

Why Negative Feelings are Important when Assessing Well-Being

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Abstract Present knowledge on the human brain, and the evolutionary process that shaped it, allow for a biological model for what happiness is about. I shall discuss the assessment of happiness; arguing that based on this model, the focus should be on estimating negative affect. Feelings are a feature introduced by evolution for the purpose of evaluating behavioral options. They tend to be either positive or negative due to their role in directing behavior either toward opportunities or away from danger. Happiness can be construed as the net sum of positive and negative feelings. A salient point is that the evidence suggests the mammalian brain has a positive mood as a default setting, implying that people are reasonably happy as long as punishing circuits are inactive. Activation of negative feelings—particularly in the form of anxiety, depression and pain—is therefore likely to be the main cause of a substandard level of well-being. Consequently, instruments that probe negative affect may offer a reasonable strategy, or at least important additional information, when evaluating happiness. These instruments may also provide a suitable foundation for policy making.

Keywords Measuring well-being · Mood circuitry · Default contentment · Indexes · Brain reward · Brain punishment

1 Introduction

Over the past decades questionnaires that assess happiness, in the form of subjective well-being or life satisfaction, have gained credibility as reliable and valid contributions to estimating quality of life. The typical question asked is of the type, “On a scale from 0 to 10, how well do you feel?” Western countries in general, and Scandinavian countries in

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particular, tend to top international comparisons, with scores approaching 8 on the 0–10 scale (Helliwell et al. 2012); yet mental suffering has become a major burden of health in these societies. According to estimates, 31–50 % of the population experiences a mental disorder at some point in life, and 17–33 % had a diagnosable condition during the last 12 months (Moffitt et al. 2010; Wittchen et al. 2011). Moreover, mental health costs are a main source of global economic burden (Bloom et al. 2011). The most common disorders are related to anxiety and depression, as well as chronic pain (Breivik et al. 2006), each with a lifetime prevalence of 15–20 %, but with considerable comorbidity.

The conditions mentioned above are expected to cause a considerable reduction in quality of life. As discussed elsewhere (Williams and Nesse 1991; Grinde 2009), mental problems seem to belong to the “diseases of civilization”, implying that they are partly a result of the present living conditions. That is, the observed amount of mental agony does not appear to be the natural state of the human mind, implying that it should be possible to reduce the problem by adjusting the environment (Grinde 2005). For this to happen, we need to find the causes, and we need tools that measure progress.

It is a paradox that Western countries obtain such a high score on happiness in spite of the mental burden. The paradox indicates that the presently employed happiness-measuring instruments are not optimally designed. As quality of life scores are increasingly used to inform public policy, it is important that the reported values are as accurate as possible. Several authors have pointed out the surprisingly weak correlation when measuring positive and negative affect; and the subsequent need to include both when assessing quality of life (Diener and Emmons 1984; Schimmack 2008; Helliwell et al. 2012). The present text argues that in order to improve well-being, the most important target is to reduce unwarranted activity of the brain’s punishment circuits. By focusing on this parameter in the assessments, we may achieve a more pertinent policy for improving quality of life.

1.1 Present Strategies for Assessing Happiness

There is no gold standard when it comes to measuring happiness, thus it is hard to tell which instruments offer the information of interest. Happiness surveys covering large populations typically include relatively few items (five or less), and tend to focus on questions of how well one feels; survey instruments include *Satisfaction With Life Scale* (Diener et al. 1985) and *Subjective Happiness Scale* (Lyubomirsky and Lepper 1999). It is considered relevant to distinguish between cognitive life evaluations (asking how happy people are doing with their lives as a whole), and emotional reports (asking more specifically about various types of positive and negative affect) (Helliwell et al. 2012). The *Scale of Positive and Negative Experience* (SPANE) (Diener et al. 2010b), and the *Positive and Negative Affect Schedule* (PANAS) (Watson et al. 1988) are examples of the latter. All these instruments ask direct questions, as opposed to probing the issue more indirectly, which, for instance, could be in the form of asking about sleeping habits in order to indicate anxiety or stress. The direct strategy seems rational, as long as the purpose is self-reported, or subjective, well-being; although it does open for report bias.

Psychometric instruments are evaluated for reliability (the extent to which the same type of questions yield comparable answers) and validity (whether the scores obtained reflect the true value of the element to be measured). The reliability issue seems to be unproblematic; life satisfaction items worded in different ways generate a reasonably consistent response (Diener et al. 2009). However, as with most psychometric tests, the validity of the scores is more difficult to evaluate.

One potential bias is that people tend to give more weight to present feeling, rather than the “net sum” of feelings over time, particularly in Western societies (Wirtz et al. 2009). Another bias is to confuse success, for example in economic terms, with actual satisfaction. A person who believes to have done well compared to his peers, may rate himself high on questions pertaining to well-being even in the presence of devastating emotional problems. Consequently, questionnaires that try to distinguish between positive feelings and a successful life have been employed, and the results indicate that the two concepts differ (Kahneman and Deaton 2010; Diener et al. 2010a). For example, the score for how good, in terms of successful, we perceive our lives to be does correlate with income; while the more emotional aspect of well-being is hardly correlated at all. Unless these two qualities are separated, the answers to questions pertaining to subjective well-being are likely to reflect both.

Besides the issue of actual success in life, people may elevate their score of happiness because they like to be perceived (by themselves or others) as happy; what is referred to as socially (or personally) desirable responding. It seems plausible that there are cultural differences as to how this factor will impact on the responses given; for example, there appears to be a tendency in Western cultures to report an exaggerated impression of one’s personal mood (Hoorens 1995; Headey and Wearing 1988). There may also be cultural differences in the interpretation of questions, or in the use and meaning of response scales, that can affect the results (Oishi 2010). Furthermore, the subpopulation that actually answers the questionnaires may be more or less typical for the population that one wishes to probe (Henrich et al. 2010).

These biases may help explain the high scores obtained by Western countries in spite of the prevalence of mental agony. Regardless of the validity of cross-cultural comparisons, the apparent innate, and universal, tendency for optimism (Diener and Diener 1996; Lykken 2000) may generate an elevated score in all societies. Contrary to this suggestion, the World Happiness Report does describe a world average of 5.3, that is, close to the median value on the 0–10 scale (Helliwell et al. 2012). However, one might argue that the “true” value could be below five, considering the prevalence of mental disorders as well as the adverse conditions in typical third world countries; while the score in an ideal world should be well above five.

It seems particularly difficult to determine test validity in the case of happiness. Various forms of comparison do suggest that the scales discussed above are somewhat valid (Helliwell et al. 2012). For example, even simple self-report measures correlate with intuitively relevant variables such as amount of smiling, physiological measures, health, longevity, and how friends evaluate the happiness of the responder (Pavot 2008). Yet the evaluation does not exclude that the results are distorted by the types of bias discussed above, particularly when comparing various cultures.

In view of the above discussion, it seems pertinent to take a closer look at the relationship between happiness and the level of punishing feelings.

2 The Biology of Happiness

2.1 Neurological Units Responsible for Mood

The mammalian brain has been shaped by evolution to care for a variety of purposes, including anything from controlling the movement of a finger to instigating anger. A

reasonable approach to understand the brain is therefore to consider it as divided into numerous modules or functional units. A module can be understood as the neurobiological correlate of a function. Each module deals with a particular need that arose during our evolutionary history and can be engaged when required. Neural networks or circuits are the substance of brain units, but the actual anatomical location and neurochemistry of networks corresponding to particular functions are complex and rarely known in detail. It is important to note that the modules are not fixed, but open to be molded by environmental impact.

The part of the brain responsible for positive and negative feelings can be referred to as *mood modules*. Happiness can be construed as the product stemming from these modules, a notion previously referred to as the biology of happiness or Darwinian happiness (Grinde 2002, 2012a, b).

The primary purpose of nervous systems is to direct the organism either to take advantage of opportunities or to avoid dangers; as exemplified by respectively obtaining food and escaping a predator. These two functions—attraction and aversion—are still a key ingredient in even the most advanced brains. In the mammalian brain, evolution has installed positive and negative feelings for the purpose of making relevant behavioral decisions: *Brain rewards* imply any pleasurable sensations and should direct the animal toward whatever is good for the genes; while *brain punishments* are defined as processes meant to be unpleasant and thus should move the animal away from danger (Watson and Platt 2008). The mood modules encompass the brain circuitry involved. The function of the mood modules can be described as telling the individual animal (or human) whether it is on the right or wrong track toward survival and procreation.

Feelings, in the form of pleasure and pain, represent the subjective, hedonic value of rewards and punishments. The strategy presumably evolved due to the advantages of having a “common currency” for evaluating various options (Cabanac 1992).

2.2 Biological Correlate of Happiness

It seems pertinent to define happiness as the sum of activity, or net output, of the mood modules; a quantity that is reflected in the term *mood value*. According to this model, well-being is a question of maximizing mood value; preferably as integrated over a life-time. It should be noted that the mood modules may be active most of the (awake) time, and that rewards and punishments can be elicited by either external or internal stimuli. Moreover, the units are controlled by “dimming switches” rather than simple “on–off” buttons.

The word “mood” in this context includes not only the long-term aspects of temperament or emotions, but also short-term pains and pleasures; and it includes both sensual stimuli and eudaimonic contentment. Mood is here considered to be an aspect of the mind, or the conscious experience, that moves up or down a scale that ranges from unpleasant to pleasant; the ups and downs being due to variations in the degree of reward and punishment activation. The term emotion typically focuses on the particular functional role (for example, love, grief or anger), while mood points to the actual positive or negative quality of affects, emotions and sensations. According to the present model, there are independent neuronal networks caring for the particulars of each type of emotion or sensation, while they converge on partly shared structures responsible for their mood value. The latter point is discussed below.

Positive feelings are best understood as depending on two distinct overarching functional units, referred to as *seeking* (some scientists call it wanting or incentive salience) and *liking* (the reinforcing feelings associated with the actual consumption) (Berridge 2003;

Panksepp 1998). Even in the early nervous systems, seeking and liking presumably reflected two independent functions: the animals were instigated first to search for relevant items in the environment, such as food, and subsequently for devouring the items. As these two functions were separated at an early stage in the evolution of nervous systems, they are expected to have distinct neurobiology, which appears to be the case (Kringelbach and Berridge 2009).

The neurobiological correlates of positive and negative feelings have been examined by methods including brain scans, the use of neurochemical modulators, and electrical stimulation. Briefly, the more ancient (presumably subconscious) neural circuitries involved are located in subcortical parts of the brain—including thalamus, hypothalamus, amygdala and hippocampus; while the cognitive extension appears to involve circuitry in the orbitofrontal, lateral prefrontal, insular and anterior cingulate parts of the cortex (for reviews, see: Kringelbach and Berridge 2009; Leknes and Tracey 2008). The subcortical parts are probably essential for generating positive and negative feelings, while the cortex adds specific content, and helps facilitate conscious experience. Consciousness is required for feelings to make any sense—as well as for the capacity to moderate their impact (Grinde 2013).

There is growing evidence supporting the notion that the various types of pleasures and pains—including sensual input as well as social gratification and agony—converge on certain key neurobiological features. For example, experiencing envy of another person's success activates pain-related circuitry, whereas experiencing delight at someone else's misfortune (what is referred to as *schadenfreude*), activates reward-related neural circuits (Lieberman and Eisenberger 2009; Takahashi et al. 2009). Similarly, feeling excluded, or being treated unfairly, activates pain-related neural regions (Eisenberger et al. 2003). On the other hand, positive social experiences, such as obtaining a good reputation, being treated fairly, and cooperating with others, offer rewards similar to those obtained from desirable food (Izuma et al. 2010; Tabibnia and Lieberman 2007; Tabibnia et al. 2008). Moreover, the same reward related brain regions are activated when having sex or enjoying music (Blood and Zatorre 2001).

The main neurotransmitters involved in the mood circuits are dopamine, serotonin, and opioids (Mitchell and Phillips 2007). Interestingly, these are used in even the most primitive neural systems, such as that of nematodes, where they apparently serve the evolutionary homologues functions of attraction and avoidance (Chase and Koelle 2007; Nieto-Fernandez et al. 2009). This observation further strengthens the idea that the human mood circuitry represents an evolutionary expansion of processes involved in directing animals either toward opportunities or away from dangers.

The various mood modules are best understood as separate entities that can, to some extent, operate independent of each other. However, in order to generate a conscious experience the input from all active units is integrated to form a merged percept (Grinde 2013).

The mood circuitry may be activated directly from a sensory experience, such as tasting sweet food or burning a finger; but cognitive functions may intervene to the effect of either subduing or enhancing the rewarding or punishing feelings. Cognition can also instigate feelings in the absence of external stimulation as when daydreaming. Minor alterations in a situation or a line of thought—whether due to conscious input, subconscious brain activity, or external factors—can change the net effect abruptly from a positive to a negative experience.

Grief is an illustrative example. Normally this is an unpleasant feeling as it is evoked by events that are unfortunate for the person (and the genes), such as the loss of a partner. The

brain reacts by marking the occurrence as something to be avoided. On the other hand, the reaction of grief serves a purpose in that it may help the individual overcome the situation. Furthermore, the sorrow is visible in the face, which suggests that communicating this feeling is beneficial, presumably by eliciting support. The notion that grief may actually improve fitness implies that the individual is best served by engaging the emotion; and in order to instigate this setting of the mind, a reward is called for. Consequently, sorrow may feel either good or bad. This conjecture helps explain why people attend sad movies: When your own situation is not jeopardized, the reward part of grief may overwhelm the negative aspects. In fact, it has been shown that while grief normally activates pain-related areas of the brain, in some situations it activates reward centers (O'Connor et al. 2008).

In other words, it is not obvious whether a particular situation will add or subtract to the level of happiness; that is, whether the situation will activate positive or negative mood circuits. The context, the particulars, as well as cognitive assessment, may move the experience toward being either pleasant or unpleasant.

2.3 Default Contentment

Much of daily conscious activity has only limited relevance for the level of happiness. People do not experience life as a stream of either good or bad events, but rather as a relatively steady state. Mood may move slightly up or down, as when respectively working on an interesting task or being worried. More rarely, episodes may cause a particular surge of pleasure or pain. In other words, the functional units generating mood do not normally dominate the mind; but that does not imply they are inactive. It seems more appropriate to envision a tonus of mood caused by a balance of positive and negative activity. The steady state tonus can also be referred to as a *setpoint of happiness* or *subjective wellbeing homeostasis* (Lykken 2000; Cummins et al. 2014).

The setpoint presumably reflects genetic factors in that happiness has an heritability component. Whether the setpoint is solely written in the genes, or can be molded by life events, may be down to choice of definitions. As far as assessing the setpoint for individuals, it seems likely that how the mind is shaped by early experiences will impact on the values measured. The important point is that while it is easy to find a stimulus that sends happiness temporarily beyond the setpoint, it is more difficult, but not impossible, to boost the general level of happiness.

The setpoint may be seen as a way to homeostatically protect the mood and thus improve resilience to negative life events (Cummins and Wooden 2014). A negative mood is meant to induce a change of behavior, but it should not prevail as it may be counter-productive for long term life sustenance. A similar argument is relevant for positive feelings, for example, the pleasure of eating should end when the stomach is filled up. Yet, resilience when experiencing harsh conditions seems more important for survival than turning off excessive positive mood, which suggests that the population, on average, should maintain a positive frame of mind.

The dichotomy of hedonism (sensual pleasures) and eudaimonia (human flourishing) has been a core issue in the discussion of happiness (Deci and Ryan 2008; Fredrickson et al. 2013). It is important to note that although the biological model stresses the stimulation of reward circuits as essential for happiness, the model does not promote hedonism. Based on the following two arguments, typical hedonic stimuli are probably of limited importance for the mood value when integrated over a lifetime: One, hedonic pleasures tend to be of short duration, and some are potentially harmful later in life (Stice et al. 2013). Two, although hedonic stimuli typically activates the reward circuitry, so do

eudemonic experiences and situations. For example, engaging in “meaningful activities”—a typical eudemonic approach to happiness—is associated with rewards, presumably because it is rational for evolution to attach positive feelings to utility. The brain encourages us to do something constructive. Similar reasoning applies to other values typically incorporated in eudaimonia, such as being virtuous and obeying social rules. As pointed out in the former subchapter, social gratification apparently activates the same reward circuits as do typical hedonic incitements. Thus, although hedonic stimuli may elevate the short-term mood value, they are not required for a positive output, and they may lead to a decrease in life-time mood.

As pointed out above, humans (and most likely other mammals) appear to be designed to be in a positive state of mind. In the absence of adverse factors, it is presumably in the interest of the genes to reside in a body/mind with a positive attitude to life, as this state of affairs is conducive to the pursuits required for survival and procreation. The individual is more likely to take the trouble of looking for food or a spouse if in a good mood. As pointed out by Kahneman and Krueger (2006, p. 19): “the predominant emotional state for a vast majority of people during most of the time is positive”. The point, which has been referred to as a *default state of contentment*, is discussed in more detail elsewhere (Grinde 2012a). In support of the default contentment hypothesis, there is considerable data suggesting that people tend to be happy and optimistic; e.g., in connection with gambling and when responding to questionnaires related to happiness (Diener and Diener 1996; Lykken 2000). Presumably it is possible to be alert and focused, and thus ready to respond to both opportunities and dangerous situations, while retaining a content mind; that is, without activating the fear module.

The default contentment is likely to be associated with eudaimonia rather than hedonia, as it does not require any external (sensual) stimuli, and as it is not in any way detrimental. Furthermore, retaining this state of mind is probably more relevant for the long-term level of happiness compared to pursuing typical hedonic pleasures. Yet, it seems likely that the default contentment simply reflects that the mood circuitry is designed to operate with a net positive value as long as punishment is not specifically activated. That is, a person with proper mental health, whose basal needs are cared for, retains a positive frame of mind.

2.4 Impact of Negative Feelings

Based on the above arguments, it would seem that the most important factor as to the level of happiness is whether negative feelings are activated in the absence of due cause. In other words, in order to obtain happiness it is important that the nerve circuits responsible for punishment are not primed for superfluous action.

It should be stressed that the brain’s capacity for delivering punishment is an essential ingredient in life. People who lack this capacity, e.g., those with congenital insensitivity to pain (Cox et al. 2006), or inability to experience fear due to damaged amygdala (Feinstein 2013), have a predicament that can easily cause either reduced quality of life or a premature death. Any activity of the punishment circuitry is expected to decrease (biological) happiness temporarily, but the lack of such activity is likely to cause a much more severe reduction in the longer run. Consequently, the problem is the excessive triggering. Negative feelings (such as fear) may be generated regularly in a low quality (dangerous) environment, but as long as the stimuli are real, this is not considered superfluous activity in the present context. Excessive fear is when the reaction does not stand in proportion to actual danger, such as a fear of harmless animals, or when the reaction is triggered solely by the imagination.

As pointed out above, various emotions may activate either positive or negative feelings depending on the situation; yet certain emotions seem to be responsible for most of the unwarranted reduction in happiness. The more pertinent sentiments are fear, low mood, pain, and perhaps anger. In the present vocabulary, excessive triggering of punishing feelings of the former two is referred to as respectively anxiety and depression. Chronic pain is typically considered superfluous, disproportionate anger similarly.

In the Introduction, I point to references suggesting that clinical anxiety, depression and chronic pain each have a life-time prevalence of some 15–20 % (it is difficult to find a similar figure for excessive anger). The term “clinical” presumably suggests unwarranted activity. It seems unlikely, as argued elsewhere, that the prevalence reflects the natural state for the human species; the conditions are debilitating and would therefore be expected to be selected against in ancestral populations (Grinde 2009). A reasonable interpretation is that the high prevalence is due to suboptimal aspects of the present environment causing enhanced responsiveness. Furthermore, the conditions considered pathological may be the tip of the iceberg when it comes to reduced quality of life. Perhaps a majority of the population in industrialized countries does, at some point, suffer from excessive fear or low mood, without the condition being sufficiently severe to warrant a diagnosis. The high prevalence is unlikely to reflect changes in genetic constitution, as there has not been sufficient time (or cause) for evolution to modify the genes; but presumably reflects aspects of the current way of life. Moreover, I would not argue that the conditions were any better a hundred or a thousand years ago. As argued elsewhere, the main change in way of life came with the transformation from a tribal setting to large scale societies (Grinde 2012b).

An important feature of the punishing circuitry is that it tends to be easily triggered, as discussed in Grinde (2012a); and consequently is more likely, compared with reward circuitry, to impact on the mood level. Punishment circuitry also seems to be more easily (for the same reason) strengthened by experience; that is, excessive activity of negative feelings is more common than excessive activity of positive feelings.

3 Assessing Negative Feelings

The present analysis suggests that the main determinant of (un)happiness is the level of punishing activity. If so, an assessment of happiness may be achieved by probing negative feelings.

There are well known instruments for the more relevant emotions. For anxiety and depression one may, for example, use parts of the *General Health Questionnaire* or the *Symptom Check List* scales (Koeter 1992); for pain, the *Brief Pain Inventory* (Breivik et al. 2006); and for anger/aggression the *Spielberger Anger Expression Scale* (Knight et al. 1988).

These instruments are generally used to probe what is typically considered unwarranted, or inappropriate, emotions; although it is understandably difficult to distinguish between appropriate and inappropriate. The complete questionnaires are relatively long and cumbersome for a larger, population centered study. Short versions may, however, be used; weighing ease of administration against accuracy and bias. Other negative emotions can be added, for example simple questions as to guilt, shame, loneliness, and jealousy. Together the items included may be employed to calculate a score reflecting excessive negative affect, which may be used as an inverse assessment of happiness. Details as to how that is

best achieved are beyond the scope of the present article. All questionnaires need to be designed for the actual population and purpose in mind.

There are some caveats to this approach. For one, it seems difficult to design simple questionnaires that cover all relevant negative affects, while simple questions as to how well one feels have a proven merit. The latter questions may also yield a higher rate of participation. Moreover, measuring happiness by this strategy would not eliminate possible bias. For example, people may still answer according to what is felt as socially (or personally) desirable.

Another issue regarding negative states is the question of how the individual deals with the situation. A given level of anxiety, for example, can be devastating for one person, yet reasonably bearable for another. In this case, the obvious response is to differentiate based on degree of coping, but the current scales used to assess anxiety may not be ideal for this purpose.

While I argue that both negative and positive affect are relevant for the assessment of well-being, it is not obvious how the data should be combined. Not only the scales used to probe negative versus positive feelings differ, the two may differ in functional terms. Although it is possible to simply add the two scores, how to weight them would be somewhat arbitrary. The main argument for the present purpose is that both approached can be used to obtain meaningful data, and thus should be pursued.

4 Discussion

When trying to improve the well-being of a population, it seems appropriate to distinguish between possible means and the actual aim. The aim is true happiness as a quality of the mind; possible means include education, health services, a sense of control over life situation, and a level of personal freedom. These are not necessarily required for a positive mind, but they are likely to promote happiness; at the very least they correlate with measures of subjective well-being.

Although the political focus tends to be on establishing the various means, it would be highly preferable to have a reasonable relevant and direct way of measuring success in terms of the average mood value of the population. Unfortunately there is no direct measure for mood value; but based on a biological understanding of what happiness is about, I argue for the inclusion of scales that assess negative feelings. Kahneman and Krueger (2006) argued similarly when suggesting that the use of a “U-index” (for “unpleasant” or “undesirable”) may be less easily biased. The U-index probes the percentage of time that people spend in an unpleasant state, which is defined as an episode where negative emotions outbalance positive emotions (a negative mood value in the present terminology).

For the time being, the best strategy may be to supplement, rather than to replace, the present happiness instruments in order to improve our estimates of quality of life. Positive psychology developed from a sense that the traditional focus on negative conditions did miss something (Diener and Diener 1996), it may be time to take a step back and include negative emotions in order to better evaluate the positive.

Simple scales for probing negative feelings have been employed on a global scale. As pointed out in *The World Happiness Report* (Helliwell et al. 2012), countries scoring low on negative affect do not match those scoring high on positive affect. Consequently, when combining the two, which seems a logical thing to do, the score-list of nations deviate

considerably from the list probing solely subjective well-being. According to the biological perspective discussed in the present article, the score for negative feelings may be more relevant than probing happiness directly.

Negative emotions appear to be where the shoe pinches in present societies. Regardless of to what extent that is correct, they are presumably the factors one ought to focus on in order to improve quality of life—preferably in terms of prevention (Grinde 2005, 2009, 2012b). That is, it seems easier to improve the level of happiness by reducing the impact of pains compared to boosting the pleasures. The relevance of focusing on how to prevent negative affect was pointed out by Kahneman and Krueger (2006) as well.

The main reason for taking on the task of evaluating quality of life is to facilitate change. It is arguably best to use an instrument that as directly as possible measures the quantities one wishes to improve. If the main target is to reduce the burden of negative feelings, such as anxiety and depression, this is better cared for by focusing on negative affect when assessing progress.

Ideally one should have objective (physiological) measurements that directly gauge output of the mood modules and thus the level of (biological) happiness. Although attempts have been made to find the neurobiological correlates of both positive and negative affect (primarily by EEG and brain scans), these correlates are not yet sufficiently accurate to substitute for questionnaire data (Huppert et al. 2005; Kringsbach and Berridge 2009), neither are they practical to implement on a population scale. One line of future research should be to improve our knowledge of the neurological correlates of mood modules; thus facilitating more direct measurements of mood value. However, substantial research is required before that is a viable option.

In the shorter time span, it would be worthwhile to obtain better data as to how positive and negative affect correlates. Moreover, the instruments presently used to assess negative emotions are typically designed with particular clinical conditions, such as anxiety and depression, in mind. A more general instrument would be desirable; that is, an instrument designed for probing a healthy population rather than meant to identify clinical problems; and designed to assess the negative emotional impact rather than the mere presence or level.

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