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Emotions and Behavior Regulation in Decision Dilemmas

Joaquin Gómez-Miñambres [1] and Eric Schniter [2,*]

[1] Department of Economics, Lafayette College, 730 High St, Easton, PA 18042, USA; jgminambres@gmail.com
[2] Economic Science Institute, Chapman University, 1 University Dr, Orange, CA 92866, USA
* Correspondence: eschniter@gmail.com; Tel.: +1-714-628-7272

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Abstract: We introduce a dynamic model of emotional behavior regulation that can generalize to a wide range of decision dilemmas. Dilemmas are characterized by availability of mutually exclusive goals that a decision maker is dually motivated to pursue. In our model, previous goal pursuant decisions produce negative emotions that regulate an individual's propensity to further pursue those goals at future times. This emotional regulation of behavior helps explain the non-stationarity and switching observed between so-called "preferences" revealed in repeated decision dilemmas (e.g., by choosing A over B at time 1, then choosing B over A at time 2). We also explain how behavior regulation under dilemma conditions is affected by the set of available options and how the strength and decay rate of emotions affect the tendency to choose behaviors pursuant of extremely (rather than moderately) different options over time. We discuss how emotional behavior regulation insights provided by our model can extend to a variety of topics including approach and avoidance, temptation and self-control, moral balancing, impulse buying and shopping momentum, dieting and exercise, work and leisure, sleep regulation, cooperation, and competition.

Keywords: self-control; behavior regulation; decision; dilemma; emotion; dynamic choice

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"Everyone must choose one of two pains: The pain of discipline or the pain of regret."

Jim Rohn

1. Introduction

1.1. Self-Control in Decision Dilemmas

Despite the central importance of self-control and cooperation problems in everyday life, the systems producing their dynamics have been poorly understood and remain among the most intriguing puzzles for economists and cognitive scientists to solve (e.g., see [1]). The standard economic model of rational choice posits a single decision making system with well-defined preferences (i.e., capable of ordering alternatives based on the amount of utility each is expected to provide) and ability to make optimal choices in accordance with those preferences. While this paradigm helps us understand some observed behavior and it also provides a benchmark when describing sub-optimal deviations, there remains a great deal of behavior that the traditional model does not explain. For instance, many economists and cognitive scientists are puzzled by switching between "preferences" revealed in repeated decision dilemmas (e.g., by choosing A over B at time 1, B over A at time 2, A over B at time 3, . . .). Also puzzling is how, under dilemma conditions, "extreme" behavior is commonly chosen, despite available options for more moderate behavior. Others have also found anomalous effects on behavior by altering the set of available options (e.g., [2,3]) or by manipulating the strength and decay rate (or memory) of recent emotions (e.g., [4,5]).

Evolutionary psychologist and decision theorists have introduced multi-process theories of evolved cognitive "modules" involved in decision-making [6–9] to better explain behavior regulation. According to this perspective, several cognitive systems in one's brain can become activated and interact with each other in the presence of situations that they were selected to respond to. Specific cognitive systems function to pursue specific goals. As such, the interaction between cognitive systems can result in mutual cooperation (when they work together towards regulating behavior pursuant of a common goal or related goals) or competition for behavior control (when they conflict with one another and interfere with each other's goal achievements).

In this paper, we address how conflicting cognitive systems become activated in decision dilemmas characterized by availability of mutually exclusive goals that an individual (containing these conflicted systems) is dually motivated to pursue. In particular, we provide a simple theory capturing the process by which previous goal pursuant decisions produce negative emotions that regulate an individual's propensity to further pursue goals at future times (Section 2). Finally, we discuss how our theory's explanation for temporally inconsistent individual choices can be extended to a wide variety of decision dilemmas (Section 3).

1.2. Inconsistent Intertemporal Choice

A rational decision maker (DM) with well-defined and stable preferences is expected to consistently reveal the same choices given repeated exposure to the same set of available options (e.g., by choosing A over B at time 1, A over B again at time 2, and so on). Yet, the preferences that DMs reveal over time tend to be "labile, inconsistent, subject to factors we are unaware of, and not always in our own best interests." [10] (p. 2). Economists frequently employ the terms dynamic inconsistency or time inconsistency to describe the phenomena where a DM shows change in her preferred choice among options, such that a "revealed preference" can become inconsistent at another point in time.

For the past several decades, researchers (theorists and experimentalists) have been studying inconsistent intertemporal choice in a variety of contexts. In the context of savings and rewards, a long-standing puzzle has been to explain why decision makers prefer a small reward today to a big reward tomorrow and, at the same time, a big reward in 1 year and 1 day to a small reward in 1 year (see [11–17] for comprehensive surveys). In the economics literature, this pattern of change (e.g., preferring the sooner of two rewards today, but the delayed of two rewards in a year) has been explained by a variety of discounting [18] and dual-self [19] theoretical frameworks that fit the data better than the standard models which the behavior violates.

What the above models cannot explain is behavior that switches both back and forth between choices upon repeated exposure to the same choice dilemma. Alternating or switching behavior has been reported for approach and avoidance behaviors [20,21], consumers' savings and spending cycles [22], dieters' overconsumption and restriction cycles [23] cycles of work and leisure [24], cycles of sleep regulation [25] exercise cycles [26], cycles of moral and immoral behavior [27], cycles of competitiveness and cooperation [28], and various other cycles oscillating between more restrained and more tempting behaviors (e.g., drug and alcohol consumption, extra-marital sex, gambling, exploitation). In many of these scenarios, DMs rationalize their indulgence as self-reward for prior effortful restraints, and their restraint as self-punishment for their guilty indulgences [22,29,30]. In line with this idea we provide a novel explanation for how a DM's self-control is affected by previous temptation-controlled and self-controlled decisions, leading to a non-stationary consumption path.

An alternative interpretation of non-stationary consumption is that consumers simply have "preference for variety". In the marketing literature, Ratner and colleagues [31] discuss variety seeking behavior by consumers who know what they like yet choose not to consume liked products that were recently consumed. Kaiser and Schwabe [32] discuss preference for variety held by consumers who know what they like to purchase yet prefer to shop at places offering a greater variety of products (including never and rarely bought products) over places offering slightly more competitive prices on a smaller set of regularly purchased products including those that they like. Unlike DMs in decision dilemmas, variety seekers do not struggle with their decisions, rather they are expected to clearly reveal a "preference for flexibility" in their choice of available alternatives, while DMs struggling to show self-control strictly prefer smaller sets and reveal a "preference for commitment".

To illustrate this difference, consider Gul and Pesendorfer's [33] example of a decision maker who must choose between apples and bananas in several periods.[1] If the DM has preference for variety, he would like to alternate consumption of apples and bananas over time. In this case, he would prefer to have regular access to both apples and bananas so as to accommodate his changing tastes. On the other hand, a DM in the type of decision dilemmas we focus on this paper is better captured by the alternative example of a dieter who must choose between apples and cakes. If the dieter chooses cake in one period, regret is generated—increasing the probability of choosing apples in the future, while the alternate choice of apples causes self-control effort—increasing the probability of choosing cakes in the future. Note that, though DMs alternate between options in both examples, the reasons why they do are very different. We can empirically disentangle self-control dynamics from variety seeking dynamics by looking at whether consumers prefer to "pre-commit" to smaller sets of decisions given the opportunity; such as by paying a higher price to go to a "healthy" store where cakes are not available. This is precisely the idea of a "Ulysses pact" [34].

1.3. Emotions and Behavior Calibration

We formalize the generation of emotions using the concept of "forgone utilities" [19,35]. The gist of this concept is that a decision maker (DM) conflicted between two mutually exclusive goals, cannot simultaneously maximize the utility of achieving each goal by taking an action. This is an important consideration missing from standard rational choice models: under dilemma conditions, each option chosen (over others available) creates unachieved goals, memories of missed opportunities, or "forgone utilities", which are quantified by the difference between the maximum possible utility that was available and the realized utility (that was chosen). We interpret and model the memory of these missed opportunities as a "stock" of forgone utilities to formalize the negative emotions that consumers derive from previous dilemma decisions and which affect subsequent decisions.

While standard economic models have largely ignored emotions [36], emotions have received significant attention in other disciplines. Evolutionary psychologists [7,8,37] have proposed that emotions are functionally designed to orchestrate physiological and cognitive systems for the purpose of predisposing those who feel or remember them to act more or less in a certain way. According to this adaptationist perspective, distinct problems with mutually exclusive goals have led to a modular mind that is internally conflicted at times. Emotions have co-evolved with conflicted behavioral systems to process information about decision outcomes and available options, essentially functioning as "guidance systems" regulating future behaviors [7]. Livnat and Pippenger's [38] analysis of decision making systems finds support for the perspective that, under computational constraints (e.g., expected for organisms with limited resources), an optimal brain system may involve dynamically linked subsystems that are in conflict with one another—consistent with a modular view of the mind and the notion that emotions were selected for because they provided solutions for dynamic problems in changing environments.

In this paper, we focus on negative recalibrational emotions that respond to changes in option sets and facilitate behavior regulation for the conflicted DM via negative affective feedback (i.e., unpleasant feelings). The common and unpleasant experience of indulgence guilt or indulgence regret (here forward regret), experienced after an indulgence [39–41], limits the tendency to further indulge upon future opportunity [42]. The unpleasant emotion of restraint effort (here forward effort), whether in the form of "wistful feelings of missing out" [39] or the feeling of "mental burden", concentration

[1] We are grateful that an anonymous referee called our attention to this example emphasizing the difference between preference for flexibility and preference for commitment.

"fatigue" [43,44], or "painful exertions of the human will" [45] (p. 60) has been identified as commonly experienced during and after restraint decisions that forgo more pleasurable alternatives [43,46]. The behavior-regulating recalibrational effects of these emotions have already been previously described in the psychology literature [47], though not formally modeled so as to generate careful insights into the roles of emotional memory and changing option sets across repeated decision dilemmas. Though we focus on a few key emotions in our decision dilemma examples below, each particular decision dilemma will involve an appropriate set of emotions that may or may not be involved in other decision dilemmas.

2. Behavior Regulation in a Dynamic Decision Dilemma

In this section, we provide the theoretical framework that we use to formalize the effect of regret and effort emotions on behavior regulation. Section 2.1 describes the set-up of the model and Section 2.2 characterizes the optimal consumption path. For readers uninterested in technical details of this section, we redirect attention to the beginning of Section 3 where we provide a brief summary of the main results and intuitions, as well as our discussion of how to apply our model to different self-control dilemmas.

2.1. The Model

In our model a decision maker (DM) is confronted with a dynamic decision dilemma. Every period $t = 1, 2, \ldots$ the DM must take an action that is represented as a location on a Hotelling line of unit length $[0, 1]$. We denote by x_t the DM's action in period t and define M as the time invariant compact set of available alternatives.[2] The set of alternatives in a decision dilemma form a closed interval that lies on the Hotelling line (see Figure 1). Thus, $M \equiv [\underline{m}, \overline{m}] \subseteq [0, 1]$ with $\underline{m} \leq \overline{m}$. We assume that the DM is perfectly informed about the set of alternatives available within the decision dilemma interval.

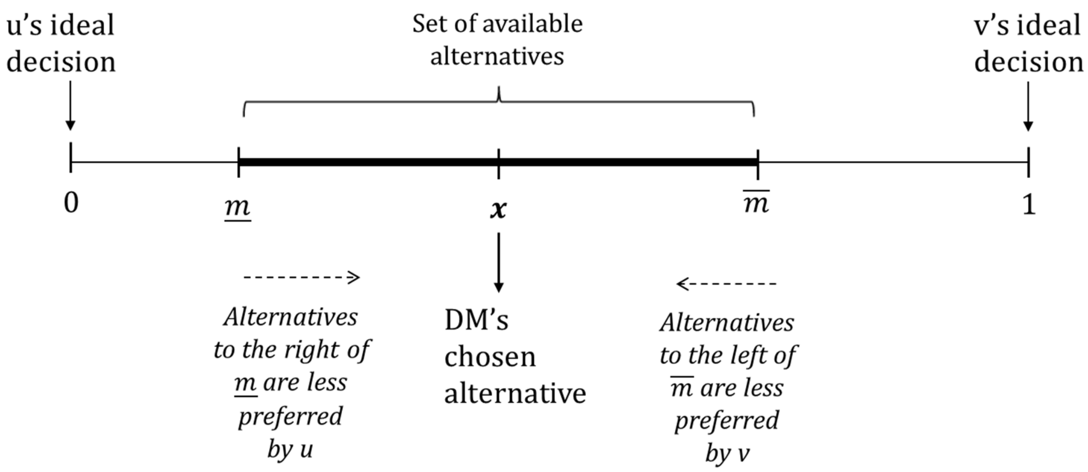

Figure 1. The Hotelling line decision dilemma interval with a set of available alternatives $[\underline{m}, \overline{m}]$.

For decades, intuitive and theoretical accounts of dual-system regulated intertemporal choice have been described in behavioral economics (e.g., "hot" vs. "cold" [49] and "planner" vs. "doer" or "forward-looking" vs. "myopic" [15,50–52])[3], in psychology ("controlled" vs. "automatic" [53,54] and "reflective" vs. "impulsive" [55]), and in neuroscience (one localized brain system vs. another

[2] See Gómez-Miñambres and Schniter [48], Section 4, for an example of a time variant set of available options.

[3] Thaler and Shefrin [50] model the "planner" and "doer" using a principal-agent framework, similar to the agency conflict between the owners and managers of a firm.

localized brain system [56–59]). Consistent with many of these dual-system notions, we assume that when the DM faces a dilemma, the presence of available options triggers two conflicting goal pursuant systems—each producing emotions to encourage or discourage specific behaviors.[4]

Our thesis is that, across most dilemmas, DMs struggle to choose a preferred course of action because they are dually motivated by two different and mutually exclusive ideals: self-control (needed to restrain temptation-control) and temptation-control (the innate reaction to tempting stimulus).[5] We represent these ideals as utility functions: u (the self-control utility) and v (the temptation utility), each a distinct goal and located at the extremes of the Hotelling line. We assume that, under dilemma conditions, the goals associated with our evolved cognitive modules are differentially aligned with the extremes of the Hotelling line (see Figure 1). Without loss of generality we consider that the u's ideal goal is located at zero while the v's ideal goal is located at one.

Since available options may lay at interior locations on the interval, when the DM takes an action that is not "ideal," she experiences a disutility cost. By simplicity, we assume that this cost of unachieved ideals is quadratic, so the individual utilities are given by:

$$u(x_t) \;=\; s - x_t^2 \tag{1}$$

$$v(x_t) \;=\; s - (1 - x_t)^2 \tag{2}$$

where $s \in \mathbb{R}_+$ represents the DM's sum of achieved ideals (i.e., utility when making the ideal decision).[6]

When the DM confronts a dilemma, she has to decide upon an action from a set of alternatives, knowing that the choice will not maximize both ideals simultaneously and will, thus, produce *foregone utilities*. Given the DM action x_t in period t, the forgone utilities of competing u and v are $\max_{x \in M} u(x) - u(x_t) = u(\underline{m}) - u(x_t)$ and $\max_{x \in M} v(x) - v(x_t) = v(\overline{m}) - v(x_t)$ respectively. Note that resisting temptation (i.e., x_t closer to $\underline{m}$) creates a high forgone v-utility (but a low forgone u-utility), while yielding to temptation (i.e., x_t closer to $\overline{m}$) generates a high forgone u-utility (but a low forgone v-utility). The Hotelling interval can be interpreted as a continuum of options ranked with respect to a particular variable dimension (e.g., price, quality, calories, sweetness, etc.).

To formalize the role of emotions in behavior regulation we build on Becker's [67] concept of "personal capital" that has been used widely in economic models of variety seeking, addiction, and habit formation. This approach incorporates past consumption into the explanation of inconsistently revealed preferences; so that functions describing the utility of decisions depend not only on current decisions but also on the history of past consumption. Our point of departure from this idea is that instead of simply considering previous consumption, we assume that revealed preferences depend on the remembered history of missed opportunities. This approach allows us to incorporate the idea of *regret* (the memory of missed indulgence opportunities) and *effort* (the memory of self-control missed opportunities) into a dynamic dual-system model of decision making. In particular, we define *emotional capital* as the sum of all previous forgone utilities, each depreciating at a constant rate. Thus, the *foregone-temptation capital* transition equation is given by

$$e_{t+1} \;=\; (1 - \lambda)e_t \;+\; [v(\overline{m}) - v(x_t)] \tag{3}$$

while the *foregone-self-control capital* transition equation is

$$g_{t+1} \;=\; (1 - \lambda)g_t \;+\; [u(\underline{m}) - u(x_t)] \tag{4}$$

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[4] The earliest two-factor models of behavior regulation in psychology were introduced by William James [60] and Sigmund Freud [61].

[5] Automatic and mindless behavior, triggered by a stimulus, has been described by others [62–65].

[6] Gómez-Miñambres [66] considers a similar modeling approach to formalize dual-system preferences in a monopoly pricing model where products are horizontally differentiated.

With initial conditions $e_1 = g_1 = 0$, and where $\lambda \in [0,1]$ represents the psychological depreciation rate of emotions. We refer to $(1-\lambda)$ as *emotional memory*. Thus, emotional capitals are the forgone utilities (missed opportunities from the past) remembered at a particular point in time, while additional decisions (generating forgone utilities) continue contributing new emotions every period. Moreover, we define a DM's *emotional balance* as the difference between both kinds of emotional capital:[7]

$$B_{t+1} = e_{t+1} - g_{t+1} = (1-\lambda)B_t + 1 - 2x_t + \mu \tag{5}$$

where $\mu = \underline{m}^2 - (1-\overline{m})^2 \in [-1,1]$ is a function that depends on the boundaries of the available option set. This function indicates that emotions depend, not only on the stock of previously generated emotions (B_t) and present decisions (x_t), but also on available options that are not necessarily chosen. If $\mu > 0$, the option set contains alternatives closer to the temptation ideal and we refer to the option set as *temptation shifted*. Similarly, if $\mu < 0$, the option set contains alternatives closer to the self-control ideal and we refer to the option set as *self-control shifted*. Finally, if $\mu = 0$, the available options do not favor one ideal over the other and we refer to the option set as *neutral*.

Now we can define the following *extended utility* functions[8] (explaining "revealed preferences") in period t that depend on the actual action and the emotional capital at each period:

$$U(x_t, e_t) = u(x_t) - \rho e_t(1-x_t) \tag{6}$$

$$V(x_t, g_t) = v(x_t) - \rho g_t x_t \tag{7}$$

where $\rho \in \mathbb{R}_+$.

The extended utility functions in our model capture the idea that a stock of negative emotions generated by memory of *foregone tempting opportunities* (e) *and foregone self-control opportunities* (g) impose "emotional costs" that decrease the cardinal scale of utilities. Our proposed functional form captures the intuitive behavior-regulating recalibrational effects of emotions like *self-control effort* and *indulgence regret* that have been previously described in the psychology literature [44,68] and marketing literature [69,70]. While effort and regret can be used to describe the emotions generated by choices across a variety of decision dilemmas, we conjecture that additional concomitant negative emotions (e.g., fear, pain, nausea, craving, frustration, insecurity, guilt, embarrassment, shame, exhaustion, fatigue) may be evoked by choice consequence in particular dilemmas (see Section 3). From $V(x_t, g_t)$, we know that choosing the tempting option (x_t close to $\overline{m}$) is costly and that costs were greater when the DM yielded to temptation, and hence accumulated regret. Similarly, from $U(x_t, e_t)$ we know that

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7 In this model we treat *foregone-temptation capital* (e) *and foregone-control capital* (g) emotions symmetrically. This assumption is made for the sake of simplicity and exposition. Alternatively, we can consider that e and g are not equally important emotions (a more realistic assumption). In particular, we can define the emotional balance as $B_{t+1} = e_{t+1} - kg_{t+1}$, where $k \in \mathbb{R}_+$ is the relative weight of g with respect to e, so if $k > 1$ g is relatively more important than e and if $k < 1$ e is relatively more important than g for the DM. The asymmetry of e and g would include a new parameter and hence an extra degree of freedom in the model but the main qualitative results would remain unchanged.

8 As we mentioned above, our formalization of negative emotions as stock of previous experiences affecting current choices is inspired by the notion of an *extended utility function* [67] widely used in the economic models of addiction and habit formation. These models provide a function, not only defined by present consumption trade-offs, but also "extended" to include a stock of past consumption, called "consumption capital". The important feature of this class of models is that, while preferences remain stable, they are defined by not only "ordinary goods" but also by features (e.g., past consumption, social desirability, or emotions) not normally thought of as "goods". Although related, our extended utility analysis includes several novelties with important implications. First, in considering an individual's two internally-conflicted preferences we specify not one but two different extended utilities. More importantly, in determining the marginal utility of consumption we model emotional capital as captured by stocks of previous forgone utilities (and their emotional consequences), not just a single stock of previous consumption. Since forgone utilities depend upon options not chosen, the menu's set of alternatives (specifically, the available options) plays a very important role in determining our extended utilities, while it would be irrelevant under the concept of consumption capital in models of addiction. Finally, our concept of negative emotions departs from models of addiction because the emotionally regulated consumption in our model presents "adjacent substitutability" (instead of "adjacent complementarity") across periods. In other words, in contrast to the standard consumption capital in models of addiction, the marginal utilities in our model decrease with the experience of negative emotions.

resisting temptation is costly and that the costs are greater if the DM previously resisted temptation and recalls the effort it generated.

While the primitive utility functions representing a DM's ideals, u and v, are constant, the extended utilities representing a DM's revealed preferences incorporate emotional capital depend on t and are therefore non-stationary. Thus, previous self-control decisions and the allure of available option sets generate emotions that recalibrate the DM's self-control, by affecting the relative weight between conflicting extended utilities.

We assume that the DM is myopic, with no thought of the future. When deciding, the myopic DM only takes into account her present emotional capital, not how her decisions affect future emotional capital and hence future extended utilities and decisions. Therefore, each period the DM maximizes her overall utility given by the sum of the extended utilities:

$$\max_{x \in M} U(x, e_t) + V(x, g_t) \qquad \text{[P1]}$$

In an online appendix we provide numerical simulations of a forward looking DM model. However, the results that we emphasize in this paper remain unchanged. Therefore, our decision to focus on a myopic DM is based on our desire to provide a simple model that can be easily understood not only by theoretical economists but also by those from behavioral sciences and related fields.

Finally, note that, in contrast to a standard utility model ($\rho = 0$), our model implies time variant choices.[9] To see this, let's consider $M = [0, 1/2]$ and a DM with $\rho > 0$. Since the DM starts with no emotions (i.e., $U(x_1, e_1) = u(x_1)$; $V(x_1, g_1) = v(x_1)$), the action taken in the first period is $x_1 = \underset{x \in [0, \frac{1}{2}]}{\text{argmax}} u(x_1) + v(x_1) = \frac{1}{2}$. Therefore, the effort capital (e) in period 2 will be zero while the guilt capital (g) will be (1/4). This leads to the following extended utilities in period 2:

$$U(x_2, e_2) = u(x_2) \text{ and} \tag{8}$$

$$V(x_2, g_2) = v(x_2) - \rho(1/4)x_2 \tag{9}$$

Therefore, the action in period 2 will be $x_2 = \underset{x \in [0, \frac{1}{2}]}{\text{argmax}} U(x, e_2) + V(x, g_2) = \frac{1}{2} - \frac{\rho}{16} < \frac{1}{2}$. Thus, although the DM reveals a preference for 1/2 over $1/2 - \rho/16$ in period 1, she reveals the opposite in period 2. This is not the case when emotions play no role ($\rho = 0$).

2.2. The Optimal Decision Path

The DM's optimal decisions are given by the solution of problem [P1]. Therefore, $x_t = 1/2 + \frac{\rho}{4} B_t$. Note that this means that actions are closer to the self-control ideal if the emotional balance is dominated by the memory of *foregone self-control* ($e_t < g_t$) and closer to the temptation ideal if the emotional balance is dominated by the memory of *foregone temptations* ($e_t > g_t$). The next proposition summarizes the result.

Proposition 1. *Let x_t^* be the optimal action in period t. Then,*

$$x_t^* = \frac{1}{2} + \frac{\rho}{4} B_t \tag{10}$$

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9 Other self-control models in the economics literature (e.g., [19,35]) only address consumers' revealed preferences that are stable over time, making choices time invariant. In our model, decision paths indicated by revealed preferences can be non-stationary. Gómez-Miñambres and Schniter [48] provide a detailed discussion of the related literature and further explore how, in contrast to the existing models, a theory with recalibrational emotions can explain the back and forth intertemporal switching behavior that we describe here.

$$\text{with } B_t = 2\mu\left(\frac{1-\left[1-\lambda-\left(\frac{\rho}{2}\right)\right]^{t-1}}{2\lambda+\rho}\right) \tag{11}$$

Intuitively, when the DM is most strongly under the influence of negative emotions generated by *foregone self-control opportunities,* she has an easier time being "in control" of dilemma choices and not swayed by temptation (x_t closer to $\underline{m}$). However, when she feels dominated by a sense of effort generated by *forgone tempting opportunities,* she "loses control" and yields to the power of neglected temptation (x_t closer to $\overline{m}$).

In the following corollary we show under which circumstances the decision path tends to a stable 'steady state'.

Corollary 1. *If* $\rho + 2\lambda < 4$ *there exists a stable steady state given by*

$$\lim_{t\to\infty} x_t^* = \begin{cases} \overline{m} \; if \; \frac{\mu\rho}{2\lambda+\rho} \geq 2\overline{m}-1, \\ \frac{1}{2}\left(1+\frac{\mu\rho}{2\lambda+\rho}\right) if \; \frac{\mu\rho}{2\lambda+\rho} \in (2\underline{m}-1,\, 2\overline{m}-1) \\ \underline{m} \; if \; \frac{\mu\rho}{2\lambda+\rho} \leq 2\underline{m}-1. \end{cases} \tag{12}$$

We can graphically represent the stable steady state using a phase diagram:

The horizontal axis in Figure 2 graphs the emotional balance, while the vertical axis graphs "investments" in emotional balance (i.e., the additional emotions generated by a DM's new decisions). Thus, $i_B = [v(\overline{m}) - v(x_t)] - [u(\underline{m}) - u(x_t)] = \mu - (2x_t - 1)$. The lines with arrows represent the amount a DM invests in emotional balance as a function of the existing emotional balance ($i_B = \mu - \frac{\rho}{2}B_t$). Note how the result depends on the available set of alternatives. If the available set of alternatives is temptation shifted ($\mu > 0$), an interior steady state has an emotional balance dominated by e, the memory of foregone tempting opportunities while if the available set of alternatives is self-control shifted ($\mu < 0$), the emotional balance is dominated by g, the memory of foregone self-control opportunities.

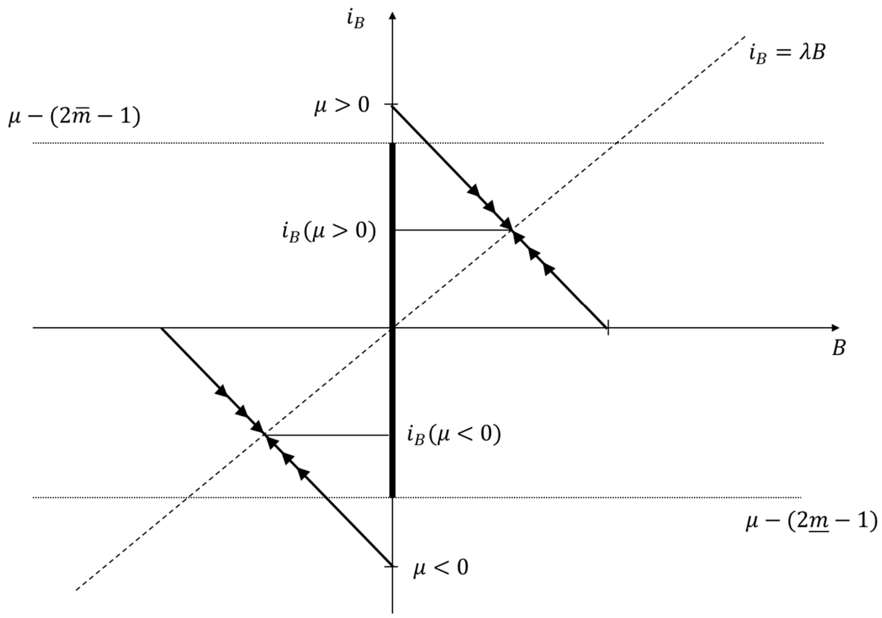

Figure 2. A stable steady state solution.

By Corollary 1 we know that a DM's action tends to a stable steady state when emotions have a small impact on the DM's revealed preferences (ρ is low) or when the DM remembers most of the previous emotions (λ is low). Note that, although equivalent in the DM's actions, both cases have different implications for DM's payoffs. In the first case emotions do not impose significant costs and hence do not have a big impact on decisions. However, in the second case the emotions, although costly, calibrate decisions and achieve consistent behavior.

In the following corollary we summarize the effect of available alternatives on the decision path.

Corollary 2. *Let x_t^* be the optimal action in period t, then* $\frac{d|x_{t+1}^* - x_t^*|}{d|\mu|} > 0$.

Therefore, the amplitude of decision cycles increases with the shift of the option set $|\mu|$. Since the DM starts emotionally balanced ($e_1 = g_1 = 0$), we know by Proposition 1 that $x_1 = 1/2$. A greater asymmetry (or shift) of the option set with respect to $1/2$ corresponds to greater forgone utilities affecting the subsequent path of decisions. If the option set is temptation shifted ($\mu > 0$), the forgone temptation utility will be high. If the option set is self-control shifted ($\mu < 0$), the forgone self-control utility will be high. In both cases the absolute value of emotional balance in the next period ($|B_2|$) will be high. As a result, the difference between choices across periods ($|x_{t+1} - x_t|$) will be high as well.

In Figure 3 we plot the decision path of the myopic DM with a temptation shifted option set.

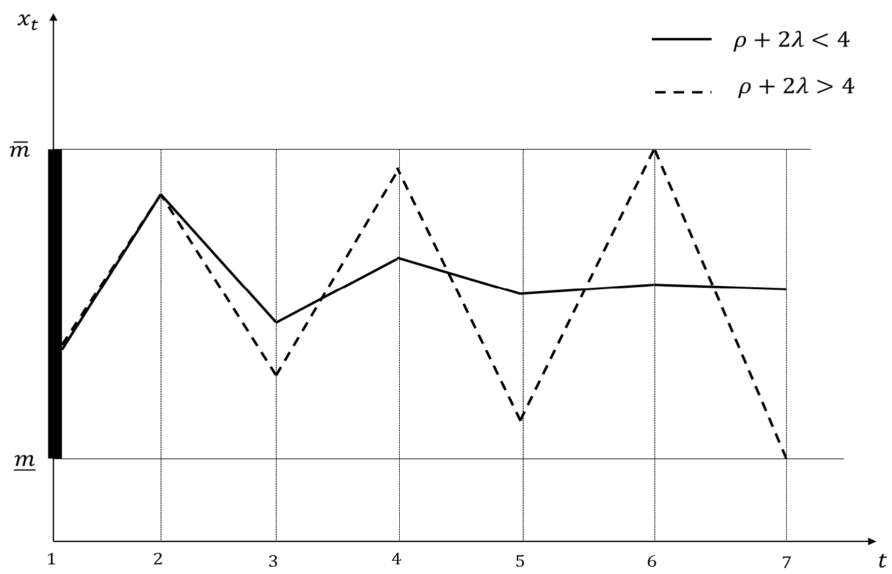

Figure 3. Decision paths with lower ($\rho + 2\lambda < 4$) and higher ($\rho + 2\lambda > 4$) impact of emotions and depreciation rate.

It is important to note that the emotional calibration of self-control depends on the model's parameters. The decision path follows compensatory temptation-controlled and self-controlled cycles where the DM alternates between periods of yielding to temptation, and hence high regret (g), with periods of resisting temptation, and hence high effort (e). If the impact of negative emotions (ρ) and the depreciation rate (λ) are sufficiently high, this behavior persists indefinitely. Otherwise, the amplitude of cycles decreases over time as decisions approach a stable steady state. Therefore, we can explain both dynamically stable (e.g., moderation) and unstable (e.g., abstinence-binge) behavior for particular parameters of the model.

3. Discussion: The Role of Negative Emotions in Dynamic Decision Dilemmas

The model presented above can help us understand how negative emotions like regret and effort affect dynamics of behavior in the presence of decision-dilemmas by adapting decisions to available option sets, why self-control and cooperation failures are common (despite intentions to stay in control), why DMs in repeated decision dilemmas reveal a switching of so-called "preferences" over time, and why the amplitude of this switching pattern increases with the impact but decreases with the recall of previously generated emotions. One intuitive rationale behind this switching pattern is that DMs want to "launder" their mind of negative emotions by compensating an action with its opposite in the next period. This also helps explain consistent choice of extreme alternatives over moderate alternatives available. This process is referred to as "moral balancing" in the psychology literature on moral self-regulation [71]. Much in line with our own theoretical predictions, Cornelissen and colleagues [27] conduct several experiments to show the existence of two contrasting decision paths: *moral consistency* and *moral balancing*. For individuals showing moral consistency, behaving ethically or unethically increases the likelihood of engaging in the same type of behavior later on, while individuals showing moral balancing tend to switch between ethical and unethical decisions over time. As we discussed above, our model predicts the existence of these two different types of behaviors depending on the degree of negative emotions and the emotional memory of subjects (see Figure 3). DMs with high emotional memory and/or low impact of negative emotions tend to a stable decision path (moral consistency) while those individuals with low emotional memory (i.e., who only remember the most recent emotions) and/or high impact of negative emotions tend to an unstable, temporally inconsistent decision path. The remainder of this section is dedicated to a discussion of how to apply these ideas to better understand the role of negative emotions in behavior regulation across a variety of dynamic decision dilemmas.

We propose that a wide variety of decision dilemmas can be understood in terms of conflicting choices between mutually exclusive goals. In addition, while most choice dilemmas involve a conflict between more desirable short-term goals and more-aversive and effortful long-term goals, not all dilemmas are easily framed this way (e.g., consider the approach/avoidance dilemmas where DM's are conflicted by two visceral systems, discussed in Section 3.1). We suggest to our readers that dilemmas should be considered in adaptive design-specific terms: by considering the evolutionary pressures our ancestors faced (and which, via natural selection, shaped the selection of our minds), we can identify fundamental conflicting elements of particular decision dilemma situations. We caution against embracing general-purpose dual-system models of behavior regulation (see Stanovich for are review of these [1]).[10] If the cognitive modules regulating our behaviors evolved in gradual steps through natural selection, they are likely to be hierarchically organized, with some design features widely shared across brain systems and others specific to particular processes and information inputs [72]. As such, pursuit of a long-sighted goal in one kind of decision dilemma (requiring willful "control") should not necessarily affect the DM's tendency towards long-sighted (as opposed to short-sighted) goal pursuit in another kind of decision dilemma (though it might in some situations).

Finally, we caution the reader to recognize that what one DM considers a "tempting" alternative vs. an alternative requiring "self-control" may be conceptualized in a diametrically opposed manner by another DM with different emotional responses and habits. For example, while many people are "*reluctant workers*" who experience a guilt-dominated struggle to be more diligent workers and ignore the leisure temptations which too often frustrate their goal of being more productive, "*workaholics*" experience quite the opposite, they regret that they work too much and find that they experience frustration and effort when they try to muster enough self-control to the take breaks from their work schedule that will provide them needed rest, relaxation, or socialization (for further discussion see Section 3.4). Consistent with our model, we expect that all dilemma conditions (even those less represented among most people) produce negative emotions consequent of choices made and goals

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[10] A popular string of literature in economics, not mention in this section, proposes to formalize individual decision making in terms of a battle between two opposing forces such as the "hot system" versus the "cool system" [73], "doing" versus "planning" [50], "now" versus "later" [74], and "temptation" versus "commitment" [19]. This intrinsic conflict between opposing systems of cognition constitutes an essential part of the explanation for impulsivity in economic decisions. The reader interested in the technical details of these types of decision models can find a comprehensive survey of the literature in Lipman and Pesendorfer [75]. We also discuss some of these papers as well as the differences and similarities of a model with emotions in Gómez-Miñambres and Schniter [48].

foregone. Below we present a table of decision dilemma scenarios that includes characterizations of decision makers who experience the dilemmas from more commonly encountered or "normal" perspectives as well as from opposite or perhaps "abnormal" perspectives (see Table 1).

Table 1. Decision dilemmas, conflicting goals, benefits and possible negative emotional consequences of differential goal pursuit.

Topic and Decision Dilemma *	**Decision Maker Habit or Type**	**Goal 1—Temptation Utility (Benefits of Achieving Goal 1) †** **[Possible Negative Emotions from Foregoing Goal 2]**	**Goal 2—Control Utility (Benefits of Achieving Goal 2) †** **[Possible Negative Emotions from Foregoing Goal 1]**
I. Approach/ avoidance:	**a.** *"Scaredy-cat"*	Avoid danger (Morbidity/mortality reduction) [craving, frustration]	Obtain resource (Consumption gratification) [effort, fear, pain]
	b. *"Greedy person"*	Obtain resource (Consumption gratification) [regret, fear, pain]	Avoid danger (Morbidity/mortality reduction) [effort, craving, frustration]
II. Consumer purchasing:	**a.** *"Impulsive shopper"*, *"Spendthrift"*	Purchase (Satisfy acquisition needs, satiate consumption cravings) [regret, guilt]	Save (Maintain wealth and purchasing power) [effort, anxiety, craving]
	b. *"Tight-wad"*, *"Miser"*	Save (Maintain wealth and purchasing power) [craving, regret]	Purchase (Satisfy acquisition needs) [effort, frustration]
III. Diet regulation:	**a.** *"Overweight dieter"*	Consume, overindulge (Satiation, gratification) [regret, guilt]	Abstain or restrain (Morbidity/mortality reduction, avoid weight gain) [effort, exhaustion, craving]
	b. *"Competitive eater"*, *"Anorexic"*, *"Persistence hunter"*	Abstain or restrain (Avoid feeling over-full, avoid unpleasant consumption, avoid weight gain/delay) [regret]	Consume, overindulge (Gain competitive eating ability; Stock-up on nutrition) [effort, pain, nausea]
IV. Exercise regulation:	**a.** *"Sedentary non-athlete"*, *"Burn-out athlete"*	Do not Exercise, do not maintain regular exercise schedule (Avoid effort and opportunity costs of exercise) [guilt, regret, depression]	Exercise, maintain schedule (Maintain/ improve fitness and health; Achieve personal goals; Reduce exercise effort and pain) [effort, exhaustion, pain]
	b. *"Fitness freak"*, *"Exercise dependent athlete"*	Exercise, maintain schedule (Maintain or improve fitness/low effort habit; Avoid exercise withdrawal costs, Achieve personal goals) [fatigue, regret]	Do not Exercise (Rest/tissue repair, rejuvenation; Avoid opportunity costs of exercise) [effort, guilt, frustration, anxiety, craving, depression, pain]
V. Work/leisure:	**a.** *"Reluctant worker"*	Leisure (Relaxation, recreation, socialization, gratification) [guilt, regret]	Work (Labor production) [effort, frustration, craving, exhaustion]
	b. *"Workaholic"*	Work (Labor production; Achieve personal goals) [fatigue, exhaustion, regret]	Leisure (Relaxation, recreation, socialization) [effort, frustration, anxiety, craving]
VI. Sleep regulation:	**a.** *"TV binge-watcher tempted to stay up late watching"*	Wakeful activity (Avoid opportunity costs associated with sleep) [regret, guilt, exhaustion]	Restorative sleep (Improve health and long-term productivity; Wake refreshed) [effort, frustration, craving]
	b. *"Tired machine operator/driver"*, *"Worker or student pulling an all-nighter"*	Restorative sleep (Reduce driving/operating danger; Improve health and long-term productivity; Wake refreshed) [frustration, regret]	Wakeful activity (Operate machine/drive for longer; Improve short-term productivity or information recall) [effort, guilt, craving, exhaustion]

Table 1. *Cont.*

Topic and Decision Dilemma *	Decision Maker Habit or Type	Goal 1—Temptation Utility (Benefits of Achieving Goal 1) † [Possible Negative Emotions from Foregoing Goal 2]	Goal 2—Control Utility (Benefits of Achieving Goal 2) † [Possible Negative Emotions from Foregoing Goal 1]
VII. Charity and helping behavior:	**a.** "*Self-interested tightwad*"	Keep, withhold, refuse (Maintain capital) [guilt, embarrassment, shame]	Donate, help, give (Help others) [effort, regret, frustration]
	b. "*Altruistic*", "*Ascetic*"	Donate, help, give (Help others; self-discipline; achieve personal goals) [craving, regret]	Keep, withhold, refuse (Maintain capital) [guilt, embarrassment, shame, effort, frustration]
VIII. Trust, cooperation:	**a.** " *Non-cooperator*", "*Exploiter*", "*Opportunist*"	Lie, defect, cheat, exploit, defend (Short-term gain, security, and exploitation of available opportunity) [guilt, embarrassment, shame]	Tell truth, trust, reciprocate, cooperate, share (Develop cooperative relationship; Avoid contracting, monitoring, defense) [effort, craving]
	b. "*Cooperator*", "*Trusting trustor*", "*Trustworthy reciprocator*"	Tell truth, trust, reciprocate, cooperate, share (Develop cooperative relationship; Avoid contracting, monitoring, defense) [craving]	Lie, defect, cheat, exploit, defend (Short-term gain, security, and exploitation of available opportunity) [effort, guilt, embarrassment, shame]

* Citations for dilemma topics are found in Section 3.1; † Control (temptation) utilities entail potential social benefits (costs). Demonstration of self-control may bring reputation benefits (e.g., increased status) while avoiding status loss and costly emotions (e.g., guilt, embarrassment, shame) associated with being "out of control" and choosing less socially desirable options. In other contexts, those who demonstrate too-much self-control accrue costs [76].

3.1. Approach and Avoidance

The theory described in Section 2 relies on the fundamental idea that the regulation of decisions made under dilemma conditions can be explained by dynamics of conflicting cognitive systems (mathematically formalized as utility functions). In other words, an essential micro-foundation of our model is the now well-established idea that the brain is composed of different modules (or parts) sometimes working together towards a common goal but at other times in a direct competition to influence the DM's pursuit of mutually exclusive goals.

More than fifty years ago, Olds and colleagues [77,78] first provided evidence of separate neural mechanisms involved in pleasure and pain. Miller's [79] classic research on conflict presented rats with a stimulus that created an approach/avoidance dilemma: it provided both reward (i.e., food) and punishment (i.e., electrical shock)—causing oscillation between approach and avoidance. Similar behavioral evidence of distinct internally-conflicted systems later came from Berridge and Grill's [80] study of taste responses in rats, indicating that when a combined solution of sucrose (sweet) and quinine (bitter) is tasted, it triggers vigorous alternation between the opposing reflexes associated with continued intake and rejection behaviors. Structures and functions of what later became better known as "approach and avoidance" systems were understood with greater clarity by later studies [81–83].

Bargh and colleagues [20,21] demonstrated parallel approach and avoidance responses in humans, in the absence of conscious awareness, and others have demonstrated similar effects using other behavioral responses that correspond to approach and avoidance dispositions [84–86]. Together, these studies further support the idea that peoples' approach and avoidance of stimuli can function quite automatically—that is, without conscious control over the speed of their responses or conscious awareness of the association between responses and approach/avoidance motivation. Nevertheless, because individuals may become aware of their propensities towards avoidance over approach (e.g., those of us labeled "*scaredy-cats*") or approach over avoidance (e.g., those of us identified as "*greedy*"), DMs in these otherwise "automatic" dilemmas may attempt to engage self-control efforts, sometimes with success and other times with failure. We consider approach-avoidance dilemmas and emotional consequences of differential goal pursuit from a self-control perspective for two distinct types of DM in Table 1.

More recent developments in neuroscience confirm that distinct brain circuitry underlies emotional regulation of conflicting goal-pursuant modules [87]. For instance, in adults and infants, electroencephalography (EEG) has shown that arousal of positive, approach-related emotions (e.g., in response to positive events) is associated with selective activation of the left frontal region, while arousal of negative, withdrawal-related emotions (e.g., in response to negative events) is associated with selective activation of the right frontal region [88–90]. Other brain imaging studies have also shown that two separate neural subsystems are activated when self-control problems are faced [56,58]. Self-control problems, many of which we review in Sections 3.2–3.6 below, span a wide variety of individual-decision phenomenon, some of which bear relationship to social-dilemma problems discussed in Section 3.7.

3.2. Impulse Buying, Shopping Momentum

Efficient and tempting media advertisement via radio, television, print, and internet has created an ubiquitous self-control problem for consumers with limited spending ability who now face unlimited temptations available for purchase. While some consumers are cursed to be "*tight wads*" and "*misers*" with tendency to save and forgo opportunities to purchase desired or even needed items, then later regret and crave those missed opportunities, the great majority of consumers tend towards quite the opposite pattern: demonstrating characteristics of "*impulse shoppers*". We consider buyer dilemmas and emotional consequences of differential goal pursuit from a self-control perspective for two distinct types of DM in Table 1.

"Impulse" buying generally refers to purchases that depart from normal purchase patterns for the consumer, and that may be influenced by strong emotions and subsequent dissatisfaction or regret [91]. Since credit opportunities have increasingly made impulse buys "easier" and thus generated more associated problems, impulse buying has received a great deal of attention. Our model, and in particular the important role of recalibrational emotions produced by past decisions, may help explain impulse-shopping cycles of indulgence and restraint [22].

The idea that a DM's recent behavioral history can shape their current decision has been explored by Dhar and colleagues [92] who report extensive evidence that the likelihood of purchasing a subsequent item (the "target") increases with the purchase incidence of an initial, unrelated item (the "driver"). This "shopping momentum effect" is consistent with many commercial practices (loss leaders, strategic shelf-space allocation, promotions encouraging a first purchase, etc.) that rely on the consumer's past consumption decisions to provide a psychological impulse affecting their subsequent decisions.

In Section 2, we formalized a compensatory decision cycle of a conflicted DM affected by negative emotions (e.g., *indulgence regret* and *self-control effort*). This same decision cycle has been found in consumption. For instance, Förster and colleagues [29] argue that when DMs with conflicting goals recall past behaviors, they tend to inhibit previously fulfilled goals and instead activate unfulfilled ones. Similarly, Read and colleagues [93] argue that recalling a past decision at the point of making a current decision serves to bracket the two decisions together and hence increases the probability that the prior decision will have an influence on the current decision. As in the moral self-regulation literature, this influence could result in consistent behavior, with the same decision repeated again and again, or it could result in switching behavior, such that the opposite of the last decision is always chosen.

3.3. Diet Regulation: Feasting and Fasting

Food intake is regulated with help of salient and cognitively intrusive hunger and satiation impulses [94]. While these physiological impulses usually correspond to one's energy balance and state of abdominal bloat, there are emotional factors and ecological contexts (e.g., menu effects) that greatly influence eating behavior. Human eating behavior presents a puzzle because it manifests as more irregular than energy balance models expect. For a menu of consumption opportunities, non-pathological humans will demonstrate deliberate overeating (e.g., *feasting*: where more energy is taken in than had been expended since last meal) or deliberate dietary restriction (e.g., *fasting:* where one abstains from taking in available energy needed to recoup energy losses since last meal), such as while enduring effortful activities, or even for reasons as mundane as to better enjoy a large dinner. For example, describing analyses of data from the Beltsville one year dietary study [95], Casper and Beaton [96] describe "normal" day-to-day cycles of caloric consumption cycling between positive and negative energy balance among non-bulimic samples. In a note elaborating on Becker and Murphy [97], Dockner and Feichtinger [98] show cyclical consumption introducing two consumption capitals (eating capital and weight capital) in an extended utility function, consistent with the normal everyday behavior that we struggle to control—with occasional success and failure.

The "self-control" ability to deliberately regulate diet beyond the directives of a homeostatic energy balance system likely co-evolved with a suite of behavioral responses that helped humans forage optimally in environments characterized by mobile prey, shifting patchy resources, regular threats of food scarcity, and the need to constantly migrate in search of more bountiful resources [99]. Under those ancestral conditions, there were likely scenarios where available resource patches would need to be abandoned in search of new (and hopefully better) opportunities, or where persistence tracking of prey would require those involved to forego consumption opportunities in the hope of acquiring greater returns. We suggest, as have others, that the human physiological abilities to acquire high levels of fat by "feasting" or over-eating, to convert stored resources into energy while fasting, and to promote effortful behavior are adaptive responses to the selection pressures of feast and famine cycles [100–102].

Experiments have demonstrated that feasting and fasting cycles have distinct effects on patterns of weight gain (loss) and are strongly driven by recalibrational negative emotions. In the 1940 Minnesota Starvation Experiment, healthy male volunteers were subjected to severe caloric restriction over a period of 24 weeks, followed by gradual restoration of calories over a 12-week rehabilitation phase. These dieters became progressively disturbed by negative emotions and obsessively focused on food (not only talking and thinking about food constantly, but also buying cookbooks, developing recipes and even dreaming about food), even after the refeeding period had begun. During the period of refeeding, Keys and colleagues [103] noted that fat accumulated at an abnormally fast rate and well past the baseline level, leading to "weight overshoot". Weight overshoot, attributed to dietary restraint followed by binge eating has been documented in other studies following severe caloric restriction [104]. Pathological consumption patterns (e.g., anorexia and bulimia) that also cycle between periods of bingeing and compensatory fasting [105,106] are well documented by psychiatric and health-care professionals who also note that these consumption patterns are closely related with and regulated by negative emotional experiences. In particular, as a consequence of these extreme consumption behaviors, individuals report high negative affect (e.g., guilt) after bingeing and purging [107,108]. We present two sides of a diet regulation self-control problem as experienced by different types of decision makers in Table 1: for example, the *overweight dieter* who is tempted to feast and then regretful and guilted into effortful fasting and restraint, and the *anorexic* who suffers from a tendency to abstain or restrain from eating. Interestingly, negative emotions like effort, pain and even nausea experienced by the anorexic are also experienced by those who need to over-eat for strategic reasons, for example, *competitive eaters* training to increase their consumption tolerance and stomach capacity [109], and people preparing for extended strenuous activity with little food—such as seen with long distance migration or *persistence hunting* that were characteristics of our evolutionary ancestry [110].

Mukhopadhyay and colleagues [30] found evidence that impulsive consumers who recalled resisting (yielding to) the temptation of eating tasty but unhealthy food demonstrated temporally inconsistent choices; upon repeated exposure to tempting options they experienced greater activation of the unfulfilled self-control (temptation) ideal of recent past choices. Thus, as our model shows, recently indulgent consumers who recall their behaviors tend to show control when facing temptations again and recently restrained consumers tend to yield to temptation when recalling their self-control.[11] Finally, an important result of our model is that decisions evolve over time so as to adapt to the set of available options. If the option set is temptation shifted, effort will dominate, down-regulating appeal of the self-control ideal and bringing decisions closer to the temptation ideal. Similarly, if the option set is self-control shifted, guilt will dominate down-regulating temptation and bringing decisions closer to the self-control ideal. This result is consistent with concerns raised by nutritionists that expanding portion sizes have contributed to the rise of obesity in United States. In line with our model, Rolls and colleagues [2] found evidence that availability of large portions of food contribute to excess consumption when compared to small portions of food.

The self-control problems associated with diet-regulation bear similarity with self-control problems associated with the wide range of vices that many people struggle with (e.g., alcohol, smoking, drugs, sex, gambling)—especially those people referred to as "*hedonists*" and "*myopics*". While most people have a tendency to state preferences aligned with long-term goals, their revealed preferences favor short-term goals when they switch to preferences aligned with what are considered "vices" (alternatives that are more pleasurable to consume in the short-run) from "virtues" (alternatives that benefit the consumer more in the long-run) as the decision moment draws closer. For many of us, vices can become addictive and lead to strong feelings of regret and guilt. A minority of us can and do refrain from indulgence and are characterized as "*conservative*", and in the extreme, "*ascetic*". The overly self-controlled who too-often shun short-term pleasures actually experience *self-control regret* and uncomfortable feelings of having missed out [39].

3.4. Exercise vs. Rest

More than one-third of adults and 17% of youth in the United States are obese, with insufficient exercise given dietary intake a major cause [111]. Many have been puzzled by the heterogeneity observed in body mass, dietary and exercise habits and by the constant self-control struggles that people engage in with regards to these behaviors.

According to Adams and Kirkby [26], regular bouts of vigorous exercise (e.g., 5 times a week) with occasional "days off" (i.e., not running) can lead to emotionally variable cycles characterized by "dependency" and "withdrawal" symptoms. Regular exercise is psychologically rewarding, providing intrinsic motivation to continue exercise behavior [112,113] despite associated costs such as accumulated injuries, neglected commitments to family and work [114], and medical advice explicitly recommending to take days off [115]. It is this addiction to exercise that explains why despite a tendency towards rest for the average "*sedentary person*", "*fitness freaks*" develop dedicated habits of engaging in daily exercise. Nevertheless, injuries, sickness, or commitments sometimes require dedicated athletes to take days off from their exercise schedule, which for many can lead to adverse psychological states. We consider exercise dilemmas and emotional consequences of differential goal pursuit from a self-control perspective for two distinct types of DM in Table 1.

Robbins and Joseph [116] surveyed 345 runners (both genders, both competitive and noncompetitive) who ran regularly and reported that most runners, when forced to miss a run, reported withdrawal symptoms including a substantial level of distress from negative emotions such as irritability, restlessness, frustration, guilt, regret, and depression. Significantly higher levels of low mood and negative emotions on days off compared to running days have been reported among a number of other samples of regular runners [115,117–119]. In some cases, the depression associated with this exercise withdrawal produces "*burn-out athletes*" who choose extended non-exercise (despite

[11] As in Cornelissen et al. [27] there is another type who is able to achieve stable decisions over time. Mukhopadhyay and colleagues [30] refer to them as "non-impulsive consumers". As we mentioned above, our model predicts the existence of both impulsive and non-impulsive types depending on the degree of impact of negative emotions and memory of past experienced emotions.

opportunity to return to regular exercise), similar to the behavioral tendency observed with sedentary non-athletes [120].

An interesting phenomenon that our model may help explain is that regular runners often run longer on days before or after their days off to avoid the distress produced by not running [115,116]. The motivational role of negative emotions produced by exercise withdrawal not only causes compensatory up-regulation in exercise bout durations, but may motivate habit formation characterized by continued participation in regular exercise routines. One runner who suffers extreme guilt when he cannot run, explained: "I am glad, however, that I feel this way because it is the watchdog which makes sure I do my running" (quoted in [121]).

3.5. Work vs. Leisure

Another type of decision dilemma that most individuals struggle with is: work vs. leisure. While some workers (e.g., "*workaholics*") find their jobs very engaging and have trouble taking time out to enjoy leisure, most people are "*reluctant workers*" who struggle to ignore available leisure options and rely on self-control to accomplish necessary work despite the aversive feelings of effort and exhaustion that it produces. We consider worker dilemmas and emotional consequences of differential goal pursuit from a self-control perspective for two distinct types of DM in Table 1.

In recent years new technologies have exacerbated the decision dilemma of work vs. leisure. In fact, nowadays most workers in developed countries have regular access to the Internet via their smartphones, tablets, and personal computers, providing them an omnipresent and tempting alternative to effortful tasks such as work [122]. Perhaps as a consequence of the ubiquity of Internet access in the modern workplace, American employees are allocating about 13% of their on-the-job time to browsing the Internet (for non-work related purposes), and about an equal amount of time on other non-work related activities [123]. A similar rise in Internet use, interspersed with other work activity, is also reported for university students [124]. Corgnet and colleagues [125] studied the impact of Internet availability on a paid mental arithmetic task in the laboratory—finding that participants made regular use of the internet as a non-paid leisure activity, to break up the monotony of the effortful arithmetic task. Though not all were affected by the leisure option, those participants who switched frequently between work and leisure activity suffered the largest reductions in productivity. Indeed, on-the-job internet browsing has been shown to negatively impact workers' productivity [126,127] and has cost U.S. corporations more than $85 billion a year [128]. The effortful nature of work and the enjoyable nature of leisure activities (whether on-the-job or off-the-job) provide workers everywhere an inescapable decision dilemma: work or leisure? Our model can help explain the self-control failures observed among many workers struggling with this dilemma, and can also help explain the heterogeneity in work patterns observed for different kinds of workers.

3.6. Staying Awake Vs. Sleeping

Staying awake vs. sleeping presents a decision dilemma that many may have actually experienced from opposite perspectives at different points of time and in different situations. For example, people sometimes find themselves in position of needing sleep despite temptations which can keep them awake (e.g., the *"TV binge-watcher tempted to stay up late watching"*). For these types, it takes self-control to forego the temptations otherwise keeping them awake. There are also situations where we struggle to stay awake, despite the temptation to fall asleep: consider the *"tired driver or machine operator"* trying to get a little more driving or work done, or the *"student pulling an all-nighter"* who crams for an exam. These latter examples characterize people who attempt to utilize self-control to stave off the temptation of sleeping so as to accomplish something. We consider sleep dilemmas and emotional consequences of differential goal pursuit from a self-control perspective for two distinct types of DM in Table 1.

Many of us find ourselves in both kinds of self-control dilemmas: being tempted to sleep too little, then at some later point in time being tempted to sleep too much. For example, many adolescents and adults across the world get less sleep than they need during weekdays [35]. For most, this decreased nocturnal sleep is associated with increasingly delayed bedtimes, yet fixed morning wake-up times (e.g., for school or work). As a result, adolescents and adults have a tendency to "sleep-in", and sleep for longer on weekends in an effort to "catch up" on this insufficient sleep [129,130]. Weekend catch-up sleep reduces sleepiness, making it more difficult to fall asleep on subsequent weekdays, producing a recurring cycle of sleep deprivation through the week and recovery sleep on weekends [131]. Our model can help us understand the successes and failures of behavior regulation efforts in these different situations as well as the cycling between under- and over-sleeping that most people experience.

3.7. Social Dilemmas: Trust, Cooperation, Contest, and Competition

Many social dilemmas involve tradeoffs between two goals: cooperation (or trust) and non-cooperation (or exploitation), and present DMs uncertainty—since interaction partners may be more tempted to cooperate than defect or else more tempted to defect than cooperate (see types described in Table 1). One such dilemma is the Investment game modelled by Berg, Dickhaut, and McCabe [131], which is also commonly referred to as the Trust game. From a short-sighted perspective, the Trust game provides opportunity for gaining available resources. From a longsighted perspective, the Trust game provides the possibility of developing the foundations for a trust-based exchange relationship that our minds consider a security against income risks associated with luck-based asymmetries (such as resulting from the 50% chance of being the investor in this kind of game). According to the recalibrational perspective suggested by Schniter, Shields, and Sheremeta [132], the investor's decision trades off his shortsighted "opportunistic" goal (achieved with earnings from a kept endowment and a maximally profitable investment) with pursuit of his long-sighted "cooperative" goal (achieved by developing an exchange relationship in which both trust and trustworthiness are maximally demonstrated). Likewise, the trustee, having received a trust-based multiplied transfer of funds from the investor, must decide whether to pursue her short-sighted program's goal by keeping this income, or else pursue her longsighted program's goal. The trustee's long-sighted program's goal is to develop a trust-based exchange relationship by returning an amount equal to or greater than what the investor originally sent and thereby demonstrating her trustworthy cooperativeness. After a Trust game, an individual's integration of new information (from trust-based decisions and interaction outcomes) triggers the activation of "immediate" positive and negative emotions serving subsequent short- and long-sighted goal pursuits. Schniter and colleagues [132] have identified Trust game outcomes that trigger suites of specific emotional responses including mixed or "conflicted emotions", and have additionally demonstrated that the recalibrational emotions, predictably triggered by Trust game outcomes, are predictive of subsequent behaviors in rematched Trust game interactions [133].

A few others have also proposed multiple-system models of behavior regulation in social dilemmas. Schino and Aureli [134] describe 'attitudinal-based' reciprocity, which has also been called 'emotional book-keeping'. Their perspective assumes that DMs automatically update a cognitive account after experiencing an emotionally positive or negative interaction with a social interaction partner.[12]

In line with the notion of moral balancing described above, Khan and Dhar [136] provide experimental evidence of unstable, temporally inconsistent decision paths in charitable giving: Donors in their study are less willing to donate money to charity if they have previously committed to helping a foreign student. According to our model, these examples of unstable, temporally inconsistent decision paths are expected for DMs with poor emotional memory and/or who experience strong negative emotions. In other cases (such as where emotional memory is strong, or where the experience of recalibrational emotions is weak) we could expect steady states for behavioral types who get

[12] Related to these concepts of emotional or reputational capital, Rabin [135] proposed a model of a self-interested DM without moral concerns, but guided by a system that imposes self-restraint whenever tempting actions produce a negative externality on others. In his model, if social harm is not a consequence, then the DM can pursue self-interested and immoral actions.

characterized for their habits as either "communal pacifists" (preferring to avoid competition) or "agentic competitors" (preferring to engage in contests).

A large theoretical literature on contests (reviewed by [137]) suggests that the decision to compete or refrain from competition may also share rudiments with and parallel decision dilemmas mentioned in trust game and prisoner dilemma settings [59],[13] and models of spatial market competition [142].[14] A typical prediction for contests is that agents compete at the level where marginal benefit of winning the contest equals to the marginal cost of competing. An experimental literature, however, finds that for most (though not all) competition is more aggressive than predicted (see [28] for review) and that more frequent conflict increases negative emotions [143]. It is a long-standing puzzle why participants compete more than predicted [144]. One explanation offered is that contestants are motivated by a non-monetary utility of winning [145] that could be experienced emotionally (e.g., via a sense of pride or satisfaction). More recently, Sheremeta [146] provided evidence that overly competitive behavior of participants can be understood as a consequence of impulsivity (i.e., an inability to restrain the temptation-driven system). Krakel [147] shows that positive (negative) emotions resulting from contest feedback recalibrate contestants efforts to compete harder (less hard) in subsequent contests. Due to their reliable roles in behavior regulation, expressions of felt emotions can also function as gaurantors of threats, promises, and credible messages in strategic interactions [148]. We expect that recalibration emotions can explain some of the puzzling heterogeneity in contest behavior including, occasional over-investment and under-investment (given available information and feedback). While the contest literature has not explained inconsistent switching behavior (e.g., alternation between competition and non-competition over time) from a dual-system perspective, it seems a likely candidate for the application of our model.

4. Conclusions

In this paper, we have attempted to encourage readers to consider the disparate and often competing goals and psychological motives behind behaviors demonstrated in decision dilemmas, and why we should expect the observation of quite opposite behaviors and even habits (e.g., consistency and inconsistency) for DMs facing decision dilemmas. In some cases we can find inter-individual differences characterized by vary different stable habits for different individuals (e.g., the impulsive spendthrift vs. the miser) and in other cases we find intra-individual differences in behavior from one time to another, or from one decision domain to another. As suggested by our model and corroborating evidence, people facing decision dilemmas may differ in the degree to which they anticipate and are motivated by either of two conflicting utilities and the degree to which they experience and can regulate emotional consequences of past decisions [5], and perhaps because of sex differences affecting the perception of different emotions [149]. The conflicted goal approach of considering a DMs utility function may be even more important for understanding *intra*-individual differences revealed at

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[13] Soutschek and colleagues [59] have suggested that the brain regions underlying self-control mechanisms involved in individual decision dilemmas (e.g., trading off impulsive short vs. restrained long-term goals) are also underlying decisions in social dilemmas (e.g., trading off exploitative and individually beneficial vs. cooperative and mutually beneficial goals). Soutschek et al.'s suggestion that a common neural mechanism involved in interpersonal and intertemporal decision-making makes the strong prediction that preference for delayed (over immediate) rewards in studies of temporal discounting correlates with preference for cooperation in iterated prisoner's dilemma games, as also suggested by others [138]. This correlation has been reported in the context of Prisoner's Dilemmas played among college students [139,140] and opioid abusers [141].

[14] Similarly, DMs in competitive markets may be facing decision dilemmas trading off benefits of maximizing their short-term pay-offs (at others' expense) and benefits of maximizing their contribution to others' welfare (which can encourage loyal mutualism over the long-term). Game theoretic solutions to models of spatial competition (e.g., [45]) show that as DMs in a competitive market change their locations to capture optimal customer traffic (a limited resource that they compete over), the costs of competition are affected—changing the landscape of profitability for competitors. Thus, DMs in a dynamic ecology of spatial competition are constantly trading off what is best for their short-term profits and what may be better for their long-term profits because it is optimal from a social welfare perspective, that is, in their customers interest (which contributes to customer loyalty and positive brand reputation). These tradeoffs inherent in market competition may also be motivating behavior seen in other contest domains.

different points of time or in different decision dilemmas. A single "time preference" propensity hardly seems to describe the complexity found for any individual's various behavior regulation habits. Consider how some people engage in risky driving yet carefully plan for their retirement, while others smoke like chimneys yet insist on eating only healthy foods. Or consider the politician who carefully grooms his reputation to build up status and further his career, yet engages in sexual indiscretions that effectively amount to "career suicide". Because of our complexity, we each have our unique struggles and strengths—in some cases discounting the future and in other cases valuing it highly. What is universal to all humans is that we are emotional creatures composed of multitudes of evolved cognitive modules reliably organized into dynamic system of behavior regulation.

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Appendix

Proof of Proposition 1.

By the emotional balance transition equation and the fact that $x_t = \frac{1}{2} + \frac{\rho}{4} B_t$ we know that

$$B_{t+1} = \left(1 - \lambda - \frac{\rho}{2}\right) B_t + \mu \tag{A1}$$

Solving recursively, with the initial condition $B_1 = 0$, we get

$$B_t = 2\mu \left(\frac{1 - \left[1 - \lambda - \frac{\rho}{2}\right]^{t-1}}{2\lambda + \rho} \right) \tag{A2}$$

□

Proof of Corollary 1.

Immediate from Proposition 1.
□

Proof of Corollary 2.

Immediate from Proposition 1.
□

References

1. Stanovich, K.E. *The Robot's Rebellion: Finding Meaning in the Age of Darwin*; University of Chicago Press: Chicago, IL, USA, 2005.
2. Rolls, B.J.; Morris, E.L.; Roe, L.S. Portion size of food affects energy intake in normal-weight and overweight men and women. *Am. J. Clin. Nutr.* **2002**, *76*, 1207–1213. [PubMed]
3. Stroebe, W.; Mensinka, W.; Aartsa, H.; Schuta, H.; Kruglanski, A.W. Why dieters fail: Testing the goal conflict model of eating. *J. Exp. Soc. Psychol.* **2008**, *44*, 26–36. [CrossRef]
4. Giner-Sorolla, R. Guilty pleasures and grim necessities: Affective attitudes in dilemmas of self-control. *J. Personal. Soc. Psychol.* **2001**, *80*, 206. [CrossRef]
5. Paschke, L.M.; Dörfel, D.; Steimke, R.; Trempler, I.; Magrabi, A.; Ludwig, V.U.; Schubert, T.; Stelzel, C.; Walter, H. Individual differences in self-reported self-control predict successful emotion regulation. *Soc. Cognit. Affect. Neurosci.* **2016**, *11*, 1193–1204. [CrossRef] [PubMed]

6. Brocas, I.; Juan, D.C. Dual-process theories of decision-making: A selective survey. *J. Econ. Psychol.* **2014**, *41*, 45–54. [CrossRef]
7. Tooby, J.; Leda, C. The past explains the present: Emotional adaptations and the structure of ancestral environments. *Ethol. Sociobiol.* **1990**, *11*, 375–424. [CrossRef]
8. Nesse, R.M. Evolutionary explanations of emotions. *Hum. Nat.* **1990**, *1*, 261–289. [CrossRef] [PubMed]
9. Pinker, S. How the mind work. *Ann. N. Y. Acad. Sci.* **1999**, *882*, 119–127. [CrossRef] [PubMed]
10. Lichtenstein, S.; Paul, S. *The Construction of Preference*; Cambridge University Press: New York, NY, USA, 2006.
11. Kirby, K.N. Bidding on the future: Evidence against normative discounting of delayed rewards. *J. Exp. Psychol. Gen.* **1997**, *126*, 54. [CrossRef]
12. Kirby, K.N.; Herrnstein, R.J. Preference reversals due to myopic discounting of delayed reward. *Psychol. Sci.* **1995**, *6*, 83–89. [CrossRef]
13. Ainslie, G. *Picoeconomics: The Strategic Interaction of Successive Motivational States Within the Person*; Cambridge University Press: Cambridge, UK, 1992.
14. Ainslie, G. *Breakdown of Will*; Cambridge University Press: New York, NY, USA, 2001.
15. Ainslie, G.; Nick, H. Hyperbolic discounting. In *Choice over Time*; Lowenstein, G., Elster, J., Eds.; Sage: New York, NY, USA, 1992.
16. Frederick, S.; Loewenstein, G.; O'Donoghue, T. Time discounting and time preference: A critical review. *J. Econ. Lit.* **2002**, *40*, 351–401. [CrossRef]
17. Herrnstein, R.J.; Rachlin, H.; Laibson, D.I. The matching law. In *Papers in Psychology and Economics*; Rachlin, H., Laibson, D., Eds.; Sage: New York, NY, USA, 1997; pp. 137–156.
18. Laibson, D. Golden eggs and hyperbolic discounting. *Q. J. Econ.* **1997**, *112*, 443–477. [CrossRef]
19. Gul, F.; Wolfgang, P. Temptation and self-control. *Econometrica* **2001**, *69*, 1403–1435. [CrossRef]
20. Chen, M.; Bargh, J.A. Consequences of automatic evaluation: Immediate behavioral predispositions to approach or avoid the stimulus. *Personal. Soc. Psychol. Bull.* **1999**, *25*, 215–224. [CrossRef]
21. Duckworth, K.L.; Bargh, J.A.; Garcia, M.; Chaiken, S. The automatic evaluation of novel stimuli. *Psychol. Sci.* **2002**, *13*, 513–519. [CrossRef] [PubMed]
22. Mukhopadhyay, A.; Johar, G.V. Indulgence as self-reward for prior shopping restraint: A justification-based mechanism. *J. Consum. Psychol.* **2009**, *19*, 334–345. [CrossRef]
23. Casper, R.C.; Beaton, G.H. Food Deficits, Nutritional Status, and Appetite Signals. *Biol. Feast Fam. Relev. Eat. Disord.* **1992**, 301–313.
24. Primeau, L.A. Work and leisure: Transcending the dichotomy. *Am. J. Occup. Ther.* **1996**, *50*, 569–577. [CrossRef] [PubMed]
25. Monk, T.H.; Buysse, D.J.; Rose, L.R.; Hall, J.A.; Kupfer, D.J. The sleep of healthy people—A diary study. *Chronobiol. Int.* **2000**, *17*, 49–60. [CrossRef] [PubMed]
26. Adams, J.; Kirkby, R.J. Excessive exercise as an addiction: A review. *Addict. Res. Theor.* **2002**, *10*, 415–438.
27. Cornelissen, G.; Bashshur, M.R.; Rode, J.; Menestrel, M.L. Rules or consequences? The role of ethical mind-sets in moral dynamics. *Psychol. Sci.* **2013**, *24*, 482–488. [CrossRef] [PubMed]
28. Dechenaux, E.; Kovenock, D.; Sheremeta, R.M. A survey of experimental research on contests, all-pay auctions and tournaments. *Exp. Econ.* **2015**, *18*, 609–669. [CrossRef]
29. Förster, J.; Liberman, N.; Higgins, E.T. Accessibility from active and fulfilled goals. *J. Exp. Soc. Psychol.* **2005**, *41*, 220–239. [CrossRef]
30. Mukhopadhyay, A.; Sengupta, J.; Ramanathan, S. Recalling past temptations: An information-processing perspective on the dynamics of self-control. *J. Consum. Res.* **2008**, *35*, 586–599. [CrossRef]
31. Ratner, R.K.; Kahn, B.E.; Kahneman, D. Choosing less-preferred experiences for the sake of variety. *J. Consum. Res.* **1999**, *26*, 1–15. [CrossRef]
32. Kaiser, K.; Schwabe, R. Preference for variety. *BE J. Theor. Econ.* **2011**, *12*. [CrossRef]
33. Gul, F.; Pesendorfer, W. Self-control and the theory of consumption. *Econometrica* **2004**, *72*, 119–158. [CrossRef]
34. Elster, J. *Ulysses and the Sirens: Studies in Rationality and Irrationality*; Cambridge University Press: New York, NY, USA, 1979.
35. Kopylov, I. Perfectionism and choice. *Econometrica* **2012**, *80*, 1819–1843.

36. Rick, S.; Loewenstein, G. The role of emotion in economic behavior. In *The Handbook of Emotion*, 3rd ed.; Lewis, M., Haviland-Jones, J.M., Barrett, L.F., Eds.; Guilford: New York, NY, USA, 2008.
37. Haselton, M.G.; Ketelaar, T. Irrational emotions or emotional wisdom? The evolutionary psychology of affect and social behavior. In *Hearts and Minds: Affect in Social Thinking and Behavior*; Forgas, J.P., Ed.; Taylor & Francis Group: New York, NY, USA, 2006; Volume 8, pp. 21–40.
38. Livnat, A.; Pippenger, N. An optimal brain can be composed of conflicting agents. *Proc. Natl. Acad. Sci. USA* **2006**, *103*, 3198–3202. [CrossRef] [PubMed]
39. Kivetz, R.; Keinan, A. Repenting hyperopia: An analysis of self-control regrets. *J. Consum. Res.* **2006**, *33*, 273–282. [CrossRef]
40. Lascu, D.-N. Consumer guilt: Examining the potential of a new marketing construct. In *Advances in Consumer Research*; Holman, R., Solomon, M., Eds.; Association for Consumer Research: Ann Arbor, MI, USA, 1991; Volume 18, pp. 290–295.
41. Thaler, R. Toward a positive theory of consumer choice. *J. Econ. Behav. Organ.* **1980**, *1*, 39–60. [CrossRef]
42. Baumeister, R.F.; Heatherton, T.F. Self-regulation failure: An overview. *Psychol. Inq.* **1996**, *7*, 1–15. [CrossRef]
43. Kurniawan, I.; Guitart-Masip, M.; Dolan, R. Dopamine and effort-based decision making. *Front. Neurosci.* **2011**, *5*, 81. [CrossRef] [PubMed]
44. Hockey, G.R.J. A motivational control theory of cognitive fatigue. In *Cognitive Fatigue: Multidisciplinary Perspectives on Current Research and Future Applications*; Ackerman, P.L., Ed.; American Psychological Association: Washington D.C., USA, 2011; pp. 167–187.
45. Senior, N.W. *An Outline of the Science of Political Economy*; Verlag Wirtschaft und Finanzen: London, UK, 1836.
46. Kurzban, R. *Why Everyone (Else) is a Hypocrite: Evolution and the Modular Mind*; Princeton University Press: Princeton, NJ, USA, 2012.
47. Kurzban, R.; Duckworth, A.; Kable, J.W.; Myers, J. An opportunity cost model of subjective effort and task performance. *Behav. Br. Sci.* **2013**, *36*, 661–679. [CrossRef] [PubMed]
48. Gómez-Miñambres, J.; Schniter, E. Menu-Dependent Emotions and Self-Control. *J. Behav. Exp. Econ.* **2017**, *68*, 110–118. [CrossRef]
49. Bernheim, B.D.; Rangel, A. Addiction and cue-triggered decision processes. *Am. Econ. Rev.* **2004**, *94*, 1558–1590. [CrossRef]
50. Thaler, R.H.; Shefrin, H.M. An economic theory of self-control. *J. Polit. Econ.* **1981**, *89*, 392–406. [CrossRef]
51. Schelling, T.C. *Choice and Consequence*; Harvard University Press: Cambridge, MA, USA, 1984.
52. Fudenberg, D.; Levine, D.K. Timing and self-control. *Econometrica* **2012**, *80*, 1–42.
53. Schneider, W.; Shiffrin, R.M. Controlled and automatic human information processing: I. Detection, search, and attention. *Psychol. Rev.* **1977**, *84*, 1–66. [CrossRef]
54. Shiffrin, R.M.; Schneider, W. Controlled and automatic human information processing: II. Perceptual learning, automatic attending and a general theory. *Psychol. Rev.* **1977**, *84*, 127–190. [CrossRef]
55. Metcalfe, J.; Mischel, W. A hot/cool-system analysis of delay of gratification: Dynamics of willpower. *Psychol. Rev.* **1999**, *106*, 3–19. [CrossRef] [PubMed]
56. McClure, S.M.; Laibson, D.I.; Loewenstein, G.; Cohen, J.D. Separate neural systems value immediate and delayed monetary rewards. *Science* **2004**, *306*, 503–507. [CrossRef] [PubMed]
57. Peters, J.; Büchel, C. Overlapping and distinct neural systems code for subjective value during intertemporal and risky decision making. *J. Neurosci.* **2009**, *29*, 15727–15734. [CrossRef] [PubMed]
58. Hare, T.A.; Camerer, C.F.; Rangel, A. Self-control in decision-making involves modulation of the vmPFC valuation system. *Science* **2009**, *324*, 646–648. [CrossRef] [PubMed]
59. Soutschek, A.; Ruff, C.C.; Strombach, T.; Kalenscher, T.; Tobler, P.N. Brain stimulation reveals crucial role of overcoming self-centeredness in self-control. *Sci. Adv.* **2016**, *2*, e1600992. [CrossRef] [PubMed]
60. James, W. *The Principles of Psychology, (1890)*; Holt: New York, NY, USA, 1950.
61. Freud, S. Formulations on the Two Principles of Mental Functioning. In *The Standard Edition of the Complete Psychological Works of Sigmund Freud*; Strachey, J., Freud, A., Eds.; Hogarth: London, UK, 1911; Volume 12.
62. Langer, E.J.; Blank, A.; Chanowitz, B. The mindlessness of ostensibly thoughtful action: The role of "placebic" information in interpersonal interaction. *J. Personal. Soc. Psychol.* **1978**, *36*, 635–642. [CrossRef]
63. Langer, E.J.; Imber, L. Role of mindlessness in the perception of deviance. *J. Personal. Soc. Psychol.* **1980**, *39*, 360–367. [CrossRef]

64. Weinberg, P.; Gottwald, W. Impulsive consumer buying as a result of emotions. *J. Bus. Res.* **1982**, *10*, 43–57. [CrossRef]
65. Holbrook, M.B.; O'Shaughnessy, J.; Bell, S. Actions and reactions in the consumption experience: The complementary roles of reasons and emotions in consumer behavior. *Res. Consum. Behav.* **1990**, *4*, 131–163.
66. Gómez-Miñambres, J. Temptation, horizontal differentiation and monopoly pricing. *Theor. Decis.* **2015**, *78*, 549–573. [CrossRef]
67. Becker, G. *Accounting for Tastes*; Harvard University Press: Cambridge, MA, USA, 1996.
68. Gilovich, T.; Medvec, V.H. The temporal pattern to the experience of regret. *J. Personal. Soc. Psychol.* **1994**, *67*, 357–365. [CrossRef]
69. Tsiros, M.; Mittal, V. Regret: A model of its antecedents and consequences in consumer decision making. *J. Consum. Res.* **2000**, *26*, 401–417. [CrossRef]
70. Inman, J.J.; Marcel, Z. Regret in repeat purchase versus switching decisions: The attenuating role of decision justifiability. *J. Consum. Res.* **2002**, *29*, 116–128. [CrossRef]
71. Nisan, M.; Kurtines, W. The moral balance model: Theory and research extending our understanding of moral choice and deviation. In *Handbook of Moral Behavior and Development Application*; Erlbaum: Hillsdale, NJ, USA, 1991; pp. 213–249.
72. Barrett, H.C. A hierarchical model of the evolution of human brain specializations. *Proc. Natl. Acad. Sci. USA* **2012**, *109* (Suppl. 1), 10733–10740. [CrossRef] [PubMed]
73. Loewenstein, G.; Read, D.; Baumeister, R.F. *Time and Decision: Economic and Psychological Perspectives on Intertemporal Choice*; Russell Sage Foundation: New York, NY, USA, 2003.
74. O'Donoghue, T.; Rabin, M. Doing it now or later. *Am. Econ. Rev.* **1999**, *89*, 103–124. [CrossRef]
75. Lipman, B.; Pesendorfer, W. *Temptation*; Working Paper; Boston University: Boston, MA, USA, 2011.
76. Gambetta, D.; Origgi, G. L-worlds. The curious preference for low quality and its norms. *Oxf. Ser. Work. Pap. Linguist.* **2009**, *1*, 23.
77. Olds, J. Self-stimulation of the brain. Its use to study local effects of hunger, sex and drugs. *Science* **1958**, *127*, 315–324. [CrossRef] [PubMed]
78. Olds, J.; Milner, P. Positive reinforcement produced by electrical stimulation of septal area and other regions of rat brain. *J. Comp. Physiol. Psychol.* **1954**, *47*, 419–427. [CrossRef] [PubMed]
79. Miller, N.E. Learning resistance to pain and fear: Effects of overlearning, exposure, and rewarded exposure in context. *J. Exp. Psychol.* **1960**, *60*, 137–145. [CrossRef] [PubMed]
80. Berridge, K.C.; Grill, H.J. Isohedonic tastes support a two-dimensional hypothesis of palatability. *Appetite* **1984**, *5*, 221–231. [CrossRef]
81. Hoebel, B.G.; Rada, P.V.; Mark, G.P.; Pothos, E.N. Neural systems for reinforcement and inhibition of behavior: Relevance to eating, addiction, and depression. In *Well-Being: The Foundations of Hedonic Psychology*; Kahneman, D., Diener, E., Schwarz, N., Eds.; Cambridge University Press: New York, NY, USA, 1999; pp. 558–572.
82. Gray, J.A. Brain systems that mediate both emotion and cognition. *Cognit. Emot.* **1990**, *4*, 269–288. [CrossRef]
83. Gray, J.A. Neural systems, emotion and personality. *Neurobiol. Learn. Emot. Affect* **1991**, *4*, 273–396.
84. Cacioppo, J.T.; Priester, J.R.; Berntson, G.G. Rudimentary determinants of attitudes: II. Arm flexion and extension have differential effects on attitudes. *J. Personal. Soc. Psychol.* **1993**, *65*, 5–17. [CrossRef]
85. Epley, N.; Gilovich, T. Putting adjustment back in the anchoring and adjustment heuristic: Differential processing of self-generated and experimenter-provided anchors. *Psychol. Sci.* **2001**, *12*, 391–396. [CrossRef] [PubMed]
86. Neumann, R.; Strack, F. Approach and avoidance: The influence of proprioceptive and exteroceptive cues on encoding of affective information. *J. Personal. Soc. Psychol.* **2000**, *79*, 39–48. [CrossRef]
87. Davidson, R.J. Affective style, psychopathology, and resilience: Brain mechanisms and plasticity. *Am. Psychol.* **2000**, *55*, 1196–1214. [CrossRef] [PubMed]
88. Tomarken, A.J.; Davidson, R.J.; Wheeler, R.E.; Doss, R.C. Individual differences in anterior brain asymmetry and fundamental dimensions of emotion. *J. Personal. Soc. Psychol.* **1992**, *62*, 676–687. [CrossRef]
89. Davidson, R.J.; Ekman, P.; Saron, C.D.; Senulis, J.A.; Friesen, W.V. Approach-withdrawal and cerebral asymmetry: Emotional expression and brain physiology: I. *J. Personal. Soc. Psychol.* **1990**, *58*, 330–341. [CrossRef]
90. Davidson, R.J. Emotion and affective style: Hemispheric substrates. *Psychol. Sci.* **1992**, *3*, 39–43. [CrossRef]

91. Wood, M. Socio-economic status, delay of gratification, and impulse buying. *J. Econ. Psychol.* **1998**, *19*, 295–320. [CrossRef]
92. Dhar, R.; Huber, J.; Khan, U. The shopping momentum effect. *J. Mark. Res.* **2007**, *44*, 370–378. [CrossRef]
93. Read, D.; Loewenstein, G.; Rabin, M.; Keren, G.; Laibson, D. Choice bracketing. In *Elicitation of Preferences*; Springer: Dordrecht, The Netherlands, 1999; pp. 171–202.
94. Burnett, C.J.; Li, C.; Webber, E.; Tsaousidou, E.; Xue, S.Y.; Brüning, J.C.; Krashes, M.J. Hunger-driven motivational state competition. *Neuron* **2016**, *92*, 187–201. [CrossRef] [PubMed]
95. Mertz, W.; Kelsay, J.L. Rationale and design of the Beltsville one-year dietary intake study. *Am. J. Clin. Nutr.* **1984**, *40*, 1323–1326. [PubMed]
96. Casper, R.C.; Beaton, G.H. Food Deficits, Nutritional Status, and Appetite Signals. In *The Biology of Feast and Famine: Relevance to Eating Disorders*; Anderson, G.H., Kennedy, S.H., Eds.; Academic Press: San Diego, CA, USA, 1992; pp. 301–313.
97. Becker, G.S.; Murphy, K.M. A theory of rational addiction. *J. Polit. Econ.* **1988**, *96*, 675–700. [CrossRef]
98. Dockner, E.J.; Feichtinger, G. Cyclical consumption patterns and rational addiction. *Am. Econ. Rev.* **1993**, *83*, 256–263.
99. Potts, R. Variability selection in hominid evolution. *Evolut. Anthropol. Issues News Rev.* **1998**, *7*, 81–96. [CrossRef]
100. Pond, C.M. *The Fats of Life*; Cambridge University Press: New York, NY, USA, 1998.
101. Kuzawa, C.W. Adipose tissue in human infancy and childhood: An evolutionary perspective. *Am. J. Phys. Anthropol.* **1998**, *107*, 177–209. [CrossRef]
102. Wells, J.C.K. Evolution of the human profile of fatness. *J. Hum. Ecol.* **2005**, *13*, 17–22.
103. Keys, A.; Brožek, J.; Henschel, A.; Mickelsen, O.; Taylor, H.L. *The Biology of Human Starvation*; University of Minnesota Press: Minneapolis, MN, USA, 1950.
104. Dulloo, A.G.; Jacquet, J.; Girardier, L. Poststarvation hyperphagia and body fat overshooting in humans: A role for feedback signals from lean and fat tissues. *Am. J. Clin. Nutr.* **1997**, *65*, 717–723. [PubMed]
105. Kurth, C.L.; Krahn, D.D.; Nairn, K.; Drewnowski, A. The severity of dieting and bingeing behaviors in college women: Interview validation of survey data. *J. Psychiatr. Res.* **1995**, *29*, 211–225. [CrossRef]
106. Heatherton, T.F.; Nichols, P.; Mahamedi, F.; Keel, P. Body weight, dieting, and eating disorder symptoms among college students, 1982 to 1992. *Am. J. Psychiatr.* **1995**, *152*, 1623–1629. [PubMed]
107. Lynch, W.C.; Everingham, A.; Dubitzky, J.; Hartman, M.; Kasser, T. Does binge eating play a role in the self-regulation of moods? *Integr. Physiol. Behav. Sci.* **2000**, *35*, 298–313. [CrossRef] [PubMed]
108. Whiteside, U.; Chen, E.; Neighbors, C.; Hunter, D.; Lo, T.; Larimer, M. Difficulties regulating emotions: Do binge eaters have fewer strategies to modulate and tolerate negative affect? *Eat. Behav.* **2007**, *8*, 162–169. [CrossRef] [PubMed]
109. Levine, M.S.; Spencer, G.; Alavi, A.; Metz, D.C. Competitive speed eating: Truth and consequences. *Am. J. Roentgenol.* **2007**, *189*, 681–686. [CrossRef] [PubMed]
110. Liebenberg, L. *The Art of Tracking: The Origin of Science*; David Philip Publishers: Claremont, South Africa, 1990.
111. Ogden, C.L.; Carroll, M.D.; Kit, B.K.; Flegal, K.M. Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA* **2014**, *311*, 806–814. [CrossRef] [PubMed]
112. Frederick, C.M.; Morrison, C.; Manning, T. Motivation to participate, exercise affect, and outcome behaviors toward physical activity. *Percept. Mot. Skills* **1996**, *82*, 691–701. [CrossRef] [PubMed]
113. Scully, D.; Kremer, J.; Meade, M.M.; Graham, R.; Dudgeon, K. Physical exercise and psychological well-being: A critical review. *Br. J. Sports Med.* **1998**, *32*, 111–120. [CrossRef] [PubMed]
114. Joseph, P.; Robbins, J.M. Worker or runner? The impact of commitment to running and work on self-identification. In *The Psychology of Running*; Sacks, M.H., Sachs, M., Eds.; Human Kinetics: Champaign, IL, USA, 1981; pp. 131–146.
115. Pierce, E.F.; McGowan, R.W.; Lynn, T.D. Exercise dependence in relation to competitive orientation of runners. *J. Sports Med. Phys. Fit.* **1993**, *33*, 189–193.
116. Robbins, J.M.; Joseph, P. Experiencing exercise withdrawal: Possible consequences of therapeutic and mastery running. *J. Sport Psychol.* **1985**, *7*, 23–29. [CrossRef]
117. Morris, M.; Steinberg, H.; Sykes, E.A.; Salmon, P. Effects of temporary withdrawal from regular running. *J. Psychosom. Res.* **1990**, *34*, 493–500. [CrossRef]

118. Conboy, J.K. The effects of exercise withdrawal on mood states in runners. *J. Sport Behav.* **1994**, *17*, 188.
119. Mondin, G.W.; Morgan, W.P.; Piering, P.N.; Stegner, A.J.; Stotesbery, C.L.; Trine, M.R.; Wu, M.-Y. Psychological consequences of exercise deprivation in habitual exercisers. *Med. Sci. Sports Exerc.* **1996**, *28*, 1199–1203. [CrossRef] [PubMed]
120. Gould, D. Personal motivation gone awry: Burnout in competitive athletes. *Quest* **1996**, *48*, 275–289. [CrossRef]
121. Glasser, W. *Positive Addiction*; Harper & Row: New York, NY, USA, 1976.
122. Smith, A. *Smartphone Ownership Update*; Pew Research Center's Internet & American Life Project: Washington, DC, USA, 2013.
123. Malachowski, D. Wasted time at work costing companies billions. Available online: http://www.systemsdynamics.net/aeprod/articles/05092.pdf (accessed on 17 May 2017).
124. Corgnet, B.; Hernán-González, R.; Schniter, E. Why real leisure really matters: Incentive effects on real effort in the laboratory. *Exp. Econ.* **2015**, *18*, 284–301. [CrossRef]
125. Young, K.S. Internet addiction prevention and education: Preventive education training can reduce problematic Internet use in the workplace and help employers create a work environment that encourages identification and treatment of addictive online behaviors. *J. Empl. Assist.* **2005**, *15*, 15–19.
126. Young, K.S. The Internet and workplace transformation. *Adv. Manag. Inf. Syst.* **2006**, *7*, 193–204.
127. Alder, G.S.; Noel, T.W.; Ambrose, M.L. Clarifying the effects of Internet monitoring on job attitudes: The mediating role of employee trust. *Inf. Manag.* **2006**, *43*, 894–903. [CrossRef]
128. Bartlett, D.J.; Marshall, N.S.; Williams, A.; Grunstein, R.R. Sleep health New South Wales: Chronic sleep restriction and daytime sleepiness. *Int. Med. J.* **2008**, *38*, 24–31. [CrossRef] [PubMed]
129. Cain, N.; Gradisar, M.; Moseley, L. A motivational school-based intervention for adolescent sleep problems. *Sleep Med.* **2011**, *12*, 246–251. [CrossRef] [PubMed]
130. Pollak, C.P.; Bright, D. Caffeine consumption and weekly sleep patterns in US seventh-, eighth-, and ninth-graders. *Pediatrics* **2003**, *111*, 42–46. [CrossRef] [PubMed]
131. Berg, J.; Dickhaut, J.; McCabe, K. Trust, reciprocity, and social history. *Games Econ. Behav.* **1995**, *10*, 122–142. [CrossRef]
132. Schniter, E.; Sheremeta, R.M.; Shields, T.W. Conflicted emotions following trust-based interaction. *J. Econ. Psychol.* **2015**, *51*, 48–65. [CrossRef]
133. Schniter, E.; Sheremeta, R.M. Predictable and predictive emotions: Explaining cheap signals and trust re-extension. *Front. Behav. Neurosci.* **2014**, *8*, 401. [CrossRef] [PubMed]
134. Schino, G.; Aureli, F. Reciprocal altruism in primates: Partner choice, cognition, and emotions. *Adv. Study Behav.* **2009**, *39*, 45–69.
135. Rabin, M. *Moral Preferences, Moral Constraints, and Self-Serving Biases. Mimeo*; University of California at Berkeley: Berkeley, CA, USA, 1995.
136. Khan, U.; Dhar, R. Licensing effect in consumer choice. *J. Mark. Res.* **2006**, *43*, 259–266. [CrossRef]
137. Konrad, K.A. *Strategy and Dynamics in Contests*; Oxford University Press: New York, NY, USA, 2009.
138. Rachlin, H. *The Science of Self-Control*; Harvard University Press: Cambridge, MA, USA, 2009.
139. Harris, A.C.; Madden, G.J. Delay discounting and performance on the prisoner's dilemma game. *Psychol. Rec.* **2002**, *52*, 429–440.
140. Yi, R.; Johnson, M.W.; Bickel, W.K. Relationship between cooperation in an iterated prisoner's dilemma game and the discounting of hypothetical outcomes. *Learn. Behav.* **2005**, *33*, 324–336. [CrossRef] [PubMed]
141. Yi, R.; Buchhalter, A.R.; Gatchalian, K.M.; Bickel, W.K. The relationship between temporal discounting and the prisoner's dilemma game in intranasal abusers of prescription opioids. *Drug Alcohol Depend.* **2007**, *87*, 94–97. [CrossRef] [PubMed]
142. Hotelling, H. Stability in Competition. *Econ. J.* **1929**, *39*, 41–57. [CrossRef]
143. Caldara, M.; McBride, M.T.; McCarter, M.W.; Sheremeta, R.M. A Study of the Triggers of Conflict and Emotional Reactions. *Games* **2017**, *8*, 21. [CrossRef]
144. Sheremeta, R.M. Overbidding and heterogeneous behavior in contest experiments. *J. Econ. Surv.* **2013**, *27*, 491–514. [CrossRef]
145. Sheremeta, R.M. Experimental comparison of multi-stage and one-stage contests. *Games Econ. Behav.* **2010**, *68*, 731–747. [CrossRef]

146. Sheremeta, R.M. Impulsive behavior in competition: Testing theories of overbidding in rent-seeking contests. Available online: https://mpra.ub.uni-muenchen.de/73731/1/MPRA_paper_73731.pdf (accessed on 17 May 2017).
147. Kräkel, M. Emotions in tournaments. *J. Econ. Behav. Organ.* **2008**, *67*, 204–214. [CrossRef]
148. Reed, L.I.; DeScioli, P. The Emotional Moves of a Rational Actor: Smiles, Scowls, and Other Credible Messages. *Games* **2017**, *8*, 18. [CrossRef]
149. Filkowski, M.M.; Olsen, R.M.; Duda, B.; Wanger, T.J.; Sabatinelli, D. Sex differences in emotional perception: Meta-analysis of divergent activation. *NeuroImage* **2017**, *147*, 925–933. [CrossRef] [PubMed]