Cognitive Psychology: The Foundation

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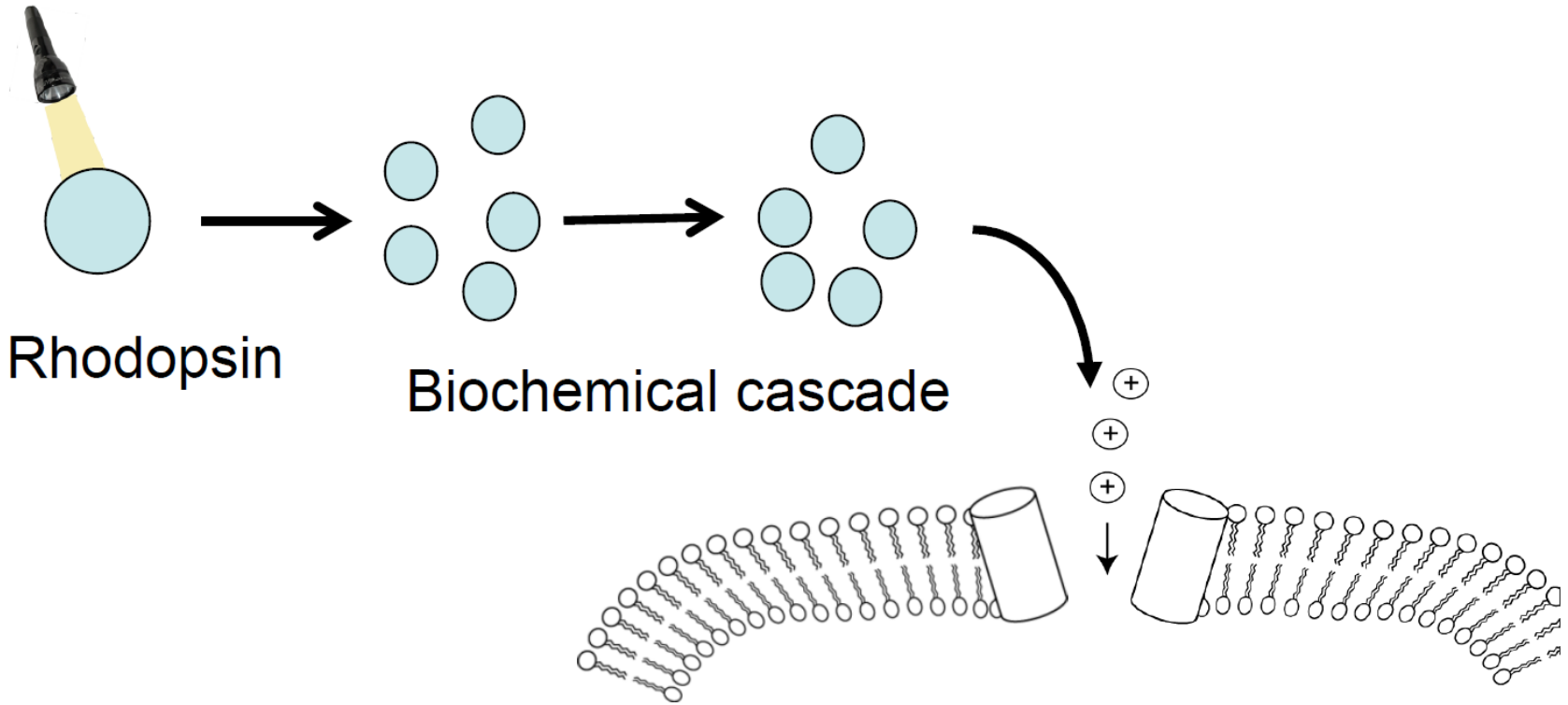
The Story of Epistemology So Far

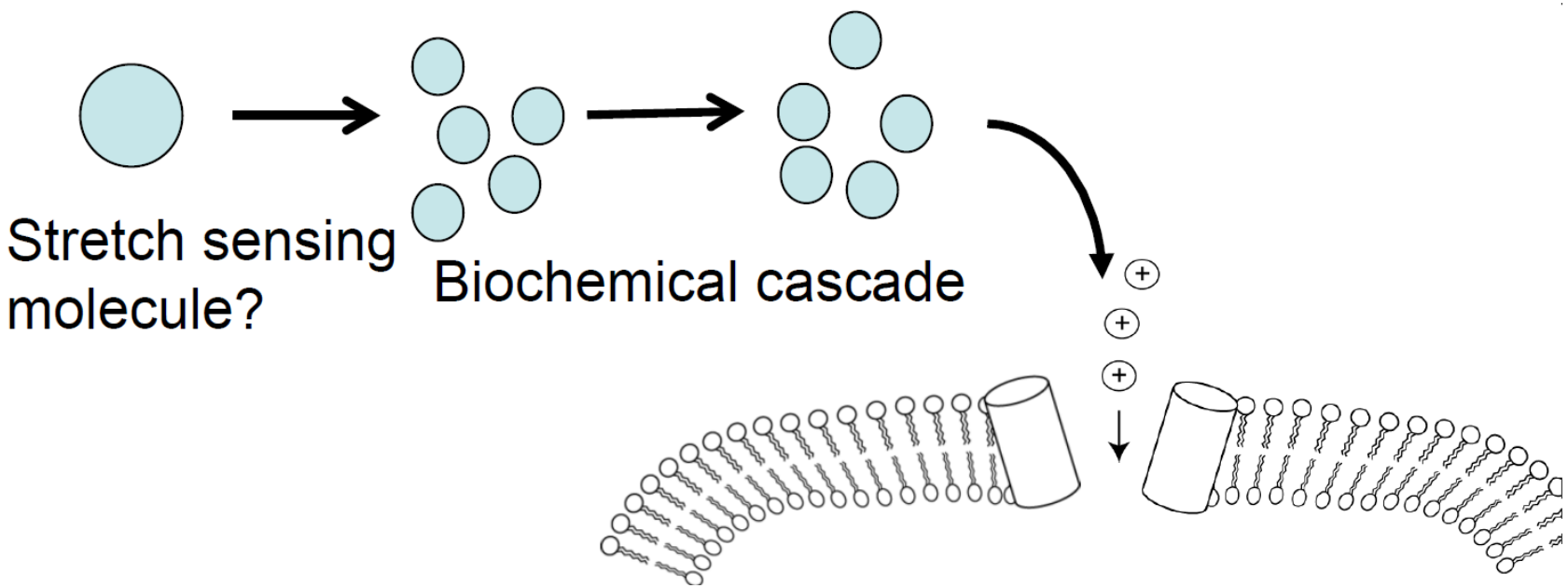
- Kant claimed to had explained why arithmetic and geometry can be known *a priori* with certainty.
- He also claimed that he provided a refutation of Hume's skepticism about induction. Although the metaphysical skepticism is still there.
- Kant's idea is that the Euclidean space and time is the pure form of our intuition.
- But is that true? Can we learn about how we know where thing are using empirical methods?

Visual Sensation

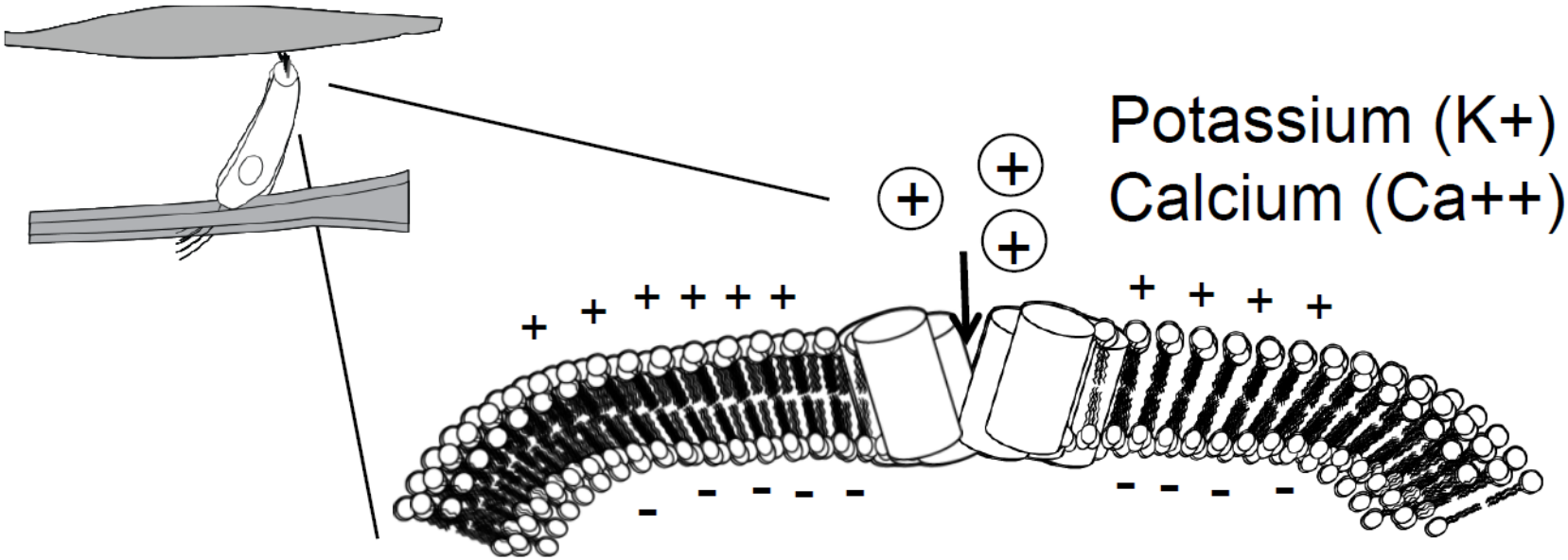


Possible mechanotransduction mechanism 2

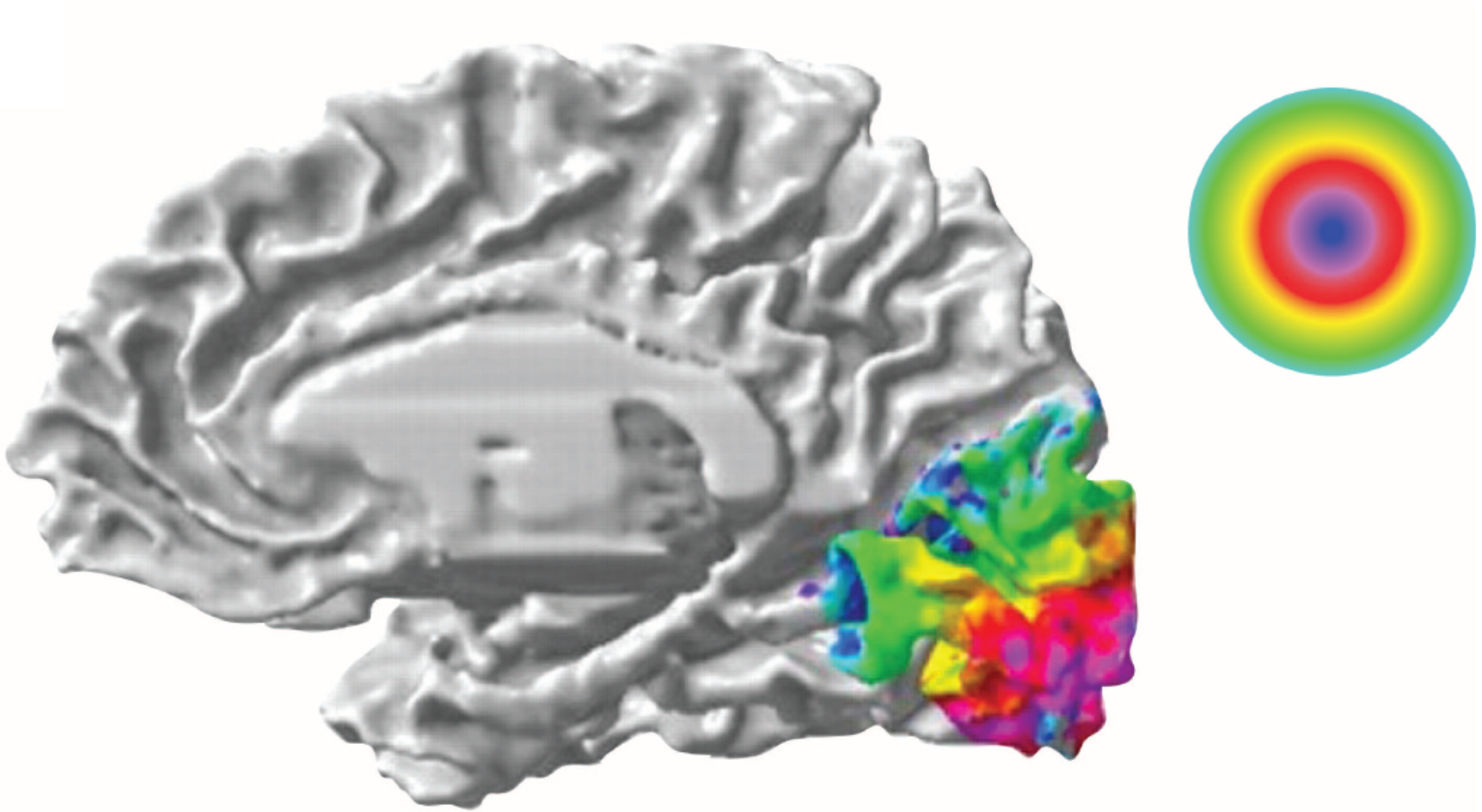
Lackner, J. R. (1988)



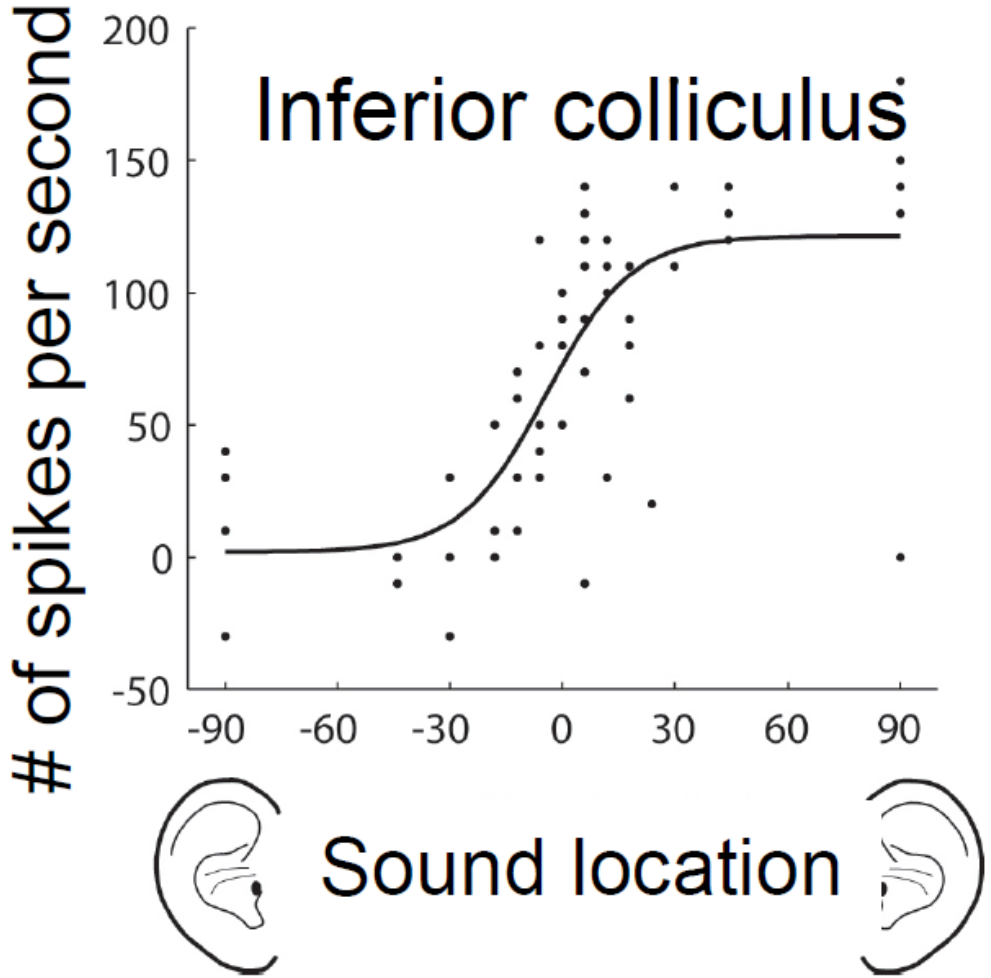
Auditory Transduction



Retinotopic Maps

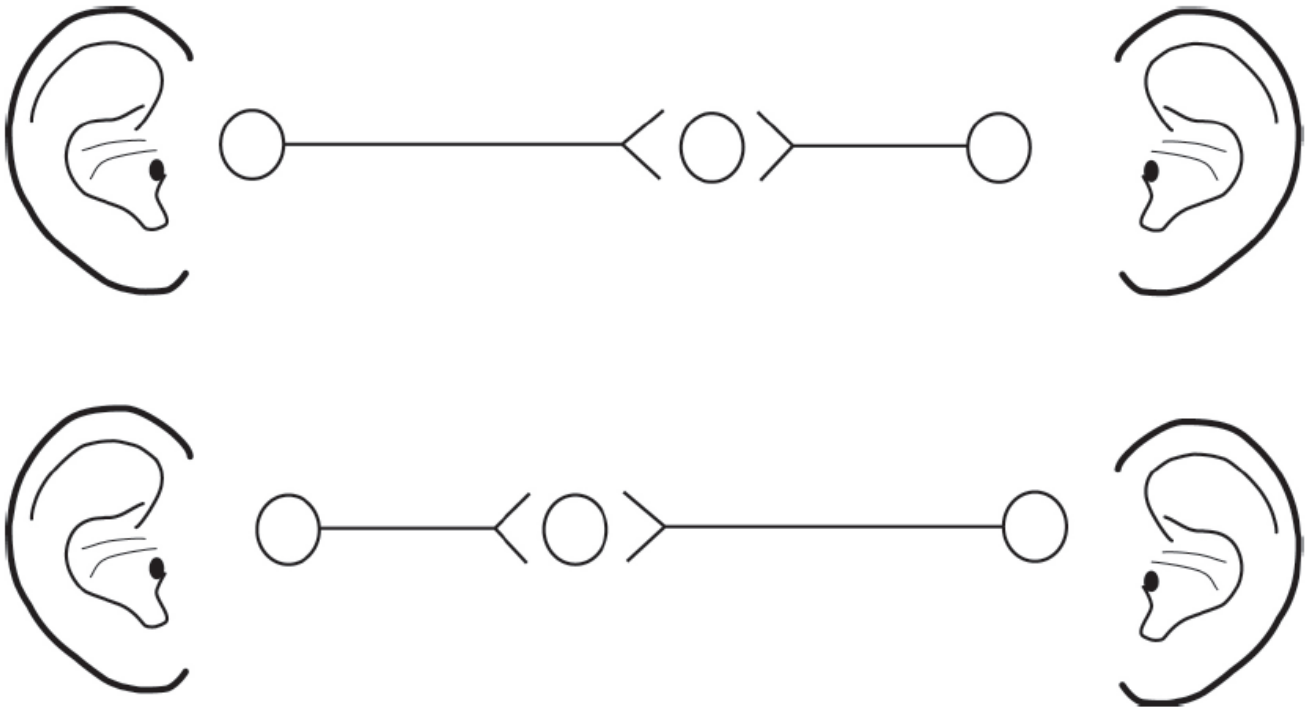


Coding of Sound Location

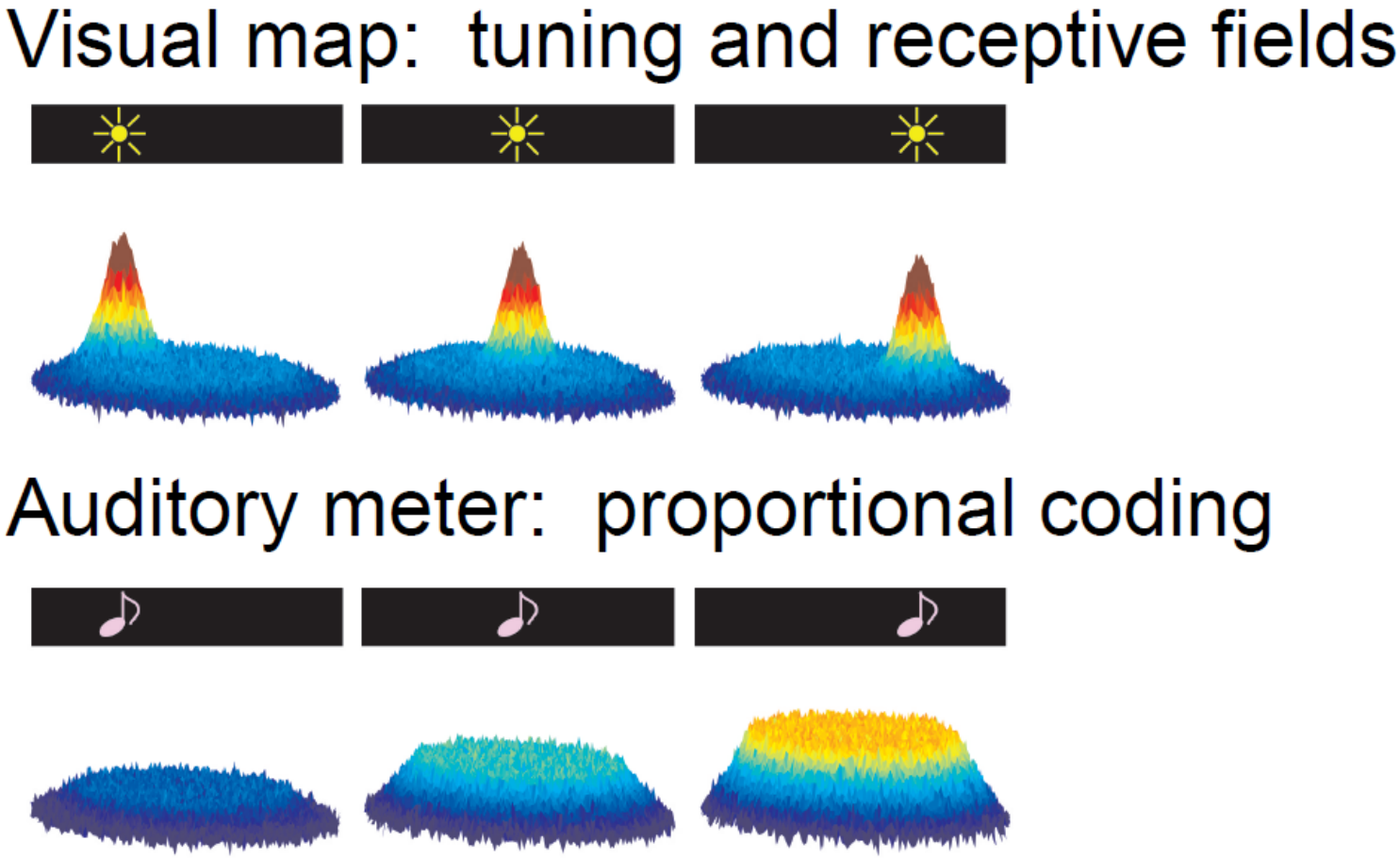


Werner-Reiss and Groh, J. Neurosci, 2008

Detecting Interaural Timing Differences: Delay Lines



Integration of Image and Sound Location Coding: Superior Colliculus



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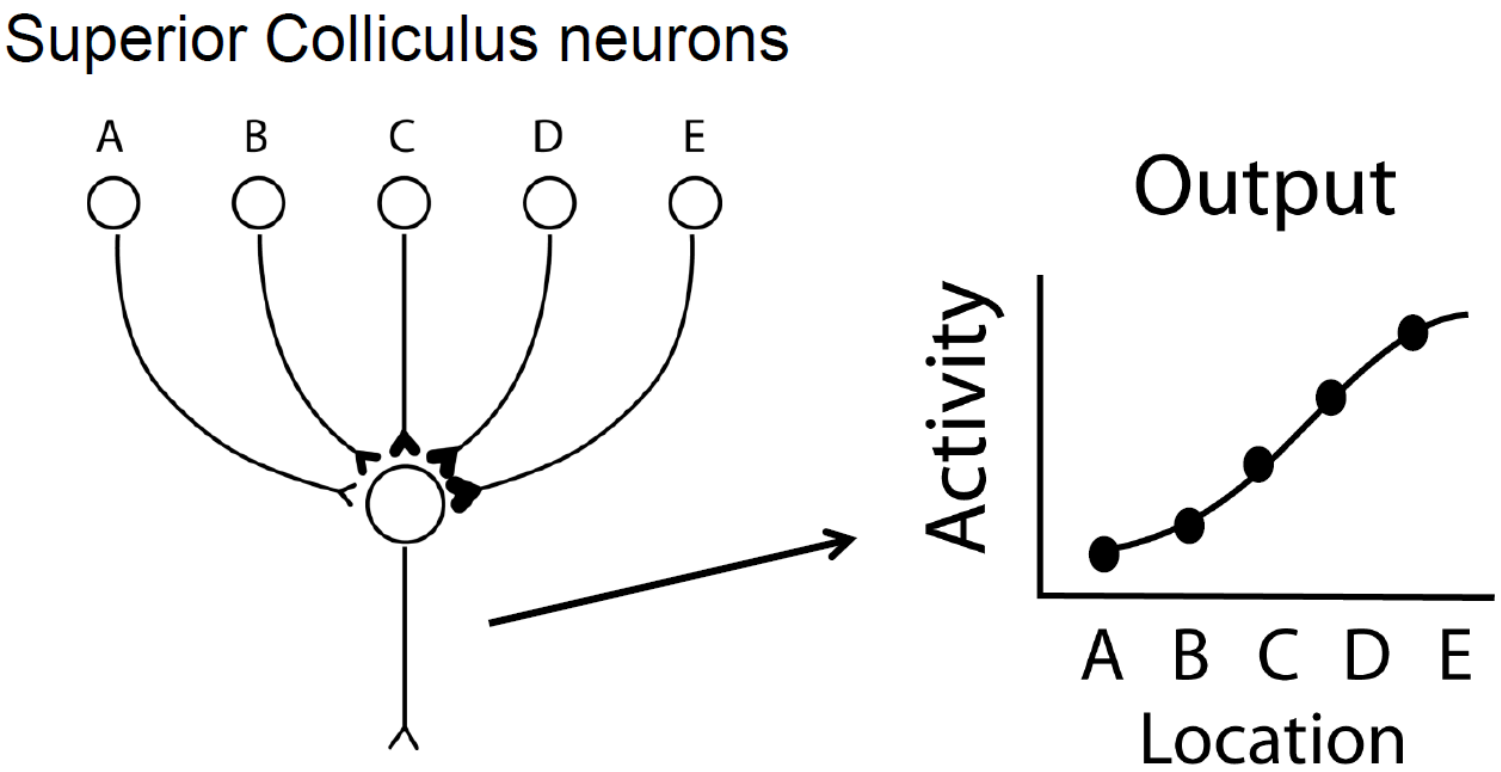
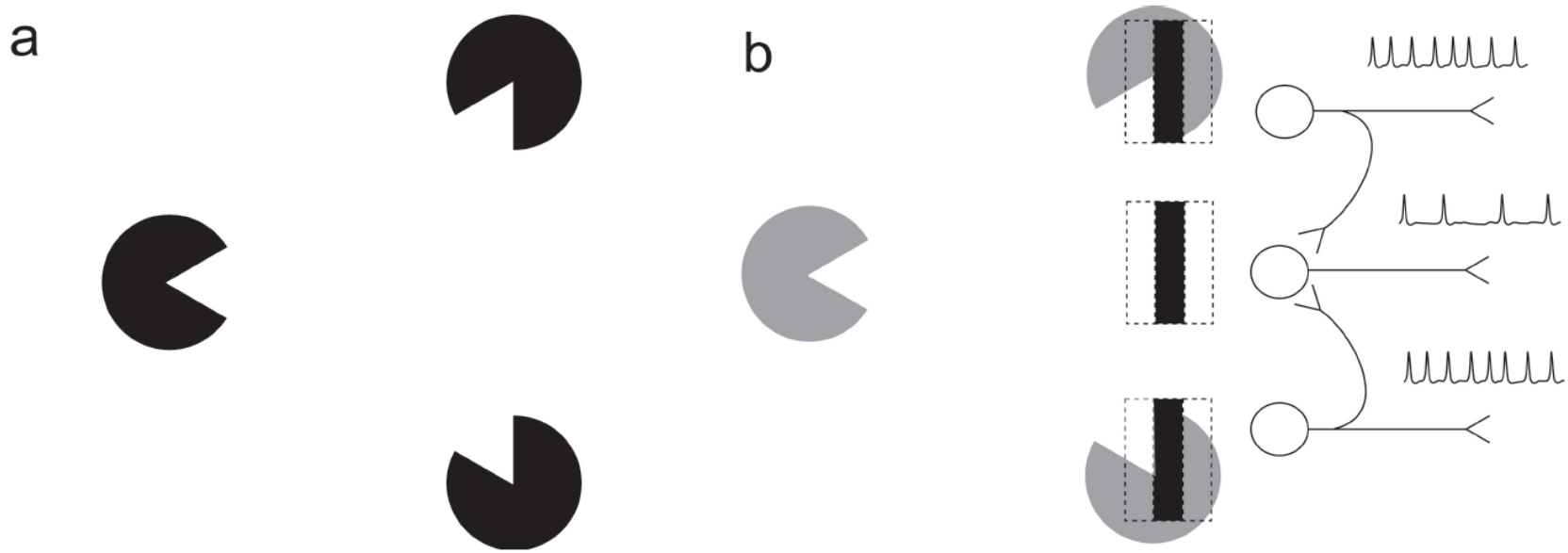


Kanizsa Triangle: Illusory Contours



What is Right about Kant

- We do construct the space.
- The construction is not subject to our free will.
- Spatial experience is part of our intuition.

What is Wrong about Kant

- We do need experimental methods to investigate our cognitive faculties.
- Our spatial experience can be changed and learned.
- The spatial experience is not just inside of our mental world. It is out there in the real world.
- Perception can be a source of knowledge about the object world, although not necessarily reliable.
- Condition of possibility of spatial experience is not unique.
- We simply cannot stop at Kant. General level descriptions of knowledge are abstract, and we need details even for an overall and comprehensive understanding.

Another Issue: Knowledge about the Mind

Can we obtain knowledge about our mind?

Outline

The Basic Assumption of Cognitive Psychology

- In some sense, the whole notion of cognitive psychology seems counter-intuitive.
- The basic assumption in cognitive psychology concerns the existence of an inner world, the mind-space, where the mental processes take place
- and where each element of the external "real" world is somehow "represented".

The Problem of "Abstract"

- "abstract" used to designate something that is defined without reference to the material (physical) world - that of objects.
- thoughts, beliefs, emotions, etc. are all abstract because, while they may describe aspects of the physical world, they themselves are not physical entities.
- However, the fact that we can talk and theorize about these abstract entities, is slightly problematic.

"Physical" and the "Mental"

Consider the statement: "Lee 'decided' to 'make' a sandwich because he 'felt' hungry."

- How is it that two mental events, "feeling" and "deciding" can cause a physical event of "making a sandwich"?
- There is very little indication of the means by which the mental and physical are supposed to interact (Fodor 1981).

The Mind-Body Problem

- Humans have (or seem to have) both physical properties and mental properties.
- Physical Properties: size, weight, shape, colour, motion through space and time, etc.
- Mental Properties: consciousness (including perceptual experience, emotional experience, and much else), intentionality (including beliefs, desires, and much else)
- The mind-body problem concerns the relationship between these two sets of properties.

The Mind-Body Problem

- The mind-body problem is the problem: what is the relationship between mind and body?
- Or alternatively: what is the relationship between mental properties and physical properties?

The Mind-Body Problem

The mind-body problem breaks down into a number of components.

1. The ontological question: what are mental states and what are physical states? Is one class a subclass of the other, so that all mental states are physical, or vice versa? Or are mental states and physical states entirely distinct?
2. The causal question: do physical states influence mental states? Do mental states influence physical states? If so, how?

The Mind-Body Problem

The mind-body problem breaks down into a number of components.

3. The problem of consciousness: what is consciousness? How is it related to the brain and the body?
4. The problem of intentionality: what is intentionality? How is it related to the brain and the body?
5. The problem of the self: what is the self? How is it related to the brain and the body?

"Physical" and the "Mental"

- However, it is quite possible to discuss mental states and processes in the absence of any discussion of physical states and processes.
- In other words, it should be possible to posit that the mind is an abstract entity, with the only implication being that it can be discussed and defined without reference to the physical states and processes. (the basic assumption of cognitive psychology)
- from this perspective, cognitive psychologists are not so concerned with the physical states and processes that take place between the ears. They are more concerned with what mental states and processes might be like in their own right.

An Important Question

- Can science, which is concerned with the physical nature of the world, help us understand the nature of the mind, which essentially is non-physical?
- What methods could be applied to study the mind?
- Psychologists attempt to understand human behavior and assume that a large component of this understanding requires the detailing of how the mind works. (Steven Pinker, "How the Mind Works")

Outline

Behaviorism: An Alternative Account

- Behaviorism, is the view that a true science of psychology strives to achieve a description of human nature in terms of laws of behavior.
- We must strive to generate laws of behavior in terms of physical events and physical processes.
- The laws will contain statements only about observable things that can be measured. Like Newton's Laws of Motion.
- The eventual theory of human behavior therefore, should contain universally established principles (laws); that should correctly predict behavior.

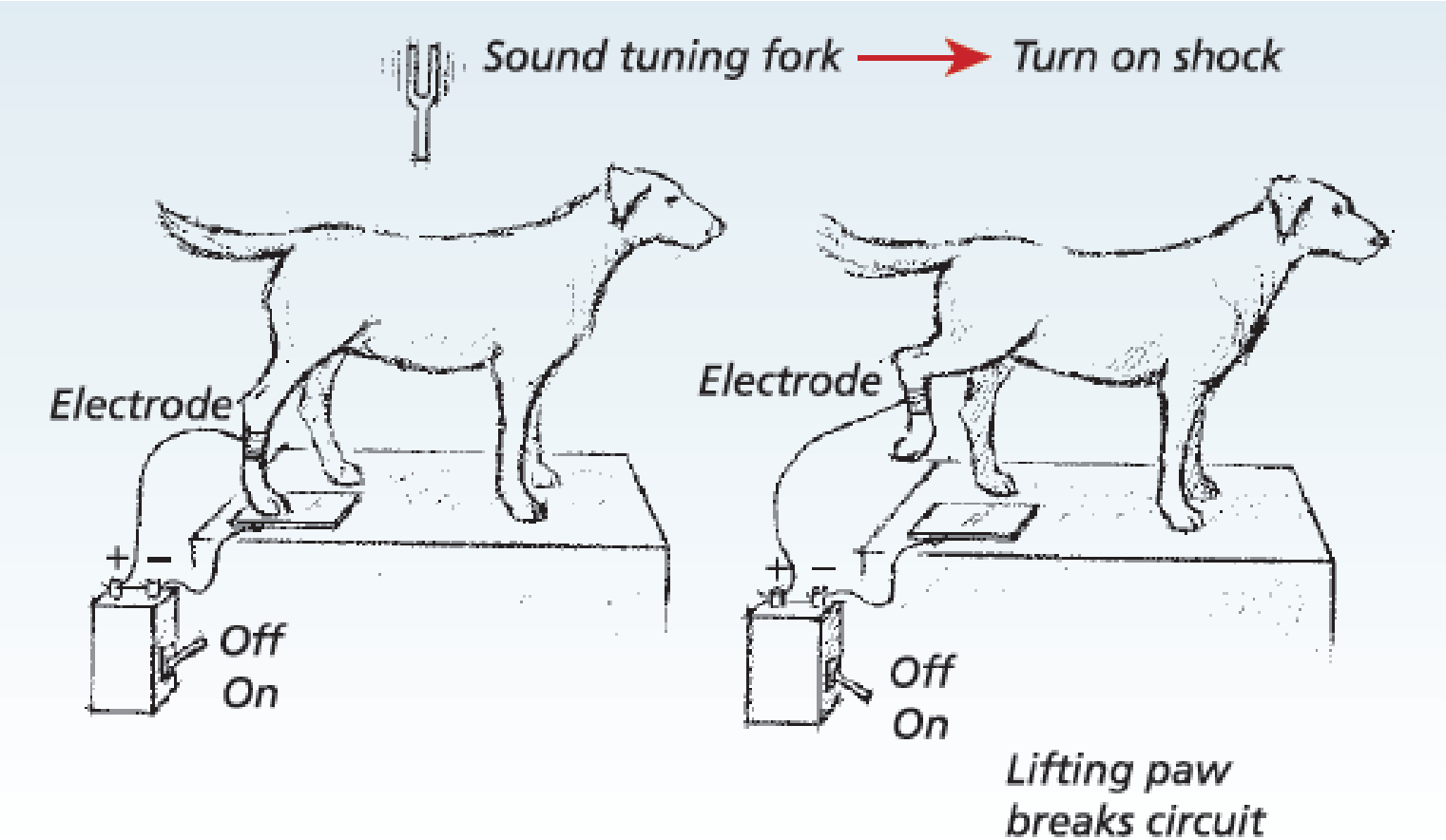
Laws of Effect

- For instance, "any given human will seek out pleasurable things over unpleasant things" and "given two outcomes, the human will choose the pleasurable option over the unpleasant one."
- The above is actually referred to as the law of effect which was proposed by Edward L. Thorndike.
- Thorndike put forward the idea that animals learn responses that result in rewarding consequences and they learn to drop responses that result in punishing consequences.
- Because, the "effect" of making a particular response was thought to govern learning.

Laws of Effect: S-R Bond

- Moving further with this assumption, one could posit associations between stimuli and their contingent responses, and discuss whether these associations could be strengthened or weakened.
- Strengthening a S-R bond implies that the tendency to make a particular R increases for a particular S.
- Weakening a S-R bond implies that the tendency to make a particular R decreases for a particular S.

The Law of Effect in Practice



Other Laws

- Under principle of associationism contingent reward or punishment does not play a necessary role.
- For example the strength of a particular S-R bond is found to be directly related to the frequency with which S and R co-occur.
- Further, the association between S and R will also reflect how closely S and R have co-occurred in the past, i.e. recency.
- For axample: how frequently a criminal is punished for a crime and also how quickly.

Learning

- So, useful learning can take place from being able to register the contiguity (i.e. closeness in time and space) and the frequency of co-occurrence of stimuli and responses.
- Learning depends on the ability to register the co-variation of stimuli and their corresponding responses.
- Hume's skepticism of causation

Problem of Behaviorism

- Applying the principles of associationism, the behaviorists had hoped to show that behavior could be predicted and controlled.
- Animal experiments were conducted in large numbers in controlled environments and their behaviors were predicted on knowing the previous history of reinforcement and by applying the laws of behavior.
- The ultimate goal was to extrapolate the results of these experiments to the whole of human society and hence provide a theoretical framework for explaining and understanding human behavior (Skinner, 1985)

Problem of Behaviorism

- Note that, mind as an explanatory concept for behavior was deliberately avoided.
- An implication of the behaviorist research programme was that animals and even humans are considered nothing more than machines.
- The point being conveyed is that, according to behaviorism, human behavior is seen to be described in terms of a deterministic system whereby certain stimuli cause certain responses.

Problem of Behaviorism

- So, as with any other machine, as long as we can identify the physical antecedents to some form of behavior, we can then claim to understand the causes of that behavior.
- In other words, behavior is fully determined by physical antecedents.
- Such an account is in line with all the other scientific theories of the world: i.e. objects and events are linked by certain causal relations, and future actions can be predicted perfectly by the occurrence of their causal antecedents.

Problem of Behaviorism

- John Searle (1994, page 33) Methodological Behaviourism.
- In behaviourism, there is no room of free will as their aim is to provide an account of human behavior that avoids any mention of decision making or choice.
- Behaviourists limit themselves to describing behavior solely in term of deterministic principles.

Outline

The Cognitivist View

- The cognitivist view assumes that there is an abstract entity called the mind and that is composed of mental states and mental processes.
- The goal of psychology is concerned with exploring the nature of these mental states and processes.
- Cognitive Psychology may be defined as the study of mind, to the extent that we can generate testable statements about these abstract entities.

The Cognitivist View: Methodology

- We operate within a framework where we make certain assumptions about the subject of inquiry, and on the basis of these assumptions we generate certain hypotheses that result in testable predictions.
- Importantly though, for our science to work properly we must attempt to generate falsifiable theories.

The Cognitivist View: Methodology

- For example, in designing a new aircraft, one needs to test the safety of the aircraft in order to evaluate performance and safety standards.
- It would be foolish to only test the aircraft on a clear, sunny day; when the chances of failure are anyways minimal.
- We would like to test the aircraft in the hardest of flying conditions, in order to be sure about the safety standards of the design.

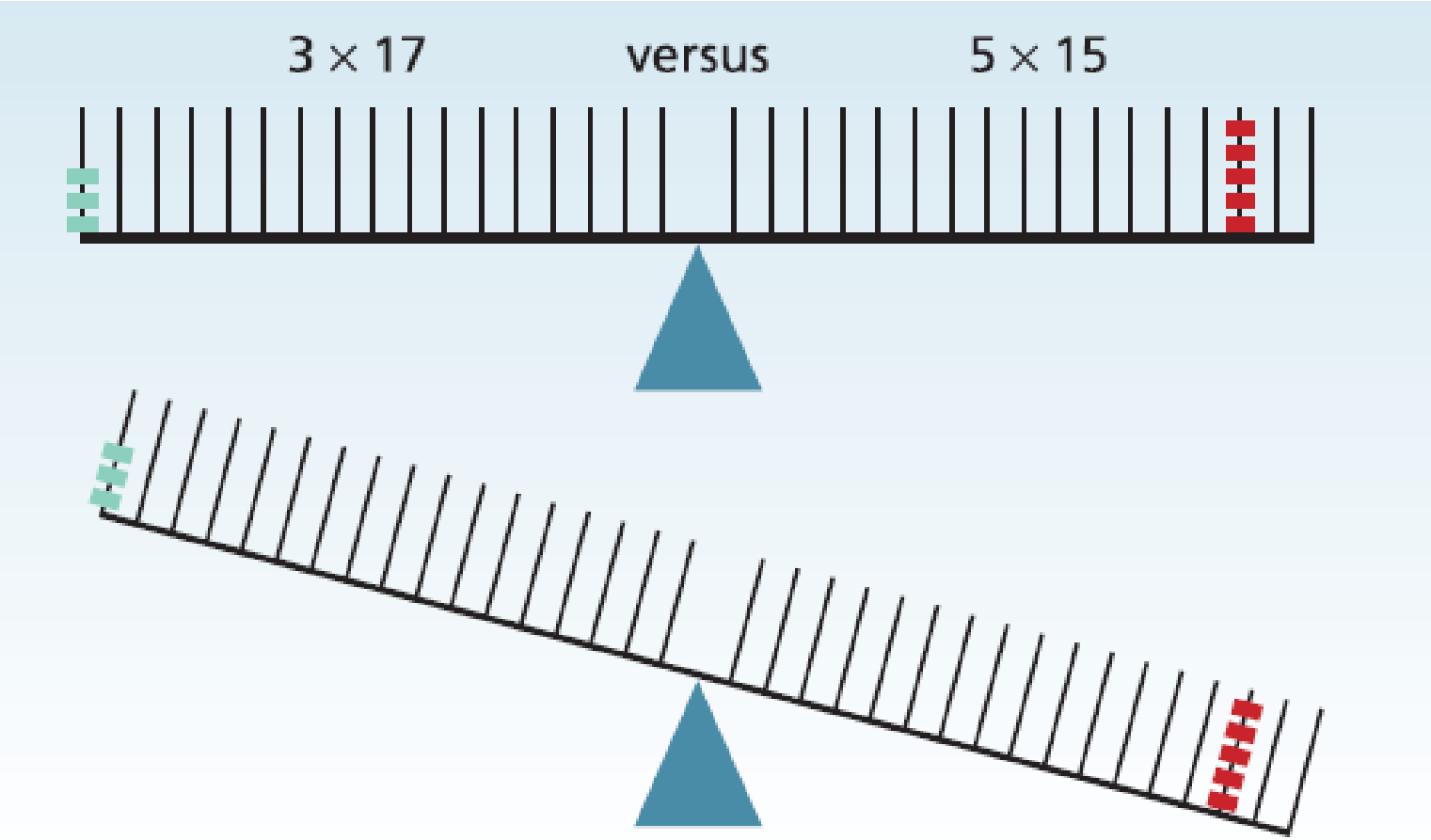
The Cognitivist View: Methodology

- Cognitive Psychologists are allowed to posit abstract entities on the assumption that they can be tested in a scientific way.
- Theories in cognitive psychology, must be testable, refutable, and falsifiable.
- Further, theories in cognitive psychology also should be extremely simple or parsimonious.

The Cognitivist View: An Example

- Mental arithmetic, i.e. a set of numerical operations that are carried out in the mind. e.g. compare (15×5) with (17×3).
- Although we differ in our abilities to carry out mental arithmetic, from a cognitive perspective it seems fairly reasonable to assume that this ability depends upon mental representations (of numbers) and mental processes (for calculations).
- Whether the cognitive explanation is necessary to postulate mental operations? What about a physical device?
- In order to understand this, we have to look at the fundamental question of the science of mind: how are the mind (abstract) and the brain (physical) related?

The Cognitivist View: An Example



Central State Identity Theory

- Our mental lives are intimately connected with the things that go on in our brains. e.g. brain damage results in deleterious effects on aspects of cognition and behavior.
- Various attempts have been made to explore the mapping between mental events (e.g. thinking of a Burger) and neurological events (such as neuron assemblies firing).
- The assumption is that the two are related, it's the mechanisms and processes that are still under investigation.

Central State Identity Theory

- The central identity theory therefore forms the foundation of all current work in human neuroscience/cognitive neuroscience.
- Type identity theory: each type of mental event maps onto a different type of neurological event; e.g. remembering to perform task X maps onto a pattern of nerve cells firing and choosing not to perform the task X maps onto a pattern of B nerve cells firing.

Central State Identity Theory: An Example

- If you hurt yourself (say hitting the door with one of your toes).
- The defining element of pain will be the sensation of hurting.
- Something peculiar with pain is that is not merely a sensation but also a matter of perception/subjective experience.
- So the problem with identity theory is that it seems to force different things to be the same, so there is the feeling of pain (a mental event) and there is this pattern of nerve cell firing (which is a physical event).

The Different Brains Problem

Consider the following example:

- Johns thinks it might rain, nerve cells A, B, C, and D fire.
- Smith's brain is different from John's brain and hence when Smith thinks it might rain, nerve cells E, F, G and H fire.

Both men are entertaining the same thought, but different cells are firing in the different brains.

Central State Identity Theory

- Token identity theory asserts that mental events correspond with neurological event, but there is an acceptance that there may well be a variety of neurological events that may underlie each mental event.
- Hence, it is quite acceptable that the firings of nerve cells A, B, C, D and also E, F, G, H may separately correspond to the same thought in different brains.
- As it stands, it is token identity theory's brand of materialism that provides the foundations for all kinds of work in cognitive neuroscience.

Outline

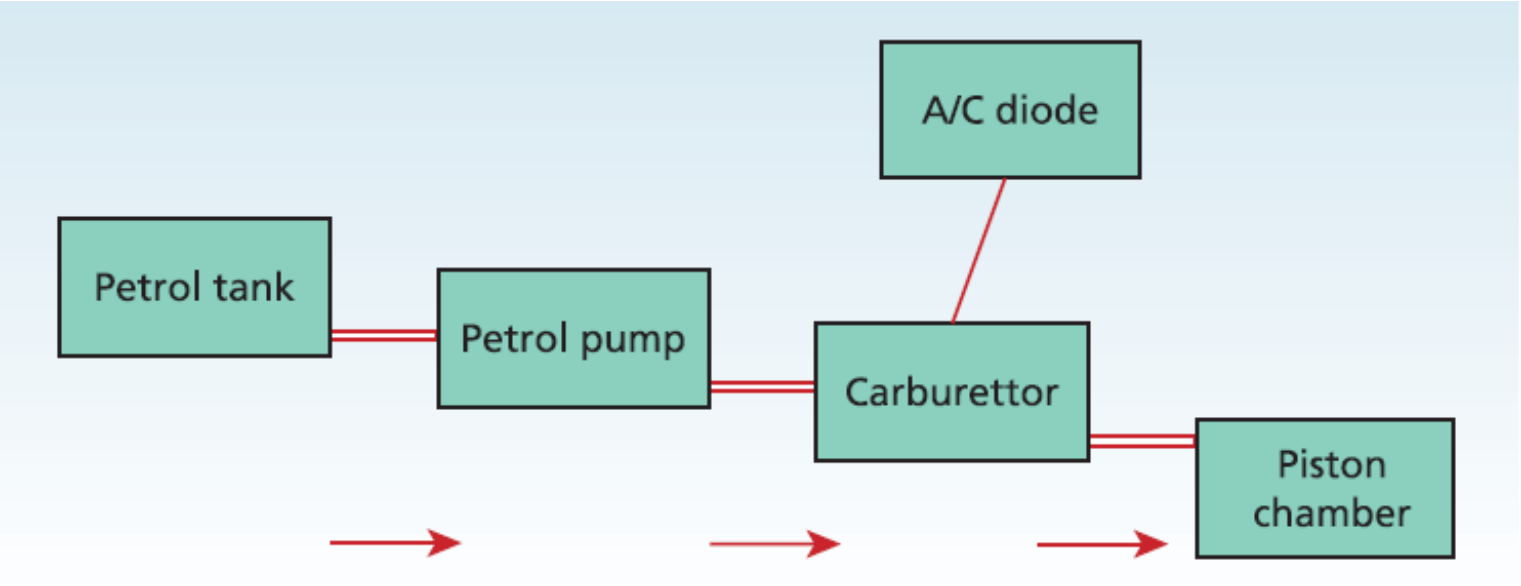
Function and Functional Roles

- Function, could be the purpose of anything.
- As the function of the umbrella or the chalk or the board etc.
- So, the structure of something could be different from its function: i.e. what is the physical make-up and what it does.

Example: A Car Engine

- We could offer a functional description of the engine by specifying what the purpose of each component is.
- The assumption is that to attain a full understanding of the workings of a car's engine we need to have:
  1. a description of the structure of its components
  2. a specification of how these are interconnected
  3. a complete description of the functional role of each component
- Such a description allows us to discuss each of the individual components in the abstract, i.e. without commitment to any particular physical entity.

Example: A Car Engine



Functionalism

- It is now possible to see how two different brain states may underlie the same mental state - as long as the two neurophysiological states serve the same functional role, then they capture the same mental state.
- Mental state x is defined purely in terms of its function.
- This view is called functionalism.
- Function is now defined in terms of causation - the mental state x has a particular function insofar as it leads to the same consequences, be these new mental states or some form of behavior.

Functionalism

- E.g. Anne thought it was going to rain and remembered that she had left her ketchen window open. She would go to close it.
- Here, mental state x caused mental state y and results in action/behavior z.

Functionalism

- The cognitivist view of mind and behavior allows the assumption of abstract mental events as theoretical basis of human behavior.
- Further, it stresses on generation of scientifically testable assumptions which can explain human behavior in a scientific, though simple manner.
- Further, it takes the functional description of mental states.

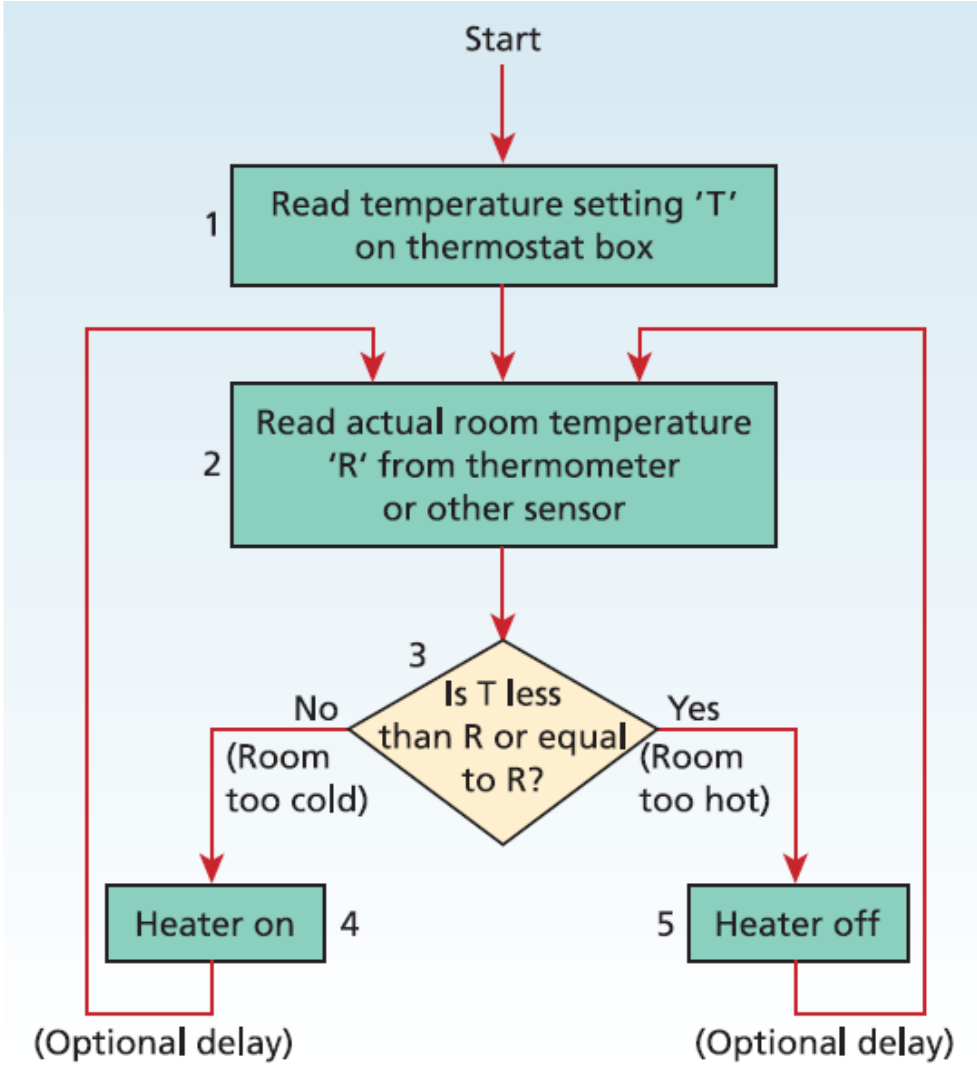
The Hardware/Software Analogy

- Hardware refers to any physical device that is either a computer itself or a peripheral that may be linked up to a computer (e.g. printer)
- software refers to the programs that run on the computer.
- We know that the computer is a physical device but its programs are abstract.
- So we talk about the software without reference to the physical hardware involved in the computer.

The Hardware/Software Analogy

- By adopting such a functional approach, we can argue that, by analogy, "The mind is to the brain as the program is to the hardware." (Searle, 1994)
- So, cognitive psychologists endeavor to understand the programs that collectively make up the mental activity: they essentially deal with flowcharts of the mind.

Example: Thermostat



The Hardware/Software Analogy

- while the flow chart gives us an idea of functional parameters of a thermostats, it needs to be supplemented with the knowledge of actual physical components to actually be able to build a thermostat.
- The problem is more complex when you consider human cognition: we already have our device ready (the brain) and we are trying to figure out just what is going on.
- So, we do reverse engineering, i.e. we are trying to understand how the workings of the brain underpin the mind.

The Hardware/Software Analogy

- Big Jigsaw Solving Enterprise = Cognitive Psychology!
- By analogy, the mental entities including mental states, representations and processes seem akin to computer states,
- hence, we have the mental software analogy, or the idea that the brain be characterized as an information processing system.

Reductionism

- If we accept some version of the central state identity theory, then we are accepting that mental states and processes are nothing other than neural states and processes.
- According to reductionists, understanding the human mind can be reduced to understanding the basic electrochemical states and processes that characterizes the behavior of neurons.
- So if we understand these physical states and processes, we understand the mind.

Reductionism

- Another version of reductionism is known as eliminative materialism.
- Churchland (1984) states that once we have a full understanding of the behavior of neurons in terms of basic electrochemical principles, we can then eliminate any mention of any other level of description from our science.
- Maybe we can get rid of the mind after all?

Reductionism

- Even if one has a complete account of the nature and operation of neurons, this is a completely different level of explanation that what cognitive psychologists are actually concerned with.
- Cognitive psychologists are interested in uncovering the functional architecture of the mental components that constitute the mind (the flowcharts) and in this regard the properties of neurons are of little help.

Reference

- Philip Quinlan and Ben Dyson. (2008) *Cognitive Psychology*, Pearson Education Limited.