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Cognitive Neuroscience Case Study
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Overview

Cognitive Neuroscience is a globally active scientific field specifically concerned with identifying and studying the neural connections in the human brain involved in mental processes underlying consciousness and cognition[1]. Individual researchers and research units conduct experiments through universities or private institutions, investigating specific domains within the field ranging from human sensory perception to the biological mechanisms of learning and memory. Notable contributions from the field include the localization and functional implications of cortical regions responsible for sensory motor initiation, facial recognition, and speech production, allowing for both improved medical treatments and advances in understanding human cognition.

The organization of Cognitive Neuroscience principally partitions cognition and consciousness into discrete functional and operational research domains. Organization of training, investigation, and other assets is connected with each domain, supporting both broad and specific interactions such as paring similar research paradigms with facilities and participants to allow for efficient investigation.

What

Consciousness is the resource, and is organized by the domain or specific modality of cognition. It is organized based on the type of modality to support focused interactions between researchers, subjects, and methodologies. This organization supports requirements of interactions on the part of researchers in terms of machinery, lab equipment, faculty, access to subjects or data, and other necessities for particular investigations. Individual research units and resources are further organized by institutional affiliation, organizing availability to resources, lab memberships, tenures, funding allocation, and the extent at which the system is partitioned to effectively investigate consciousness.

How Much

Cognition is partitioned into many broad disciplines of conscious experience including perception, attention, learning and memory, language, decision-making and emotion.
The individual disciplines are further subdivided into more specific lines of investigation within each field. “Perception” can be broken down into subcategories of “vision,” “audition,” and “somatosensation,” which too can be further subdivided, placing “speech recognition” and “pitch detection” as distinct subordinate fields within the subcategory of “audition”. This partitioning applies to all domains within Cognitive Neuroscience, allowing for thorough work from

[1] About CNS. (2015). Retrieved April 25, 2018, from https://www.cogneurosociety.org/background/

specialized researchers without sacrificing the field's global efficiency due to broad domain distributions of these specializations.

This categorization is implemented through research groups at universities or institutions, where individual labs investigate a discrete domain. In this system "vision" research using fMRI and ECoG methods on clinical patients, and "emotive" research conducted with behavioral and EEG assays on volunteers are partitioned into entirely separate labs, instantiating this categorization. Individual project investigators, PhD students, and postdocs within labs further partition interactions between resources, researchers, subjects, equipment, and materials, in which one PhD student may be concerned with only "EEG" methods while a postdoc may be investigating clinical populations.

An alternative principle of this organization is seen with clinical patients able to participate in research, in which case researchers and paradigms are organized based upon methodology and procedures the patient can undergo rather than by what the researchers are investigating. For example, a patient with intracranial electrodes placed in a few cortical regions of interest would participate in "emotive," "attentional," and a visual "facial recognition" paradigms. Organizing resource interaction with these patients is thus modified, as their availability is limited and because their participation can provide a unique opportunity for researchers from all domains to obtain valuable data.

Why

All scientific disciplines follow some pattern of organization to support thorough investigation of questions within the field, safe and HIPPA compliant subject interaction, advanced training and development of scientists, and facility and material procurement and management. Cognitive Neuroscience follows these principles to allow for efficient resource interaction. Relevant placement of researchers within labs grants access to the tools, facilities, and methodologies necessary for their work with relevant subject populations. Wide spanning lab affiliations allow for interoperability between researchers and their findings, allowing both personnel and information to travel between locations, giving access to otherwise unavailable tools, data and subject populations.

Cognitive Neuroscience's organization supports the investigation of human cognition, which is central to understanding the scientific basis of human consciousness. PhD students enter labs investigating a topic of their interest, and are trained in the skills and methodologies required to further investigate the field. These students then contribute their findings to the larger body of work comprising the field. Project investigators and advisors oversee the PhD students who they accept into their labs, to train and guide the students in the lab's area of expertise. This organization creates a mechanism for conducting and furthering the mission of Cognitive Neuroscience as a field.

How or by Whom

The organization of Cognitive Neuroscience began as a consequence of loss of function discoveries in both humans and animals over the span on centuries, now combining biological, psychological, and philosophical definitions and facets of cognition. Cases of brain damage, like those of Phineas Gage and Henry Molaison, along with direct studies of cortical systems, like Hubel and Wiesel's discovery of edge detectors in visual cortex, contributed to the current broad organizational system of distributed functionality [2] [3]. This biologically observed distribution of cognitive components across cortex and the brain provides the basis of categorization that is instantiated by the individual domains of study within Cognitive Neuroscience.

Individual Labs interested in investigating a particular cognitive category, say attention, ask specific questions about this category. These questions by the researchers will involve specific cortical regions of interest, which in turn require specific tools, such as functional magnetic resonance imaging (fMRI), electrocorticography(ECoG), or electroencephalography (EEG) to answer their questions about this cognitive category. This creates a partitioning that facilitates the hierarchical organization system of the field, as cognitive features become domains of study based on modality, subtended by the specificity of research questions, the instruments required to answer the questions, and the necessary participant population for conducting these experiments.

Other Considerations

The organization of Cognitive Neuroscience allows for modularized investigation into what constitutes human consciousness, but is not without apparent biases and tradeoffs. A major tradeoff and limitation to the organization system is in obtaining a big picture understanding of cognition. The compartmentalized structure allows for very detailed and thorough investigation into each specific domain, but does a poor job of facilitating global integration of the information between categories, and often creates structural limitations to cross-domain interactions. Cross domain questions in the field are difficult investigations to begin with, and experiments doing so run into issues of obtaining appropriate participant populations, necessary instrumentation, and other features to facilitate this type of resource interaction. Additionally, researchers rarely have multi-domain expertise because of the category specific training within the field.

The bias can be seen with the overrepresented of certain domains. The subcategories of decision making, vision, and language are each investigated in an equal capacity to their entire parent domain. The reasons for this are many, including more information about and better scientific understanding of certain systems compared to others, more direct translation of research results to industry applications, or their necessity to the advancement of medical treatment.

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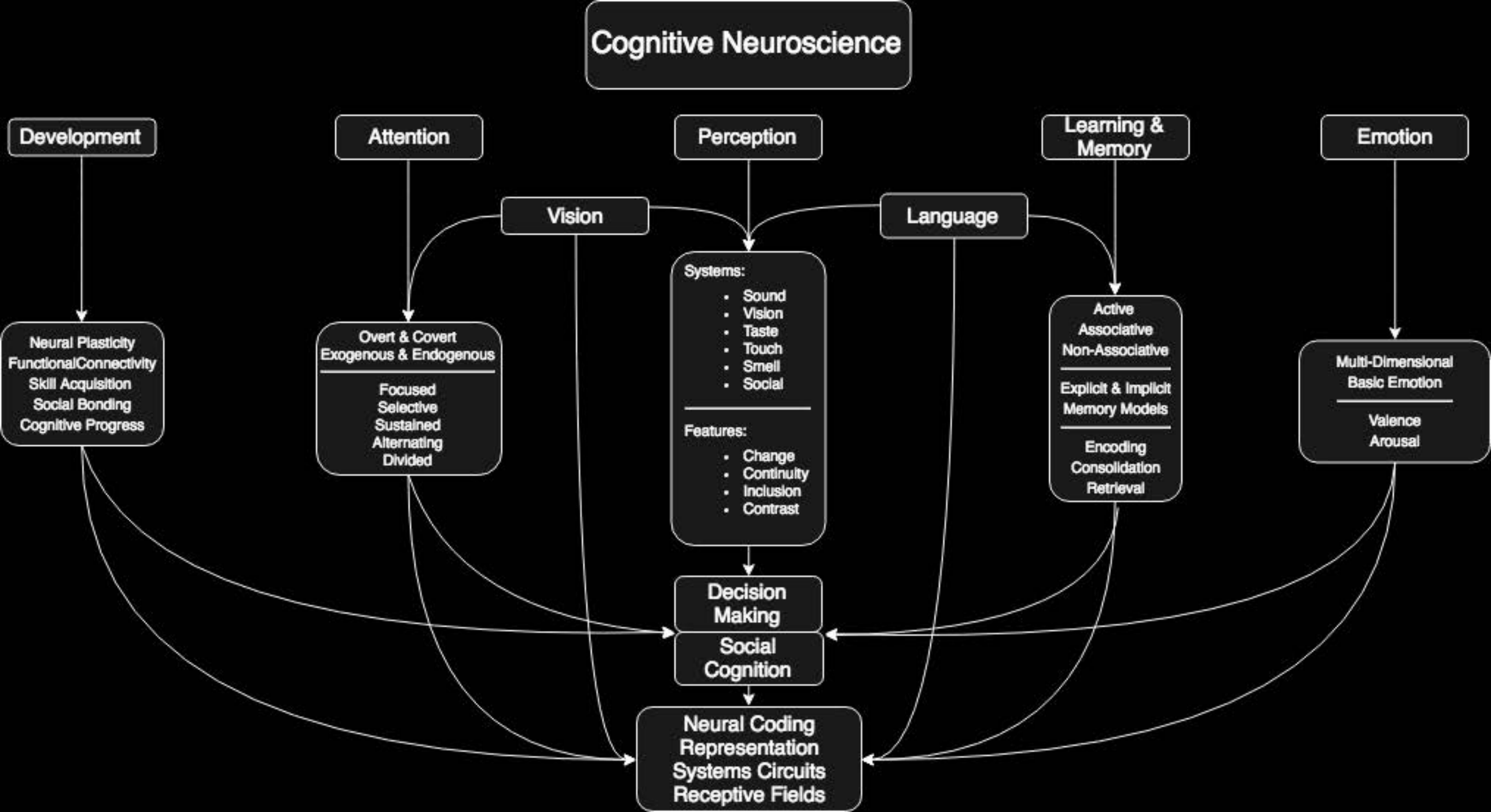
[2] Damasio, et al. "The Return of Phineas Gage: Clues about the Brain from the Skull of a Famous Patient." *Science*, American Association for the Advancement of Science, 20 May 1994

[3] Wurtz, R. H. (2009). Recounting the impact of Hubel and Wiesel. *The Journal of Physiology*, *587*(Pt 12), 2817–2823.


Cognitive Neuroscience
Development
Attention
Perception
Learning & Memory
Emotion
Vision
Language
Neural Plasticity
FunctionalConnectivity
Skill Acquisition
Social Bonding
Cognitive Progress
Overt & Covert
Exogenous & Endogenous
Focused
Selective
Sustained
Alternating
Divided
Systems:
Sound
Vision
Taste
Touch
Smell
Social
Features:
Change
Continuity
Inclusion
Contrast
Active
Associative
Non-Associative
Explicit & Implicit
Memory Models
Encoding
Consolidation
Retrieval
Multi-Dimensional
Basic Emotion
Valence
Arousal
Decision Making
Social Cognition
Neural Coding
Representation
Systems Circuits
Receptive Fields