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Disentangling Motivational and Experiential Aspects of “Utility” – A Neuroeconomics Perspective

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Abstract

Although decision makers are often reported to have difficulties in making comparisons between multi-dimensional decision outcomes, economic theory assumes a uni-dimensional utility measure. This paper reviews evidence from behavioral and brain sciences to assess whether, and for what reasons, this assumption may be warranted. It is claimed that the decision makers' difficulties can be explained once the motivational aspects of utility ("wanting") are disentangled from the experiential ones ("liking") and the features of the different psychological processes involved are recognized.

Keywords: *utility, neuroeconomics, index number problem, wanting, liking, affective forecasting*

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> "How do we sum up, on the basis of some objective measures of intensities, the respective desires for an ice-cream, freedom from a headache, writing the most beautiful sonnet ever written, going to bed with one's favorite film star, and being morally impeccable?" (Sen, 1981, 200)

1 Introduction

At the heart of microeconomic theorizing lies the concept of individual preferences. In its present, axiomatically founded form, it is the outcome of a century-long transformation of utility theory and core notions (Mirowski, 1989; Lewin, 1996; Bruni and Sugden, 2007). Initially, in the writings of classical utilitarians like Bentham and Mill, the notion was substantiated in terms of physiological and psychological conjectures about how utility arises from the enjoyment of a variety of pleasures and the avoidance of various pains and, hence, in multiple dimensions. Today the standard interpretation of "utility" has mutated into the abstract concept of a uni-dimensional index number stripped off of all sensory connotations. It serves as a placeholder for "... that which represents a person's preferences" (Broome, 1991, italics omitted). The "purging out" of the physiological and psychological hedonistic aspect of utility (as Samuelson, 1947, 90-1 put it) helped to increase the "mathematical fitness" (Warke, 2000b) of the theory, but it came at a cost.

Where classical utilitarianism gave the enjoyment/avoidance of the various sorts of pleasures/pains as the reason that motivates corresponding actions, in modern preference theory there is now only an abstract idea of preference satisfaction. More substantial hypotheses about the motivations that are causing actions are lacking. Under such conditions it is difficult, if not impossible, to resolve two problems which modern preference theory faces.

The first problem is to assess whether "preference satisfaction" is meant to be the motivating force of an action or the experienced outcome of an action. Or can it be both at the same time? The second problem relates to the question of whether a uni-dimensional index number is indeed an appropriate measure for utility. Corresponding to the different underlying motivations that may simultaneously be present there are different sources from which utility can arise. One might be inclined therefore to follow the classical utilitarians in their assumption of a multi-dimensional measure. Consider the example of a wristwatch. It may be a source of utility as a chronograph, as an esthetic pleasure, as a status symbol, as a collector's item, etc. Can utility derived from the different sources indeed be lumped together? If so, how is this done? Suppose it cannot be done and assume that a fountain pen is a source of similar multiple utilities. Would a decision maker then have to determine the substitution rates between wristwatches and fountain pens in all the different dimensions of utility independently?

Regarding the first problem, standard preference calculus obviously conflates the two interpretations of a desire to satisfy preferences by a particular action (the motivating aspect) and the experience of preference satisfaction connected with that action (the welfare or well-being aspect). In recent works in behavioral economics (Berridge, 1999; Berridge and Robinson, 2003; Winkielman and Berridge, 2003; Markman and Brendl, 2005) the two qualities of utility as motivator and experienced reward are identified with the concepts of “wanting” and “liking” respectively. They do not necessarily accord with each other. An agent wanting a particular choice may eventually find herself in a situation of not liking that choice and vice versa. The challenge that a potential discrepancy implies for rational decision making is obvious (Sen, 1973).

In this paper we will argue that both the dimensionality or index number problem and the potential discrepancy between “wanting” and “liking” are closely connected to each other. In order to come to grips with both it is necessary to put some flesh on the bare bones of preference theory. We suggest to revive the interest of classical utilitarianism in physiological and psychological hypotheses and to elaborate them in the light of new findings from the behavioral and brain sciences.

The paper is structured as follows. In Section 2 we will first expand on the dual problem and of uni- versus multidimensional utility on the one hand and that of “liking” versus “wanting” on the other. Section 3 then discusses relevant evidence from the behavioral and brain sciences that allows to better assess whether or not utility is properly represented as a uni-dimensional magnitude. The discussion will be linked here to an analysis of how the brain processes reward. While there may be multiple sources of reward, evidence supports the view that, in experiencing them (i.e. in scaling the “liking”), the brain spontaneously aggregates them into a uni-dimensional neural substrate, a common neural “currency”. However, as will be explained in Section 4, this does not mean that the aggregate value of reward in terms of the neural currency that can be obtained from multiple sources is always anticipated correctly. “Wanting” usually precedes “liking” in time. Decision makers may therefore have difficulties in accurately scaling predicted utility resulting from their choices (i.e. the future "liking") at the stage at which their “wanting” induces them to take the action. Section 5 offers some tentative conclusions.

2 The Plural Aspects of Utility

As is well known, in the canonical representation utility derived from taking some action A is conceptualized as a uni-dimensional variable $u(A)$ which represents an index number. The conceptualization can be given an axiomatic, preference-theoretic foundation if a decision maker’s preferences satisfy the conditions of transitivity, convexity, and completeness. Let action A be the choice of a commodity bundle $x \in X$, where X is the commodity space. Let an alternative action B be the choice of the commodity bundle $y \in X$. If the preference relation is also assumed to be continuous on X, there exists a continuous utility function $u(x)$. This function assigns a numerical value to each element in X and ranks these according to the preferences so that $u: X \to \mathbb{R}$ is a utility function that represents these preferences provided for $\forall\, x, y \in X: x \succcurlyeq y \leftrightarrow u(x) \geq u(y)$ holds ($\succcurlyeq$ denotes a preference relation).

In this conceptualization the reasons motivating the decision makers' orderings are not addressed, even if corresponding information is available.[1] Classical

[1] This lacuna extends into the sphere of normative economics and social choice where the satisfaction of abstract subjective preference orderings is assumed to generate "well-being", i.e. is taken as a measuring rod for individual welfare, see Binder (2010).

utilitarianism had had an entirely different approach. With its elaborate, empirically informed theory of utility it drew on a remarkable psychological intuition in tracing the action motivation back to sensory origins. Identifying utility with the enjoyment of pleasures or avoidance of pains, Bentham and his followers recognized that an action can trigger different pleasures or pains at the same time. These different pleasures/pains were considered sources of qualitatively different kinds of utility (Warke, 2000c). A utility measure was implied here that, unlike in the modern conceptualization of utility, is irreducibly multi-dimensional. Thus, the utility obtained from taking an action *A* would have to be represented by an *n*-dimensional vector, where *n* denotes the total number of different sources of utility,

$$U(A) \quad = \quad \begin{bmatrix} u_1\,(A) \\ \dots \\ u_n\,(A) \end{bmatrix}.$$

Such an assumption creates some serious problems. Consider a decision maker facing two possible actions – acquiring a wristwatch *(A)* or a fountain pen *(B)* say, to use the example again. The question is whether to choose *A* or *B*. Let there be $n = 4$ different sources or dimensions of utility: (1) the functional dimension (chronograph; writing utensil), (2) the esthetic dimension, (3) the status signaling dimension, and (4) the collector's pleasures dimension. A choice between *A* and *B* expressing consistent preferences requires an aggregation of the different kinds of utility into a compound measure by consistently weighing the utility arising in the four dimensions. The decision maker would have to be able to rate pleasures/pains in each of the different dimension cardinally and to attach a vector of weights $W = [w_1 \; \dots \; w_n]$ that reflects the relative importance the different sources or qualities of utility have for her.

However, as the initial quote from Sen (1981) highlights, any such deliberate utility accounting would amount to a significant cognitive challenge. In each single dimension wristwatches and fountain pens can be substitutes for a host of other commodities which, in turn, can be assessed simultaneously in yet other utility dimension. An attempt to keep track of the substitution rates between all relevant alternatives if income and/or prices change is prone to errors, biases, and other inconsistencies. The question is, of course, whether deliberation is necessary at all for utility accounting. The behavioral and brain sciences provide some evidence for spontaneous processes in the brain by which, under certain circumstances, perceptions of pleasures and pains coming from different sources are homogenized into a kind of common neural currency. The neural currency is sensed as a feeling of enjoyment or satisfaction that is homogeneous across the types of pleasures and pains.[2] In that case, the index number problem seems to disappear.

Before this possibility will be discussed further in the next section it is useful, however, to extend the perspective to include the second complication mentioned in

2 The evidence seems to support what Jevons (1879, 30-39) had it in mind when he lumped together into one compound "feeling" all the different kinds of sensory experiences that Bentham had been eager to distinguish. By claiming that the "feeling" and, hence, "utility" is neither measurable nor interpersonally comparable Jevons (ibid., 15-17) gave his interpretation a strong subjectivist flavor that became momentous for modern preference subjectivism. However, this is neither necessary, nor does a strict preference subjectivism appear warranted in a neuroscience perspective, see Kahneman et. al (1997).

the introduction. This is to the problem of whether "preference satisfaction" is meant to be the motivating force of an action or the experienced outcome of an action. The distinction does not play much of a role when, in a static economic decision calculus, the time dimension is neglected. (It is perhaps for this reason that, in the usually static textbook representations of modern utility theory, the potential is hardly ever mentioned.) The distinction matters, however, once cause (the choice of an action) and effect (the outcome) do not occur at the same time. In that case, a discrepancy can occur between the expectation that motivated the choice of an action and the actually experienced preference satisfaction caused by the action.

The motivational aspect of choosing an action can be identified with the notion of "wanting" (Berridge, 1996, 1999 which in biology relates to appetite or incentive motivation. The incentive value of an action – the reward expected in terms of enjoying pleasures or relief from pain – corresponds to forward looking preferences. Unless entirely random, the choice of an action is usually contingent on some form of expectations, i.e. more or less rudimentary forms of "predicted utility" (Kahneman et al. 1997). Once a specific action has been taken, its outcome has an experience quality that may, of course, differ from the predicted one. Choosing to eat a food item, for example, may or may not lead to a feeling of reward, i.e. a pleasurable experience. This experience may be called the "liking" aspect of utility (the evaluative side, not the motivational side).[3]

The experienced "liking" can, but does not necessarily do, feedback (correctly) on the underlying reward expectations. Apparently, humans do not easily correct for their faulty forecasting through experiential learning. Such learning seems to be forestalled by impeding factors like conformity bias (the tendency to focus attention only on information that confirms an individual's intuitive theories of how the world works), systematically distorted memories of pleasant experiences, and the need for repetition to learn from experience (Loewenstein and Schkade, 1999, 99). Many repeated situations are not completely identical and thus involve some dimensions that differ from the initial experience, thus making such learning more difficult.

The motivation to seek rewards ("wanting") is essential for the survival and reproduction of all animals. From a biological perspective it is, however, not the pursuit of pleasure and the avoidance of pain that represents the ultimate goal but reproductive success. Yet, nature has ingeniously made actions that are likely to benefit reproductive success also actions that, for animals and humans alike, cause a rewarding experience in terms of "liking". (The reverse is not true.) The reward often originates from a homeostatic process that seeks to regulate bodily functions such as controlling body temperature, oxygen supply, or calorie intake. If the organism detects a deviation from "set points" as regards the parameters that are necessary to allow its continued functioning, mechanisms set in to restore the balance condition. The organism becomes hungry, for example, to motivate the replacement of lost calories. The negative hedonic feeling of deprivation that is associated with the deviation from set points is nature's way of motivating action of the organism to restore homeostatic balance.

3 These likings can also be taken as a foundation for assessing individual well-being or welfare as it has indeed been suggested in welfare economics and social choice, see Ng (2003); Camerer et al. (2005); Binder (2010).

An experience of reward tends to reinforce the behavior that has triggered it. As a consequence, the frequency distribution of actions chosen over time can change. Many instances on which such reinforcement occurs, e.g. the intake of food when hungry, are genetically hardwired primary reinforcers.[4] Assuming that the experience of pleasure or relief from pain is felt as a reward, reinforcement learning can be interpreted as a non-cognitive form of behavior adaptation that is compatible with sensory utilitarianism. It is important to note, however, the complex dynamic interplay between the motivational side ("wanting" on the basis of predicting a rewarding experience) and the experience itself ("liking"). The pleasure aspect inherent in "liking" results from the instantaneous evaluation of the moment. This means that, unlike "wanting" which is informed by more or less concrete expectations, the actually experienced "liking" denotes the hedonic qualities of reward. "Wanting" and "liking" are not causally independent of each other. Yet, they can be dissociated from each other at the time axis. Moreover, they have different neural correlates (Berridge, 1999; Knutson and Peterson, 2005; Markman and Brendl, 2005).

3 Neuroeconomic Insights on Utility

The neurosciences and their affiliate neuroeconomics have recently been promoted as being able to help understanding decision making behavior with so far unknown scientific precision. Some technological and methodological problems notwithstanding,[5] a plausible case can be made that data gained in neuroeconomic experiments (or neuroscientific data more generally) provide additional evidence for evaluating competing economic theories.[6] In our particular context, understanding the neural correlates of "utility" may lend some assumptions of utility theory more biological substance than others.

Without going into the details of brain imaging here, e.g. PET, fMRI etc., it can be claimed that studies on reward processing have opened up to some extent what was previously a "black box", namely the brain activities that are triggered when an individual encounters a rewarding object (see, e.g., McClure et al., 2004). By seeing how pleasure is coded in the brain (see Kringelbach and Berridge, 2010), the neurobiology of reward can differentiate between three psychological components of reward (Berridge and Kringelbach, 2008, Becker and Meisel, 2007, 741). These components are "learning", "liking" and "wanting". Individual organisms learn that goal objects are rewarding because of their affective (hedonic) qualities and because

[4] Leslie (1996), Damasio (2003, 131-2). For a discussion of some economic implications see Witt (2001). By associative learning, previously neutral stimuli can be learned to be reinforcing as well, leading to instances of secondary reinforcement. Learned reinforcers are always conditioned on primary reinforcers, even if the chain of associations may sometimes be quite long and idiosyncratic (see Cabanac, 1979; McClure et al., 2004).

5 For example, the preeminent method of functional magnetic resonance imaging is quite coarse and aggregates information of thousands to millions of neurons in the brain, additionally suffering from a low temporal resolution of several seconds, at the time of writing this article, see, e.g., McCabe (2008); Harrison (2008); Logothetis (2008).

6 The potential that neuroeconomics has in this regard is discussed in Clithero et al. (2008). See also Jamison (2008), Landreth and Bickle (2008) and Caplin (2008). As Camerer et al. (2005, 10, italics omitted) state, "the study of the brain and nervous system is beginning to allow direct measurement of thoughts and feelings".

of the incentive salience (the "wanting") that is attached to these hedonic qualities. All three component parts are mediated by multiple, interactive neural systems.

To explain how reward is mapped onto brain functions let us first identify the brain regions in which rewards are processed (we draw here on the reviews of Berridge and Kringelbach 2008, Kringelbach and Berridge, 2010, Leknes and Tracey, 2008). While different tasks in general activate different brain regions, rewarding stimuli seem to consistently activate the same specific regions. [7] Dopamine systems project from the ventral tegmental area (VTA) to the nucleus accumbens (NAcc), amygdala and frontal cortexand also from the substantia nigra to the dorsal striatum (Becker and Meisel, 2007). Besides these core areas, the orbitofrontal cortex (OFC, which is a part of the prefrontal cortex), the ventral pallidum, and the ventral striatum play a role as brain substrates of reward processing.[8] The OFC has been found to receive direct input from primary taste and olfactory cortices as well as from higher-order visual and somatosensory areas (Kringelbach, 2005). It is thus an ideal place for the storage of reward values of sensory stimuli (McClure et al., 2004, 260-1). The amygdala, in contrast, seems to be involved in processing the intensity of positive and negative stimuli (Anderson et al., 2003). The ventral striatum also plays an important role regarding rewards because of its connection with the mesencephalic (midbrain) dopamine system.

The release of the neurotransmitter dopamine from the VTA on the NAcc has often been mentioned as mediating pleasure. However, this finding has been qualified in recent research (see Berridge and Kringelbach, 2008, Kringelbach and Berridge, 2010, Salamone et al., 2007). Increasing evidence shows that the release of dopamine does not seem relevant for generating "liking" (Robinson and Berridge, 2003). Activation or suppression of mesolimbic dopamine systems does not change the liking of sweet tastes (Kaczmarek and Kiefer, 2000, Berridge, 2007, Leyton, 2010). Lesions that eliminate dopamine in the NAcc do not impair the liking either (Berridge and Robinson, 1998). A more plausible hypothesis seems to be that dopamine does play a role in reward processing by mediating “wanting” and, maybe, "learning" (Wyvell and Berridge, 2000, Cheer et al., 2007, Salamone et al., 2007, Bayer and Glimcher, 2005, Kable and Glimcher, 2007, Caplin and Dean, 2008).

It thus seems that “liking” is mediated consistently in few small and dedicated “hedonic hotspots” through the release of different neurotransmitters, namely the endogenous opioids and GABAergic neurons (GABA stands for γ-aminobutyric acid). These two neurotransmitters are acting mainly in the shell of the NAcc and in the ventral pallidum and parabrachial nucleus (PBN) areas.[9] While “wanting” and

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[7] Activation of these brain regions means that they consume more oxygen. From increased blood flow in these regions, one thus infers on increased neural activity. This is measured –admittedly quite coarsely at the moment– non-invasively through functional magnetic resonance imaging/tomography (fMRI). The measures taken thus do not report absolute levels but relative increases in blood flow, see Kenning and Plassmann (2005, 345).

[8] A more detailed description of the location and functions of the OFC can be found in Kringelbach (2005) and of the amygdala and the ventral striatum circuits in Everitt et al. (1999) and Delgado (2007).

[9] See Becker and Meisel (2007). Referring to Pecina and Berridge, (2000) and Kelley et al. (2002), Berridge and Robinson (2003, 509) write: “One neural component of ‘liking’ involves opioid neurotransmission onto GABAergic spiny neurons in the nucleus accumbens (especially in the shell region). Microinjection of opioid agonists into the accumbens shell causes increased facial ‘liking’

"liking" represent interacting networks in the brain (and function in parts in overlapping regions such as the NAcc), we can see that different neural correlates mediate the component processes.

To establish the role of these brain regions in reward processing, a wide array of brain imaging experiments have been conducted. In these experiments a host of different stimuli were presented. Among them were food, juice, water (e.g. Berns et al., 2001, O'Doherty et al., 2002), smells (e.g. Gottfried et al., 2002), sexual stimuli (e.g. Arnow et al., 2002), sexual behavior (e.g. Komisaruk et al., 2004), conditioned rewards such as money and positive feedbacks (e.g. Delgado et al., 2000, O'Doherty et al., 2001), but also abstract conditioned rewards such as light flashes (e.g. Pagnoni et al., 2002) and social rewards (e.g. Aharon et al., 2001, Rilling et al., 2002, Rolls et al., 2003). Although the functional mapping onto the above mentioned complex of neural systems is crude in terms of exact location, it seems that reward processing generally takes place in these regions (see Becker and Meisel, 2007, Leknes and Tracey, 2008, Kringelbach and Berridge, 2010). These studies lend credibility to the contention that all forms of pleasures, irrespective of how different they may appear, seem to be processed in brain regions that overlap with each other. "Higher-order pleasures" (e.g. monetary, artistic, musical etc.) seem to re-use circuitry involved in the causation of biologically highly relevant "basic pleasures" (e.g. food, sex, social; see Berridge and Kringelbach, 2008, 459).

The neural activities involved in to the implicit forecast of future rewards at the stage of "wanting" are not yet fully understood. However, following the model by Shizgal (1999), they can tentatively be outlined as follows. When an higher organism encounters a so called "goal object" (a reinforcer) at the stage in which the motivation to act ("wanting") is determined, three different brain processes work in parallel. First, there is perceptual processing to discern the identity, location and physical properties of the object. Second, there is evaluative processing resulting in the attribution of goal worth. Finally, a stop-watch timer process computes when the goal object will be available and how often this will be the case. Of these automatically performed processes, the latter two determine the reward (i.e. predicted utility) the organism associates with the goal object.

When a reward is eventually experienced, this experience is made up of stimuli that can differ regarding time, reward intensity, sensory quality and so on -- which amounts to a multi-dimensional record. However, by a spontaneously produced internal valuation that uses a weighing scheme or "currency function" (Shizgal, 1999, 509) a compound value for the experienced reward seems to emerge. Montague and Berns (2002, 279) write: "Together, these results suggest that the OFS [orbitofrontal cortex and striatum] circuits act to generate a common internal currency (scale) for the valuation of payoffs, losses …". It may be argued that this internal condensation of a multidimensional profile of the reward record results in the continuous calculation of what Kahneman et al. (1997) have called "instant utility". Instant utility is the continuous hedonic evaluation of sensory experience over time in the form of positive or negative valence.

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reactions to sweetness. … Other components include mesolimbic outputs to the ventral pallidum and related structures elsewhere in the brain."

Summing up the reported findings we suggest the following hypotheses. Reward is being processed in some fixed and highly complex interdependent brain regions. The brain converts multidimensional payoff records into one single “common currency” (McFarland and Sibly, 1975, Kringelbach and Berridge, 2010). This means that reward is always processed “along a single final common pathway” (McClure et al., 2004, 261). The neural currency is the basis of experiencing the reward associated with goal objects. Evidence suggests that this reward (which would be called “utility” in economics) is uni-dimensional as regards its neural correlates, lending support to a uni-dimensional measure for utility. Some of these findings may still be considered speculative because of some methodological limitations mentioned. Yet, the plausibility of the “common currency hypothesis” of reward does not seem to be affected (Kringelbach and Berridge, 2010, Leknes and Tracey, 2008, 318). In accordance with the methodological considerations presented above, we thus conclude that the assumption of multidimensional utility lacks “biological plausibility” (Clithero et al. 2008).

4 On the Divergence between Wanting and Liking

Choices are embedded in a time structure. Unlike in a static approach it is therefore necessary to differentiate the notion of utility in a way that can do justice to the time structure. The utility arising from a choice that has been made, i.e. the pleasures or pains experienced as a consequence, comes as a more or less continuous flow of instantaneous utility along the time axis. Yet, experiencing an episode of “likings”, as one could say, is one thing. Looking ahead to, and looking back at, such an episode, is something different. The flow of instantaneous utility may be remembered in ways that differ from what was actually experienced during the episode. The reason for the divergence of instantaneously experienced and *ex post* remembered utility are cognitive effects that distort an individual’s memory (Kahneman et al., 1997; Schreiber and Kahneman, 2000). When looking ahead at the time before or while making a choice, the utility to be derived from a choice is forecast on the basis of the memory of previously experienced similar episodes, or by cognitively constructed inferences. During all three stages (past, present, future), different psychological processes occur.[10]

There are difficulties in adequately predicting the “liking” of future outcomes for two reasons. First, “affective forecasting” is associated with systematic biases and errors (see Wilson and Gilbert, 2003). The valence of a future episode may be misrepresented (e.g. something negative is predicted to be of positive valence). Emotions may be attributed wrongly (e.g. one expects to experience fear but experiences anger instead). Or the intensity or duration of the affective experience is not adequately anticipated (the so-called “impact bias”, ibid.).

A second difficulty arising for predictions of the “liking” of future outcomes is directly relevant to the above discussed question of the multi-dimensionality of utility. The aggregation of the various sources from which utility is obtained into a single neural currency is spontaneously achieved in the brain by actually experiencing a reward. The aggregation is triggered by the corresponding sensory inputs and requires

10 Mitchell et al. (1997, 426). Note that despite the heavy cognitive mediation, decision makers need not be conscious of some of these processes (Winkielman and Berridge, 2003).

these inputs for being carried out. As long as these inputs are not yet experienced, e.g. when at the stage of wanting a future reward is predicted, the forecast may be incomplete and flawed in some or all dimensions, depending on the reliability of previous experiences. If, in particular, future utility is predicted through deliberation, a complete aggregation may fail due to selective attention paid to only some, often particularly salient and special aspect(s) of the future outcome of an action.[11] Furthermore, the emotional situation of the decision maker at the time of forecasting the outcome of an action can influence which aspects of future outcomes are selectively gaining cognitive attention.

Concerning the influence of selective cognitive perceptions of future utility, normative expectations existing in the presence are a case in point. Attention then tends to be focused on aspects relating to the relevant norm(s) so that other aspects are discounted our ignored. It has been found that individuals seem to have a “rosy view” regarding life events that are commonly supposed to have positive connotations, such as holidays. Such occasions are predicted to be and remembered to have been more positive than they were actually experienced (Mitchell et al., 1997). The congruence between anticipation and memory may be the result of a desire to avoid dissonances. One wants to have congruence between what one anticipated and how one remembers an event. This constitutes a failure to properly represent an episode *cognitively*, as opposed to cases of *affective* misrepresentation. In the latter case, an individual mispredicts that some event will be pleasurable but turns out to be painful, see Wilson and Gilbert (2003).

When it comes to unfamiliar or even unknown or highly abstract future events, there is no other way than using deliberation for constructing an assessment of the affective value or utility that may be derived in the future. If individuals then base their affective forecast on a wrong construction of reality, the predicted utility is likely to be inaccurate e.g., if the forecast relies on untypical examples or mistaken analogies. It is easy to think of examples of how one forms selective expectations of events one has not yet experienced, based on information that is not accurate. Consider events such as marriage, childbirth or becoming tenured (often close to wishful or overly optimistic thinking, see Gilbert et al., 2002; Wilson and Gilbert, 2003; Bovi, 2009). A discrepancy between wanting and liking is then likely to follow.

With respect to the influence of the emotional situation of the decision maker a frequently occurring bias is connected with a state of deprivation. If deprivation is high enough, “visceral factors” (Loewenstein, 1996) can have an overriding influence on estimates and decisions. They can result in forward looking preferences that do not materialize later in terms of experienced (instantaneous) utility. Estimates of future affect that are made in a “hot” visceral condition (being deprived, e.g., due to being hungry or sexually aroused) would fail to take into account that the subsequent

[11] So-called “focalism” was found in a study where individuals were asked about the impact of a tenure decision on their utility. They neglected the importance of other events happening concomitantly and thus overestimated the impact of a possibly negative tenure decision on their utility (Wilson et al., 2000). Similarly, neglecting other aspects of the same episode or action can also misinform the affective forecast (see also Dolan and Metcalfe, 2010). Attention processes play a strong role here, focusing the individual on the more salient or even random aspects of an episode, depending on a variety of external factors (including most prominently the effects of current weather on mood).

condition of the individual may be "cold". This effect also works in the opposite direction. For example, when, in a "cold" state, one fails to take the possibility into account of being in a "hot" state later. Failure to properly account for future visceral states is constitutive to an "empathy gap". Individuals fail to empathize with (or imagine) needs and wants of their future selves', leading to a discrepancy between predicted and actually experienced utility (see also Read and Leeuwen, 1998; Brendl et al., 2003; Trout, 2009; Jamison and Wegener, 2010).

A special cause of misrepresenting future utility is due to the frequent failure to anticipate hedonic adaptation (Kahneman and Snell, 1992; Loewenstein and Schkade, 1999). This means that dynamic properties of affect such as a dulling of an affective stimulus over time are neglected. For example, the preference for buying an expensive, luxurious car may be based on an affective forecast that overestimates the enjoyment one gets out of driving such a car (neglecting that one quickly gets used to driving it). As a consequence the purchase of the car is likely to only partly turn out to satisfy the predicted preference. A different example is that individuals seem to overestimate the diversity of dishes they may want to consume (Read and Loewenstein, 1995).

Faulty affective forecasting has been demonstrated experimentally in many different settings going beyond the illustrating examples given here.[12] It indeed seems to be due to the fact that the spontaneous process by which the "liking" of an outcome is actually experienced cannot perfectly be anticipated when the affective value of future outcomes needs to be predicted. This is not to say that predicted utility, in contrast to experienced utility, is multi-dimensional. Rather what we conclude is that, in their motivation to act, human decision makers often fail to forecast fully and without biases the later experienced (uni-dimensional) value of utility. The reason is that they cannot do beforehand the aggregation their brain later carries out spontaneously.

5 Conclusion

The concept of utility was never an easy one and it has undergone major changes in its history. In Bentham's and Mill's classical utilitarian accounts, utility was a multidimensional measure clearly related to many qualitatively different pleasures and pains. During the marginalist revolution and in the heyday of positivism, this notion has been replaced by the assumption of a uni-dimensional measure and eventually a theory of preference orderings. These developments increased the mathematical rigor of the theory. On the other hand, they did away with physiological and psychological conjectures that had given the classical utilitarianism its empirical substance.

[12] See the references in Wilson and Gilbert (2003). Apparently, humans do not easily correct for their faulty forecasting through experiential learning. Such learning seems to be forestalled by impeding factors like conformity bias (the tendency to focus attention only on information that confirms an individual's intuitive theories of how the world works), systematically distorted memories of pleasant experiences, and the need for repetition to learn from experience (Loewenstein and Schkade, 1999, 99). Many repeated situations are not completely identical and thus involve some dimensions that differ from the initial experience, thus making such learning more difficult.

As has briefly been outlined in the present paper, a multi-dimensional utility measure would indeed imply serious complications for choice theory and the assessment of individual welfare. In order to not just assume away the problem by invoking an uni-dimensional measure, we have tried to assess how, from the point of view of recent research in the behavioral sciences and neuroscience utility should best be conceived of. It turned out that the empirical evidence does not seem to favor the view that behavior is founded on a multidimensional utility measure.

We then provided an answer as to why some pleasures (or sources of utility) nevertheless seem so difficult to compare as our initial quote from Sen (1981) hinted at. We have traced back this phenomenon to an entanglement in the utility notion between “wanting” (the motivation to act) and “liking” (the sensory experience of the consequences). “Liking”, i.e. the experienced utility, seems indeed to be one-dimensional. This is so because of a spontaneous process in which the brain aggregates the pleasures and pains emanating from different sources into a single neural currency that serves a uni-dimensional utility measure. The measuring rod that could be used for assessing well-being and welfare – experienced utility – does not seem to be complicated by being of multi-dimensional nature.

However, the spontaneous process of aggregating the different source of utility cannot (perfectly) be carried out beforehand when choices are made at the stage of "wanting". Instead, cognitive operations and “affective forecasting” take over and result in difficulties in fully accounting for the many dimensions of the future pleasures and pains in an unbiased way and in aggregating them consistently. If the motivation to act depends on inconsistent, biased, or even erroneous forward looking preferences, this is likely to lead to deviations from a “rational” standard – deviations that have often been addressed in behavioral economics, though not in the context of utility theory.

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