

# Mechanisms of Psychology

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## Abstract

James Clerk Maxwell conjured a demon in 1867 to explain the unexplainable behavior of quantum systems. Over the last century, the demon has been evoked more than a few times. Daniel Kahneman talked about a stranger who reconciles the dual fast-slow thinking psychological systems in 2011. The overlap of psychology with physics might not seem intuitive, but if psychology was considered a class of information, one could see the functioning of a mechanism and understand the stranger. Historically thinkers have talked about systems in psychology, be it Rae's Intertemporal Choices, Lamprecht's observation that psychology was a mechanic for history, Freud's two principles of mental functioning, Ainslie's system of specious reward, or Kahneman's thinking fast and slow system. But most of the time psychology has been seen as decisions that traverse between states, not as information that runs through a mechanism. The author explains how psychological states like impulsiveness and thriftiness, instant and delayed gratification, pleasure-unpleasure, and slow and fast thinking are mechanisms of psychology that can be expressed as a Markov chain with transitional probabilities. Such mechanism thinking can bring the needed measurability for psychology, connect it with Physics and enable it to get rid of its strangers.

## The Demon's Mechanism

The story of "Mechanisms of Psychology" begins back in time but we can pick up its threads in 1867 when Maxwell talked about the Maxwell's Demon [1] a thought experiment to explain how Nature overcame the second law of thermodynamics. An intelligent subatomic demon created order from disorder by catching the fast molecule and allowing the slow one to pass.

Kahneman talked about a similar demon, a stranger which reconciled the dual fast-slow thinking psychological systems in 2011 [2]. Both thought experiments illustrate the inexplicability of how order is extracted out of disorder, be it psychological systems or quantum systems. The same question was later asked by Schrodinger in "What is life?"

## Laws of Thought

The quest for understanding the mechanism of Nature is not new. Stanley Jevons proposed the laws of thought in his 1871, "Theory of Political Economy", [3] where he explained that the fundamental mental powers for knowledge acquisition are the power to discriminate, detect identify, and retain. The three laws are the law of identity, the law of contradiction, and the law of duality. The first law is described as "Whatever is, is" and implies that a thing is always identical to itself, something that is self-evident. The second law is the classical law of contradiction: "A thing cannot both be and not be". The third law is the law of the excluded middle: "A thing must either be or not be."

If one looks at psychology from a Jevonian lens, the present [I want a reward now] and the future [I can have a reward later] are two different identities. The present reward and future reward create a contradiction, you can choose one not the other. The duality suggests that till a certain time, both states have a likelihood to happen.

Economists, the first social scientists documented people's ability to sharply discount the future because a future was always less influential than the present, due to "improvidence" due to "intellectual as well as moral causes" [Mill 1848/1909] or a "defect of will" [Bohm-Bawerk, 1891] but the articulation of the duality, whether one could live in the future or the present was always a mystery.

### **Instant and Delayed Gratification**

John Rae introduced inter-temporal choice [IC] in his 1834 "Sociological Theory of Capital" [4]. Rae was the first to highlight the duality of instant and delayed gratification. The subject studies the relative values people assign to two or more rewards at different points in time, e.g. Should I speculate today or invest for the future? Because humans tend to discount the future more than the present, IC's objective was to realize how the various choices are made or how they should be made.

"The prospects of future good, which future years may hold out to us, seem at such a moment dull and dubious, and are apt to be slighted, for objects on which the daylight is falling strongly, and showing us in all their freshness just within our grasp. There is no man perhaps, to whom a good to be enjoyed today, would not seem of very different importance, from one exactly similar to be enjoyed twelve years hence, even though the arrival of both were equally certain"

John Rae, The Sociological Theory of Capital, Page 54

The theory was further elaborated by Bohm-Bawerk [1889] and Fisher [1930]. In the 1950s, more well-defined models built on discounted utility theory and approached the question of inter-temporal consumption as a lifetime income optimization problem. Samuelson [1937] spoke of it as a "perspective phenomenon" implying that it is an innate property of the way we perceive time. Stroz [1956] noted that people often change their preferences as time passes, even though they have found out nothing new about the situation.

### **Psychology as a mechanics for history**

While Rae was articulating IC, Lamprecht was writing his masterwork, What is History? [5]. He was one of the first scholars to develop a systematic theory of psychological factors in history, Kulturgeschichte (History of Civilization), and the idea of "scientific history." His principal thesis was that history achieves scientific status not through the exactitude of detail in particular instances but rather through the achievement of a general and philosophical synthesis arising from the comparative study of collective psychologies in different periods.

He assumed that studying the operation of these psychological laws over time would demonstrate empirically the laws of history and the development patterns that lent coherence to the past. The observation that psychology visibly performs the service of a mechanic for history suggested the role of the collective mental phenomenon in a nation's self-knowledge and hence in the formation of a structure in history.

“The elements and laws which the modern psychology of the individual has produced also governed the mechanics of the great sociopsychic movements of history”

“History is nothing else but applied psychology”

“The discipline of psychology provides the bridge between history and the universal verities of natural Science.”

### **Freudian Pleasure-Unpleasure Mechanism**

One would think, that a talk about mechanisms and psychology may be far away from a Freudian world, but just about 50 years from Karl's masterwork, Sigmund Freud described the basic laws of the psyche in his 1956 “Formulations of the two principles of mental functioning” [6]. The principles provide the basis for ordering mental functioning as a whole and making it intelligible. The two main principles of the psychic apparatus are the pleasure/unpleasure principle, and the reality principle, and their dialectical relationship and composition explain the organization of psychic dynamics. The principles describe the orientation of the action of the psychic processes, which determines their direction and limits the conditions under which they are put into effect.

The unpleasure principle posited in the 1900 “The Interpretation of Dreams” stated that the psyche aimed to reduce or eliminate sources of tension that result in unpleasure. However, as early as the “Project for a Scientific Psychology” (1895), Freud postulated the existence of a psychic process that also aims to select memory traces of pleasurable experiences.

The formulations had two aspects. One to reproduce and represent to the psyche experiences that have produced pleasure in the past or are likely to produce pleasure in the present and the second to avoid or eliminate experiences that have resulted in unpleasure. This implied a selection exercised through hallucinatory wish-fulfillment, for pleasurable experiences, or through repression, for unpleasurable experiences. However, hallucinatory wish-fulfillment or repression cannot cause intrapsychic tensions to disappear, and an organism limited to the pleasure/unpleasure principle alone could not survive. The pleasure was no longer attained as a result of an absolute reduction of intrapsychic tensions, but rather through a reduction relative to a certain threshold or constant, and by submission to certain requirements of reality. Psyche tended to an immediate and absolute reduction (to zero) of sources of tension.

In the 1920 “Beyond the Pleasure Principle” Freud began to describe processes that seemingly contradicted the pleasure-unpleasure principle. He emphasized the existence of mental impulses that reactivate experiences that had not produced any conscious or unconscious satisfaction, either at the time or through deferred action. These exceptions to the pleasure-unpleasure principle are due to the “repetition compulsion”. In this way, the pleasure principle appears as a secondary principle and the fundamental tendency is no longer the avoidance of unpleasure or the search for pleasure, but rather a repetition of an earlier state, the tendency to return to an earlier state.

Freudian ideas of dual states, psychic dynamics, orientation, action, dynamic process, limiting conditions, laws, reproduction, representation, relative reduction, repetition of an earlier state, and tendency to return to an earlier state are the hallmarks of a mechanism.

## Humans, Pigeons, and Delayed Gratification

Mainstream research during that fertile Freudian period focussed on human's defective conception of future time and why presumably the learning was faulty [Stein, Sarbin, and Kaulik 1968] and how to build the value of delayed gratification in humans and animals, and the effect of delay in time on learning. But it was George Ainslie, who wrote a brilliant paper in 1975, "Specious Reward: A behavioral theory of Impulsiveness and impulse control" [7] to explain the phenomenon of time inconsistency and gratification using the idea of dual states of small early rewards and later large rewards.

By 1975 Pigeons could be taught the value of delayed gratification and theories could explain that a grade school child who chose a larger coin or candy bar at a long delay [from 1 to 30 days] over a smaller - immediate reward was positively correlated with age, intelligence, social responsibility, and presence of a father in the home and negatively correlated with an acquiescent personality [yea-saying], a disadvantaged family, and the length of the delay interval. Research in social psychology and the "need for achievement" was also found to be high in people who delay their gratifications and low in those who do not.

### Characteristics of the Mechanism

The small-reward [Impulsiveness] and later-reward [Thriftiness] mechanisms had many characteristics. Impulsiveness was a hyperbolic curve that described the decline in the effectiveness of rewards as the rewards are delayed from the time of choice. Such curves predicted a reliable change of choice between alternative rewards as a function of time. This change of choice provided a rationale for the known kind of impulses control and related them to several hitherto perplexing phenomena like behavioral rigidity, time-out from positive reinforcement, willpower, self-reward, compulsive traits, projection, boredom, and the capacity of punishing stimuli to attract attention. The curves take different shapes when plotted for different rewards in time, had a negative acceleration, and were so consistent and robust in expression that they could be used to teach humans and animals.

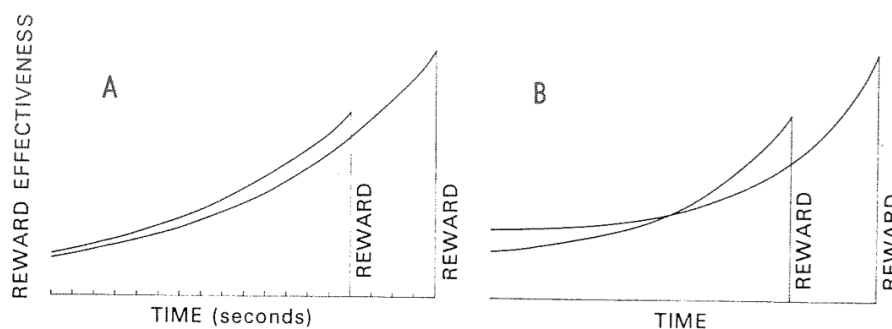


FIGURE 1. The predicted effectiveness of two alternative rewards in the period before they are available: A, if effectiveness declines in an exponential curve  $\{Y = Y_0 \times \exp [-0.1 (T_{r_0} - T)]\}$  in which  $Y_0$  is the reward; and B, if effectiveness declines in a curve more concave than an exponential one (drawn freehand).

Source: George Ainslie, "Specious Reward: A behavioral theory of Impulsiveness and impulse control", 1975

## **Manipulation Devices**

The tendency of animals and people to learn recommitting devices is probably limited not only by whether they can discover them but also by the unpredictability of the rewards involved. The subject is motivated to control impulses or understand why the conflict between impulse and control is not resolved like a simple choice.

Odysseus has traditionally been viewed in the Iliad as Achilles' antithesis. Unlike Achilles whose anger is self-destructive, Odysseus is renowned for his self-restraint and diplomatic skills. While passing through the land of sirens, known for their luring fatal songs, he orders his men to stop their ears with beeswax and ties himself to the mast of the ship. Recognizing that in the future he may behave irrationally, Odysseus limits his future agency and binds himself to a commitment mechanism (i.e. the mast) to survive the disaster of instant gratification.

Humans could manipulate the discount function but not bend the curve into a less concave shape. [skinner 1953] lists ways to control impulses physical restraint and physical aid, changing the stimulus, deprivation, and satiation, manipulating emotional conditions, using adverse stimulation, drugs, operant conditioning, and punishment or doing something else. The problems of impulse control emerged as a clash between the individual's wishes and those of the society.

## **Kahneman's Stranger**

Kahneman's dual system, one which is fast, instinctive, and emotional, and the second which is slower, deliberate, and logical are standing on the shoulder of giants like John Rae who in 1905 articulated the dual system of Instant and delayed gratification. System 1 - System 2, Fast-Slow thinking, Experiencing - Remembering selves classify well under instant gratification [IG] and delayed gratification [DG] systems. IG is impulsive, fast, frequent, and subconscious while delayed gratification is conscious, infrequent, effortful, slow, etc.

Kahneman's dichotomy between the two modes of thought was first highlighted in Jevon's laws. The instinctive and emotional parts that Kahneman lays out are a part of Anislie's work. Kahneman's rational and non-rational reference, complementarity, and conflict are part of psychology's foundational legacy built by thinkers like Freud, Simon, and a host of other researchers who have contributed to mechanism thinking in psychology.

In 1957 Herbert Simon [8] sought a redefinition of human rationality and would have been displeased labeling homo economics as predominantly irrational. Maybe this is why he said human rationality is bounded by the limits of available information and with time the bounds extend, and rationality increases. The soul of psychology belongs to Lamprecht as he dared to talk about history as an extension of collective psychology.

Kahneman came close to acknowledging the role of statistics in psychology when he cites his experience with flight instructors.

"This was a joyous moment of insight when I saw in a new light a principle of statistics that I had been teaching for years. The instructor was right - be he was also completely wrong! His observation was astute and correct: occasions on which he praised a performance were likely to

be followed by a disappointing performance, and punishments were typically followed by an improvement...regression to mean due to random fluctuations..."

Kahneman illustrates the mistake in Daniel Bernoulli's utility [built on Fechner's psychophysical laws] and explains how the idea of utility is redundant without the context of reference i.e. you can't say whether Bill is happier than John, both receiving a million dollars, till you know how much money they had to start with. Rae talked about reference and relative positioning in preference back in 1834.

Kahneman does not refer to the statistical and mathematical work cited before him and highlights that humans are not statistically capable to compute, the decision-making selves diverge and human behavior experiences random normal reversions, which can't be explained. He points out that Bernoulli's inability to miss such an obvious aspect was a weakness of the scholarly mind that he has often observed in himself. He calls it theory-induced blindness which explains how once a theory or tool is accepted, it's hard to find its flaws.

This is where Kahneman stops, on the edge of unknown, unexplored, inexplicable, and unpredictable when he mentions the stranger. The stranger determines which self will prevail; the slow and deliberate or the fast and impulsive.

*"Odd as it may seem, I am my remembering self, and the experiencing self, who does my living, is like a stranger to me."*

Daniel Kahneman, Thinking Fast and Slow, 2011

History of mechanisms was however replete with reference points context and statistical behavior. Complete self-control may not be possible but repeatedly choosing the same direction weakens the tendency to choose in that direction because response alternation [Dember & Fowler, 1958] is another example of reversion. While behaviors followed by reward tend to recur is an example of persistence.

And sometimes persistence stops dead in its tracks. Behaviors followed by punishment tend not to recur and when both information and reward were delayed, even an intelligent animal like Chimpanzee did not learn discrimination [Perin 1943a]. Studies found that pigeons that have already learned to respond to immediate reward continue to emit it at an undiminished rate if the delay of reward is gradually increased to 1 min. Once the time was increased, beyond a threshold, the animal's behavior came to equilibrium over a large number of trials making complete learning unlikely.

Preference for reward was seen as inversely proportional to its delay. When the second tasks were rewarded on variable-interval schedules, the bird preferred them in proportion to the mean immediacies of their reward [Shimp, 1969]. Even Human preference could be described by the same simple proportion that describes pigeons' preference for food. [Schroeder and Holland 1969].

Even People trying to control their behaviors were not rewarding themselves haphazardly but according to some rules. Children who are given private access to rewards after performing a game of skill do not take all that is available, but rather reward themselves in proportion to their

perceived success [Bandura & Whalen 1966]. All these instances illustrated an ability of an irrational man to rationalize.

### **Mechanisms of Psychology**

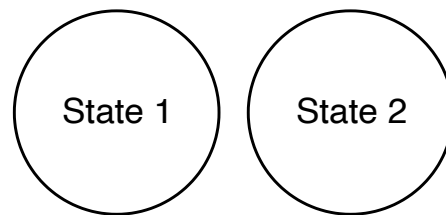


FIGURE 2: Impulsive-Thrifty, Pleasure-Unpleasure, Small Early Reward – Large Late Reward, Fast – Slow Thinking, etc. are dual informational states.

Psychology does not work in isolation. Human decision-making relies on many extraneous factors that force it to adapt. The self may never know when IG kicks in and when DG brings in balance. Most of us don't kill ourselves with alcohol, smoking, or other addictions. Many of us rehabilitate and live for tomorrow. The bi-stability (multi-stability) of the systems is not always in conflict. If decision-making would be conceived as a mechanism that relies on the disequilibrium, the noise, and the error assists the mechanism to perpetually stay in motion.

Experiments in animals suggest that the effectiveness of delays reward declines in a curve with a marked upward concavity so that preference between certain pairs of small-early and larger-later awards can be expected to shift from the larger to smaller reward simply as a function of elapsed time. Passive time could transform a virtuous human to indulge in instant gratification.

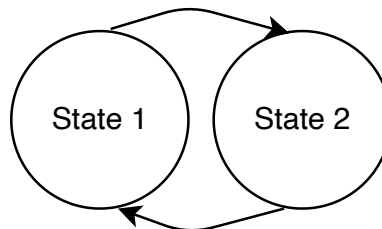


FIGURE 3: In time the decisions shifted from one state to another.

Mechanisms of psychology are statistical and hence can be explained probabilistically. Despite the continuous mechanics driven by hyperbolic discounting, there is a lot of conflict, error, and inexplicability, which can only be estimated probabilistically. Behavioral finance could not identify the stranger because the subject focussed on manipulation devices and not on the mechanism. Reducing psychological content to an informational reference [or context] allowed the subject to think probabilistically about the transition between states.

Psychology as a probabilistic mechanism might seem indigestible conception but if we break down psychology into elements of objective temporal choices, which operate with a hyperbolic discounting mechanism, the elements of psychology become objective and measurable. The

work on discounting can easily lend itself to the probabilistic calculation of IG and DG system choices.

This hypothesis, that subject's preferences can often be expected to change regularly over time in the absence of any new information about the alternatives, turns out to have great organizing power over what has been a mystifying body of data.

The realization that the demon and the stranger may be one entity is a revolution because it indicates that it's physics that might be driving psychology like psychology was driving history.

Once we estimate the probabilities, we can demystify the stranger. If we look at the combined states as a Markov chain, we can assign the states a probability  $[p]$  of stickiness and a probability of detachment  $[q]$ . And because the system is dynamic the probabilities change, grow, and decay in time, perpetually.

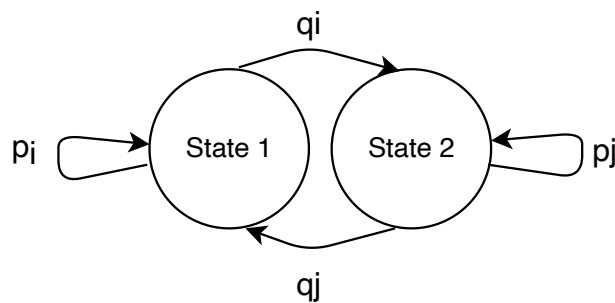


FIGURE 4: The Mechanism of Psychology as a Markov Chain with a probability of stickiness and detachment.

## Conclusion

“Mechanisms of Psychology” drive our day-to-day decisions and operate through a dual [multi] state system. These states interact and create complexity and unpredictability. Despite this disorder, the hyperbolic curve behavior in human psychology persists. The psychological states that underlie this robustness have established boundaries and limits. These limits sometimes create extremities that lead to reversals and hence keep the mechanism perpetually in motion. Timing the expression of these states is an impossibility. This is why Kahneman referred to this unpredictability as a stranger. Maxwell had observed a similar strangeness while explaining the failures of the second law of thermodynamics and referred to the inexplicability as a demon.

Mind is a chaotic process. This is why we need mechanisms of psychology to assist us in estimating the chances of failure and success of a state [a decision]. Without such probabilistic estimates, we can only wish for an Odyssey's greatness, which was capable to bridge both the instant and delayed gratification.

If the states were assumed to function as a Markov chain with probabilities of attachment and detachment, operating as a mechanism of psychology, the study would become more measurable and less inexplicable.



Psychology can be seen as information, driven by a mechanism steeped in Physics. Whether we see it now or sometime in the future, time is the true demon that no human conceived mechanism can ever demystify.

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