Judgment and Motivation in Conflict: A Decision Field Theory Model of Real-Time Self-Control and Akrasia

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Abstract. This position paper proposes a computational model of *real-time self-control* and *akrasia*, developed as a two-field extension of Decision Field Theory. The model formalizes a separatist view of the relationship between evaluation and motivational force, drawing primarily on Alfred Mele's theoretical analysis, according to which the evaluation of a specific attribute of an option and its associated motivational force can be misaligned. The model distinguishes between the field of practical judgment (or *better judgment*), whose state evolves through the serial attentional sampling of evaluations, and the field of motivational forces not mediated by judgment, in which multiple such forces can operate in parallel and fluctuate over time. These two fields jointly determine, moment by moment, the overall decision weights associated with the various options, thereby guiding intention formation. This approach makes it possible to operationally define three possible decision outcomes: motivational alignment, successful real-time self-control, and akrasia (understood as the formation of an intention contrary to one's better judgment). An illustrative simulation shows that a single parameterization can yield all three types of outcomes, while also highlighting certain limitations of their operational definitions.

Keywords: Decision Field Theory · Self-control · Akrasia · Dual-process models · Practical judgment · Motivation

1 Introduction

A self-control conflict arises when what a person judges to be the best course of action, all things considered, clashes with a motivation that drives them to act differently. For instance, when dieting to lose weight, one might judge it best to eat vegetables while simultaneously feeling a strong urge to eat a dessert. Similarly, someone facing a work deadline might judge it best to keep working, even while strongly desiring to go out to dinner with their friends. In such situations, the psychological conflict is one between an *overall practical judgment* (also known as *better judgment* [18]) in favor of a particular option, and a motivation that runs counter to this judgment – a temptation – which favors an alternative option.

In the kind of self-control conflict we intend to examine here, the intention the agent ultimately forms is crucial: if, despite the contrary motivation, the agent forms an intention consistent with their judgment, then we have a case of successful self-control; if, conversely, they form an intention that runs counter to what they judge, we have a case of *akrasia* [17,18]. In the first example considered, the better judgment in favor of eating vegetables may prevail over the temptation to eat the dessert, leading to the formation of an intention to eat vegetables; alternatively, the temptation for the dessert may dominate, resulting in the formation of an intention that contradicts the better judgment.[1] Empirical studies show how frequent temptations are in everyday life, along with the conflicts they trigger and the attempts we make to resist them [12,14].

This paper, in particular, aims to provide a mathematical formalization of the psychological phenomenon that can be defined as *real-time self-control* [21] – the form of self-control that can be exercised during a decision-making episode, when a better judgment tries to guide, in real time, the formation of an intention consistent with itself, despite the simultaneous presence of conflicting motivations, or temptations. The model presented in this paper examines both instances in which a better judgment successfully guides the formation of a consistent intention notwithstanding the temptations at play, and instances of *akrasia*, in which temptations prevail and an inconsistent intention is formed. Forms of so-called *preventive self-control*, however, fall outside the scope of this study: in such cases, the individual anticipates a potential conflict between their current better judgment and future temptations, and adopts in advance strategies to increase the likelihood of outcomes consistent with that current better judgment [13,11].

In forming a better judgment, an agent takes into account various attributes of the available options, evaluating them in more or less favorable terms. These *evaluations* help determine what the agent judges to be the best option, all things considered. At the same time, the very same attributes can exert motivational forces that are not necessarily in line with the respective evaluations. The taste of a dessert, for instance, might be evaluated only moderately positively, yet still trigger a very strong motivational pull. This force does not imply a correspondingly positive evaluation of the taste, nor, *a fortiori*, that the agent's practical judgment favors the dessert. This potential dissociation between evaluation and motivational force is central to what are known as *separatist views* in philosophy [24].

Our proposal draws primarily from the philosophical work of Alfred Mele [17,18]. Two of Mele's theses are especially significant: the first articulates the separatist view according to which «the motivational force of our desires is not always in line with our evaluation or assessment of the objects of our desires»; the second asserts that «better judgments are formed, in significant part, on the basis of our evaluation or assessment of the objects of our desires» [17,18].

[1] It is important to note, however, that the model proposed in this paper focuses on the formation of an intention to act, without considering its subsequent execution into action. The formation of an intention to act, in fact, does not necessarily entail the actual execution of the corresponding action.

These two principles allow us to distinguish between evaluations of attributes of objects – which enter into the formation of the better judgment – and independent motivational forces associated with those same attributes, which need not align with the former. This does not mean, however, that a judgment is motivationally inert; in Mele's view, a judgment possesses its own motivational force, through which it can guide the agent in forming an intention that is consistent with it.

Strictly speaking, therefore, the true dichotomy does not lie, in itself, between evaluation and motivation, but rather between two ways in which a specific aspect of an option can contribute to the formation of an intention: the first is through its evaluation, which enters into a judgment that possesses its own motivational force; the second is through its motivational force, which is independent of the associated evaluation and whose effect on intention formation is, consequently, not mediated by the judgment. It is precisely this distinction, which is central in separatist views such as Mele's, that we intend to formalize.

This proposal is part of an extensive body of literature on self-control that already includes various formal models, such as economic approaches [8], value-based choice models [2], dual-process models [16], and recent dynamic-stochastic formalizations [6]. Two previous studies are especially important for this paper: the model by Loewenstein *et al.* [16], which describes choice as the outcome of the interaction between a deliberative process and an affective-motivational process, and the model by Diederich [6], which implements a dual-process architecture within a dynamic-stochastic evidence-accumulation process. However, our proposal differs from these models in that it attempts to formalize the aforementioned separatist view regarding the relationship between evaluation and motivational force, and more specifically the two theses articulated by Mele – an aspect that existing models do not explicitly address.

To this end, we propose a two-field extension of *Decision Field Theory* (DFT) [4,19]. The first field, J_t, represents the temporal evolution of practical judgment, which is driven by the serial consideration of evaluations associated with specific attributes of the various options. The second field, M_t, represents the evolution of the motivational forces that are not mediated by judgment. These motivational forces can be active in parallel and fluctuate over time; above all, they are not necessarily aligned with the evaluations of the very same attributes of the options with which they are associated. Both fields employ the dynamic structure of DFT, based on comparative valences and a feedback mechanism, but they differ in terms of both their inputs and the methods used to sample those inputs. The contributions from both fields are then integrated into overall decision weights, upon which intention formation depends. Broadly speaking, this architecture bears some resemblance to the classic distinction between System 2 and System 1 [20,15,7], but it remains agnostic regarding many of the properties commonly associated with that dichotomy.

The proposed architecture allows for the operational definition of three possible decision outcomes: *motivational alignment*, in which both fields favor the same option; *successful real-time self-control*, in which the two fields favor different options, but the resulting intention is consistent with one's practical judgment;

and *akrasia*, in which the two fields favor different options and the resulting intention is instead consistent with the motivational field, and thereby is in conflict with one's practical judgment.

The dynamic-stochastic structure of DFT also allows, at least in principle, for predictions to be made regarding both the probabilities of various decision outcomes and the time required for the corresponding intentions to form. In this paper, however, our primary aim is to illustrate how the model works, without yet proceeding to its empirical validation. To this end, we present an illustrative simulation, based on the example of choosing between dessert and vegetables, which shows how a single set of parameters can generate all three possible decision outcomes. The simulation also serves to highlight certain limitations of the operational definitions we adopt to distinguish among these outcomes.

The remainder of the paper is organized as follows: Section 2 presents the theoretical background, provides an intuitive overview of the model, and discusses its relationship to other models in the literature; Section 3 details its mathematical formalization; Section 4 presents the illustrative simulation and its results; Section 5 discusses the contribution of this proposal, its limitations, and potential avenues for future development; and Section 6 concludes the paper.

2 Background and Model Intuition

2.1 Separatist Views on Evaluation and Motivation

Separatist conceptions, following the terminology of Tenenbaum [24], distinguish between the evaluation of an object and the motivational force of the desire directed toward it. Similarly, Watson distinguishes between an *evaluational system* and a *motivational system* [27], while Stocker considers the possibility of desiring something that one does not evaluate positively [22]. In Mele's philosophical analysis, to which we refer in this article, the separatist thesis that «the motivational force of our desires is not always in line with our evaluation or assessment of the objects of our desires» is accompanied by a second thesis: «better judgments are formed, in significant part, on the basis of our evaluation or assessment of the objects of our desires» [17,18].

For Mele, however, practical judgment is not motivationally inert: *practical evaluative reasoning* – or, more simply, *practical reasoning* – which is the process of forming a better judgment, is underpinned by a «motivation to settle upon a course of action» [18]. This motivation also supports the resulting judgment, typically enabling it to guide the formation of an intention consistent with it. The distinction, therefore, is not between a judgment devoid of motivational force and motivations that determine on their own what intention is formed; rather, it is a distinction between two ways in which a single attribute of an option can contribute to the formation of an intention: either through its evaluation, which helps form a judgment endowed with its own motivational force, or through a motivational force that is independent of the evaluation and therefore not mediated by judgment. The model, therefore, will have to maintain these contributions distinct, without requiring an alignment between the two.

2.2 Decision Field Theory as a Starting Point

DFT describes the formation of preferences and the process leading to a decision in dynamic-stochastic terms [4,19]. In the standard multi-attribute version, attention selects one attribute at a time, bringing to the fore the evaluations of the various options with respect to that attribute. A contrast mechanism transforms these evaluations into *comparative valences*, which contribute to updating the preference state. This state update, in turn, follows a *feedback* mechanism that combines the persistence of the effects of previously considered evaluations with *lateral inhibition* among the options: in other words, the state associated with each option tends to persist over time, but is also inhibited by competition from other options – an effect that intensifies as the similarity between their respective evaluative profiles increases. Furthermore, DFT includes a stopping rule that determines when a decision is made and which option is selected.

This framework, based on comparative valences and feedback, provides a mechanism for representing the formation and updating of practical judgment through the serial consideration of evaluations – consistent with Mele's second thesis. Our model applies this same dynamic structure to motivational forces that are not mediated by judgment. While evaluations, represented by the matrix V, feed into the field of practical judgment (J_t), motivational forces – represented by the matrices F and Z – feed into the field of motivational forces not mediated by judgment (M_t). In our model the two fields differ not only in their inputs, but also in the ways in which these inputs are sampled: in the judgment field, evaluations relating to single option-attribute pairs are sampled serially; in the motivational field, by contrast, multiple motivational forces can be active in parallel and such activations can fluctuate over time.

2.3 An Intuitive Sketch of the Two-Field Architecture

We now try to give an intuitive sketch of the model. As mentioned, the model treats the two fields as stochastic processes that evolve over the course of a single decision-making episode. The first field, $\{J_t\}_{t\geq 0}$, represents the agent's practical reasoning: at any given time t, J_t expresses the current state of practical judgment – that is, the extent to which practical reasoning favors each of the options. The second field, $\{M_t\}_{t\geq 0}$, represents the dynamics of motivational forces that are not mediated by judgment, with their current state expressed by M_t.

Both fields follow the dynamic structure of DFT, but they differ in terms of the inputs that drive them and the manner in which such inputs are sampled. In the judgment field, a single evaluation from the matrix V, corresponding to a specific option-attribute pair, is sampled at any given time step. In the motivational field, by contrast, multiple forces can be active simultaneously and their activation can fluctuate over time: some are associated with the same attributes in V and are represented in matrix F, while others, represented in matrix Z, are associated with attributes that are motivationally, but not evaluatively, relevant. In both fields, following DFT, the momentarily active inputs are transformed into comparative valences, which update the state of the respective field via a

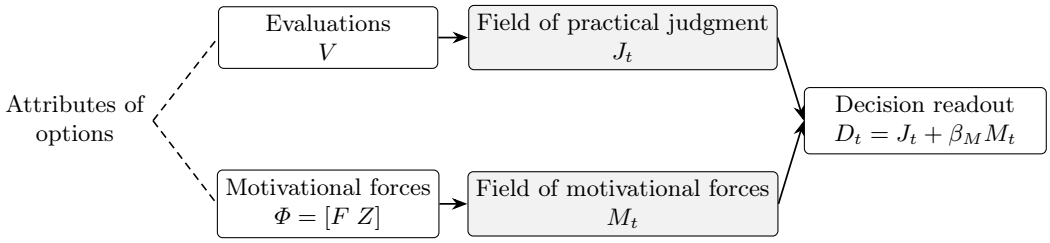

Fig. 1. Schematic representation of the two-field model and their integration into the *decision readout*.

feedback mechanism: this process preserves some effects of previously sampled inputs while introducing inhibitory competition among the options.

Let us return to the example of choosing between a dessert and vegetables: the judgment field is updated as the agent serially considers, for instance, the evaluation of the dessert's taste, the evaluation of the vegetables' healthiness, and so on; at the same time, the taste of a dessert can exert a strong motivational pull – regardless of the (likely only moderately positive) evaluation assigned to it – and thus contributes to the field M_t, alongside all other active motivational forces. The two fields can thus evolve in ways that favor different options, and both contribute to the formation of an intention.

Indeed, since practical judgment also possesses its own motivational force, the two states are combined, moment by moment, into a *decision readout* $D_t = J_t + \beta_M M_t$, the components of which represent the overall decision weights associated with the various options. The decision-making process concludes, in accordance with the adopted *stopping rule*, when the overall decision weight associated with an option reaches a predetermined threshold or when a maximum time limit expires; at that moment, an intention is formed toward the option with the highest overall decision weight. Fig. 1 summarizes the proposed architecture.

2.4 Relationship to Existing Models

Loewenstein *et al.* [16] model choice as the outcome of an interaction between a deliberative process and an affective-motivational process. The relative weight of these processes depends on the cost of deliberative control, which is, in turn, influenced by residual willpower and cognitive load. However, their static model does not account for the dynamic formation of judgment during deliberation through the accumulation of evaluations of individual option-attribute pairs. Furthermore, the motivational field as we model it is not limited solely to affective motivations.

Diederich [6] proposes instead a dynamic-stochastic model in which a single accumulation process incorporates valences associated with both System 1 and System 2, following a serial or quasi-parallel architecture. While this model can predict choice probabilities and response times, it is not specifically designed to study phenomena such as self-control and akrasia. Our focus, by contrast, is

on the formation of intentions in situations where there is a conflict between practical judgment and opposing motivations. Specifically, we aim to represent this conflict through Mele's separatist perspective, distinguishing the contribution of practical judgment from that of motivational forces not mediated by it. To this end, our proposed extension of DFT to two fields allows for the formalization of both of Mele's theses.

3 A Two-Field DFT Model of Real-Time Self-Control

We now formalize the components introduced in the previous section: evaluations and practical judgment, motivational forces not mediated by judgment, the integration of these fields into the decision readout, and the stopping rule for the formation of an intention. Time is discretized into steps indexed by t.

3.1 Options, Attributes, and Evaluations

Let $\mathcal{O} = \{1, \ldots, n\}$ be the set of available options and $\mathcal{A} = \{1, \ldots, m\}$ the set of evaluatively relevant attributes or aspects. Let $V = (v_{ik}) \in (\mathbb{R} \cup \{\bot\})^{n \times m}$ denote the agent's matrix of *evaluations*, where $v_{ik} \in \mathbb{R}$ is the evaluation assigned to attribute k of option i when that attribute is applicable to that option, whereas $v_{ik} = \bot$ indicates that attribute k is not applicable to option i.[2] Positive values represent favorable evaluations, negative values represent unfavorable evaluations, while $v_{ik} = 0$ represents a neutral evaluation. The distinction between $v_{ik} = 0$ and $v_{ik} = \bot$ allows us to differentiate between neutrality and the non-applicability of an attribute. The rows of V correspond to the evaluation profiles of the individual options: for example, V_i is the evaluation profile of option i, that is, the vector of evaluations associated with option i. In accordance with Mele's second principle, the evaluations in V constitute the input for *practical evaluative reasoning* and thus contribute to the formation and moment-by-moment evolution of the practical judgment J_t [17,18].

We can thus define the set of option-attribute pairs for which an evaluation is defined:

$$\Omega = \{(i, k) \in \mathcal{O} \times \mathcal{A} : v_{ik} \neq \bot\}. \tag{1}$$

As will be shown, the serial attentional sampling process considers only those pairs belonging to Ω. Indeed, the model does not posit that the agent's overall practical judgment is derived from the instantaneous aggregation of all evaluations contained in matrix V; rather, it is formed gradually by sequentially attending to the individual option-attribute pairs belonging to Ω. The distinction between V and J_t is conceptually significant: while matrix V contains all evaluations potentially available as input for *practical reasoning*, J_t represents the current practical judgment, obtained by considering these evaluations serially, moment by moment, up to time t.

[2] For example, the attribute "taste" is applicable to the options "dessert" and "vegetables," but not to "fasting". In the case of fasting, this attribute is undefined, rather than neutral (i.e., equal to 0).

3.2 The Field of Practical Judgment

We denote by $J_t = (J_{1,t}, \ldots, J_{n,t})^\top \in \mathbb{R}^n$ the current state of the field of practical judgment, where $J_{i,t}$ represents the accumulated degree to which, at time t, *practical reasoning* favors option i. J_t therefore represents the intermediate state resulting from the serial consideration of the evaluations up to time t and must not be interpreted as something definitive: especially in the initial stages of the process, many of the evaluations have not yet been taken into consideration or, if they have been, they have only been sporadically. When J_t becomes sufficiently stable or, more operationally, at the time τ in which the entire decision-making process stops, we can instead consider J_τ as the expression of the agent's *better judgment*. The best option according to this judgment is therefore the option i^* such that $i^* = \arg\max_{j \in \mathcal{O}} J_{j,\tau}$.

A first difference between our model and standard DFT concerns the granularity of the serial attentional sampling of the evaluations. In the latter, at each instant, the entire column of evaluations associated with a specific attribute is taken as input [5,19]. In our model, however, only the evaluation associated with a single option-attribute pair $(i,k) \in \Omega$ is sampled.[3] Our model therefore allows, for example, moving from sampling the evaluation of a certain option-attribute pair to sampling, at the next instant, the evaluation of a pair with the same attribute but a different option, or with the same option but a different attribute.[4]

Let $e_i \in \mathbb{R}^n$ be the i-th vector of the canonical basis of $\mathbb{R}^n$ and $e_k \in \mathbb{R}^m$ the k-th vector of the canonical basis of $\mathbb{R}^m$, and let $E^{ik} = e_i e_k^\top$ be the $n \times m$ matrix with a single element equal to 1 at position (i,k) and all others equal to 0. The sample at time t, W_t^J, takes values in the set $\{E^{ik} : (i,k) \in \Omega\}$. Furthermore, let H_t be the vector of variables upon which W_t^J may depend, and let h_t be a specific configuration of these variables. We thus define

$$\Pr(W_t^J = E^{ik} \mid H_t = h_t) = \pi_{ik,t}(h_t), \qquad \sum_{(i,k)\in\Omega} \pi_{ik,t}(h_t) = 1, \tag{2}$$

where $\pi_{ik,t}(h_t)$ is the sampling probability for the option-attribute pair (i,k) at time t, conditional on the configuration h_t of the variables governing the sampling. Since W_t^J can only take values corresponding to pairs in Ω, pairs for which $v_{ik} = \perp$ cannot be sampled; in other words, if we were to extend the definition of $\pi_{ik,t}(h_t)$ to all pairs in $\mathcal{O} \times \mathcal{A}$, we would have $\pi_{ik,t}(h_t) = 0$ for every $(i,k) \notin \Omega$. The model does not depend on a particular specification of the sampling probabilities: in a simple case, where they are independent of H_t and time-invariant, we have $\pi_{ik,t}(h_t) = \pi_{ik}$; in the even simpler case of uniform sampling, we have $\pi_{ik} = 1/|\Omega|$.[5]

[3] This is not, however, an essential characteristic of the model, which can be appropriately adapted to recover the standard DFT sampling mechanism.

[4] This change is intended to better reflect human attention, whereby only one option-attribute evaluation is considered at a time, rather than those of all options for a given attribute.

[5] More elaborate sampling rules are possible based on which variables are included in H_t. For instance, dependence on the preceding sample W_{t-1}^J would yield a Markov

The momentary evaluative input available at time t is $X_t^J = (V \odot W_t^J)\mathbf{1}_m$, where $\mathbf{1}_m \in \mathbb{R}^m$ is the column vector whose m elements are all equal to 1 and $\odot$ denotes the component-wise product of the two matrices, defined as $(V \odot W_t^J)_{ik} = v_{ik} w_{ik,t}^J$ when $v_{ik} \in \mathbb{R}$, and $(V \odot W_t^J)_{ik} = 0$ when $v_{ik} = \perp$.[6] If $W_t^J = E^{ik}$ – that is, if the pair (i,k) is sampled – we simply have $X_t^J = v_{ik} e_i$. As in the standard DFT, this input is then transformed into a vector of momentary *comparative valences*, denoted by Q_t^J; to determine this vector, we employ the uniform *contrast matrix* C_J:

$$Q_t^J = C_J(V \odot W_t^J)\mathbf{1}_m, \qquad C_J = \frac{n}{n-1}\left(I_n - \frac{1}{n}\mathbf{1}_n\mathbf{1}_n^\top\right). \tag{3}$$

The diagonal elements of C_J are equal to 1, while the off-diagonal elements are equal to $-1/(n-1)$. If the evaluation v_{ik} is considered at time t, it therefore yields a momentary comparative valence of v_{ik} for option i and a momentary comparative valence of $-v_{ik}/(n-1)$ for all other options.[7]

The field of practical judgment is constantly updated based on the momentary comparative valences:

$$J_{t+1} = S_J J_t + Q_{t+1}^J + \varepsilon_{t+1}^J = S_J J_t + C_J(V \odot W_{t+1}^J)\mathbf{1}_m + \varepsilon_{t+1}^J. \tag{4}$$

The term $S_J J_t$ determines the persistence of the accumulated state of the field of practical judgment; the comparative valence vector Q_{t+1}^J introduces the new evaluation sampled by the attentional sampling process; and ε_{t+1}^J represents a residual noise attributable to neither the dynamics of the accumulated field nor the sampling process. Following the standard DFT framework, the *feedback matrix* S_J simultaneously encodes the persistence of the accumulated state and *lateral inhibition* among the various options:

$$(S_J)_{ij} = \begin{cases} 1 - \epsilon_J, & i = j, \\ -\mu_J s_V(V_i, V_j), & i \neq j, \end{cases} \qquad 0 < \epsilon_J < 1, \quad 0 \leq \mu_J \leq 1, \quad 0 \leq s_V(V_i, V_j) \leq 1. \tag{5}$$

sampling process. A further possibility, particularly relevant to self-control, is to make the sampling probabilities depend on the motivational state M_{t-1} or on the forces f_{ik} defined in Section 3.3, for example through $\pi_{ik,t} \propto \exp(\gamma|M_{i,t-1}|)$ or $\pi_{ik,t} \propto \exp(\gamma|f_{ik}|)$, with $\gamma > 0$. These latter specifications would constitute instances of *motivational capture of attention*.

[6] In the case where $v_{ik} = \perp$, it necessarily holds that $w_{ik,t}^J = 0$, since, by Eq. 2, W_t^J can take the value 1 only at positions $(i,k) \in \Omega$ where $v_{ik} \in \mathbb{R}$. There is therefore no need to assign a meaning to the product of $\perp$ and 1, as it can never occur. Consequently, $V \odot W_t^J \in \mathbb{R}^{n \times m}$ for any admissible value of W_t^J.

[7] The role of the contrast matrix C_J differs slightly from that in standard DFT. In the latter, it contrasts the evaluations of all options for a sampled attribute; in our model, it transforms a single sampled option-attribute evaluation into comparative valences for all options. The contrast mechanism is thus preserved, despite the finer granularity of the attentional sampling.

The diagonal elements of matrix S_J measure the persistence of the accumulated state values into the next time step, while the off-diagonal elements implement a competitive interaction among the options in the form of lateral inhibition. In particular, the term $s_V(V_i, V_j)$ measures the similarity between the evaluation profiles of option i and option j: the greater the similarity between the two options, the greater the lateral inhibition between them. Furthermore, we assume that $s_V(V_i, V_j) = s_V(V_j, V_i)$; consequently, the matrix S_J is symmetric – that is, $S_J = S_J^\top$.[8]

By recursively iterating Eq. (4), we can rewrite the state of the practical judgment field at time t as $J_t = S_J^t J_0 + \sum_{s=1}^{t} S_J^{t-s}(Q_s^J + \varepsilon_s^J)$. This expression shows that the contribution of each sampled momentary comparative valence depends on the time elapsed between the moment the valence was sampled and the current time, as well as on the feedback dynamics implemented by S_J. Furthermore, if $J_0 = 0$, the expression simplifies to $J_t = \sum_{s=1}^{t} S_J^{t-s}(Q_s^J + \varepsilon_s^J)$.

In addition, we assume that $\rho(S_J) < 1$, where $\rho(S_J) = \max_\ell |\lambda_\ell(S_J)|$ is the spectral radius of the matrix S_J – that is, the maximum of the absolute values of its eigenvalues. This condition ensures that the influence of sampled valences decays progressively over time and that, given inputs with a constant mean value, the average dynamics of the field of practical judgment converges to a finite value rather than diverging.[9]

For the sake of clarity, it is useful to distinguish the role of matrix C_J from that of matrix S_J. While the contrast matrix C_J operates on the evaluative input, transforming it into a vector of comparative valences that serves as the actual input for the field of practical judgment, the feedback matrix S_J operates on the current state of the field of practical judgment: it determines the extent to which these values persist into the next moment versus the extent to which they are neutralized by inhibitory competition among the options. Finally, we note that the field of practical judgment can begin from an initial state of $J_0 = 0$, in which case the agent starts with a judgment that is not yet formed, or from a judgment that is already partially or even fully formed. The latter case, in particular, is quite common in the context of self-control, where a person may have already formed a judgment regarding the comparatively better option and subsequently simply applies that judgment in real time when a self-control conflict arises.

3.3 The Field of Motivational Forces Not Mediated by Judgment

We now define the second field, which formalizes the dynamics of motivational forces not mediated by judgment. First, we consider the evaluatively relevant

[8] A possible specification for the similarity function between evaluation profiles is $s_V(V_i, V_j) = m^{-1} \sum_{k=1}^{m} s(v_{ik}, v_{jk})$, where $s(x, y) = 1$ if $x = y = \perp$, $s(x, y) = 0$ if exactly one of x and y equals $\perp$, and $s(x, y) = \exp(-\gamma_V |x - y|)$ if $x, y \in \mathbb{R}$, with $\gamma_V > 0$.

[9] The condition $\rho(S_J) < 1$ implies $S_J^t \to \mathbf{0}_{n\times n}$ as $t \to \infty$. With time-invariant sampling probabilities independent of H_t, i.e., $\pi_{ik,t}(h_t) = \pi_{ik}$, and zero-mean residual noise, $\mathbb{E}[\varepsilon_t^J] = 0$, we have $\mathbb{E}[J_t] \to (I_n - S_J)^{-1} q$, where $q = \mathbb{E}[Q_t^J]$ is constant. Thus, $\rho(S_J) < 1$ prevents the feedback from causing divergence of the mean judgment field.

attributes – those in $\mathcal{A}$ – already represented in the evaluation matrix V. For these, we introduce a matrix $F = (f_{ik}) \in \mathbb{R}^{n\times m}$, where f_{ik} represents the evaluation-independent motivational force associated with attribute k of option i; this force can thus contribute to the formation of an intention with no mediation by judgment. Consequently, for every pair $(i,k) \in \Omega$, both an evaluation v_{ik} and an independent motivational force f_{ik} are defined. We do not assume any proportional relationship between them. In particular, f_{ik} may take a high value while v_{ik} takes a low value, or vice versa, and the two values may even have opposite signs. In this way, the model formally implements a *separatist view*, according to which the evaluation of an option-attribute pair and its associated independent motivational force can diverge. This separation is clearly articulated in Mele's first principle, which states that «the motivational force of our desires is not always in line with our evaluation or assessment of the objects of our desires» [17,18]. Furthermore, we clarify that for evaluatively relevant attributes that do not apply to a specific option, we set $f_{ik} = 0$.

However, it should be noted that not all motivational forces necessarily stem from evaluatively relevant attributes. Indeed, there may be attributes that are motivationally relevant without being evaluatively relevant. Examples may include whether or not an option is a default, an option's spatial position or proximity within the visual field, or attributes linked to specific emotional associations. Let $\mathcal{A}' = \{m+1,\dots,m+r\}$ denote these additional attributes and let the matrix $Z \in \mathbb{R}^{n\times r}$ represent the corresponding motivational forces, where $z_{i,\ell}$ represents the motivational force associated with attribute $m+\ell$ for option i. We further define the matrix of all motivational forces as:

$$\Phi = [F\ Z] \in \mathbb{R}^{n\times(m+r)}, \tag{6}$$

where a positive element induces motivational attraction toward the corresponding option, and a negative element induces repulsion.[10]

We denote by $M_t = (M_{1,t},\dots,M_{n,t})^\top \in \mathbb{R}^n$ the state of the field of motivational forces not mediated by judgment at time t. Unlike the serial attentional sampling process characterizing the field of practical judgment, in this case, multiple distinct motivational forces can be simultaneously active at any given moment. To represent this, we introduce a motivational gating matrix $W_t^M = (w_{ia,t}^M) \in \{0,1\}^{n\times(m+r)}$, without, however, imposing any constraint such as $\sum_{i,a} w_{ia,t}^M = 1$. In the simplest case, the gates associated with the various motivational forces are i.i.d. Bernoulli random variables with parameter $1/2$; that is:

$$\Pr(w_{ia,t}^M = 1) = \Pr(w_{ia,t}^M = 0) = \frac{1}{2}, \qquad \forall\, i,a,t. \tag{7}$$

The values of W_t^M thus indicate whether, at time t, the motivational forces associated with the various option-attribute pairs are effectively active at that

[10] This distinction between motivationally and evaluatively relevant attributes recalls the *nudging* literature's distinction between *nudges* that bypass practical reasoning and those that engage it [25,10,23]. Within our framework, the former could be interpreted as interventions on Φ, particularly Z, whereas the latter as interventions on the evaluations in V or their sampling W_t^J.

moment. As we mentioned, their activation can fluctuate over time and multiple forces can be active in parallel. The dynamics of the field follow, in this instance as well, the fundamental structure of DFT already applied to the field of practical judgment. First, the effective motivational forces are integrated into a vector of momentary comparative valences:

$$Q_t^M = C_M(\Phi \odot W_t^M)\mathbf{1}_{m+r}, \qquad C_M = C_J, \tag{8}$$

and the state of the motivational field not mediated by judgment evolves according to the law:

$$M_{t+1} = S_M M_t + Q_{t+1}^M + \varepsilon_{t+1}^M = S_M M_t + C_M(\Phi \odot W_{t+1}^M)\mathbf{1}_{m+r} + \varepsilon_{t+1}^M. \tag{9}$$

We also define the feedback matrix S_M, in parallel with the matrix S_J:

$$(S_M)_{ij} = \begin{cases} 1 - \epsilon_M, & i = j, \\ -\mu_M s_\Phi(\Phi_i, \Phi_j), & i \neq j, \end{cases} \qquad 0 < \epsilon_M < 1, \quad 0 \leq \mu_M \leq 1, \quad 0 \leq s_\Phi(\Phi_i, \Phi_j) \leq 1, \tag{10}$$

where the term $s_\Phi(\Phi_i, \Phi_j) = s_\Phi(\Phi_j, \Phi_i)$ denotes the similarity between the motivational profiles of options i and j.[11] We further assume that $\rho(S_M) < 1$, so as to prevent the average field dynamics from diverging. Finally, as in the case of the field of practical judgment, the initial state M_0 can be set to zero or can represent a motivational state that is already partially activated at the beginning of the process.

3.4 Integration of the Fields and Formation of Intention

The fact that the state of the field of practical judgment, J_t, is distinct from the state of motivations not mediated by judgment, M_t, does not in itself imply that the former is motivationally ineffective. As we have already discussed in Section 1, practical judgment indeed possesses its own motivational force: as Mele observes, practical reasoning is driven by the «motivation to settle upon a course of action» [17,18]; once this process generates a better judgment, that same motivation extends to the judgment itself and contributes to the formation of an intention consistent with it. Our model thus distinguishes between two motivational components that can contribute to the formation of an intention: the first, identified with J_t, is effectively the motivational component mediated by judgment; the second, identified with M_t, is the motivational component not mediated by judgment. For a given instant t, we can then define the *decision readout* as

$$D_t = J_t + \beta_M M_t, \qquad \beta_M > 0. \tag{11}$$

[11] The similarity function between motivational profiles can be defined analogously to that in note 8, possibly using a different parameter $\gamma_\Phi > 0$. Since inapplicable attributes have zero motivational strength, no special cases are needed: $s_\Phi(\Phi_i, \Phi_j) = (m+r)^{-1} \sum_{a=1}^{m+r} s(\phi_{ia}, \phi_{ja})$, where $s(x, y) = \exp(-\gamma_\Phi |x - y|)$.

where D_t is the vector of overall decision weights associated with the various options at time t. It is important to emphasize that D_t does not constitute a third field endowed with its own recursive dynamics analogous to those of J_t and M_t. Rather, at each instant, it represents the readout resulting from the combination of the two fields. The parameter β_M measures the relative weight assigned to the motivational component not mediated by judgment compared to the motivational component mediated by judgment. For this reason, it would be misleading to interpret it simply as a parameter of akrasia: when J_t and M_t favor the same option, a higher value of β_M actually increases that option's overall decision weight relative to the other options and can consequently increase the probability that an intention consistent with the practical judgment is formed. Conversely, when J_t and M_t conflict, a higher value of β_M increases the overall decision weight of the option favored by M_t relative to the other options and can thus increase the probability of forming an akratic intention.

To determine the moment when the intention is formed, we adopt – following the standard DFT framework – a *stopping rule* [19,3,26]: the decision-making process terminates when the overall decision weight associated with one of the options reaches a *decision threshold* $\theta > 0$; we also introduce a maximum deadline, $T_{\max}$, in case no option reaches the threshold within that time limit.

$$\tau_\theta = \inf\left\{t : \max_{i\in\mathcal{O}} D_{i,t} \geq \theta\right\}, \qquad \tau = \min\{\tau_\theta, T_{\max}\}, \qquad I = \arg\max_{i\in\mathcal{O}} D_{i,\tau}. \tag{12}$$

We thus denote by τ_θ the first instant at which an option reaches the decision threshold θ, and by τ the actual stopping time of the process. If the threshold is reached before $T_{\max}$, the process stops at τ_θ; if, however, no option reaches the threshold within $T_{\max}$, the process terminates at $T_{\max}$. The resulting intention I thus favors the option that, at the stopping time τ, exhibits the highest overall decision weight.

Equations (2)–(12) thus define the model in its entirety: the two fields, J_t and M_t are governed by distinct, albeit structurally similar, dynamics and, moment by moment, jointly determine the overall decision weights D_t. When these weights satisfy the adopted stopping rule, an intention is formed. J_t and M_t may favor either the same option or different options. Section 3.5 uses J_t, M_t, and D_t to operationally define three distinct outcomes: *motivational alignment*, *successful real-time self-control*, and *akrasia*.

3.5 Three Outcomes of the Decision-Making Process

The distinction between J_t and M_t and their contribution to determining D_t allow us to operationally define three possible outcomes of the decision-making process. For simplicity, let us assume there are only two options at stake, A and B, and – without loss of generality – assume that at the time of intention formation τ, $J_{A,\tau} > J_{B,\tau}$ holds; that is, the better judgment favors option A. First, we define the outcome of *motivational alignment* as the case in which:

$$M_{A,\tau} \geq M_{B,\tau}. \tag{13}$$

In this case, at the moment of intention formation, both components favor A. Consequently, an intention toward A is formed that is compatible with both. Thus, there is no self-control conflict.

The second possible outcome is a case of *real-time self-control*. This occurs when:

$$M_{A,\tau} < M_{B,\tau} \qquad \text{and} \qquad D_{A,\tau} > D_{B,\tau}. \tag{14}$$

In this case, the motivational component not mediated by judgment favors B, contrary to the better judgment. However, the overall decisional weight D_τ remains greater for A, and the intention formed towards A is therefore consistent with the better judgment.

Finally, the third outcome is *akrasia*:

$$M_{A,\tau} < M_{B,\tau} \qquad \text{and} \qquad D_{A,\tau} < D_{B,\tau}, \tag{15}$$

in which, once again, the two components favor different options, but the formed intention runs counter to the better judgment. This constitutes, in the relevant sense, the formation of an akratic intention.[12]

4 Illustrative Simulation

The simulation presented here serves an illustrative and exploratory purpose. The parameter values that were used were not estimated from empirical data, nor should they be viewed as a realistic parameterization from which to infer the actual prevalence of the outcomes defined in Section 3.5. Primarily, the simulation serves to verify whether a single parameterization is capable of generating all three types of outcomes. Furthermore, in our view, it helps to highlight certain limitations of the intuitive operational definitions just introduced.

The simulation builds on the dessert–vegetable example used throughout the paper, that considers two options, *dessert* and *vegetables*, evaluated against two attributes, *taste* and *healthiness*. In the evaluation matrix V and the matrix of motivational forces not mediated by judgment F, the first row corresponds to the dessert and the second to the vegetable; the first column corresponds to taste and the second to healthiness. In the simulation, we do not assume the existence of attributes that are motivationally relevant but evaluatively irrelevant; therefore, $\Phi = F$. The selected parameters are:

$$V = \begin{pmatrix} 0.2 & -1.0 \\ -0.2 & 1.0 \end{pmatrix}, \qquad F = \begin{pmatrix} 1.2 & -0.6 \\ -1.2 & 0.6 \end{pmatrix}. \tag{16}$$

Regarding the evaluation matrix V, the absolute values associated with taste are substantially lower than those associated with healthiness; the reverse holds

[12] Note that, since $J_{A,\tau} > J_{B,\tau}$, the condition $M_{A,\tau} \geq M_{B,\tau}$ already implies $D_{A,\tau} > D_{B,\tau}$ by Eq. (11). Thus, Eq. 13 requires no additional condition on D_τ. When instead $M_{A,\tau} < M_{B,\tau}$, the sign of $D_{A,\tau} - D_{B,\tau}$ distinguishes self-control from akrasia; the equality case is disregarded.

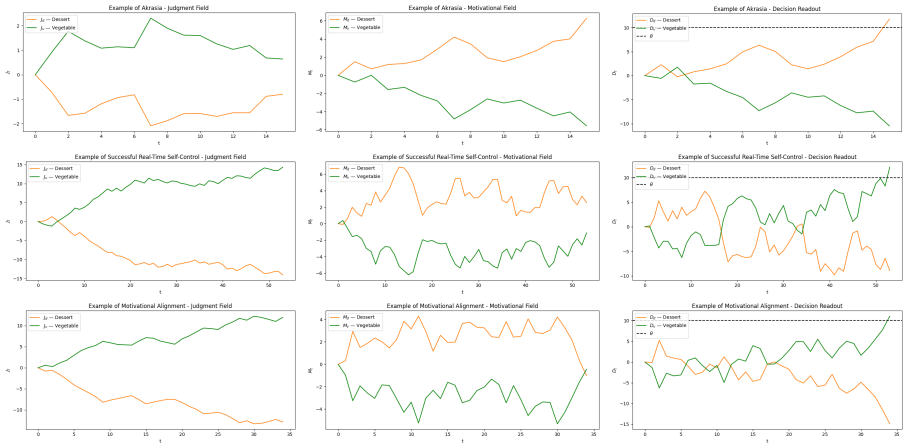

Fig. 2. Examples of runs. Top row: akrasia; middle row: successful real-time self-control; bottom row: motivational alignment. The columns show J_t, M_t, and D_t, respectively. The orange curves represent the dessert and the green curves the vegetable; the dashed black line in the D_t panels represents the decision threshold θ.

true for the matrix of motivational forces. Additionally, the process begins at $J_0 = M_0 = (0, 0)^\top$, meaning that, in the initial state, neither field favors either option. Moreover, the threshold is $\theta = 10$ and the deadline is $T_{\max} = 100$.[13]

The 10,000 Monte Carlo runs give the following results: the threshold is reached in 99.65% of cases; 73.89% of the runs are classified as successful real-time self-control, 15.20% as akrasia, and 10.91% as motivational alignment; the respective mean stopping times are 47.52, 12.80, and 24.63 steps. These results reflect solely the illustrative parameterization adopted here; indeed, our aim was to show that, once a specific parameterization is fixed, all three outcomes can emerge from the stochastic dynamics. Figure 2 shows three runs, selected pseudo-randomly from the total 10,000 runs, each representative of one of the three outcomes defined in Section 3.5.

The middle row panels show a case of successful real-time self-control. The process terminates at $\tau = 53$, when the vegetable reaches the decision threshold. At that time, the vegetable is favored by J_τ, whereas M_τ favors the dessert. The case thus satisfies the operational definition of real-time self-control in Eq. 14.

The case of akrasia, shown in the top row panels, highlights a first limitation of the operational definitions. In this run, the intention is formed very early, at time $\tau = 15$. Since the process starts from $J_0 = (0, 0)^\top$, the judgment field has

[13] The other model parameters are $\beta_M = 2$, $\epsilon_J = \mu_J = 0.02$, $\epsilon_M = \mu_M = 0.20$, and $\gamma_V = \gamma_\Phi = 1$. We also assume $\varepsilon_t^J \sim \mathcal{N}(0, \sigma_J^2 I_n)$ and $\varepsilon_t^M \sim \mathcal{N}(0, \sigma_M^2 I_n)$ for each t, with $\sigma_J = 0.20$ and $\sigma_M = 0.40$. At each time step t, the four option-attribute pairs are sampled uniformly in the field of judgment, while each motivational gate is active independently with probability 1/2. The resulting feedback matrices satisfy the stability condition, with $\rho(S_J) = 0.988$ and $\rho(S_M) = 0.839$.

had relatively little time to evolve; thus, it is not plausible to interpret J_τ as the expression of a sufficiently formed better judgment. This is problematic for the operational definition of akrasia given in Eq. 15, which classifies an intention as akratic whenever J_τ favors a different option, regardless of whether J_τ represents a sufficiently formed better judgment or not. One possible way to address this limitation is to consider the subsequent evolution of the judgment field as well. If, for $t > \tau$, J_t converges toward a sufficiently stable configuration favoring an option other than the one selected at time τ, that configuration may provide a more plausible indication of the better judgment resulting from practical reasoning. From this perspective, akrasia should not be identified simply with an intention contrary to J_τ, but rather with an intention contrary to a judgment that has reached a sufficient degree of formation, i.e. stability.

The bottom row panels show an example classified as motivational alignment. Indeed, at the time of intention formation, $\tau = 34$, the two fields are aligned. However, we observe another limitation of the operational definitions. Looking at the episode's entire temporal profile, one notes that at all instants prior to τ, the two fields are misaligned. Therefore, it seems highly problematic to classify this case as one of motivational alignment simply because the two fields realigned at the very last moment, after remaining misaligned throughout the preceding trajectory. In fact, it seems more like an instance of real-time self-control. This leads us to believe that more appropriate operational definitions of the concepts of motivational alignment, self-control, and akrasia should take into account not only what occurs at time τ, but also what happens along the entire trajectory: a local alignment at a particular moment may coexist with global misalignment across much of the episode, and vice versa.

5 Discussion

The model we have proposed tries to formalize the dynamics of self-control conflicts via a two-field extension of DFT [4,19], while simultaneously accounting for the *separatist view* of the relationship between evaluation and motivational force [24]. The first field, J_t, is the field of practical judgment; the second, M_t, is the field of motivational forces not mediated by judgment. J_t evolves through the serial attentional sampling of evaluations associated with specific attributes of individual options, whereas M_t evolves through the parallel and time-fluctuating activation of various evaluation-independent motivational forces. The two fields contribute, moment by moment, to determining the overall decision weights, D_t. An intention is formed when the stopping rule for D_t is met. Furthermore, the model provides a formal translation of two principles formulated by Alfred Mele [17,18]: the first principle, which captures the core of separatist views, is formalized through the potential misalignment between the matrix V of the evaluations and the matrix F of the motivational forces independent of evaluations; the second principle, stating that evaluations constitute the material upon which practical reasoning operates, is formalized by having the evaluations contained in matrix V serve as sampled inputs for the field of practical judgment. Furthermore,

the model allows for attributes that are motivationally relevant yet evaluatively irrelevant and can therefore influence M_t even in the absence of associated evaluations. We also note a similarity to dual-process models [20,15,7,16]. The first field resembles System 2 due to its serial sampling, whereas the second resembles System 1 due to the parallel activation of multiple forces. Based on the model, intuitive operational definitions were then formulated in Section 3.5 for three possible outcomes of the decision-making process: motivational alignment, successful real-time self-control, and akrasia.

The simulation conducted in Section 4, which served a purely illustrative and exploratory purpose, showed that all three types of outcomes can be obtained using a single parameterization. At the same time, it highlighted certain limitations of the proposed operational definitions. Indeed, these definitions rely essentially on what occurs at time τ – that is, the moment an intention is formed. However, as suggested by the examples discussed above, assessing the self-control profile of an episode seems to require a more diachronic perspective, taking into account both what happens before the formation of the intention and, potentially, what happens afterward (something that appears especially important when the judgment has not yet sufficiently stabilized at the time the intention is formed). One next step in this work will therefore be to attempt to provide definitions of these three phenomena that better account for the episode's entire temporal profile.

A second point concerns empirical validation. While the model has not yet been empirically validated, we believe that, at least in principle, it could be applied to empirical contexts to explain situations involving self-control conflicts. In this case, a central challenge would be parameter determination, as it would be necessary to ascertain both the evaluations associated with individual option-attribute pairs and their respective motivational forces. Another potential limitation relates to the way the two fields are related in the current formulation. Specifically, the field of practical judgment exerts no direct influence on the motivational field. A conceptually interesting variation of the model worth exploring could, however, allow the practical judgment to affect the motivational field by providing a *reference signal*, in the control-theoretic sense, to a controller acting on the motivational field, thereby transforming the motivational field into what is known in control theory as a *plant* [9,1].

6 Conclusion

In this paper, we proposed a two-field extension of DFT aimed at modeling phenomena of real-time self-control and akrasia, and implementing a separatist view of the relationship between evaluations and motivational forces. Our analysis also highlights certain open conceptual and operational issues that will require further refinement in future work.

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