaminergic functioning, may be one mechanism underlying a genetic predisposition to chronic drug use and relapse [29]. Finally, utilizing the long-term dopaminergic activation approach ultimately will lead to a common, safe, and effective modality to treat RDS behaviors that include among others, substance use disorders, attention-deficit hyperactivity disorder (ADHD), and obesity.

As stated earlier, DA is known as the main neurotransmitter modulating the activation of the reward system of the brain and has been associated with pleasure [35]. When DA is released into the synapse, it stimulates a number of receptors (D1–D5), which results in increased feelings of well-being and stress reduction. It is of particular interest that, the DRD2 gene

has been one of the most widely studied in neuropsychiatric disorders in general and in alcoholism and other addictions in particular [1,36]. Grasping the mechanism of motivated behavior requires an understanding of the neural circuitry of rewards [37], otherwise called positive reinforcers. A positive reinforcer is operationally defined as an event known to increase the probability of a subsequent positive response, and some argue that drugs of abuse are stronger positive reinforcers than natural reinforcers (e.g., food and sex) [38-40]. The distinction between natural rewards and unnatural rewards is an important one. Natural rewards include satisfaction of physiological drives (e.g., hunger and reproduction), and unnatural rewards are learned and involve satisfaction of acquired drives [41,42] for pleasure [43] derived from alcohol and other drugs as well as from gambling and other risk-taking behaviors [44].

Within the ventral striatum of the brain, the NAc mediates the reinforcing effects of drugs of abuse such as cocaine [45] alcohol [46], nicotine [47], food [48], and music [49]. The NAc also contributes to control of motivated behaviors such as feeding, drinking, sexual behavior, and exploratory locomotion, which are elicited by natural rewards or incentive stimuli. A basic rule of positive reinforcement is that motor responses will increase in magnitude and vigor if followed by a rewarding event. Hedonic liking for sensory pleasures is an important aspect of reward, and excessive liking of particular rewards might contribute to excessive consumption and to disorders such as RDS. Hence it is likely that there is a common mechanism of action for many powerful motivational effects [50].

In summary, we have reviewed the neurobiological and genetic variables associated with addiction [51]. We have discussed these subjects in terms of our proposed hypothesis, that addictive behaviors are motivated by relative deficiencies in the reward circuitry of an individual's brain. We believe this view best represents the most current evidence related to the neurobiological processes underlying addictive behaviors.

From this evidence, we surmise and so suggest that certain individuals are relatively predisposed to engage in self-destructive addictive behaviors and lifestyles, which likely depends upon his or her innate neurological capacity or incapacity for pleasure and reward. In the following section, we consider whether there is a similar motivating factor behind certain individuals' apparent predisposition to engage in spiritual lifestyles. In particular, we clarify our use of the term *spirituality*, and we attempt to link the concept of spirituality to relapse and recovery. We also evaluate some of the research that suggests genetic variables associated with spirituality.

Defining the Ineffable

Before we proceed with our consideration of how spirituality may be a function of the human genome, we wish to clarify our use of this term. By spirituality, we do not mean religion, understood as a system of beliefs about specific realities, and we do not mean supernaturalism, the philosophical premise that there are causal realities outside the natural cause's observable through empirical methods of inquiry. Certainly, there may be traces of spirituality in both religion and supernaturalism, but we are not presently concerned with validating or invalidating either of these systems. Rather, we understand spirituality as a

system of meta-meaning related to an individual's ultimate concerns. Accordingly, spirituality refers to the significance of objects or events beyond superficial or mundane associations; it always describes 'something-more' in terms of how an individual interprets his or her own personal purpose and value in the world.

Accordingly, spirituality includes all beliefs, thoughts, attitudes, experiences, and behaviors that are related to or about realities outside the self. Hence, self-transcendence is a predominant theme in most spiritual traditions. It is, in short, a way of seeing oneself in the world that extends into a way of being in the world. As such, spirituality may be positive or negative, healthy or unhealthy. On this view, Jerome Dollard says, "Spirituality is a lot like health. We all have health; we may have good health or poor health, but it's something we can't avoid having. The same is true of spirituality: every human being is a spiritual being. The question is not whether we 'have spirituality' but whether the spirituality we have is a negative one that leads to isolation and self-destruction or one that is more positive and life-giving¹."

With this qualification of spirituality in place, we propose that certain individuals may be genetically predisposed to 'spiritual health,' as it were. Moreover, we are encouraged to investigate into the genetics of spirituality, because of the phenomenological evidence that spirituality and addiction are linked. It is our hypothesis that healthy spirituality may come more naturally to some individuals because of the unique interaction of their genes in their environments. In the following section, we review some of the current evidence in support of this view. We will henceforth refer to this linkage between genes and spirituality as *genospirituality*.

Spirituality, Addiction, and Recovery

Addicts often describe an inner sense of disintegration, enslavement and meaninglessness. Consequently, addiction has been understood in terms of a spiritual craving for wholeness, freedom, and transformation. It is not by coincidence that the Latin root of "addict" connotes the idea of a willing slave, or one who has become enslaved by so many acts of willing devotion. Once the pursuit of the special release from self, the self-transcendence, which comes with using a particular substance or activity, becomes the organizing principle of the person's life, the hedonic habit takes on a life of its own. What initially promised freedom from the bondage of self or freedom to become someone else turns out to be a "rapacious creditor" bleeding the borrower of "all self-sufficiency and will to resist its demands" [1]. Addicts are not free in the way non-addicts are, not because they necessarily do things they don't want to do, but because they want things they don't want to want². The habit becomes obsession and eventually fragments the person until his or her will to resist is rendered impotent, or powerless. The admission of this powerlessness is an intensely personal event, which may even broach issues of ultimate concern for certain individuals. As such, it may function as the first step toward actual freedom.

From this phenomenological interpretation of addiction, we can begin to see how it is linked to spirituality [1]. This insight was captured well by the psychiatrist Carl Jung in his letter to Bill Wilson: "You see, Alcohol in Latin is 'spiritus' and you use the same word for the

highest religious experience as well as for the most depraving poison. The helpful formula therefore is: spiritus contra spiritum.” In his *Varieties of Religious Experiences*, the philosopher William James related a similar insight about this interaction in the opposite direction: “The only radical remedy I know of for dipsomania is relgiomania.” These insights have been validated more recently by neuroscientist Patrick McNamara [52]. In his book, *The Neuroscience of Religious Experience*, McNamara makes the convincing argument that religion may have evolved in the first place to facilitate the process of unifying the fractured human person by means of a spiritual experience. The same spiritual craving for wholeness, self-integration, and freedom that motivates the use and abuse of a variety of substances and activities is also that which frequently motivates people’s involvement in religious and spiritual communities.

Evidence of McNamara’s insight can potentially be observed among the contemporary movement of mutual-help fellowships, such as AA and their Twelve Step Program. According to their preamble, “AA is a fellowship of men and women who share their experience, strength, and hope with each other ... to stay sober and Jerome Dollard, as quoted by Thomas Prugh, ‘Alcohol, Spirituality and Recovery,’ *Alcohol Health and Research World* (Winter 1985-86), 28-31, 53.

²Frankfurt H (1982) The importance of what we care about. *Synthese* 53: 257-272.

help other alcoholics achieve sobriety.” To be organized around the purpose of achieving recovery and helping others is certainly a crucial piece in transforming an individual’s purpose and meaning.

Another one of the reasons for the success of the AA fellowship in facilitating these transformative experiences is their emphasis on its members telling stories about “what they were like, what happened, and what they are like now.” The continued practice of telling such stories not only serves to remind the storyteller of the despair and anguish associated with using alcohol, but also to remind them of how far they have come. It functions to facilitate a sort of deductive reasoning, where what exists today appears to have required what preceded it. Therefore, gratitude is a frequent theme in these stories. Telling these stories also requires learning to look at oneself, and especially one’s relationship with alcohol, differently. It is a major piece in transforming that way of seeing oneself in the world that extends into a way of being.

The twelve steps are also about cultivating an expanded consciousness through a reinterpretation of one’s own actions and reactions towards the people, places, and things around him or her. The morality emphasized in these steps encourages personal responsibility for one’s actions, consideration of other people’s cares and concerns, and thus, a kind of fitness in terms of the person’s conscience. They are a systematic method of actualizing the spiritual awakening that have consistently been exhorted by many of the world’s great religions.

Spirituality and the Brain

On an intuitive level, we recognize the relationship of addiction, spirituality, and the brain by the simple observation that addicts try to achieve positive experiences by using the physical substance to affect the brain. How do these addictive substances work against spirituality and *vice versa*? That is the question that motivates our present inquiry into genospirituality. This leads us to consider the neurochemistry and genetics related to these affects and whether these are relevant to spirituality.

To answer this question, first it is important to establish that the brain mediates all conscious and unconscious experiences, including spiritual experiences. In his book, *Religious and Spiritual Experiences* [53], Wesley J. Wildman refers to this as the neural mediation hypothesis. He says, “the mind does nothing we can detect that is not exhaustively mediated by and expressed in the brain.” Although this is still a point of contention, as Wildman points out, “this thesis is so well supported at this point that, if skeptics were to say that [religious and spiritual experiences] were not exhaustively mediated by the brain, the burden of proof would definitely be on them to explain what they could possibly mean.”

Genospirituality

Nilsson et al. [54] found that among boys, self-transcendence and spiritual acceptance were negatively correlated with the short 5-HTTLPR genotype, and positively correlated with the short AP-2beta genotype. Both among boys and girls, significant interactive effects were found between 5-HTTLPR and AP-2beta genotypes with regard to measures of self-transcendence and spiritual acceptance. Boys and girls with the combination of presence of the short 5-HTTLPR, and homozygosity for the long AP-2beta genotype scored significantly lower on self-transcendence and spiritual acceptance. In this regard, Comings and associates have found gene polymorphic associations with spirituality [55].

Hamer, in his popular book *The God Gene* [56] suggested that the selection for dopaminergic spirituality genes was driven by their ability to produce an innate sense of “feel-good” optimism. Accordingly, this would have selective value in the sense that optimism relates to the will to keep on living and procreating, despite the fact that death is inevitable [57]. Additionally, studies have shown that optimism seems to promote better health and quicker recovery from disease, features that would have positive selective value. Newberg [58] suggested a different kind of association of spirituality with a feel-good sensation. They suggested that the neurological machinery of spiritual transcendence may have arisen from neural circuitry [limbic system] that evolved for mating and sexual experience. This view is consistent with findings on dopaminergic genes and DA function in relation to their roles in increasing pleasure and decreasing stress [59]. Comings et al. [55] also identified the role of a specific gene in spirituality. The gene was the DA D4 receptor gene (DRD4) gene, which was found to play a role in novelty seeking, one of the personality traits in Cloninger’s Temperament and Character Inventory [60] and has been associated with compromised DA signaling in an *in vitro* study [61].

Comings et al. did identify genetic correlates of self-transcendence, but the association of this gene and novelty seeking linked to dopaminergic circuits did not emerge in a sample of

substance abusers [62,63]. Specifically, there was a borderline association with a self-forgetful sub-score but a strong association with spiritual acceptance. Other genes included the DA vesicular transporter gene (VMAT2), which was reported to be associated with spirituality. The fact that two different genes, DRD4 and VMAT2 have been found to associate with spirituality, and the fact that DA is a feel-good neurochemical, may help explain why spirituality plays a powerful role in the human condition and why the majority of people derive great comfort and happiness from a belief in a God [64].

It is of further interest that in the Comings et al. studies [55,64], those individuals who scored high on self-transcendence were less likely to abuse alcohol or drugs. Accordingly, this may be because individuals whose reward pathways, and possibly other interacting pathways (serotonergic) activated by spirituality, would have less need to artificially activate their reward circuitry with foreign substances like ethanol and cocaine. This is, indeed, the central pillar of AA's Twelve Steps [1].

Moreover, Borg et al. [65] at the Karolinska Institute in Sweden found that the binding of ethanol was lowest in those with the highest scores for self-transcendence, suggesting, "Such individuals had higher levels of brain serotonin." They showed that the serotonin 1A receptor gene was significantly associated with scores on the self-transcendence scale and with the substance of spiritual acceptance. It is noteworthy that the lysergic moiety as in LSD is similar structurally to 5-HT having modifying effects through psychedelic spiritual experiences. In fact B Wilson was very interested in using LSD to ameliorate alcoholism [1]. Finally, many different plants around the world contain a range of psychedelic drugs (serotonergic, opioid, and catecholaminergic), which are capable of strongly enhancing one's spirituality and/or spiritual awareness. Comings [55] further pointed out that these entheogens (good-producing substances) played a profound and critical role in facilitating humans' early belief in a god or gods and in the development of religion. Interestingly, Bachner-Melman [66] speculated that serotonergic neurotransmission in some human studies appeared to mediate human religious and spiritual experiences. We therefore hypothesize that the association between AVPR1a and SLC6A4 reflects the social communication, courtship, and spiritual facets of the dancing phenotype rather than other aspects of this complex phenotype, such as sensorimotor integration.

It is noteworthy that generalized healing is dependent on gene expression and its consequent activity-dependent neurogenesis, and stem cell healing is proposed as the molecular-genomic-cellular basis of rehabilitative medicine, physical, and occupational therapy as well as the many alternative and complementary approaches to mind-body healing. According to Rossi [67] the therapeutic replaying of enriching life experiences that evoke the novelty-numinosum-neurogenesis effect during creative moments of art, music, dance, drama, humor, literature, poetry, and spirituality, as well as cultural rituals of life transitions (birth, puberty, marriage, illness, healing, and death) can optimize consciousness, personal relationships, and healing in a manner that has much in common with the psychogenomic foundations of naturalistic and complementary medicine. The entire history of alternative and complementary approaches to healing is consistent with this new neuroscience world view about the role of psychological arousal and fascination in modulating gene expression, neurogenesis, and healing via the psychosocial and cultural rites of human societies.

In terms of church attendance and genes, Kendler and Myers [68] noted that as individuals mature, they increasingly shape their own social environment in large part as a result of their genetically influenced temperament. When individuals are younger and living at home, frequent church attendance reflects a range of familial and social-environmental influences that reduce levels of substance use. In adulthood, by contrast, high levels of church attendance largely index genetically influenced temperamental factors that are protective against substance use.

Future Perspectives

In a paper by Boomsma et al. [69] Information on personality, on anxiety and depression and on several aspects of religion was collected in 1974 Dutch families consisting of adolescent and young adult twins and their parents. The major point of this type of research revealed that upbringing reduces the influence of genetic factors on sensation seeking (did inhibition) in male twins. Moreover, Koopmans et al. [70] examined the role of religious upbringing as a moderator of both shared environmental and genetic influences on the risk of alcohol use initiation in a large population-based sample of Dutch adolescent and young adult twins (1967 twin pairs). They hypothesized that “the relative magnitude of the genetic influences on the risk of alcohol use initiation would be greater for those adolescents and young adults who were raised in a less religious environment compared to those adolescents and young adults who were raised in a more religious environment.” In essence they found higher heritability’s for females without a religious upbringing compared to females with a religious upbringing: specifically genetic influences accounted for 40% of the variance in alcohol use initiation in nonreligious females, compared to 0% in religiously raised females. Shared environmental influences accounted for 54% of the variance for nonreligious females and 88% of the variance in religious females. Similar but non-significant effects were observed for males. Most interestingly, recent evidence from the work of Haber et al. [71] underscores the role of religious/spirituality (RS) as a particular risk factor for the alcohol dependence (AD) especially at the initiation phase, However, after drinking has begun it is genetic influences that maintain AD not RS as much. This work does support the early intervention of spirituality in families with a history of alcoholism.

Being cognizant of the role of specific neurotransmitter gene polymorphisms and acceptance or non-acceptance of a higher power (spirituality beliefs as defined herein), and the role of RS on initiation of drug and alcohol use (possible relapse as well), our laboratory has embarked on an outcome study utilizing two independent samples - the NIDA funded Drug Addiction Treatment Outcome Study (DATOS) and alumni data derived from a holistic treatment center in North Miami Beach Florida. Interestingly, we found a significant inverse relationship between stronger spirituality beliefs and lower relapse rates in both independent samples. This work will continue to evaluate the loading of specific gene polymorphisms onto both spirituality beliefs and relapse rates.

Conclusion

The debate about the role of genes amongst religious groups like Jews, Muslims, Christians and other religious groups for not only identity but religiosity has been the subject of many

investigators [72] and seems to frame who we are and where we are going in terms of our romance with the concept to a higher power. In any case, whatever our beliefs, it is clear that healthy lifestyles are influenced by a unique interaction of spirituality, genes, and the environment. In fact it appears that belief in God, but not religious affiliation is associated with better short term psychiatric treatment outcomes [73].

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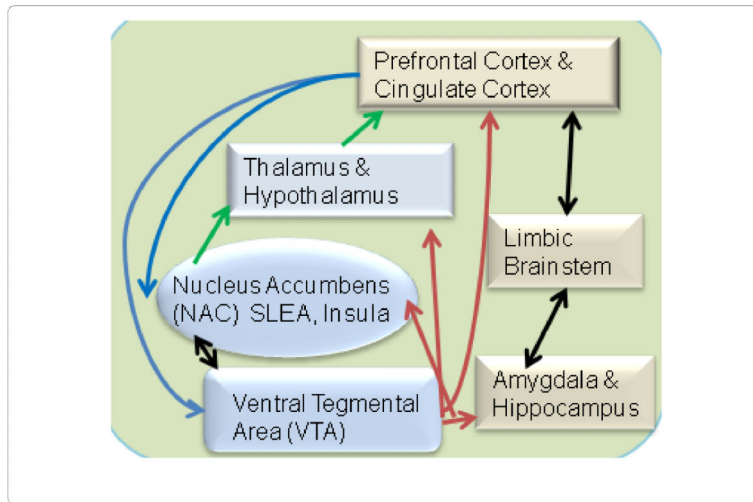
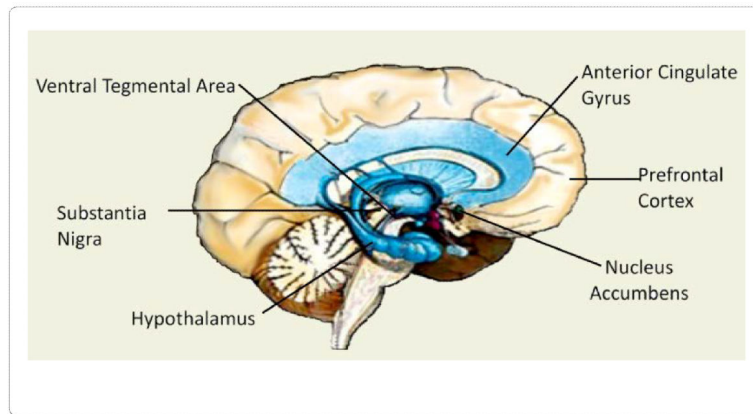


Figure 1.
a: Brain Reward sites. [1].
b: Extended brain reward circuitry [1].

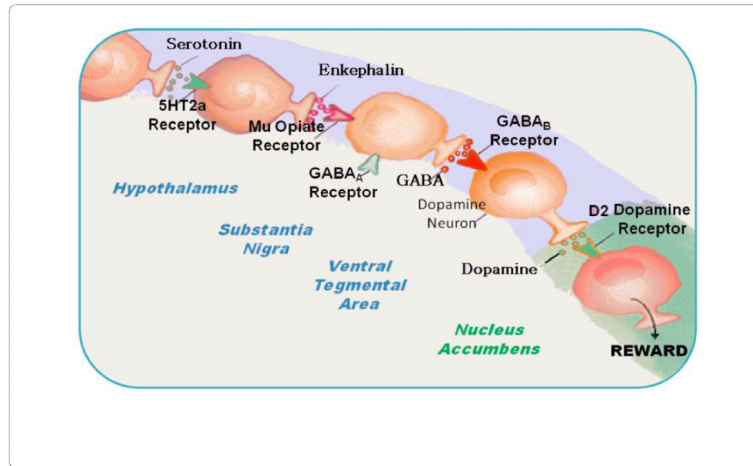


Figure 2.
Interaction of neurotransmitters within the mesolimbic brain reward cascade.

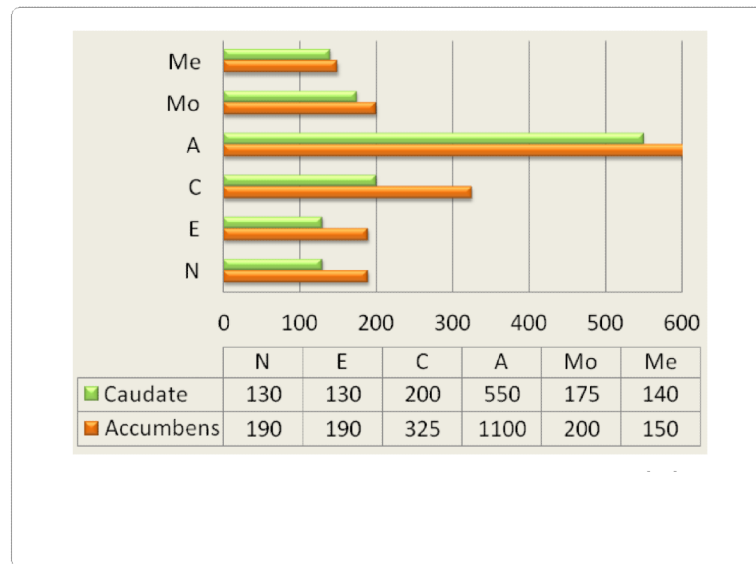


Figure 3.

Dopamine release.

Abbreviations: Me: Methadone; Mo: Morphine; A: Amphetamine; C: Cocaine; E: Ethanol; N: Nicotine [22]

Table 1

Examples of Reward Deficiency Syndrome.

Addictive Behaviors	Impulsive Behaviors	Compulsive Behaviors	Personality Disorders
severe alcoholism and drug abuse	attention-deficit hyperactivity disorder (ADHD)	aberrant sexual behavior	conduct disorder
Poly substance abuse	Tourette Syndrome	internet gaming	antisocial personality
smoking	Autism	pathological gambling	aggressive behaviors
obesity			