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15 February 2011

Online at <https://mpra.ub.uni-muenchen.de/47678/>

MPRA Paper No. 47678, posted 18 Jun 2013 23:24 UTC

# An economic approach to the self : the dual agent

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June 18, 2013

## Abstract

This paper extends the notion of the rational agent in economics by acknowledging the role of the unconscious in the agent's decision-making process. It argues that the unconscious can be modelled by a rational agent with his own objective function and set of information. The combination of both the conscious and unconscious agents is called the "dual agent".

This dual agent presents rationally biased behaviors that may not disappear through aggregation, and could be potentially measured.

It also provides a theoretical approach to the emotionally-driven actions.

On the social sciences side, the paper pleads for a wider use of substantive rationality in the understanding of human behavior.

JEL Classification: B41,D01, D81, D82.

## 1 Introduction

The rational agent hypothesis is at the heart of economic theory. Developed among the neo-classical school during the middle of the nineteenth century, this hypothesis states that economic agents are rational, meaning that they choose their actions in order to maximize their utility. By systematically disregarding all non-rational behaviors, the theory has allowed economics to abstract itself from the vagaries of human nature and, as such, has been a powerful tool in the reshaping of the discipline as a natural science.

While other social scientists were adamant in their quest to model human nature, economists created a world in which agents are perfectly rational, always optimize to the best of their knowledge and make no systematic errors.

Critics of this "perfect rational man" have been lurking in the economic literature for more than 50 years. They rightly point out that models based on such assumptions have blatantly and repeatedly failed to foresee any market

crash or other economic disruption from the theoretical equilibrium. They stress the fact that economics should acknowledge the findings of other social sciences and build on them, rather than going on assuming improbable hypothesis.

This stream of criticisms has materialized in the behavioral branches of both economics and finance, which seek to suggest mathematical alternatives with firm psychological foundations to rational assumptions.

However, it ignores the fact that psychology suffers from its own evils. The empirical approach adopted by the discipline condemns its theories to be regularly rejected or amended according to new empirical findings. Moreover, by focusing on procedural rationality rather than substantive rationality, it ignores a convenient way and potentially useful tool to think about the unconscious.

Finally, models based on fully rational microeconomic behavior usually yield results that are much richer, deeper and more interesting than those achieved by behavioral models. This is probably why despite its grossly caricatural assumptions, the rational agent is still so much in favor in economics.

If there is some kind of unconscious process undergoing within the psychic activity, its influence should be assessed by economics. If the unconscious can be seen as a separate agent that has his own set of information, his own reward and the ability to act in a way distinct from the conscious, then this agent should be encompassed alongside the conscious agent, and his influence should be analysed within the scope of economic theory.

To put things differently, economics may have been wrong in assuming one monolithic conscious agent. It has gone one step too far in its quest of simplification, and by assuming that one body should be the siege of one rational mind. It does not follow, however, that its global approach is wrong.

In this paper, I will explore how we can relieve ourselves from this one assumption of the neo-classical literature, and consider the economic agent as being composed of two rational agents, the conscious agent and the unconscious agent.

The paper is organized as follows. The next section presents the premises of the model. Introducing the unconscious within an economical model requires an extensive presentation of the acceptance of the unconscious agent we are considering, as well as of his operating process. Section 3 developps the model. It specifies the reality modeled, the conscious and unconscious agents, their objectives, and the resulting action of the combined - so-called "dual" - agent. Section 4 presents the results of the model at the microeconomic level. Section 5 assesses the model's impact for other social sciences. Section 6 concludes.

## 2 Premises

This paper will describe two agents, the conscious and the unconscious, and their possible interactions within a single economic agent.

### 2.1 The conscious agent

The conscious agent considered here is the neo-classical rational agent. He apprehends the parameters of the reality through noisy signals. He is rational in the sense that he chooses his actions to optimize his welfare given all the information at his disposal.

Since this agent will turn out to be quite familiar, I will rather dwell on the modelisation of the unconscious agent.

### 2.2 The unconscious agent

#### 2.2.1 General acceptions of the unconscious

In its very general meaning, the term "unconscious" can refer to two kinds of psychic activities. In its first acception, the unconscious can be seen as the part of the psychic activity that is not part of the conscious mind, but that punctually emerges to the conscious mind. This would be an unconscious punctually emerging through dreams, slip of the tongue, etc. In its second acception, the unconscious is the part of the psychic activity that is decidedly beyond the grasp of the conscious mind. This would be the purely "neurological unconscious", so to speak, the unconscious that purely governs our body.

If we were to focus on the first definition of the unconscious, and exclusively consider the part of the mind that is not conscious, but could become conscious at some point, we could reduce the economic agent to the traditional rational agent only impaired by his imperfect information of reality, unaware as he would be of some of the parameters of the reality.

This is the option followed by behavioral economics. Boons of irrationality are seen as punctually superseding the rational agent's actions. It is taken into account but not modeled as a rational and permanent agent.

Alternatively, if we reduced the unconscious to the second part of the former definition, i.e. if it were the part of psychic activity beyond the reach of the conscious mind, the parameters of the reality the unconscious agent could react to through his action would be radically beyond the knowledge of the conscious agent. Both the conscious and the unconscious agents could, and would indeed, coexist in radically independent worlds. This could be seen as the neurological unconscious.

Our purpose would be trivial, the action of the resulting economic (combined) agent being the sum of two distinct and independent actions performed by two distinct agents, endowed with radically different knowledge and clearly defined fields of competence. Besides, in such a context, the action of the unconscious would be of slight interest to the economist.

### 2.2.2 An alternate definition of the unconscious

A more economical definition of the unconscious should start with recognizing that the unconscious agent's actions are not distinct from those of the conscious agent.

Whichever actions these two conscious and unconscious agents can take separately, there is only one physical agent that will act. Therefore we cannot treat these two agents separately.

Moreover, some human behavior, while being systematically biased and sub-optimal, are nonetheless coherent to some extent. As such, they could be modeled as the result of an alternate optimization, and in this respect, be regarded as fully rational.

The best economical approach should therefore be to describe the unconscious as a second, permanent and fully rational agent, acting alongside the conscious, yet distinct from the latter in his reward, his perception of reality, and necessarily constrained in his actions.

I will therefore consider the unconscious as a "permanent" agent that, when facing a situation, confronts it to his own grid of interpretation, reacts to it according to his own goals, i.e. maximizing his own reward, as would any economic agent would.

## 2.3 Reward

I will assume that the reward of the unconscious is to guarantee the well-being of the agent, based on a body of past knowledge, acquired through time by the individual. This body of past knowledge can be modified by past events, so that it can evolve through time<sup>1</sup>, and is therefore strongly backward-looking.

More precisely, this reward must be optimal when two conditions are met: when the individual immediate well-being is assured first, and second, when the structural, i.e. past conditions of the individual well-being, are met.

This means that the unconscious reward is both highly weighted towards the immediate present, but at the same time towards conditions that have been set in place in a very distant past, although they might have been episodically and marginally modified through time.

## 2.4 Grid of lecture

I will suppose that one of the major role of the unconscious' activity is to scan, recognize and respond to the parameters of the reality, before transmitting them, if and when need be, to the conscious. This implies that, whenever a set of characteristics is recognized as a potentially harmful data structure, i.e. situation, it will trigger a response from the unconscious before even hitting the conscious. It also implies that the conscious will be endowed with most of the parameters of the reality listed by the unconscious.

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<sup>1</sup>This refinement will not be modeled here, though.

To perform this operation, it will be convenient to think the unconscious as endowed with a structural grid of lecture through which the characteristics of the reality are scanned and analyzed.

The unconscious being innate, it must be able to process information at the very early stage of life. Its grid of lecture must therefore be both innate, precise and flexible. It will not consider definite complex situations, as the conscious could perceive them. Rather, it will list a collection of relatively small units of information considered as relevant, and compare them to pre-established elements coded as potentially dangerous - or potentially desirable.

This assumption implies two comments. First, this unconscious agent is an always operating agent : its action is continuous. The very fact that the conscious should be aware of the reality is, in our set up, the proof that the unconscious is performing its function : listing the parameters of the reality, analyzing and transmitting them to the conscious.

Second, this unconscious agent will, once the parameters of the reality are listed, project a definite grid on these parameters, and try to identify potentially harmful or desirable situations. In so doing, it cannot discard any element of information. So that whereas the conscious will tend to discard information judged harmless, the unconscious will tend to focus on harmful situations.

So that although the unconscious we are dealing with can indeed be seen as a rational agent, his set of information may trigger radically different actions from those of the conscious.

### 3 The Model

We have shown that the unconscious has his own set of information, his own reward, and his own action. He can therefore be considered as economically rational. And we have mentionned that the conscious agent is the neo-classical rational agent. Let us respectively call "conscious" and "unconscious" these two rational economic agents, and see how to model these two rational agents into one single agent, the "dual agent".

I will first present the external reality that both the conscious and unconscious face. I will then specify what are these two agents, and their respective goals. I will then present the full model of the dual agent and its optimization<sup>2</sup>.

#### 3.1 The reality

Dealing with the conscious and unconscious suppose a context, an external situation in which actions take place. We will call it the "reality". Because we are modeling rational agents, this reality must be described quantitatively by means of parameters. These parameters can take various forms: set of behaviors, agents, costs, external conditions, interactions, all that constitute the environment the dual agent<sup>3</sup> faces, to which he is confronted. The only nec-

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<sup>2</sup>To simplify the matter, the dynamics of the model is left for further research.

<sup>3</sup>And of course, the unconscious and the conscious, as mentioned in the paragraph above.

essary condition here is that these parameters should be able to be measured quantitatively, so as to be included in the reward function of the agent.

I will call  $\theta$  this set of parameters describing the reality. The reality  $\theta$  is a vector:

$$\boldsymbol{\theta} = (\theta_1, \dots, \theta_n) \quad (1)$$

Each parameter  $\theta_i$  could actually be seen as a vector of characteristics that fully describes  $\theta_i$ . This refinement is not necessary and will therefore be ignored.

### 3.2 The conscious agent

The conscious is the familiar rational agent : he chooses his actions to maximize his well-being, to the best of his knowledge. If alone, he would take an action to optimize the social reward  $R$ :

$$R(a, \theta_1, \dots, \theta_n) \quad (2)$$

Note that this reward solely depends on the agent's action and the parameters of reality. Were the conscious fully informed, its optimization would trigger the optimal action  $a^{opt}$ . For the sake of simplicity, I will assume this action to be a linear combination of the parameters of reality, so that  $a^{opt}$  will be a linear function of the parameters :

$$a^{opt} = \sum \alpha_i \theta_i$$

The optimal action is the weighed sum of the parameters of the reality, where the  $\alpha_i$  can be seen as transformers : they translate the quantitative parameters of the reality into an action.

Insofar as the conscious is not fully informed, it can at best grasp a mixed signal of the  $\theta$ . This set  $\tilde{\theta}$  is defined as:

$$\tilde{\theta} = (\theta_1 + \varepsilon_1, \dots, \theta_n + \varepsilon_n) \quad (3)$$

where the  $\varepsilon_i$  are independently and identically distributed.

#### 3.2.1 Benchmark case

A benchmark case will be defined as the optimization of the conscious, if he were the only agent acting within the dual agent<sup>4</sup>. Indeed, if alone, the "conscious" agent would optimize its expectations such that

$$E^c R(a, \theta_1, \dots, \theta_n)$$

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<sup>4</sup>And relaxing the assumption that the parameters of the reality are first processed by the unconscious.

and would therefore set his action such that

$$\begin{aligned}
 a &= E^c a^{opt} = \sum \alpha_i E^c \theta_i \\
 &= \sum \alpha_i (\theta_i + \varepsilon_1) \\
 &= a^{opt} + \varepsilon
 \end{aligned} \tag{4}$$

where  $\varepsilon$  is the overall mistake induced by the conscious' incomplete information:

$$\varepsilon = \sum \alpha_i \varepsilon_1$$

As mentioned above, this is the standard optimization of the rational agent, where imperfect information can lead the agent to take erroneous decisions.

### 3.3 The unconscious agent

The unconscious, although rational, significantly departs from the conscious in his objective function. Besides, he is strongly backward-looking.

Because his objective is "atemporal", the unconscious does not consider situations as they occur to the conscious, but sees them as a set of small units of characteristics and meaningful elements.

I will further assume that this unconscious can, as mentioned above, freely recombine these elements. It should therefore be modeled as an agent reacting to a recreated and distinct situation from the actual one, so that the situation the unconscious is facing can be characterized by its own subset of parameters  $\theta^u$ .

We define  $\theta^u$  as:

$$\theta^u = (\theta_1^u, \dots, \theta_n^u) \tag{5}$$

These parameters are the set of elements recognized as meaningful by the unconscious while analysing the reality.

The unconscious systematically and continuously analyzes the present context and confronts it to his own parameters. In turn, the recognition of part or all of these parameters within the present context will trigger the unconscious' reaction. However, Because the unconscious decomposes the reality in small units and interpret them according to its own grid of lecture, these parameters may be dismissed by the conscious, so that  $\theta^u \neq \theta_i \neq \theta$ .

Conscious and unconscious are therefore disymmetric. The conscious perceives the reality through the fog induced by his incomplete information, while the unconscious keeps on analyzing the reality according to a mainly backward-looking grid of lecture.

Once the  $\theta^u$  are recognized, the unconscious will seek to maximize a reward  $R^u$

$$R^u(a, \theta_1^u, \dots, \theta_n^u)$$



This reward depends on the situation spotted. Again, as mentioned above, because the unconscious agent is backward-looking and mostly reacts to past situations,  $R^u$  can be seen as an obsolete reward, inducing actions that actually optimize real but past situations. His actions are therefore bounded to be suboptimal in the present context.

### 3.4 The dual agent

When both conscious and unconscious are combined, they form what I call the "dual agent".

Being a combination of two agents, the conscious and the unconscious, this dual agent reacts to two sets of parameters. The parameters of the reality the conscious can grasp on the one hand, and the parameters the unconscious recognizes within the reality, on the second hand.

Therefore the dual agent will, as a single agent, optimize a combination of two rewards: the social reward of the conscious,  $R$ , and the reward of the unconscious,  $R^u$  :

$$(1 - \beta) E^c R(a, \theta_1, \dots, \theta_n) + \beta R^u(a, \theta_1^u, \dots, \theta_n^u) \quad (6)$$

where  $\beta$  is the weight of the unconscious in the process of choice. We also assume that  $R^u$  is quadratic in the  $(\theta_1^u, \dots, \theta_n^u)$ .

Stating a single reward for the two agents may seem awkward. Game Theory would suggest that these two agents could be modeled as playing one against the other, each having its own action. This remark calls for some additional comments though.

#### 3.4.1 General comments

First, it is only one agent, the "dual agent", that is playing in this model. Yet this single action must nonetheless be the result of a combination of two rewards, and two individual and independent possible actions.

Second, it seems difficult to assess in what respect the conscious and unconscious are aware of one another. Section 5 will discuss this point, but let us for now, and to simplify the matter, suppose that conscious and unconscious are unaware one of another. The dual agent's action is the result of the combined actions of the conscious and the unconscious, and this result cannot - at least in the context of this paper - be reduced through Game Theory.

Of course, the timing of the action could be refined. Each agent could act separately or sequentially, and in turn observe the result of these two actions. Alternately, we could consider an unconscious blurring the parameters of the conscious with his own parameters, thereby modifying the conscious' reward. Yet these situations would be equivalent, and are indeed more conveniently modeled through a single reward, the dual agent's reward, that combines both the conscious and unconscious agents' rewards.

### 3.4.2 The parameter $\beta$

The parameter  $\beta$  describes the "power of intrusion" of the unconscious in the dual agent's reward. The higher the  $\beta$ , the more permeable the dual agent action is to the unconscious analysis of the reality, or alternatively, the more does the reality fit the unconscious grid of lecture.  $\beta$  is therefore dependent on the parameters  $\theta$  and  $\theta^u$ , and depends, in turn, on the personal history of the dual agent. As such, it can evolve over time.

Formally, the action taken is thus a combination

$$\begin{aligned} a &= (1 - \beta) E^c a^{opt} + \beta + \sum \gamma_i \theta_i^u \\ &= (1 - \beta) (a^{opt} + \varepsilon) + \beta \sum \gamma_i \theta_i^u \\ &= (1 - \beta) (a^{opt} + \varepsilon) + \beta \left( \sum \gamma_i \theta_i^u - a^{opt} \right) \\ &= a^{opt} + (1 - \beta) \varepsilon + \beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i) \end{aligned} \quad (7)$$

Let us now examine this equation in detail and assess the results of the model.

## 4 Results

The above equation shows that the action of the dual agent is composed of three terms.

### 4.1 The optimal social action

The first term,  $a^{opt}$ , is the optimal action the conscious would have chosen had he been the sole agent involved, and had he been fully informed. It can be defined as the optimal social choice.

The last two terms taken together,  $(1 - \beta) \varepsilon + \beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$ , can be seen as an overall bias to this optimal social choice.

### 4.2 The bias

#### 4.2.1 Terms of the bias

The first term of the bias,  $(1 - \beta) \varepsilon$ , is unavoidable, and results from the conscious' lack of information about the parameters of the reality. It represents the overall noise that blurs the conscious' choice, and produces a sub-optimal and totally random outcome.

The second term of the bias,  $\beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$ , represents a pure action of the unconscious. Unlike the first term of the bias, it is not random, and represents a systematic bias with respect to  $a^{opt}$ .

Because the unconscious optimizes a reward, this term should not be sub-optimal. Yet the reward of the unconscious,  $R^u$ , does not merely optimize the

real, actual situation faced by the agent, but rather a set of past - or "atemporal" - situations reactivated by the present situation. It only seldom represents an optimal action vis-à-vis the present situation, as seen by the conscious, but should rather be seen as an effective loss for the conscious. Its impact on the dual agent's action will depend on the weight given to  $R^u$  within the dual agent's optimization.

To the dual agent however, this bias is part of his optimization, and cannot be seen as a loss. It is nonetheless inefficient on a social point of view, as being biased toward past personal events.

#### 4.2.2 Nature of the bias

What is the exact nature of this bias? The first intuition is that it results from and represents combinations and differences between, on the one side, parameters seen by the conscious and, on the other side, parameters seen by the unconscious.

While the parameters of the conscious are real and observable, the parameters of the unconscious are at least partly disregarded or unobservable to the conscious, since by definition the  $\theta_i^u$  are projections of the unconscious on the parameters  $\theta_i$ .  $\theta_i^u$  is therefore the result of an interpretation performed by the unconscious and, as such, incomprehensible to the conscious. Besides, the  $\gamma_i$  are the translators of this interpretation into actions.

This overall bias can therefore be defined as an action performed by the dual agent, directly observable to the conscious. It is a departure from the optimal action, in that it would not necessarily be required from the situation as such. The conscious does not control it, since it is induced by an unconscious activity, and is the result from the "overinvestment" or "misinterpretation" of a present situation by the unconscious.

Let us underscore that if this bias can be a material action, it is not necessarily bound to be so. It could very well be an immaterial action. It could be a slip of the tongue, for example, but it could also be a thought, an emotion, a feeling, an exclamation, etc. If we had to name this bias in a few words, we could call it "the emotive part of the agent's action".

#### 4.2.3 Estimation of the bias

This bias could be observable and quantitatively estimated.

Let me first recall that the hypothesis of an imperfectly informed conscious does not a priori allow him to suspect the presence of a bias in his optimization. Without prior knowledge of the unconscious, the conscious would deduce ex post - after revelation of the true parameters - that a suboptimal action resulted from his misestimation of the situation measured by  $(1 - \beta)\varepsilon$ . Repeated mistakes could lead him to the conclusion of a lack of estimation power.

However, the presence of the systematic bias  $\beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$  could be measured by the correlation of the mistakes in a series of similar situations.

Indeed, measuring the average of his actions through an extended period of time and over a large sample of similar actions could lead him to eliminate random errors and measure an average action

$$\bar{a} = a^{opt} + \beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$$

Ex-post, when  $a^{opt}$  is revealed, the systematic bias could be measured.

We can even venture that the  $\theta_i^u$  could be partly retrieved. By examining the biases over a sufficiently large sample of events, one could retrieve, a minima, some structural similarities among various situations, and postulate a structural form for a set of  $\theta_i^u$ . This would help determine the form of the triggers inducing the unconscious reaction. However, this would, given our description of the parameters and the relevance of their structural interactions, require to abstract oneself from the contingencies of the present situation, and rather seek similarities within situations.

Last but not least, this bias in the action of the dual agent will not always disappear when aggregating over agents. It will depend on the nature of the bias. Actually, if its trigger is a common scheme among individual, and not a personal feature, it will sum up over a population. This can give some rationale to some common seemingly irrational behaviors.

### 4.3 Comments and extensions

The fact that the bias resulting from the optimization of the unconscious is indeed observable by the conscious calls for some comments.

#### 4.3.1 Dealing with the bias

**Compensation** If the dual agent could, with time, understand that he is facing a systematic bias in his actions, he could use this bias to overweigh his actions and compensate the unconscious bias. This approach does not imply any knowledge of the  $\theta_n^u$ , but requires a constant effort to compensate for the bias, that is constantly recreated by the unconscious<sup>5</sup>.

**Rationalisation** A second approach would be to reduce the weigh of the unconscious within the optimization.

How can this be achieved? A system of trial and error could lead to guess the  $\theta_i^u$  lying behind the unconscious optimization. This is the very purpose of an analysis, whether it is a psychoanalysis or other forms of personal analysis.

Reinterpreted in the context of this model, the purpose of such an analysis would be to inform the unconscious that his grid of lecture is not adapted to the actual context.

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<sup>5</sup>This ever-going correction is reminiscent of time inconsistency in monetary economics.

**The unconscious as a blurring agent** To keep things simple, we have totally distinguished the conscious and unconscious perceptions of reality. It would actually be more accurate to consider the unconscious has able to blur the perception of the conscious.

This corresponds to replacing the conscious' perception of the parameters

$$\tilde{\theta} = (\theta_1 + \varepsilon_1, \dots, \theta_n + \varepsilon_n) \quad (8)$$

by a blurred combination

$$\tilde{\theta}' = (\theta_1 + \lambda_1 \theta_1^u + \varepsilon_1, \dots, \theta_n + \lambda_n \theta_n^u + \varepsilon_n) \quad (9)$$

In this context, an analysis would lead to a net gain of information for the conscious, by re-establishing the true signals  $\tilde{\theta}$ .

## 5 Discussion

Let us now assess how this model can impact other social sciences.

### 5.1 On irrationality

Two purely rational agents optimizing their own utility function within a single individual has resulted in an action that is a composite of both a rational and irrational action. Indeed, what we have called in the above "the emotive part of the action" could be as well be called an irrational action.

Irrationality does therefore not appear for its own sake, as behavioral economics tends to use it, but rather from the coexistence of two rational agents, each having their own grid of lecture, and bound to act through one individual.

One could argue that irrationality naturally follows from our assumptions, more specifically from the unconscious' grid of lecture. Yet this is not so. The conscious perceives the parameters of reality as they are, that is, how they are transmitted by the unconscious.

This leads to the following question: if irrationality emerges from the coexistence of two rational agents within one dual agent, what are the possible distinction one can draw between these two agents? What could be the conditions under which each agent can operate

### 5.2 An empirically founded theory of choice

H. Simon[17] argued that economic rationality, i.e. the assumption that actors maximize subjective expected utility, supplies only a small, and often not essential, part of the premises in economic reasoning.

The remainder of theses premises, auxiliary empirical assumptions about actors' utilities, beliefs, expectations, to be made correctly, required, in his words, "an empirically founded theory of choice". This theory of choice in turn

needed to specify what information decision makers use, and how they actually process it.

Including the unconscious as a rational agent in a simple model, and identifying in what respect this agent would differ from the traditional rational conscious agent has led us to do exactly that.

In order to differentiate these two agents, and allow them to see alternate features within reality, we were bound to postulate that reality itself should be observed as a set of parameters.

The model presented in this paper shows that an economical approach establishing a minimal framework for the description of the unconscious as a rational agent provides a convenient way to establish and validate empirical psychological assumptions. This is the standard scheme in which a quantitative theory can make predictions that can be tested later on.

### **5.3 Conscious and Unconscious within the dual agent**

How do the conscious and unconscious perceive one another within the dual agent? We have opted in the above for a situation in which conscious and unconscious would ignore each other's presence. This stance requires some explanations.

#### **5.3.1 Mutual awareness**

As we defined here, the conscious is by nature the least informed of the two agents. He ignores many of the information the unconscious is dealing with. For example, he ignores most of the physiological processes the unconscious is performing constantly. As such, he might as well ignore that an other and more informed agent exists along his side.

The unconscious is the most informed of the two agents in terms of scope of information. In our setting, it is the unconscious agent that perfectly scans the informational content of the reality. It is he who provides the conscious with his set of information. Most of the information the unconscious processes may well never be transmitted to, or taken into account by, the conscious. So that in the end, the unconscious agent is endowed with an information set that, in many ways, supersedes the conscious' information.

As mentioned above, it does not follow that the unconscious is fully and perfectly well informed. Because we have defined the unconscious as being "atemporal", he is bound to ignore that an alternate information exists. In his interpretation of reality, he is bound to twist it following his own grid of lecture. Besides, he has no reason to suspect that the conscious, being a dynamic agent, should know more than he does.

Because over the overlapping nature of the unconscious and conscious knowledge and actions, the unconscious could very well ignore the conscious' action. He could consider the conscious as an agent with such limited cognitive abilities that it could be dismissed.

### 5.3.2 Perception of others

In dealing with individual behaviors and psychological processes, one has to ask oneself, not only how the mind actually processes information, but also how the agent can perceive the rationale behind its environment, be it objects, persons, situations.

How do conscious agents perceive situations ? The answer is straightforward. As conscious agents, we perceive situations as being a mix of events, some of them fortunate, some others unfortunate. Among all these events, some will be intended, some other will be unintended, may they be good or bad. Our conscious will be able to distinguish the active, intended part of others' actions, and differentiate it from what must be unintended.

But if we admit that conscious and unconscious ignore one another, how could the dual agent perceive other people's action?

Here, two cases can arise: either the unconscious perceives himself as being alone within the dual agent, or he perceives the existence of a conscious agent along his side.

**One unconscious interacting with other unconscious** If the unconscious believes that he alone - as the most informed agent - decides every single action, controls everything within the mind of the dual agent, then he must consider the behavior of others as being the pure optimization of a single, and perfectly rational, agent, i.e. a fully "conscious" unconscious agent.

In this case, he will never see others' actions as a "pure accident". He will never see the bias in the other's behavior as unintended or irrational. He will rather treat it as being part of a wider optimization, that has a purpose, and even more so, that is a part of critical importance to the other's utility.

So that we can infer that an unconscious perceives the actions of other's, whatever they may be, as fully intentional, and being part of the other's utility.

**One dual agent interacting with other dual agents** Alternately, if the unconscious knows he is not alone, he also knows that his action will be a bias within the dual agent's action. And by observing the biases of other peoples' actions, he can rightly interpret the biases in others' actions as being driven by their unconscious.

He could therefore determine that every departure from a purely rational action is the sign of the other's unconscious. This does not mean that he will treat it lightly, quite the contrary. He could then act in consequence.

## 5.4 An economical approach to emotions

In this model, behaviors and emotions have a common ground : they are both explained by the introduction of a second agent, the unconscious, endowed with an alternate and specific grid of lecture of the reality.

If, according to Elster [6]:

Whereas economists mainly try to explain behavior, emotion theorists try to explain emotions. By and large, psychological studies of the emotions have not focused on how emotions generate behavior. Instead they have tried to identify the proximate or ultimate causes of the emotions.

in our setting, emotions do not generate behavior per se. Rather, they are a bias to the optimal social behavior. They can be seen as being both the natural result and the privileged means of expression of the unconscious agent.

Identifying "the proximate or ultimate causes of the emotions" is done via exactly the same means as explaining behavior. Moreover, this bias is not bound to disappear through aggregation, since part, or most, of these phenomena can be induced by unconscious collective schemes. More generally, the economic activity or decision process being necessarily a part of psychic activity, one cannot distinguish one from the other.

## 5.5 An economical approach to psychoanalysis

The simple model presented here would tend to suggest that, for the most part, unconscious activity takes place alongside the conscious activity, on a permanent basis.

### 5.5.1 On assessing the unconscious action

Considering the agent as a dual-agent would allow the observer to infer that, for any action that is both sub-optimal and systematically biased towards a specific outcome, this very bias is the sign of the unconscious' optimization.

Indeed, if for every action of the dual agent is  $\bar{a}$  such that:

$$\bar{a} = a^{opt} + \beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$$

there is a bias  $\beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$  to the optimal social agent's action,  $a^{opt}$ .

So that whenever an action is associated with an emotion, this emotion could be analyzed as a bias induced by the unconscious agent within the dual-agent's action.

This is a circular process. Emotions or, as we called it, "the emotive part of the action", are a sign of the unconscious, and its first means of expression.

### 5.5.2 Retrieving the parameters of the unconscious

Providing a methodology to actively and deliberately reduce the bias would prove our point by the same token, and if need be, validate our hypotheses.

This could be done by reducing the expression  $(\gamma_i \theta_i^u - \alpha_i \theta_i)$ , the difference of information between the conscious and the unconscious agents.

We can venture that, should emotions be regressed against the proper set of  $\theta_i^u$ , they could be totally suppressed. This requires some further hypothesis, and is left to be presented in a future paper.



So that, if the rudimentary hypotheses of this model are correct, the royal road to a knowledge of the unconscious activities of the mind should not be dreams, as Freud suggested<sup>6</sup>, but rather this emotive part of human activity, as revealed by the bias of the dual agent's optimization.

## 6 Conclusion

Modeling the unconscious as a second agent acting alongside the neo-classical rational "conscious" agent has proved to induce a bias in this "dual agent"'s optimization. This bias, although rational and optimal under the dual agent's perspective, is actually sub-optimal with respect to the actual context. Insofar as it is generated by predetermined collective schemes, it does not necessarily disappear with aggregation.

The dual agent framework represents an alternative to the economic agent, and allows to consider its actions under a psychological angle. It provides a useful theoretical framework to analysing emotionnaly-driven outcomes. And alternatively, it allows to consider psychological processes under an economical point of view.

The concepts that have been discussed here allow for a certain amount of extensions, both on theoretical and empirical grounds. On the theoretical side, the introduction of dynamics and the introduction of interaction between the conscious and the unconscious agents are the most obvious and immediate extensions. On the empirical side, the conception of tools to measure the bias are called for.

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<sup>6</sup>Freud, S. The Interpretation of Dreams (Die Traumdeutung), 1899/1900

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