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Quality of life in an evolutionary perspective

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Abstract

The main purpose of nervous systems is to direct an animal to behave in a way conductive to survival and procreation. As a rule of thumb that implies either instigation of approach (in the case of opportunities) or avoidance (in the case danger). Three brain modules are essential for this purpose: one for avoidance and two for approach (seeking and consuming). While behavior originally was based on reflexes, in humans these modules operate by the more flexible system of positive and negative affect (good and bad feelings). The human capacity for happiness, in the form of positive feelings, is presumably due to this whim of evolution – i.e., the need for more flexibility in behavioral response. An array of sub-modules has evolved to care for various pursuits, but recent studies suggest that they converge on shared neural circuits designed to generate positive and negative effect. The evolutionary perspective offers both a deeper understanding of what happiness is about, and a framework for improving well-being and mental health.

Keywords: Evolution, quality of life, mental health, brain modules, rewards, punishment

Introduction

Several lines of scientific inquiry have recently approached the question of happiness: In the social sciences the subject is typically referred to as positive psychology, and measured by questionnaires probing the level of subjective well-being (1,2). In evolutionary biology the term Darwinian happiness has been used in an attempt to understand why evolution endowed the human species with the capacity to have either pleasant or unpleasant experiences (3,4). Neuroscientists try to locate and understand the neural networks involved (5-7). This chapter draws on all these lines of investigation to generate a novel model for happiness. The model has practical ramifications, not only for the question of

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improving well-being, but for mental health in general.

Mental health and happiness are closely related issues, as there are two main quandaries associated with a non-optimal functioning of the brain: One, patients are unhappy, i.e., their quality of life suffers; and two, the patients do not function in society, which indirectly may, or may not, cause distress.

These two aspects do not necessarily go together. People with Down syndrome, for example, tend to be happy as long as they are cared for (8); while a depressed person can be deeply unhappy, but still function satisfactory. However, the quality of life is presumably reduced in most individuals with problems related to the mind.

Mental diseases have become the main burden of health in industrialized societies; in terms of the quality of life of citizens, and by disrupting the economy as a major cause of sick leaves and disability. According to estimates, 30–50% of the population suffers from a diagnosable mental disease at some point in life (9,10). The more common problems, such as anxiety disorders, depression and chronic pain, can be understood as malfunctioning of nerve circuits involved in creating negative feelings (11). Even a subclinical level of malfunctioning would be expected to reduce happiness, thus the diagnosable diseases may be the tip of the iceberg as to mental agony and suboptimal quality of life due to excess activity in these circuits.

Preventing or alleviating mental disorders is a first step toward improving well-being in society. The second step would be to create an environment where people thrive beyond what would be expected of an average healthy mind.

The evolutionary perspective

There has been a growing interest in applying the evolutionary perspective to problems of general health (12), as well as to the issue of psychiatric diseases (13) and well-being (4,14). In this perspective, a variety of medical and mental problems are related to an environment at odds with the inherent characteristics of our species. Although all aspects of health may gain from this type of evolutionary analysis, many of the more novel, and applicable, ideas concern mental health.

Evolution selects for survival and procreation – not happiness. Yet there are reasons to assume that the natural state of a healthy mind, in the absence of internal imbalance, external threats, or other stressors, is to be in a good mood. The term default contentment has been coined to reflect this point of view (4). The main argument in favor is that it is in the interest of our genes to rest within an individual with a positive frame of mind – a negative attitude will tend to diminish the effort required for survival and procreation. In further support of the default contentment assumption, there is considerable data suggesting that people are inclined to be overly optimistic – the point is reflected in the tendency to gamble (15). Moreover, when asked about subjective well-being, people claim, on the average, to be on the happy side of neutral (1,2).

Adverse events, such as hunger and fear, may cause negative feelings that temporarily reverse the positive state, but the brain should return to contentment once the particular experience is ended. When discontent is maintained in the absence of adverse events, it is presumably due to unwarranted activity in modules designed to initiate negative states of mind. Hyperactivity in these modules also explains mental ailments such as anxiety and depression. Understanding the nature of these modules may help us improve the mental condition.

Brain modules

An advanced nervous system is required in order to experience positive or negative feelings; i.e., brains such as those found in mammals.

The mammalian brain has been shaped by evolution to take care of a long list of functions; thus a useful approach to understand the brain is to consider it as divided into various modules – somewhat like a Swiss army knife. Each module deals with a particular need that arouse during our evolutionary history, such as directing movement of a finger, induce hunger in order to initiate food intake, or bring about compassion as a way of establishing relations with fellow humans. Like the various tools of the knife, they can be engaged when required; but

while the knife have a dozen or so option, the brain may be divided into perhaps thousands of modules; the number depending on to what extent they are lumped together or split into separate modules.

The brain modules are not easily defined in terms of physical parts of the brain, and are consequently best described in terms of their function. A single module may involve both the conscious and the subconscious brain; and within the conscious part, it may engage both cognitive and affective processes.

In humans, evolution has introduced an overarching unit, roughly speaking the cerebral cortex, which gives us a particularly advanced intellect, as well as the attributes referred to as self-awareness and free will. The various modules involved in conscious thoughts and affects presumably meet in the cortex. Our powerful intellect offers an opportunity to influence both conscious and subconscious affective neurobiology, and thus to some extent control how we feel. Thus, in theory we have the opportunity to manipulate the mind, and consequently the level of happiness, but in practice most people are swayed by environmental stimuli, and by incentives coming from the subconscious parts of the brain.

Rewards and punishment

Biologically speaking the body is a wrapping designed by the genes with the intent of perpetuating the genes. The brain is part of this wrapping and serves the purpose of orchestrating behavior.

The main objective of primitive nervous systems, such as those found in worms, is to direct the organisms either toward a certain objective, e.g., finding food; or to cause aversion, e.g., avoiding a predator. Thus the first nervous systems, which originated some 600 million years ago, evolved to care for these two primary functions. The corresponding, overarching brain modules – attraction and aversion – are still a key part of the mammalian brain. An important element of brain function is to guide the individual either toward or away from something. In other words, as a gross approximation, the brain is there to direct attention and actions either toward or away from particular situations or opportunities.

In invertebrates, such as worms, the reaction to environmental stimuli involves reflexes or instincts. In order to obtain a more flexible response to various challenges, evolution gradually improved the computational power of the nervous system. Feelings evolved as a means to assess the benefits of various options. Inmammals a positive feeling spurs the animal to move forward, while a negative feeling implies something to be avoided, or a bodily need that should be taken care of. The strength of the feeling indicates the importance of the suggested action. These two main categories of feelings are often referred to as brain rewards and punishment. In biology, rewards may be defined as brain activity that elicits approach and consummatory behavior, while punishments can be defined as activity that elicits avoidance or restoration of bodily homeostasis (16).

The reward module is best understood as two distinct modules, referred to as seeking (some scientists call it wanting) and liking (5,17). Going back to the early nervous systems, they presumably reflect two independent functions: The animals were rewarded first for seeking relevant items in the environment, e.g., food, and subsequently for consuming the items. The two reward functions have distinct neurobiology, yet may, for simplification, in the present context be combined in a single reward module.

The scientific enquiry into the neurobiology behind the modules that are involved in generating feelings, sensations and mood is referred to as affective neuroscience (5).

The neurobiology of reward and punishmentis partly understood (6,7,18). Briefly, certain subcortical parts of the brain serve as a kind of “motor” for positive and negative feeling. The hotspots known to cause activation, in the form of enhanced feelings upon relevant stimulation (either electrodes or local injection of neurotransmitter modulators), are found only in subcortical structures such as the nucleus accumbens and the ventral pallidum. Dopaminergic nerve cells in these regions (and the amygdala) are central in connection with seeking; the opioid system (of much the same brain areas) is involved in wanting. Partly overlapping regions are important for punishing feelings. The cortex apparently serves more like a “dashboard”, in the meaning of having a level of conscious control overthe feelings generated in the

subcortical brain. The more important cortical regions include the orbitofrontal, lateral prefrontal, insular and anterior cingulate parts.

Mood modules

The brain modules involved in generating positive and negative feelings may be referred to as mood modules. As a first approximation, happiness can be construed as a question of maximizing the net output of mood modules; i.e., stimulating reward modules, while avoiding activity in the punishment module. This way of looking at happiness requires, however, an elaboration.

Most people do not experience life as a stream of either good or bad events, but rather as a relatively steady state of mood interrupted by certain episodes causing a particular surge of pleasure or pain. That does not mean that the modules involved in generating mood are inactive most of the time. It seems more appropriate to envision a tonus of mood caused by the balance of activity between positive and negative modules. This tonus is presumably what some scientists refer to as a set point of happiness (15). Particular events may move you up or down relative to this baseline, but the baseline itself is a consequence of innate factors and previous experiences. While it is easy to find a stimulus that sends your happiness temporarily beyond the baseline; it is more difficult, but not impossible, to boost the baseline itself.

Although the combined activity of the mood modules defines the level of happiness, other parts of the brain, which handle sensory input or cognitive activity, may have considerable impact. A range of modules can affect the tonus of happiness by having neurological connections with the mood modules. Moreover, the cognitive part of the brain determines how the situation is felt – the "flavor" of the reward or punishment. A good meal, for example, offers a rather different experience from the joy of an aesthetic object; yet the pleasure itself may in both cases be cared for by partly the same neurological structures; i.e., the reward module.

The original function of the mood modules can be described as telling the animal whether it is on the right or wrong track toward survival and procreation. In human there is a considerable element of cognitive assessment that influences what is construed as beneficial or detrimental. Collecting butterflies may not improve your chance of survival, but it is possible to prime your brain to accept that acquiring a rare butterfly is the most important thing to do. The human mind is obviously open for this sort of learning and molding.

The mood modules may be activated directly from a sensory experience, such as tasting sweet food or burning a finger; or cognitive modulation may intervene in the process to the effect of either subduing or enhancing the rewarding or punishing feelings. In other words, we may tune in toward pleasure or pain, or try to ignore either. It is possible to activate both at the same time; for example, if you happen to hurt your finger while you are in love. Moreover, one particular sub-module may in certain situations activate reward while causing a punishing feeling at other times – depending on the context.

Fear is an illustrative example. Normally fear is an unpleasant feeling because it is meant to keep you away from dangerous situations. If your eyes catch a stick resembling a snake lying on the ground, you react without thinking. The startle is unpleasant. When upon closer examination you realize that it is only a stick, you relax, which is a pleasant feeling. In other situations the fear may have a positive connotation. A climber appreciates the adrenalin kick of challenging a dangerous mountain. However, if he slips and starts falling, the feeling suddenly becomes disagreeable. The connection between fear and the reward circuitry is explained in biological terms by the evolutionary advantages of occasionally facing treacherous situations. In connection with hunting, for example, one ought to take on a dangerous beast for the purpose of securing food.

Another example concerns grief. Normally this is a negative experience. It is evoked by events that are unfortunate for the genes, such as the loss of a partner or failure to complete a task. The brain reacts by marking the occurrence as something you should try to avoid. On the other hand, the reaction of grief serves a purpose. The mental engagement may help you move on with your life. Moreover, the sorrow is visible in your face, a point that generally means it helps to communicate your feeling to others. In this

case the communication may illicit support from friends and thus improve your chance of survival.

The observation that grief may actually improve your fitness implies that, in the appropriate context, you are best served by engaging this emotion; and in order to instigate grief, the emotion presumably connects with the reward module. Consequently, sorrow sometimes feels good. The theory may help explain why people flock to movies that make them cry. When the circumstances indicate that your own situation is not jeopardized, the reward part of grief may overwhelm the negative aspects. In fact, it has been shown that grief may activate either the reward or the punishing module (19).

The point of these examples is to illustrate that it is not obvious whether various situations should make your mood better or worse. The context, the particulars of the situation, and not the least your cognitive assessment, may move the experience toward being either pleasant or unpleasant.

A considerable diversity of external and internal stimuli can impact on the mood modules. Happiness is then a question of moving the balance in a positive direction.

Hedonia and eudaimonia

Considering happiness to be a question of stimulating the reward module of the brain is easily confused with the philosophical tradition referred to as hedonism. Hedonia tends to suggest gluttony related to the more typical bodily pleasures; while the alternative concept, eudaimonia, is associated with more positive values, such as socializing and finding a meaning in life.

There is no sign of an alternative neurobiology for eudaimonia. A more parsimonious model is therefore that eudaimonia reflects activity that converges on the same neural networks (the mood modules) as do bodily pleasures. The observation that people suffering from anhedonia have reduced ability to experience all sorts of happiness or contentment, further supports the contention that hedonia and eudaimonia are based on the same neurobiology (7).

The above reasoning does not necessarily imply that the dichotomy is unwarranted, the sources and nature of eudaimonia may differ appreciably from typical hedonic sensations.

One of the foremost items related to eudaimonia is having a “meaningful life”. It seems rational for evolution to attach positive feelings to utility, which implies that we are rewarded for doing something considered constructive. Thus “meaning” is presumably a feature installed to avoid having our ancestors turn into “cave potatoes”. Similar reasoning may apply to other values typically incorporated in eudaimonia, such as spiritual associations, being virtuous, and showing compassion. Evolutionary speaking, the ultimate objective should be survival and procreation, but all sorts of more proximate purposes may activate reward modules. In other words, the positive affect labeled as eudaimonia may simply reflect a subset of the vast array of stimuli that connect to a share reward motor.

The pleasures typically associated with eudaimonia are either more lasting, less likely to cause harm by misuse, or considered virtuous and beneficial to society. Thus the preference for eudaimonic values may reflect an attempt to coach people toward choosing particular types of rewards. The preferred list would include those more likely to ensure optimal long-term happiness, and those favored due to social or political priorities. Moreover, the default contentment described above does not require any form of stimuli. Consequently it cannot be misused and would therefore fall in the category of eudaimonic happiness. Yet, it seems likely that the default contentment simply reflects that the mood modules are designed to operate with a net positive value as long as the negative modules are not specifically activated. That is, in a person with proper mental health, whose basal needs are cared for, the setpoint of happiness is positive.

Exercising the brain

It is common knowledge that the size and strength of muscles will develop upon exercise. It may be less obvious that a range of other bodily functions, including the various modules of the brain, also tend to expand (functionally if not anatomically) upon use. The point is easily demonstrated in animals, where it is possible to apply experimentally controlled

stimuli and subsequently remove the brain for detailed anatomical analyses. If, for example, the fear module is stimulated excessively, the underlying neurological and endocrine tissues will be enlarged. It seems reasonable to assume that by exercising a brain module, i.e., activating it regularly, it will not only expand, but also tend to have a greater impact on consciousness. For example, by regularly stimulating the fear function, one is more likely to suffer from unwarranted or excessive activity of this module; i.e., more likely to develop anxiety related problems.

A main issue, as to quality of life, may be that modules involved in negative feelings are "exercised" to the extent that they become troublesome. In other words, environmental factors in modern societies may activate modules responsible for negative feelings, and thus cause the underlying nerve circuitry to expand. The modules consequently have a greater impact on conscious experiences than what would be typical for a Stone Age setting.

It should be mentioned that, in the case of humans, cognition allows for "containment" of expanded modules. Anxiety can, for example, be subdued with the help of cognitive therapy. The therapy presumably works not by changing the fear module itself, but by expanding neurological circuits in the brain whose function it is to turn off the fear module. In other words, the therapy may be viewed as exercising this "off-switch".

It is also possible to exercise the modules of the brain associated with rewards. In this case, the daily mood tonus would be expected to improve. Meditation appears to be relevant "brain exercise" in this respect. Certain forms of meditation, such as that based on the Tibetan Buddhist tradition, have been investigated to some detail. This practice has been claimed to be capable of installing in the brain a sufficiently strong reward circuitry to allow for a positive sentiment regardless of the external situation (20). The claim is partly substantiated by measuring activity in brain centers associated with rewards in Buddhist monks during meditation (21).

Engaging in any sort of positive feelings – including those evoked by music and aesthetics – is relevant training of the reward module according to the present model. The typical target of Tibetan Buddhists is, however, of particular interest: They often focus their meditation on compassion. Both pair-bonding and social relations most likely became important during the last 5-7 million years of human evolution; a presumed consequence is that feelings associated with agreeable relationships – including love, compassion and camaraderie – induce powerful brain rewards (22). Moreover, besides being an excellent strategy for personal happiness, expanding the compassion module carries obvious benefits for society.

Causes of reduced happiness

According to the present model, the main threat to quality of life stems from the activation of modules that instigate negative sensations. In their absence, the default state of contentment should secure a good mood. It is therefore useful to take a closer look at the key modules that contribute to an unpleasant frame of mind. By understanding what causes surplus activity in these modules, it may be possible to suggest remedies.

Pain is the classical example. Close to a third of the adult population of Norway suffers from chronic (and presumably inappropriate) pain (23). The pain is often associated with muscle and skeletal problems. One presumed cause, is a lack of physical activity, typically combined with unnatural strain on certain parts of the body, as when sitting all day in front of a computer. Another cause is a misguided immune system, in the form of an easily triggered inflammatory reaction. It is possible to alleviate pain by either cognitive or pharmacological intervention, but preventive measures would be a preferred strategy. Diverse physical activity throughout life is a possible option.

Anxiety may be viewed as a consequence of excessive, or unnatural, activity of the fear function. I have previously described a possible scenario for why anxiety has become such a common problem in Western societies (24). Briefly, infants do not understand that a locked door implies safety, as they rely on parental help to avoid any sort of danger, whether in the form of burglars or wild beasts. Parental proximity is therefore the key to avoid stimulating fear. The present way of handling infants typically involves reduced parental proximity; e.g., strollers instead of carrying, less skin-to-skin contact,

and less co-sleeping. The problem may be partly preventable by behavioral changes.

Depression is associated with hyperactivity in a "low mood" module. Patients suffering from anxiety are often at risk for depression as well. It has been estimated that roughly a third of the population over a lifespan suffer from anxiety and/or depression (9,10).

While fear has an obvious biological function, it is less clear why we need a module for low mood. One presumed function is to secure social relations. In the Stone Age a lack of a strong social network, in the form of a tribe, would be a serious threat to survival. The low mood, as exemplified with loneliness, induces negative feelings in order to teach the individual to seek fellowship with others. In other words, the low mood suggests that your social relations are not satisfactory.

The same module may be active when you are unsuccessful in a task, such as missing the game in a hunt or getting lost in the forest. Today, flunking an exam or losing a competition are probably more likely scenarios. Again the feeling induced ought to be unpleasant in order to teach the individual to try to avoid ending up in this situation the next time. The high prevalence of depression may reflect that modern societies are troubled by a suboptimal social environment and by too much pressure on achievement. Altering these conditions may alleviate the problem.

Mental health

Hyperactivity in these three modules – i.e., pain, fear and low mood – is probably the more common cause of reduced happiness in Western societies. In more overt cases, the problem is diagnosed as a mental disorder, while most people may experience a suboptimal quality of life due to more limited, but still inappropriate, activity in these modules. The point should not be to obliterate all activity, only what is excessive or non-functional – pain, for example, is often important for survival. In other words, the main challenge in connection with mental health can be viewed as moving the mind up on the continuous scale (from negative to positive) of mood module activity; without jeopardizing health.

At the face of it, the three negative sub-modules appear to induce completely different types of feelings and experiences. The present model, however, suggest that they all converge on a shared module that generate the tonus of unpleasantness, i.e., the punishment module. Similarly, the various pleasures converge on the reward module (the two reward modules, seeking and liking, if one prefers).

Various evidence supports this notion. Recent neurological research indicates that social situations that are considered either positive or negative activate much the same nerve circuitry as do stimuli such as respectively sweet taste or physical pain (6,7,25-27). The present model is based on an extrapolation of these findings to all sorts of situations that carry an element of positive or negative effect. Jealousy, for example, may touch on the module devoted to punishment; while achievements activate rewards.

The above assumption also fits with current ideas as to how evolution operates. As pointed out above, early nervous systems had limited functions beyond simply directing behavior toward or away from stimuli. The "reflex modules"in charge are present in most invertebrate animals. It is interesting to note thatthe aversion-instigation reflexes use the same neurotransmitters (dopamine, serotonin and opioids) that serve in the mammalian mood modules (5,28,29).

Evolution generally builds on existing structures by expanding on them. Thus it is to be expected that the underlying dichotomy is still present in humans, and that features of the neurobiology is retained, although in a much more advanced and intricate form. In the human brain the functions have expanded to include a range of feelings, as well as all sorts of cognitive ramifications.

It is to be expected that the modules converging on punishment are common causes of complaint. For one, people are unlikely to object if modules offering positive feelings should be hyperactive. Then again, this is less likely to happen. The negative modules are typically involved in some sort of defense; i.e., they are there to avoid dangers and adverse situations. Defense functions are, in general, designed for a low threshold of activation; as it is more important to react with fear once too often, than not to react in times of real danger.

It is better to jump at the sight of a stick resembling a snake, than not to respond when

approaching a real snake. The ease of activation implies that these functions are more likely to be "exercised" and thus end up dominating the mind.

The concept of discords

Ailments that appear to be more common now than during the Stone Age are typically referred to as diseases of civilization. Some of them are primarily a question of having more people live to a higher age, such as dementia and certain types of cancer. A range of conditions, however, are likely to be a consequence of suboptimal aspects of the present environment – for example, nearsightedness, lung cancer and diabetes. The more common types of mental diseases, including anxiety and depression, probably belong to this latter category.

If one could delineate the actual aspects of the environment that are suboptimal, one would have a strategy for prevention. An illustrative example is to reduce the habit of smoking in order to prevent lung cancer.

According to the present model, the clue to finding preventive measures, in the case of mental problems such as anxiety and depression, rests with finding the factors that contribute to elevated activity. In short, what is causing excessive exercise of the fear and low mood brain modules?

The evolutionary approach is suitable for suggesting candidate factors, but traditional psychological and epidemiological research is required to estimate their actual impact.

As in the case of any animal, humans are adapted to live under certain conditions. In the literature of evolutionary psychology these conditions are commonly referred to as the Environment of Evolutionary Adaptation (EEA); or in more colloquial terms, the Stone Age (30). Differences between present living and life in the EEA are referred to as mismatches. Mismatches may be purely beneficial, such as sleeping on a mattress instead of on the ground or being cured from an infection by the use of antibiotics; but some mismatches have detrimental effects. The latter may be referred to as discords (4,22). Discords are, per definition, responsible for the diseases of civilization (i.e., those that are not consequences of an increased age).

Although any part of the body may suffer from discords, as exemplified with lung cancer, the brain is probably particularly vulnerable. For one, it is a highly complex organ and thus easily thrown out of "balance"; two, it is designed to develop in interaction with the environment, thus when the environment differs from what the genes "expect", the brain is likely to be affected; and three, it is the most important organ of your body in regards to quality of life.

Infancy is a particularly important period. It is during the first years of life that the brain goes through its most dramatic transformation, thus discords affecting infants are more likely to leave lasting "scars" in the brain. It is possible to overcome these scars, but dealing with mental problems tends to be more difficult than curing somatic diseases. Consequently, preventive measures meant to reduce mental agony should focus on how we care for infants.

Conclusions

The present model of happiness incorporates current biological knowledge, including the neurobiology of the human brain, how the evolutionary process works, and the comparative study of animals. The value of the model depends to a considerable extent on a correct interpretation of words such as brain module, mood and happiness.

Chronic pain, anxiety and depression are arguably the most common causes of reduced quality of life. The evolutionary approach offers both an explanation for the current predicament, and possible preventive measures. Happiness depends on tuning down negative modules and tuning up positive modules; where avoiding excessive activity of the negative circuits during childhood and adolescence may be the more important issue. The predictions made as to how one can improve happiness, i.e., avoiding unnecessary stimulation of modules involved in punishment, and exercising modules involved in rewards, can be tested.

It is possible to improve happiness by engaging the reward module, but it appears to be more important to avoid letting the modules impacting on punishment dominate. Indulging in hedonic pleasures

is likely to cause health problems later in life; for example in the form of alcoholism, diabetes and obesity.To the extent that the default setting of the brain is one of good mood, it is more important that this sentiment is retained. The foremost advice as to happiness is consequently to avoid enhanced activity in negative circuits.

The model may appear to be somewhat technical, and it does not consider issues typically brought up in connection with happiness studies, such as job related matter, social network, and a meaningful life. These elements are of obvious importance, but their role, according to the present understanding of happiness, is played out by their impact on the mood modules. The model does not refute the relevance of these aspects of life, but suggest an explanation for why they matter.

One suggested rule of thumb is to adjust the conditions of life in accordance with the environment of evolutionary adaptation – i.e., to avoid discords. It is possible to exercise the rewarding sensations, but it should be emphasized that in order to be a viable strategy, the impact of engaging in reward stimuli should be calculated over a lifetime. Moreover, the pursuit of happiness should preferably not reduce the prospect of happiness for future generations.

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