Studying Cognition

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Converging Evidence for Dissociations and Associations

similarity and difference between two mental acts

Behavioral Methods

Correlational Neural Methods: The Importance of Localization

Causal Neural Methods

Modeling

Neural-Network Models

Behavioral Methods

A behavioral method measures directly observable behavior such as the time to respond or the accuracy of a response. Researchers attempt to draw inferences about internal representation and processing from such directly observable responses.

Major Behavioral Measures and Methods Used in Cognitive Psychology

Measure or Method	Example	Advantages	Limitations
Accuracy (percent correct or percent error)	Memory recall, such as trying to remember the main job requirements during an interview	Objective measure of processing effectiveness	Ceiling effects (no differences because the task is too easy); floor effects (no differences because the task is too hard); speed–accuracy trade-off ("jumping the gun")
Response time	Time to answer a specific question, such as whether you know the requirements of a certain job	Objective and subtle measure of processing, including unconscious processing	Sensitive to experimental expectancy effects and to effects of task demands; speed-accuracy trade-off
Judgments	Rating on a seven-point scale how successful you felt an interview was	Can assess subjective reactions; easy and inexpensive to collect	Participant may not know how to use the scale; may not have conscious access to the information; may not be honest
Protocol collection (speaking aloud one's thoughts about a problem)	Talking through the pros and cons of various job possibilities	Can reveal a sequence of processing steps	Cannot be used for most cognitive processes, which occur unconsciously and in a fraction of a second

Correlational Neural Methods: The Importance of Localization

Cognitive psychology has become extraordinarily exciting during the past decade because researchers have developed relatively inexpensive, high-quality methods for assessing how the human brain functions. These methods are ***correlational***: although they reveal the pattern of brain activity that accompanies information processing, they do not show that activation in specific brain areas actually results in the task's being carried out.

Correlation does not necessarily imply causation.

Correlational Neuroimaging Methods

Method	Example	Spatial Resolution	Temporal Resolution	Invasiveness	Cost (Initial; Use)
Electrical (electroencephalography, EEG; event-related potentials, ERP)	Track stages of sleep (EEG), brain response to novelty (ERP)	Poor (perhaps 1 inch)	Excellent (milliseconds)	Low	Low purchase cost; low use cost
Magnetoencephalography (MEG)	Detect activity in auditory cortex to tones of different pitches	Good (under 1 centimeter), but only in sulci, not in gyri (because of the way dendrites line up)	Excellent (milliseconds)	Low	High purchase cost (and needs a special magnetically shielded room); medium use cost (needs servicing so superconductors remain extremely cold)
Positron emission tomography (PET)	Detect activity in language areas as participants speak	Good (about 1 centimeter, but in theory higher)	Poor (an image every 40 seconds)	High (must introduce radiation)	High purchase cost (needs a cyclotron plus the PET camera); high use cost (about $2,000 per participant)
Magnetic resonance imaging (MRI) and functional magnetic resonance imaging (fMRI)	Show structure of the brain (for MRI), show activity in brain areas, same as PET (for fMRI)	Superb (millimeter range); fMRI often about 0.5 centimeter	Depends on level of resolution; typically several seconds	Low	High purchase cost (needs a specially shielded room); medium use cost (needs servicing)
Optical imaging	Show activity in brain areas, same as PET	Poor at present (about 2 centimeters)	Depends on level of resolution; typically several minutes	Medium/low (light is shined through the skull)	Low purchase cost; low use cost

Causal Neural Methods

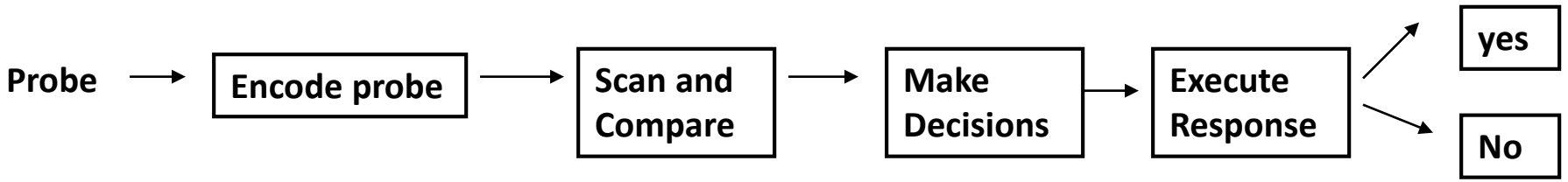
Causal Neural Methods Used in Cognitive Psychology

Method	Example	Advantages	Limitations
Neuropsychological studies (of patients with localized or diffuse brain damage)	Examine deficit in understanding nouns but not verbs	Tests theories of causal role of specific brain areas; tests theories of shared and distinct processing used in different tasks; relatively easy and inexpensive to collect	Damage is often not limited to one area; patients may have many deficits
Transcranial magnetic stimulation (TMS)	Temporarily disrupt occipital lobe and show that this has the same effects on visual perception and on visual mental imagery	Same as for neuropsychological studies, but the transient "lesion" is more restricted, and the participant can be tested before and after TMS	Can be used only for brain areas near the surface (TMS affects only tissue about 1 inch down)
Drugs that affect specific brain systems	Disrupt the action of noradrenaline, which is crucial for the operation of the hippocampus	Can alter the processing of specific brain systems; typically is reversible; can be tested in advance with animals	Many drugs affect many different brain systems; the temporal resolution may be very poor

Modeling

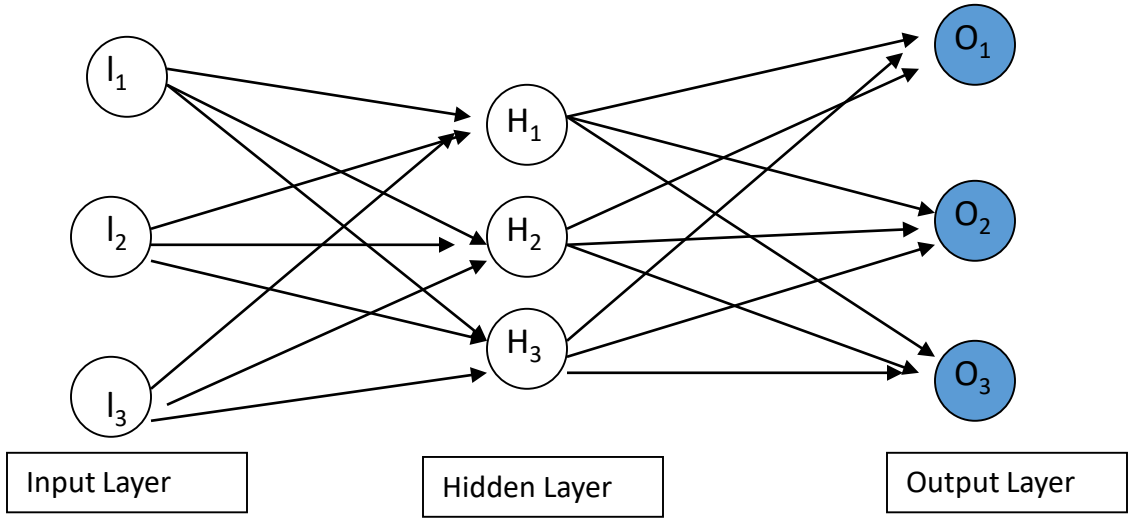
In psychology models are often implemented as computer programs which are meant to mimic the underlying mental representations and processes that produce specific types of human performance

1) ***Process Models*** **-** *specify a sequence of processes that convert an input to an output. Such models can be illustrated by using flow charts (for e.g.,)*



Modeling

2) Neural Network Models – *rely on sets of interconnected units each of which is intended to correspond to a neuron or to a small group of neurons. Units are not same as neuron but rather they specify the input-output process group of neuron perform (for e.g.)*



A Simple Feed-Forward Neural Network Model