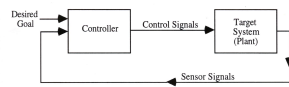


## Representation II

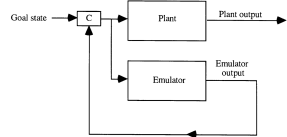
### Control Theory Ideas

Closed loop (feedback) control: The departure of the output of the plant from the target is the basis for action to produce the target

Watt's governor is an example of closed loop control



Pseudo-closed-loop control: Emulator stands in for the plant and effects of actions on the emulator are fed back to guide action



### Questions for the Emulator Theory

Does the specification of the goal count as a representation?

Presumably not because it is not part of an emulator

How does the emulator come to represent the plant?

In engineered systems, emulators are designed to do so

In biological systems, they must be acquired by evolution or learned

How do states in the emulator represent distinct features of the plant?

Grush appeals to the user, but how does the user establish the right

connection between states of the emulator and actions?

Can we represent more than just our motor system?

Grush suggests that we can also represent the environment as part of the forward model, but doesn't say how this is to work.

## Evaluating the Alternatives So Far

My account makes representations nearly ubiquitous

They will be found in any control system since such a system requires information about the plant and its operations to regulate its activity

Representations are not a distinctive feature of cognitive systems

But this seems to track neuroscientist's usage

Grush is concerned to connect representations with cognitive activities

Only a system that can be taken off-line and used in reasoning (a paradigmatic cognitive activity) involves representations

The rest of what neuroscientists call representations are recategorized as presentations

Should presentations and representations be sharply distinguished?

Or might presentations provide the building blocks for Grush's representations? I.e., presentations that get taken off line

This has the advantage of being able to invoke causal connections to link up internal states with what they will then represent

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## Intentionality: The Content of Representations

*Intentionality* refers to the ability of representations to represent something

A photograph of a person represents that person

A diagram is about a phenomenon or mechanism

A noun or verb in a text refers to a thing or its properties

A belief represents some putative fact

Since Brentano introduced the concept of *intentionality* the connection between the representation and what it represents has been mysterious

Especially since the represented thing may not exist at all or as represented

A common strategy has been to appeal to how representations carry information by being causally dependent on what they represent

In the case of the brain, this must be mediated by the senses

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## Clicker Question

Imagine standing on the beach and someone asks you what you think the temperature is. You reply "It's hot—probably in the upper 80s." What is the "traditional view of the senses" (as characterized by Akins) that explains this

Our senses act like thermometer, reporting the temperature in a servile manner

Our senses are poor indicators of temperature, as illustrated by illusions

Our senses are good indicators but generally less reliable than thermometers, reporting only values such as *hot*, *warm*, *cool*, and *cold*

Our senses typically only report changes in temperature, not the actual temperature

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## Traditional View of Sensory Representations

The brain only accesses the world via representations provided by the senses

Without them, the brain is a solipsist

### Assumptions

There is a reliable correlation between what is represented and the representation

The structure of the phenomenon represented (relations between different temperatures) is preserved in the representations

The senses offer *servile* reports—they do not impose their own interpretation

This does not require that the senses function perfectly, but error should not be widespread

For only if sensory representations satisfy these conditions will the brain acquire the information needed to operation in the world

And avoid solipsism

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## Narcissistic Sensory Systems

Narcissists focus primarily on themselves

Interpret everything in terms of its significance to themselves

Narcissism with respect to thermoreception

Receptors are not in the business of objectively reporting whats in the world, but only what the organism needs to know

Two temperature receptors, one for warm and another for cold

Two pain receptors for extreme hot and cold

Different parts of the body have different concentrations of warm and cold receptors and so are more sensitive to one or the other



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## Warm and Cold Receptors

The "static" function of the warm and cold spots is its response frequency at different temperatures

The non-linear relations shown on the left

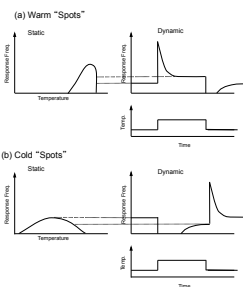
Also have "dynamic" responses to changes in temperature

For the warm spot

When the temperature increases, the response first spikes, then gradually drops back to the new static response  
When the temperature drops, the response drops before gradually returning to the new static response

Size of spike depends on size of change

Reverse for the cold spots




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## Reports Temperature as it Matters to the Organism

The organism is narcissistic: what it needs to know is not how the world is, but how the world is affecting it

Hot and cold receptors are reporting changes in temperature that might matter

What matters most is how things are changing

If temperature is changing differently for different parts of the body, they report the same stimulus differently

Hand initially in warm water reports tepid water as colder than hand initially in cold water



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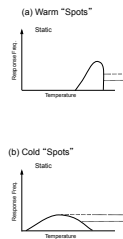
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## From the Traditional View

Thermoreception is a poor sensory system if what it is supposed to do is provide accurate information about temperature

It reports the same temperature in different ways  
Depending on how many receptors are in a given tissue

It gives the same response to different temperatures  
To stimuli on either side of the maximal response



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## Clicker Question

What is Akins' own assessment of the usefulness of narcissistic sensory systems?

They are a serious impediment to our ability to understand the world around us since they generate distortions

They aren't very useful and so humans have devised more accurate tools like thermometers  
They provide exactly the information organisms most need—the information needed to respond effectively

They are OK, but they could have been much better designed

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## Evolutionarily Sensible

"one realizes that this system is not merely inept, a defective indicator of surface temperature. Rather, the system as a whole constitutes one solution to man's various thermal needs—that he be warned when thermal damage is occurring or before it is likely to occur, when temperature changes are likely to have specific consequences, and so on."

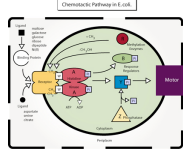
Would an objectively accurate recording of temperature work better?

In order to use such information to plan action, the organism would need to know how to reason with that information

For many purposes, what the motor system needs to know about is what matters for action

For a bacterium, is it moving up or down a chemical gradient

It doesn't need to know the actual quantity



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## Processing Information and Representation

Akins emphasizes the various types of information organisms must acquire in order to direct motor activity

Why do the neural processes involved in processing this information not count as representations?

At some points Akins seems to acknowledge that they do:

"Even our simplest actions, then, involve numerous sources and types of information (here, visual, proprioceptive, and haptic information) and, within a single system such as vision, specialized information (about shape, position using a variety of reference frames, rotation, movement, and so on) which requires diverse **representational schemes**."

Her objection seems not to be to the occurrence of representations in the brain, but to the nature of those representations

They don't represent objective features of the external world  
Rather, they represent narcissistic information

But elsewhere she speaks of such as "nonrepresentational systems"

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## Intentional Representations of which we are Conscious

Akins real concern seems to be with the intentional grounding of our conscious representational states

Her contention is that sensory receptors don't ground these states

But how do we come to have such states?

A plausible answer is that we extract them from what is represented by the senses

But Akins rejects this answer: "This suggestion, however, amounts to little more than an expression of one's faith in the traditional view.

Empirically, there is little reason to think that all sensory systems carry within them the means to "decode" their own responses."

But why think we do represent consciously all information acquired by our senses?

We may not be able to make objective claims about temperature

But with other systems, such as vision, we do reach more objective representations of the world outside us--tables, chairs

Of course this requires a lot of neural processing

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## Akins' Doubts about the Detector Theory

Akins raises a further objection to the construal of sensory systems as detectors of specific properties (including narcissistic ones)

Internal systems in the organism regularly modify the response properties of the senses so that they are not fixed detectors of a given property

Example: feedback processes alter the response of muscle spindles to changes in muscle length as the muscle is extended or contracted

What is wrong with context sensitive detectors—detectors whose sensitivity is calibrated by other activities in the system?

Of course whatever utilizes the response of the detector must also be responsive to the way the receptor was calibrated

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## Radical Anti-Representationalism

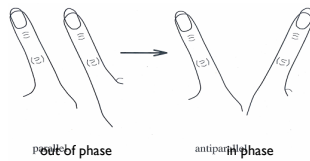
A number of theorists have rejected the project of understanding systems by identifying representations and operations that alter representations

Like van Gelder, they argue that a better approach, motivated by physics, is to characterize cognitive systems in terms of differential equations that specify how values of variable changes

Kelso introduced the finger waging task: wag your index finger on either hand

At slow speeds, you can either move them out of phase or in phase with each other

As the speed increases past a critical point, only the in phase motion is possible




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## The HKB Coordination Model

A simplest mathematical model that describes this behavior is:

$$\ddot{\varphi} = -a \cos \varphi - b \cos 2\varphi$$

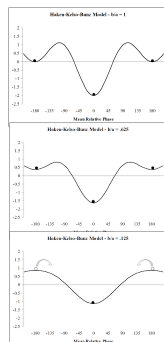
$\varphi$  is change in relative phase

$\varphi$  represents the relative phase

The ratio of the parameters  $b/a$  is inversely related to the rate

When  $b/a = a$ , there are two relatively deep attractors but

as  $b/a$  declines, a point is reached at which there is only one attractor




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## Clicker Question

What role do representations play in finger movement coordination according to Chemero?

The variable  $\phi$  represents the phase difference between the fingers

Representations are the states within the brain that figure in the control of finger movement

The attractor basins represent the stable phase relations at a given velocity

None

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## The Dynamical Approach

The HKB account describes coordination behavior without representations: "there simply is no likely candidate in the system as described by the HKB model that might serve as an information-bearing state of the animal that mediates between it and the world"

Chemero describes the method

"First, observe patterns of macroscopic behavior; then seek collective variables (like relative phase) and control parameters (like rate) that govern the behavior; finally, search for the simplest mathematical function that accounts for the behavior"

This approach has been applied to a broad range of behavioral and neural phenomena

Note: the approach is non-mechanistic: there is no attempt to decompose a system into its component parts and operations and to show how they together generate the phenomenon

The mathematical function explains the dynamic behavior to which it gives rise

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## The Options

Internal states of the organism that figure in information processing and are used to control behavior represent features of the organism and the world outside (perhaps in ways most relevant to the organism)

Only states of the organism that are used off-line as stand ins for other things count as representations

There is a disconnect between the narcissistic sensory processing systems and what figure in human intentional states

There are no representations within the organism—the organism and the environment together constitute a dynamical system that should be analyzed as such

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