



Paula Bronstein/Getty Images

# *Addiction and the Brain*

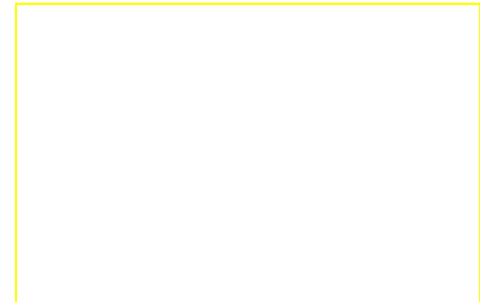
## Part 2

## Our hypotheses / assumptions

The brain's response to a drug is to promote the opposite state.

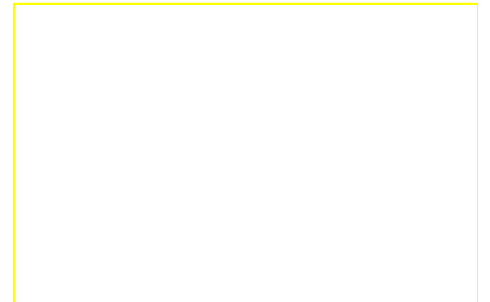
The only way for a regular user to feel normal is to take the drug.

Getting high becomes more and more short-lived and the purpose of using is to avoid withdrawal.



## Socrates:

“How singular is the thing called pleasure, and how curiously related to pain, which might be thought to be the opposite of it...he who pursues either of them is generally compelled to take the other. They are two, and yet they grow together out of one head or stem.”



# Claude Bernard

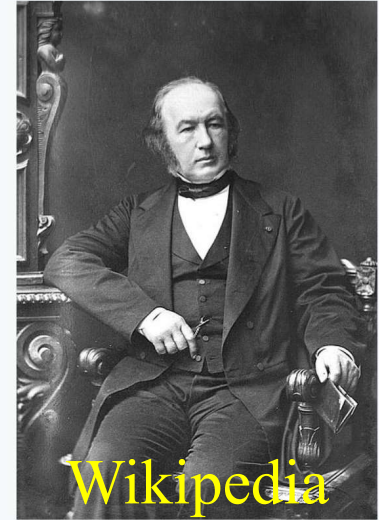
Claude Bernard: “the stability of the internal environment [milieu intérieur] is the condition for the free and independent life.”

(Also came up with the idea of blind experiments.)

Walter Cannon, ~ 80 years later, popularized Bernard’s ideas in a book titled *The Wisdom of the Body* and coined “homeostasis”.

(also coined “fight or flight”)

Claude Bernard



Claude Bernard

<b>Born</b>	12 July 1813 <a href="#">Saint-Julien</a>
<b>Died</b>	10 February 1878 (aged 64) Paris
<b>Nationality</b>	French
<b>Alma mater</b>	<a href="#">University of Paris</a>
<b>Known for</b>	<a href="#">Physiology</a>
<b>Awards</b>	<a href="#">Baly Medal</a> (1869) <a href="#">Copley Medal</a> (1876)
<b>Scientific career</b>	
<b>Fields</b>	<a href="#">Physiology</a>
<b>Institutions</b>	<a href="#">Muséum national d'Histoire naturelle</a>
<b>Influences</b>	<a href="#">François Magendie</a>

Signature

*C. Bernard,*

# Solomon and Corbit's **opponent process theory**

Any stimulus that perturbs the way we feel is actively counteracted by the nervous system in order to return to homeostasis.

The stimulus could be a drug, good or bad news, or falling in love.

Feeling states are maintained around a “set point” just as body temperature and water balance are.

*Psychological Review*  
1974, Vol. 81, No. 2, 119-145

## AN OPPONENT-PROCESS THEORY OF MOTIVATION:

### I. TEMPORAL DYNAMICS OF AFFECT <sup>1</sup>

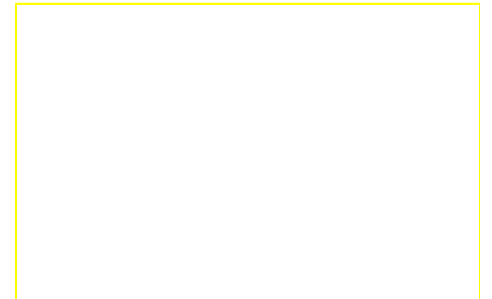
RICHARD L. SOLOMON <sup>2</sup>

*University of Pennsylvania*

JOHN D. CORBIT

*Brown University*

A new theory of motivation is described along with its applications to addiction and aversion. The theory assumes that many hedonic, affective, or emotional states are automatically opposed by central nervous system mechanisms which reduce the intensity of hedonic feelings, both pleasant and aversive. The opponent processes for most hedonic states are strengthened by use and are weakened by disuse. These simple assumptions lead to deductions of many known facts about acquired motivation. In addition, the theory suggests several new lines of research on motivation. It argues that the establishment of some types of acquired motivation does not depend on conditioning and is nonassociative in nature. The relationships between conditioning processes and postulated opponent processes are discussed. Finally, it is argued that the data on several types of acquired motivation, arising from either pleasurable or aversive stimulation, can be fruitfully reorganized and understood within the framework provided by the opponent-process model.



## Solomon and Corbit's **opponent process theory**

Any stimulus that alters brain functioning to affect the way we feel will elicit a response by the brain that is exactly opposite to the effect of the stimulus.

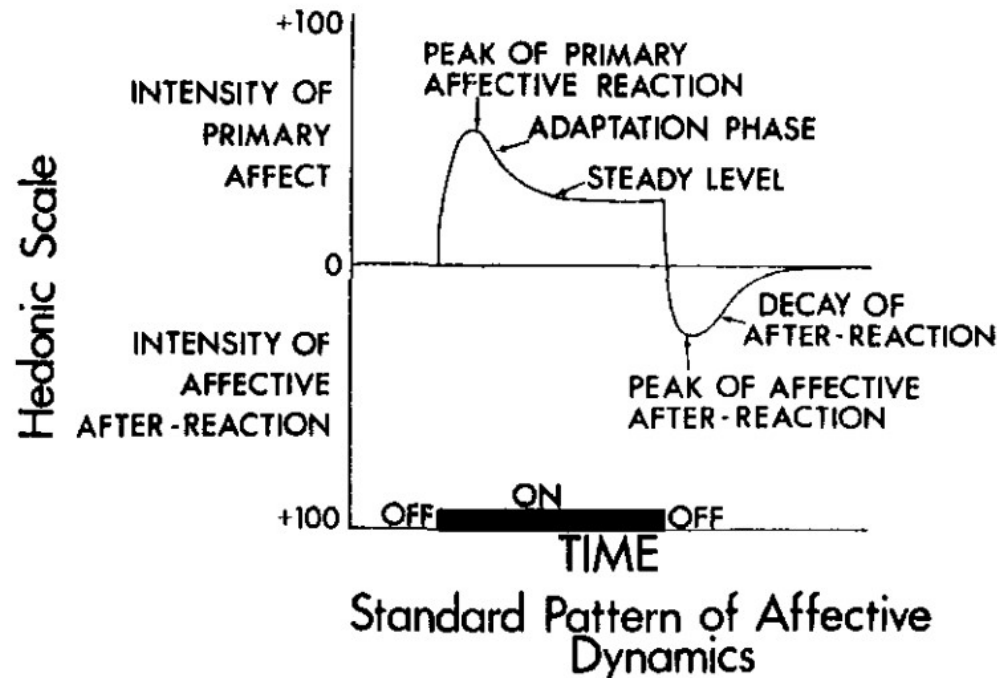
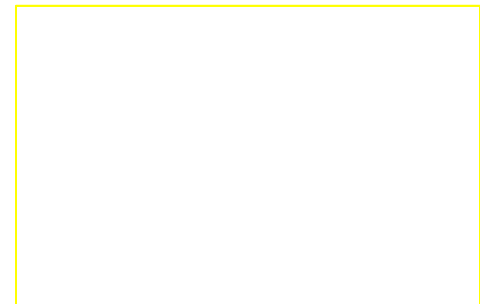


FIGURE 1. The standard pattern of affective dynamics, showing the five distinctive features:

## Neural plasticity

In addition to serving as a sensor, contrast detector, and coordinator of responses to environmental perturbations, the CNS is capable of changing itself to adapt to environmental input.

Among the brain's most distinctive features is its capacity to dynamically respond to environmental stimuli and even to anticipate them. This is called *plasticity*.



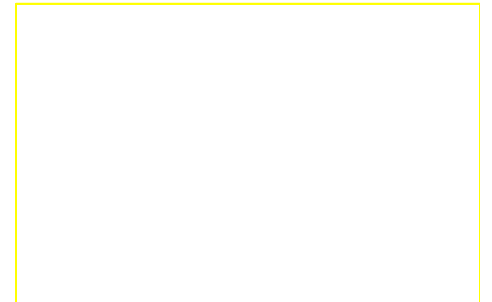
# Learning

Persistent change in response to environmental input is called learning

All organisms with a CNS learn.

In summary, learning is the neural cause of addiction.

Learning associated with addiction begins with the first exposure and results in adaptation.





## Learning and adaptation

Because learning is stronger with repetition, chronic exposure to a drug results in more lasting alterations.

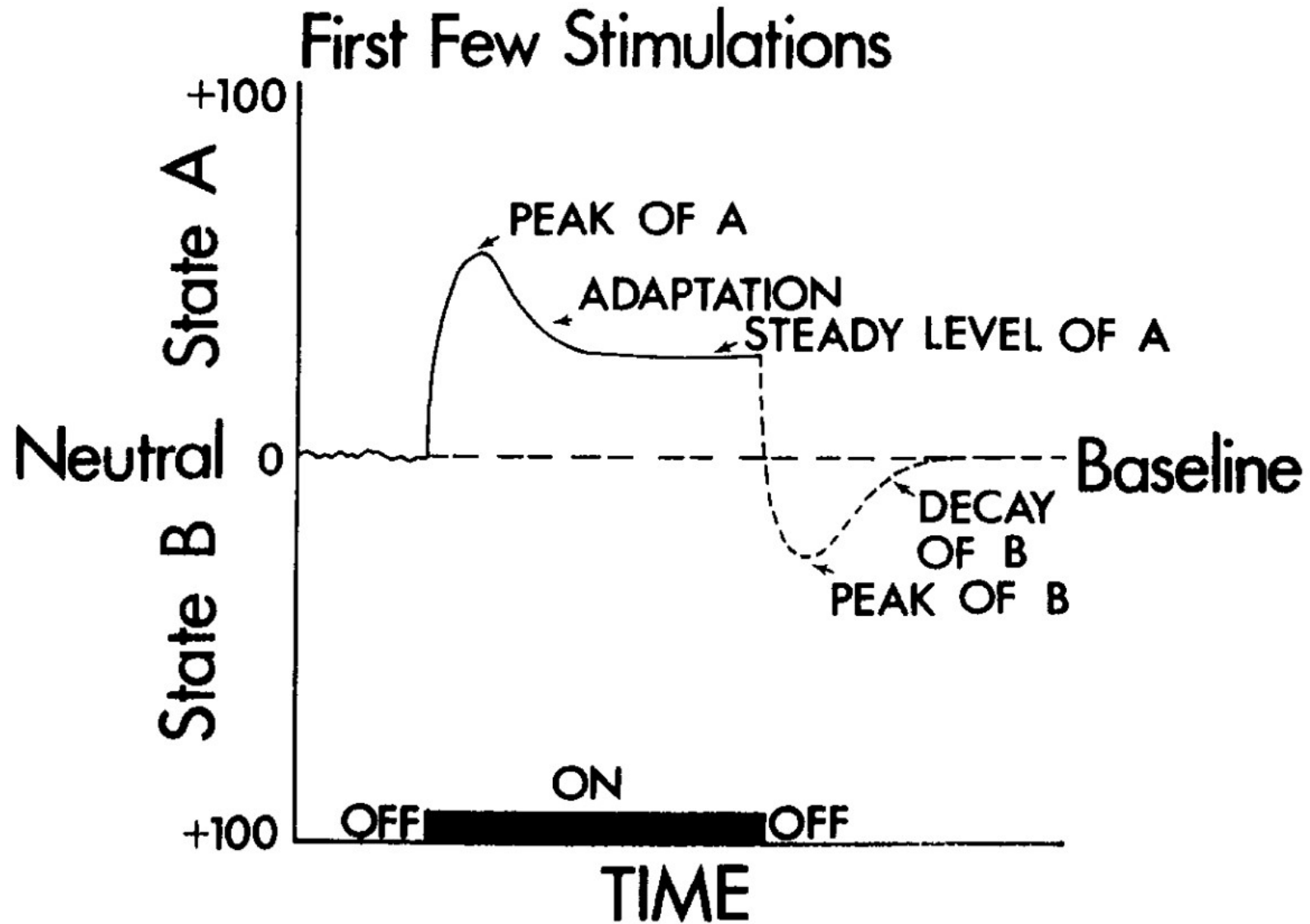
For some drugs, adaptation is therapeutic effect.

Developing tolerance to selective serotonin reuptake inhibitors (SSRIs) may help to change a pathological affective “set point” so that being depressed is no longer the patient’s normal state.

With abused drugs, however, as the brain adapts, the drug becomes less effective at stimulating dopamine transmission. \*

And the drug doesn’t produce as much of a high in this lower-than-normal baseline state.

Solomon and Corbit use the terms “State A” and “State B” to refer to opposing affective experiences.



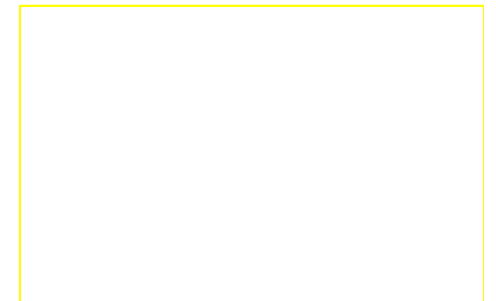
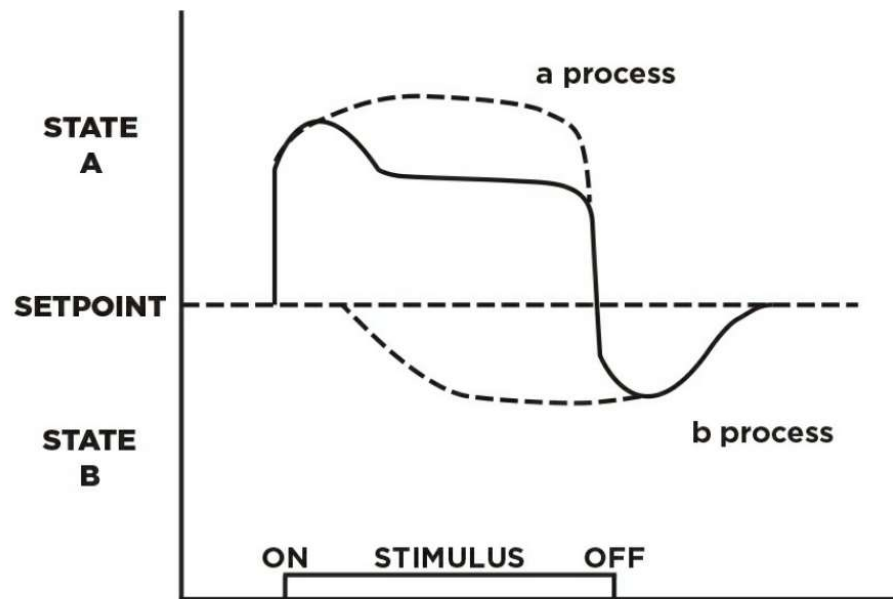
# The competition of the **a** and **b** processes

When the brain is first exposed to a stimulus, the **a** process is unmitigated by compensatory brain mechanisms, and thus State A is experienced in full.

However, as the **b** process is recruited, State A is dampened.

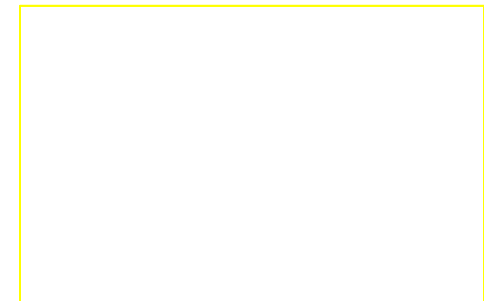
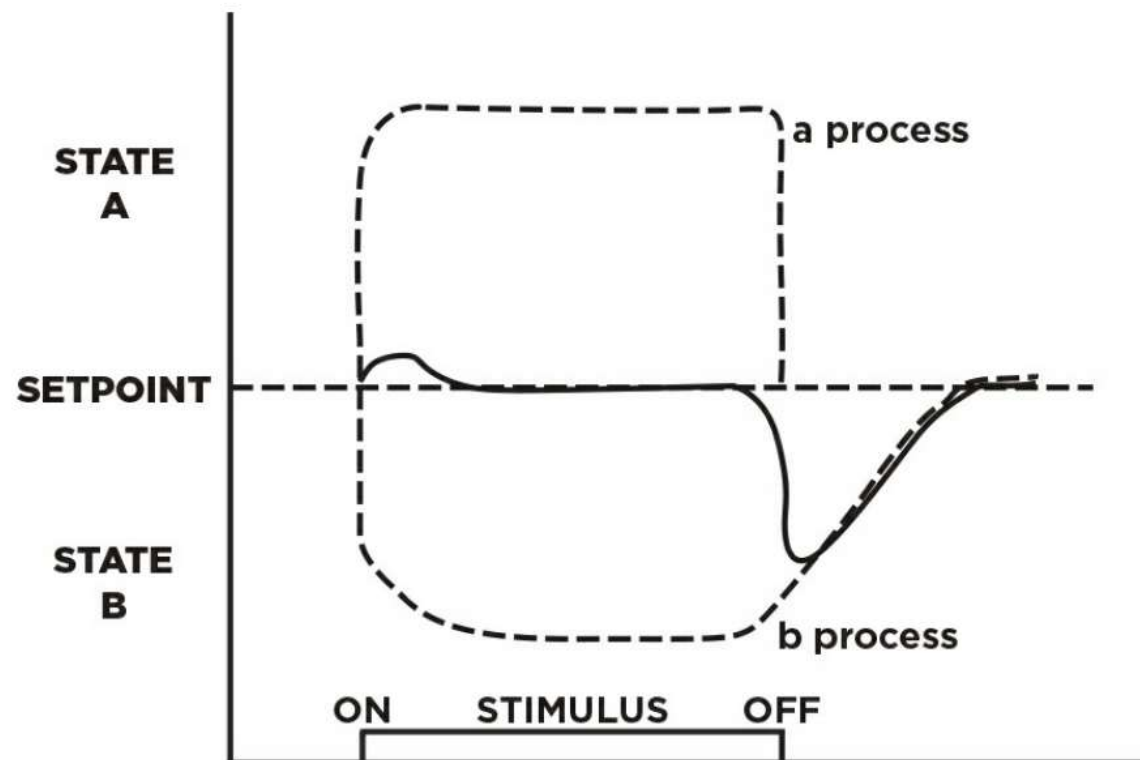
The **a** process is a direct reflection of the stimulus and so is always the same if the stimulus is the same (e.g. a glass of wine or a shot of heroin).

In contrast, the compensatory **b** process changes with time and exposure.



# The brain compensation through adaptation of the **b** process

As a result of adaptation after repeated drug taking, the opponent **b** process becomes quicker, stronger, and longer lasting—leading to a reduction in the subjective experience (**tolerance**), and **withdrawal** and **craving** when the drug is not present.



# Summary of the opponent process theory

RICHARD L. SOLOMON AND JOHN D. CORBIT

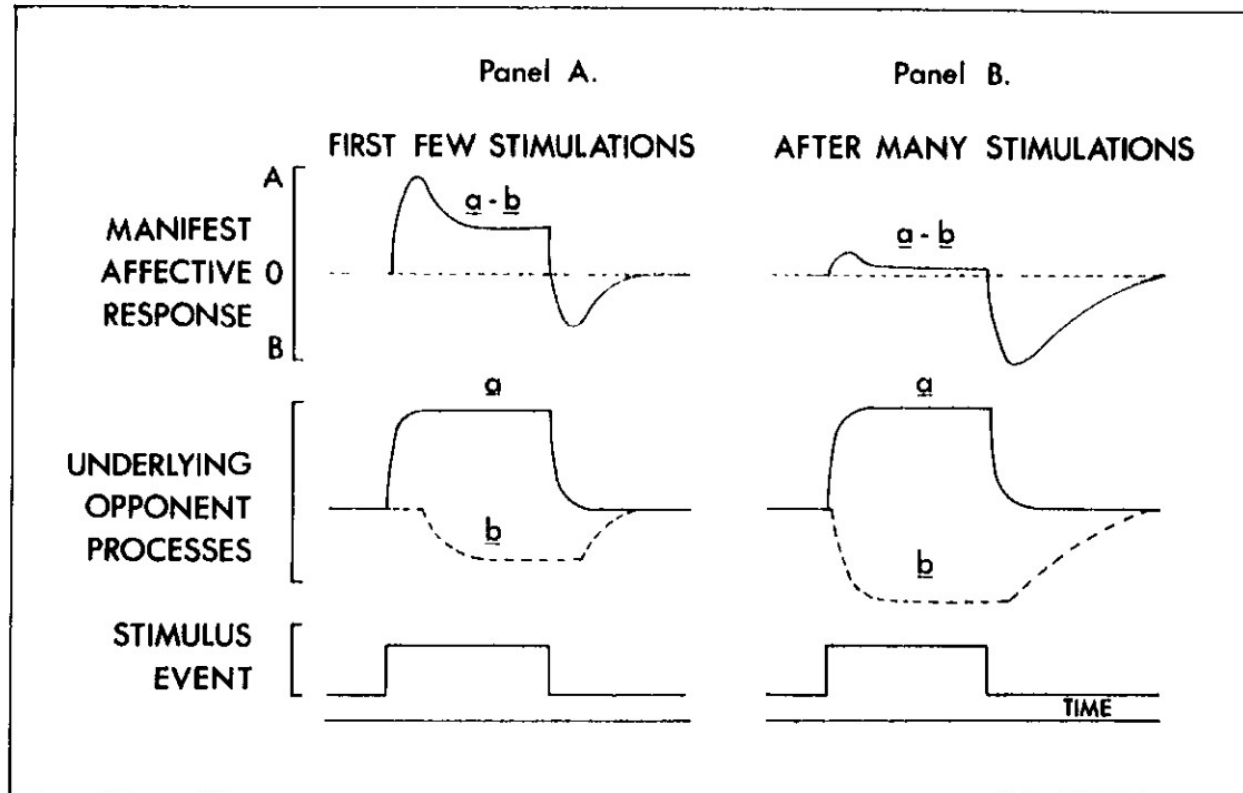
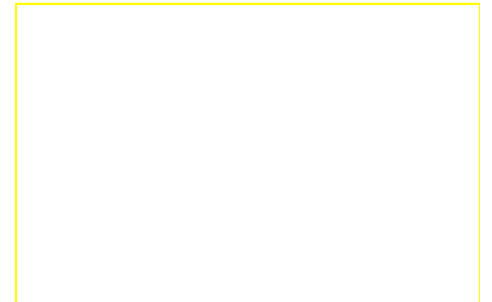


FIGURE 4. Panel A: The operation of the summing device for the first few stimulations. (The summation of the underlying opponent processes,  $a$  and  $b$ , yields the manifest affective response.) Panel B: The operation of the summing device after many repeated stimulations.

## The flip side to Solomon and Corbit's model

To achieve a sustained positive state, submit yourself to negative experiences. This way the opponent process would be positive.

Solomon and Corbit argued that such a pattern may be at work in an activity like skydiving.



## The **b** process captures the hallmarks of addiction

Tolerance, withdrawal, and craving are consequences of the **b** process.

Tolerance occurs because more drug is needed to produce an **a** process capable of overcoming a stronger and stronger **b** process.

Withdrawal happens because the **b** process outlasts the drug's effects.

Craving is guaranteed by Pavlovian conditioning, because any environmental signal that has been associated with the drug can itself elicit a **b** process.

