Topic: Semantic Memory

Semantic memory is knowledge that is not specific to any one episode in time. It forms the basis for many of our “System 1” automatic decisions without reflection.

Article Discussed

Binder, J. R., & Desai, R. H. (2011). The neurobiology of semantic memory. *Trends in Cognitive Sciences*, *15*(11), 527–536. https://doi.org/10.1016/j.tics.2011.10.001

Brief Summary

The article for this week was about neurocognitive disorders and semantic memory issues that occurred from them. It discusses the organization of semantic memory, how semantic memory processes memory and how many different areas of the brain are critical for semantic memory such as the dorsomedial and inferior prefrontal cortices. Main ideas that were questioned include modality specific and the specific regions of the brain affected by the semantic memory neurocognitive disorders. The topic of this chapter discussed how people create norms (System 1) using connections and expectations from the environment and past experiences. These norms are then used with system 2 when making decisions about daily life. This topic greatly relies on familiarity and assumptions that are created in the brain.

The class discussion for the chapter went through multiple main ideas about what the definition of a norm is and the importance it has in our everyday lives. One question asked “What is an everyday example of the norm theory?” An example the class came up with of how norms affect our everyday lives given in class is the idea that 2 marvel movies will come out each year. If this changed, the student would be shocked and confused by this because it seems unnatural. The definition of a norm was a large conversation that the class discussed and it was decided that a norm is something that is expected to occur.

Another question asked was “When he states that system 2 can learn to think statistically but few people receive the training, what kind of training is he referring to?” The class discussed how the creation of norms in a particular person may be different based on if they have a more emotional or statistical mindset about the world as well as the importance of a decision (if a decision is not very impactful a person be more likely to base their decision emotionally and vice versa). The class decided that a person with a stronger system 2 is less likely to follow norms to the letter and rely on them as often, thus, they are not jumping to conclusions.

A big idea that was noted upon for a long time is how the flight or fight mode reacting to unexpecting things encodes memory. Such that things that go against our norms are more likely to stay in our long term memory. Actions that are considered surprising, traumatic, scary, or even funny go against norms and stick in memory. However, the class could not say that those three events that go against norms are all encoded equally just based on going against expectations. Overall, the class discussion was well thought out and contributed to in depth conversation about norms and how they impact our everyday life and how to overcome them.

Cognitive process neuroimaging analysis

PubMed Top 5 Articles

1: Tonetti L, Natale V. Effects of a single short exposure to blue light on cognitive performance.

Chronobiol Int. 2019 Mar 21:1-8. doi:10.1080/07420528.2019.1593191. [Epub ahead of print] PubMed PMID: 30897969.

2: Gustavson DE, Panizzon MS, Franz CE, Reynolds CA, Corley RP, Hewitt JK, Lyons MJ, Kremen WS, Friedman NP. Integrating verbal fluency with executive functions: Evidence from twin studies in adolescence and middle age. J Exp Psychol Gen. 2019 Mar 21. doi: 10.1037/xge0000589. [Epub ahead of print] PubMed PMID: 30896200.

3: Love MCN, Pilonieta G, Geldmacher DS. Alabama Brief Cognitive Screener: Utility of a New Cognitive Screening Instrument in a Memory Disorders Clinic. Prim Care Companion CNS Disord. 2019 Mar 14;21(2). pii: 18m02336. doi:10.4088/PCC.18m02336. PubMed PMID: 30896091.

4: Mak MHC. Why and how the co-occurring familiar object matters in Fast Mapping (FM)? Insights from computational models. Cogn Neurosci. 2019 Mar 21:1-3. doi:10.1080/17588928.2019.1593121. [Epub ahead of print] PubMed PMID: 30894067.

5: Horiuchi J. Recurrent loops: Incorporating prediction error and semantic/episodic theories into Drosophila associative memory models. Genes Brain Behav. 2019 Mar 19:e12567. doi: 10.1111/gbb.12567. [Epub ahead of print] Review. PubMed PMID: 30891930.

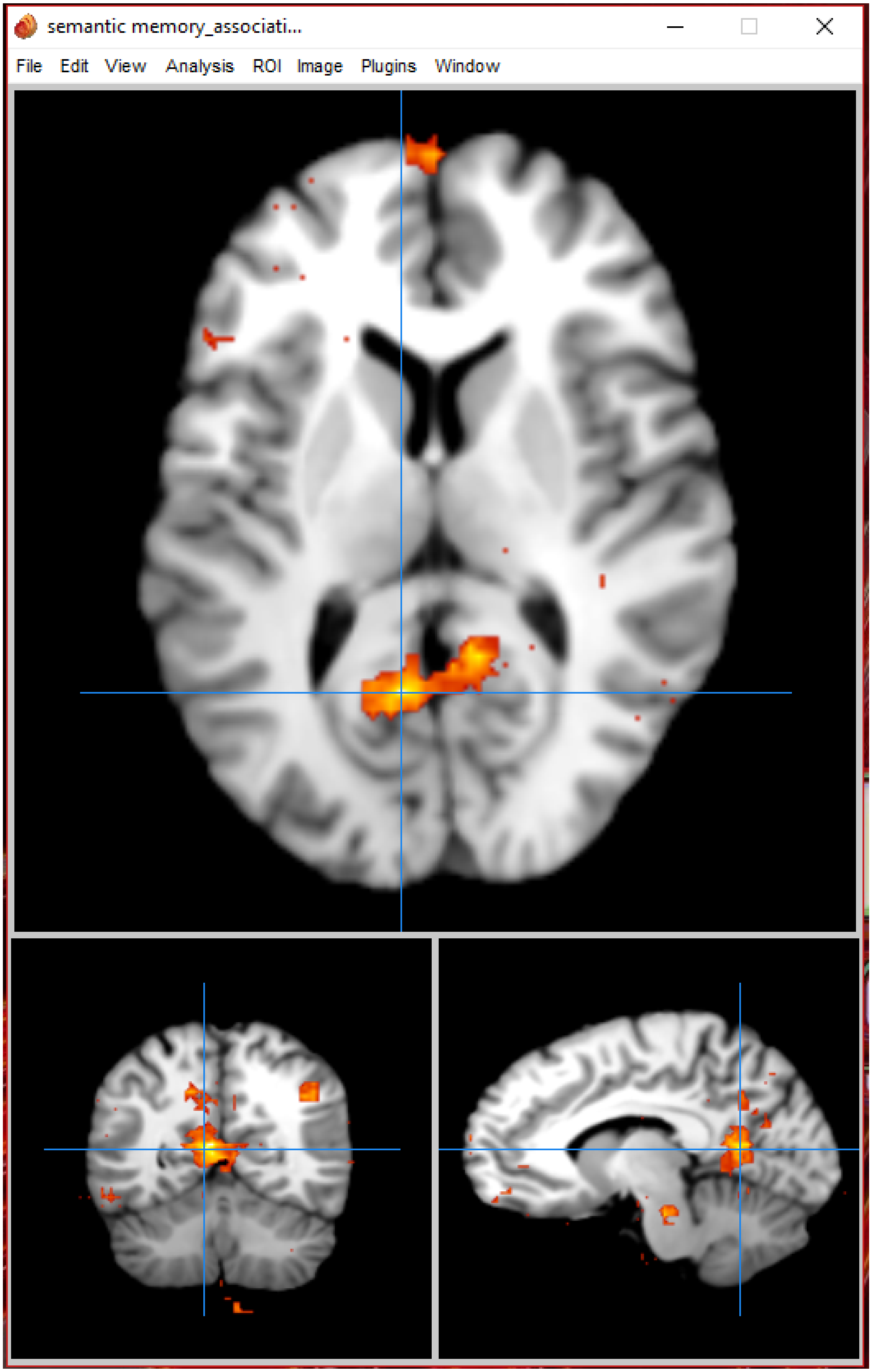
Neurosynth Top 5 Articles

Abnormal object recall and anterior cingulate overactivation correlate with formal thought disorder in schizophrenia.	Assaf M, Rivkin PR, Kuzu CH, Calhoun VD, Kraut MA, Groth KM, Yassa MA, Hart J Jr, Pearlson GD	Biological psychiatry	0.356
Neural basis for semantic memory difficulty in Alzheimer's disease: an fMRI study.	Grossman M, Koenig P, Glosser G, DeVita C, Moore P, Rhee J, Detre J, Alsop D, Gee J	Brain : a journal of neurology	0.3
Interactive effects of physical activity and APOE-epsilon4 on BOLD semantic memory activation in healthy elders.	Smith JC, Nielson KA, Woodard JL, Seidenberg M, Durgerian S, Antuono P, Butts AM, Hantke NC, Lancaster MA, Rao SM	NeuroImage	0.29
Hippocampal activation during retrieval of spatial context from episodic and semantic memory.	Hoscheidt SM, Nadel L, Payne J, Ryan L	Behavioural brain research	0.277
Specific role of medial prefrontal cortex in retrieving recent autobiographical memories: an fMRI study of young female subjects.	Oddo S, Lux S, Weiss PH, Schwab A, Welzer H, Markowitsch HJ, Fink GR	Cortex; a journal devoted to the study of the nervous system and behavior	0.277

Brain region chosen for the term

Brain Region: Retrosplenial cortex

Coordinates (-8,-56,10)


semantic memory_associati...
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Neurosynth Coordinates Associations:

	Individual voxel	**Seed-based network**		
Name	**z-score**	**Posterior prob.**	**Func. conn. (r)**	**Meta-analytic coact. (r)**
autobiographical	10.7	0.88	0.49	0.52
episodic	9.69	0.81	0.44	0.49
posterior cingulate	9.52	0.78	0.54	0.53
episodic memory	8.49	0.81	0.37	0.42
semantic memory	8.12	0.86	0.18	0.24
retrosplenial	7.77	0.85	0.41	0.49
retrieval	7.22	0.74	0.32	0.36
memory	6.85	0.69	0.2	0.29
memory retrieval	6.73	0.8	0.28	0.32
concrete	6.58	0.85	0.06	0.13

Questions posed by the class

Background and vocabulary

Q: What does orthographic or phonological properties mean?

WelcomeSoda:

Orthography: the representation of the sounds of a language by written or printed symbols

Orthographic: of or relating to orthography

Therefore, an orthographic property is a quality of something that involves the representation of sounds of languange, probably with written words etc.

Phonology: The branch of linguistics that deals with systems of sounds (including or excluding phonetics), within a language or between different languages.

Therefore a phonological property is a quality of something that involves how language sounds

Q: What does epiphenomenal mean?

SodaOxford:

Epiphenomenal can mean two things:

1. A secondary phenomenon that results from and accompanies another
2. An additional condition or symptom in the course of a disease, not necessarily connected with the disease.

Q: What is the default mode network?

SincereZigzag:

- DMN
- A set of brain regions that typically deactivate during performance of cognitive tasks
- The DMN is detectable using task-free functional connectivity MRI and has been implicated in episodic memory processing

CoolActive:

The Default Mode Network consists of the amygdala, hippocampus, posterior cingulate cortex, and medial prefrontal cortex. It represents the mind without a mental or physical focal point, allowing us to daydream, remember, and imagine.

Q: Could someone explain what exactly modality-specific simulation is?

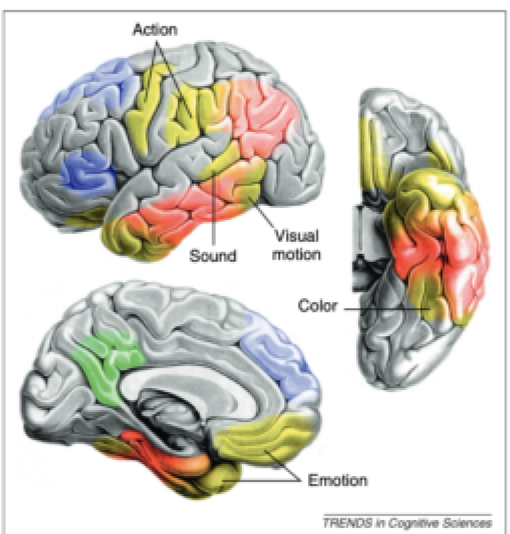
PaintLevel: Modality-specific brain areas are activated when you encounter a word that triggers the memory of something we have previously perceived via our five senses. For example, encountering the word cinnamon will stimulate the same neural pathways that are activated when you actually taste of smell cinnamon in real life because these regions are modality-specific. This is an example of modality-specific stimulation.

Q: What is the difference between general semantic and modality-specific semantic processes?

ZeroCanary: Semantic encoding is a process in which our brain processes words and converts them into a proper meaning. The article mentions a piano example. If you hear the word ‘piano’, Semantic processing on the general level will give you an image of a piano and the knowledge that it is a musical instrument_semantic. Modality-specific semantic processing is breaking down the word ‘piano’ into visual, auditory and kinesthetic specific processes. Visual, visualizing what a piano looks like; Auditory, playing the sound of a piano in your head; and Kinesthetic, visualizing playing the piano and the movements involved.

Q: Can someone explain figure 4?

AmbientBenefit: The article explains Figure 4 as “neuroanatomical model of semantic memory consistent with a broad range of available data.” Each color represents different brain regions: the yellow being modality-specific sensory **(defined in question 3)**, action and emotion systems, the red being high-level temporal and inferior parietal convergence zones (**question 7**). The blue regions are dorsomedial (*involved in sense of self and theory of mind* **- question 9**) (“Dorsomedial prefrontal cortex,” 2018) and inferior prefrontal cortices, and the green regions are the posterior cingulate gyrus and adjacent precuneus.



(From the article)

The description below the figure basically says that the yellow areas (action, visual motion, sound, color, emotions) are providing experiential input to the red regions (convergence zones), which then store abstract representations of entity/event knowledge. The blue regions control goal-directed activation and selection of the information stored in temporoparietal cortices.The green regions function as an interface between the semantic network and hippocampal memory system, and helps encodes events into episodic memory.

Convergence zones

Q: What are convergence zones?

PoloBravo:

Convergence zones when talking about the brain are areas in which information from all over the cortex come together and are input into that area to cause a function to occur. A documented example of this is the Hippocampus, which is widely known as a critical convergence zone in the brain. It is known as a funnel for information from around the brain and its vast amount of functions could be because a lot of different information is input there and the hippocampus then translates it into a function of the body.

Q: How do psychologists differentiate the roles of different regions when convergence zones exist, which seemingly mitigate roles and causality?

Theory of Mind

Q: What is “theory of mind?”

RavioliJaguar: The theory of mind helps is how an individual attributes their own mental state to oneself and others. Mental states can include but are not limited to emotions, perspectives, desires, beliefs, intentions. It helps people understand other people's thoughts and beliefs and how they might be different from their own. Researchers have delved into different areas of the brain to see if there is a particular area for "theory of mind". It has been found that the anterior paracingulate cortex, the superior temporal sulci and the temporal poles bilaterally all play a role in the function of being able to understand one's own and gauge other people's mental states.

Agent Charter:

The Theory of Mind is the idea that an individual can have mental states characterized by recognition. The theory touches on the idea that a person can understand and think critically about oneself. Empathy is tied into this idea, as well; empathy is the ability to think about other's thoughts and feelings and understand, or feel, those emotions, too, to an extent. Theory of Mind is a little different than this, however, because this theory states that the individual need not necessarily align with or experiences the same emotions as others to satisfy the definition of understanding others' emotions and feelings, Different mental disorders such as DID or schizophrenia exhibit the opposite of the ideals of Theory of Mind. These disorders are categorized by unorganized thinking and an inability recognize or think critically about oneself.

Q: How does theory of mind relate to the network in relation to social cognition?

Optiontemple: theory of mind is basically the ability to think about mental states of other people and that is very important in social cognition.

(Mason & Just, 2009)

Q: If we do have impressions of causality how would that work? That seems like something that would be learned.

Answer:

Causal Impressions are learned throughout the lifespan. We as humans rely of predicting events before they happen to survive, it is in our human nature. Hume says that it is not something that comes from our senses, but the predictions are created inside of our minds (Hume). As with all things, it is strengthened throughout the lifespan of humans, but it is a huge advantage that we have afforded to us to be able to predict events as a semi-innate ability (Young). Peter White takes a mathematical approach to explaining this, while also relating to psychology through Gestalt's idea of Common Fate (White). This says that people natural tend to view things moving together as a single object. He says that this is innate and also a way that we predict outcomes (White). Therefore, part of this phenomena is innate and the part that is learned is just improving this ability.

Bibliography:

White, P. A. (2017, March 24). Perceptual impressions of causality are affected by common fate. Retrieved from NCBI website: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6013513/

Young, M. E. (2005). Causal impressions: Predicting when, not just whether. In *Memory & Cognition*. (Excerpted from *Memory & Cognition*, 2005)

Hume and the Problem of Causation', in P. Russell (ed.), The Oxford Handbook of Hume (New York: OUP, 201)

Embodied Cognition

Q: Can we come up with an example for embodied cognition?

TwinNevada**:** The theory of embodied cognition suggests that our body is also responsible for thinking or problem solving. An example for this would be the sound of the dentist's drill might trigger a specific bodily sensation. Another example is putting your hand on a hot stove then immediately removing your hand. You move your hand away without your brain telling your hand to do so. Sensory signals could evoke positive or negative healing experiences.

Q: What is "embodied abstraction"? The provided definition on page 531 doesn't seem to make much sense.

PolarisUnique: "[T]he neuroanatomical evidence for multiple modality-specific systems gradually converging on a common semantic network suggests a process of 'embodied abstraction,' in which conceptual representation is embodied in multiple levels of abstraction from sensory, motor and affective input. The extent to which modality specific perceptual representations are activated during semantic tasks varies with concept familiarity, demand for perceptual information and degree of contextual support."

(Binder & Desai, 2011)

Q: Are there many articles demonstrating strong evidence for the strong embodiment theory?

NitroMotor: **“**At the other end of the spectrum are ‘strong embodiment’ models in which perceptual and conceptual processes are carried out by the same (perceptual) system [55,56]. These models are inconsistent with the evidence for modality- independent semantic networks reviewed above. Furthermore, conceptual deficits in patients with sensory-motor impairments, when present, tend to be subtle rather than catastrophic. In a recent study of aphasic patients [57], lesions in both sensory-motor and temporal regions were correlated with impairment in a picture-word matching task involving action words. This evidence is incompatible with a strong version of the embodiment account, in which sensory-motor regions are necessary and sufficient for conceptual representation.”

This excerpt from the article suggests that there is not strong evidence for the strong embodiment model. However, embodied cognition has recently become a popular area of interest and study. There are a few articles that discuss it and try to find scientific backing yet that still seems to be lacking. Some research says, “for the vast majority of classic findings in cognitive science, embodied cognition offers no scientifically valuable insight. In most cases, the theory has no logical connections to the phenomena, other than some trivially true ideas. Beyond classic laboratory findings, embodiment theory is also unable to adequately address the basic experiences of cognitive life.”

Brain injuries and brain regions

Q: How do semantic memory disorders impact the brain?

Answer:

First, semantic memory is the memory that helps with general knowledge, how to use those facts, and words and meanings (Matthews, 2015). When referring to semantic memory disorders, it is important to note that the most common areas of dysfunction include the anterior and inferior temporal lobe structures. One specific area that is affected is the left and right fusiform gyrus. The left fusiform gyrus affects verbal cues and the right fusiform gyrus affects nonverbal semantic knowledge (Matthews, 2015). A prime example of a semantic memory disorder is the semantic variant of primary progressive aphasia (svPPA) (Matthews, 2015). Common symptoms of semantic memory dysfunction include difficulty with words and definitions known as anomia (Matthews, 2015). In more severe cases a patients’ knowledge of everyday objects is so dysfunctional that it is detrimental to their health (eg: putting non-food objects in mouth as if food). One study also showed that people with semantic dementia had difficulty with episodic future thinking, which suggests that the two types of memory are linked (Irish, Addis, Hodges, & Piguet, 2012).

There is also evidence of semantic memory dysfunction in Alzheimer's and Lewy Body Dementia patients. Thus semantic memory disorders are also very often associated with long-term deficits, but can be independent as well (Ralph, 2001). Thus, semantic memory disorders are associated with many different memory disorders, but the most common place of deficit for semantic memory itself is in the temporal lobe.

Bibliography:

> Matthews, B. R. (2015). Memory Dysfunction: *CONTINUUM: Lifelong Learning in Neurology*, *21*, 613–626. https://doi.org/10.1212/01.CON.0000466656.59413.29
>
> Irish, M., Addis, D. R., Hodges, J. R., & Piguet, O. (2012). Considering the role of semantic memory in episodic future thinking: evidence from semantic dementia. *Brain*, *135*(7), 2178–2191. https://doi.org/10.1093/brain/aws119
>
> Ralph, M. A. L. (2001). Semantic memory is impaired in both dementia with Lewy bodies and dementia of Alzheimer's type: a comparative neuropsychological study and literature review. *Journal of Neurology, Neurosurgery & Psychiatry*, *70*(2), 149–156.

https://doi.org/10.1136/jnnp.70.2.149

Q: What is semantic dementia? And, what are some of its symptoms?

MileImport:

Semantic dementia is also known as svPPA

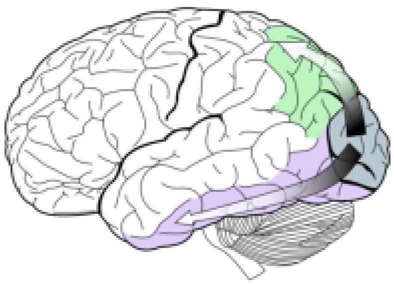
"People with semantic variant (svPPA) have increasing trouble understanding the meaning of words, finding words or naming people and objects. As time goes on, people with svPPA begin to use more general names for specific things. For example, they might say "animal" instead of "dog." As their word comprehension gets worse, they may eventually have a hard time understanding conversations."

"This form of dementia is distinct from that of Alzheimer's disease and is assumed to represent a form of circumscribed cerebral atrophy with emphasis of pathology in temporal rather than frontal regions of the brain."

TelecomElegant:

Additionally, svPPA is thought to be caused by the accumulation of TDP-43 (a protein) in the left temporal lobe ("Semantic Variant Primary Progressive Aphasia," n.d.). Over time, as more and more accumulates in this region of the brain, the brain cells die resulting in loss of brain matter and thus semantic dementia ("Semantic Variant Primary Progressive Aphasia," n.d.). This is likely why svPPa begins to appear in people 50-60 years old as it takes time for the protein to accumulate and cause noticeable damage (“Semantic Variant Primary Progressive Aphasia,” n.d.).

Q: How does trauma/brain injury affect the convergences of the perceptual processing streams mentioned in the article?



ShelfOpus:

This is a picture representing the perceptual processing streams. The dorsal stream (green) and ventral stream (purple) are shown. They originate from a common source in the visual cortex. It represents the neural processing of vision and hearing. The role of the ventral stream is object and visual identification and recognition whereas the dorsal stream takes part in spatial location of objects and speech repetition. Damage to the posterior parietal cortex can lead to spatial disorders. Some of these include Akinetopsia which is the inability to perceive motion, Hemispatial neglect where the patient in unable to perceive objects in one field of view and Simultanagnosia where the patient is unable to recognize singular objects within the context of others (for example, trees within a forest).

Q: Could the patients with damage to the inferior and lateral temporal lobe have damage to their what ventral steam in the temporal lobe?

DivideSegment:

The inferior temporal lobe is what controls visual recognition and therefore damage to it would cause damage to the ventral stream. However the inferior temporal cortex consists of area TE and the rhinal cortex, the TE located at the end of the ventral stream, lesion to this area cause object agnosia and change in behavior that depends of rewards.

Q: Do certain neurocognitive disorders get in the way of semantic memory?

VideoSport:

There are many neurocognitive disorders related to semantic memory deficits. Many articles seemed to demonstrate semantic memory issues for people with Schizophrenia, one stating “Patients demonstrated impairment in recall, in recognition, in semantic encoding, and in frequency estimation” (Beaudreau & O’Hara, 20090601).

Q: Are the temporal pole and ventromedial prefrontal cortex the only thing involved in role of emotion?

WindowComrade:

No, the entire limbic system of the brain is involved in behavioral and emotional responses. The Hypothalamus controls emotional responses. The Hippocampus is responsible for preserving and retrieving memories. The amygdala helps coordinate responses to things in your environment, especially those that trigger an emotional response. The amygdala is important in fear and anger emotions. The limbic cortex, consisting of the cingulate gyrus and parahippocampal gyrus, work together to impact mood, motivation, and judgement. Basically, it takes many parts of the brain interacting together to regulate and control emotion. The limbic system operates with other areas of the brain to produce and regulate basic emotions and feelings (What Part of the Brain Controls Emotions? Fear, Happiness, Anger, Love. (2018, July 23).

Q: If different types of memory are stored and processed in different regions of the brain, does this mean you can be better at recalling one type of memory over the other?

RespondLlama: remembering something is “replaying” a pattern of neural activity that was generated when the original event took place. It is not the exact neural activity, otherwise there would be no way to distinguish between a real event and a memory. There are three main types of memory recall: free, cued and serial. The frontal lobe can also block out unwanted memories if they are traumatic or stressful. The article I read seems to imply that certain types of memory are not easier to recall than others, but that the ability to remember something depends strongly on the quality of the cues given to you to remember whatever it is you're trying to recall.

Types of memory

Q: what else does the heteromodal cortex participate in besides semantic memory

BanditMeter: "receives input from multiple sensory or multimodal areas"

"Because of their multimodal inputs, these cortical areas are considered to be responsible for more complex or integrated cognitive activities"

Q: What are other types of memory and how does the brain work differently in using semantic memory vs using other memory?

IsotopeNirvana:

- Short-term (working) memory, which is the temporary memory that is quickly saturated. It is labeled "working" due to to its active role as we talk, think, and act.
- Episodic memory, which is the memory used when remembering memories about special events in your life.
- Long-term memory, a huge store of knowledge of all the facts that you know, all the things that you can do, and many of the events in your life plus all the surprising things you didn't even know you knew.
- Semantic memory (facts) is the store of general knowledge including facts, concepts, and vocabulary.
- Procedural memory (skills), which include physical and mental skills acquired over time that is used automatically without conscious recollection of how to apply it.

Non-human animals and artificial intelligence

Q: Could we study the types of memory talked about in this paper in non-human primate models or mice?

SocialAnvil:

In the paper semantic memory is being looked at which consists of long term memories that are remembered facts or common knowledge. So, they are not memories drawn from personal experiences, but instead are facts such as knowing the capitals of U.S. states. This makes me feel like it would be difficult to gauge true semantic memory function in non-human primates who do not have as sophisticated language as humans. In doing my research I found that the closest we can come to testing semantic memory is with episodic memory tests. In non-human subjects this means that cognitive tests are used along with neurobiological parallels to human episodic brain processing. Since episodic is more based on memory recall of personal life events, this is not exactly what semantic is. Since semantic is largely tested on the recall of 'known' facts, it seems that this paradigm is very difficult to test in non-human subjects.

Q: Do animals embody semantic memory?

DecimalSponsor:

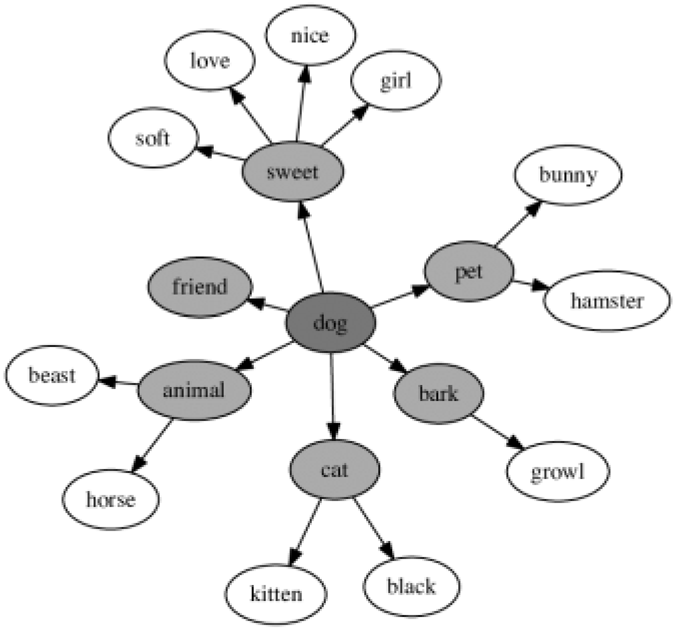
Yes, it is thought that animals do indeed have semantic memory, but not episodic memory. Studies have been conducted that have shown animals understanding general knowledge and the things around them, and these animals have also demonstrated the ability to learn things such as sign language on the spot. These point to the conclusion that nonhuman animals still have semantic memory.

Q: How does AI account for all of the processing systems of the semantic memory?

Anthony Cate:

There are several approaches to making computational models of semantic memory, including neural network simulation models and "classical AI" models based on propositions. They all tend to focus on the mechanism by which concepts or more abstract forms of knowledge are associated with each other, and with how activation of one set of knowledge spreads so that other associated ideas come to mind.

Here is a hub-and-spoke diagram that I found by looking up “spreading activation,” which is a concept about how different ideas prime one another:



Bibliography

Binder, J. R., & Desai, R. H. (2011). The neurobiology of semantic memory. Trends in Cognitive Sciences, 15(11), 527–536. https://doi.org/10.1016/j.tics.2011.10.001

Connell, L., Lynott, D., Dreyer, F. (2012). A functional role for modality-specific perceptual systems in conceptual representations. PLoS One, 7(3), e33321.

Cummins, E. (n.d.). Embodied Cognition: Definition, Theory & Experiments. Retrieved March 5, 2019, from http://study.com/academy/lesson/embodied-cognition-definition-theory-experiments.html

Donnelly K. (2011) Heteromodal Cortex. In: Kreutzer J.S., DeLuca J., Caplan B. (eds) Encyclopedia of Clinical Neuropsychology. Springer, New York, NY

epiphenomenal. (n.d.). The Free Dictionary. Retrieved from https://www.thefreedictionary.com/epiphenomenal

Gallagher, H. L., & Frith, C. D. (2003). Functional imaging of ‘theory of mind.’ Trends in Cognitive Sciences, 7(2), 77–83. https://doi.org/10.1016/S1364-6613(02)00025-6

Garrard, P., Perry, R., & Hodges, J. R. (1997). Disorders of semantic memory. Journal of Neurology, Neurosurgery, and Psychiatry, 62(5), 431–435.

Goldinger, S. D., Papesh, M. H., Barnhart, A. S., Hansen, W. A., & Hout, M. C. (2016). The poverty of embodied cognition. Psychonomic Bulletin & Review, 23(4), 959–978. https://doi.org/10.3758/s13423-015-0860-1

Greicius, M. D., Supekar, K., Menon, V., & Dougherty, R. F. (2009). Resting-State Functional Connectivity Reflects Structural Connectivity in the Default Mode Network. Cerebral Cortex, 19(1), 72–78. https://doi.org/10.109/cercor/bhn059

Hodges, J. R. (2001). Frontotemporal dementia (Pick’s disease): clinical features and assessment. Neurology, 56(11 Suppl 4), S6-10.

Hodges, John R., & Patterson, K. (1997). Semantic memory disorders. Trends in Cognitive Sciences, 1(2), 68–72. https://doi.org/10.1016/S1364-6613(97)01022-X

Hodges, John R., Patterson, K., Oxbury, S., & Funnell, E. (1992). SEMANTIC DEMENTIA PROGRESSIVE FLUENT APHASIA WITH TEMPORAL LOBE ATROPHY. Brain, 115(6), 1783–1806. https://doi.org/10.1093/brain/115.6.1783

Hume and the Problem of Causation’, in P. Russell (ed.), The Oxford Handbook of Hume (New York: OUP, 201)

Irish, M., Addis, D. R., Hodges, J. R., & Piguet, O. (2012). Considering the role of semantic memory in episodic future thinking: evidence from semantic dementia. Brain, 135(7), 2178–2191. https://doi.org/10.1093/brain/aws119

Kobayashi, S. (2009). Reward Neurophysiology and Primate Cerebral Cortex. In L. R. Squire (Ed.), Encyclopedia of Neuroscience (pp. 325–333). Oxford: Academic Press. https://doi.org/10.1016/B978-008045046-9.01559-X

Matthews, B. R. (2015). Memory Dysfunction: CONTINUUM: Lifelong Learning in Neurology, 21, 613–626. https://doi.org/10.1212/01.CON.0000466656.59413.29

Memory Recall/Retrieval - Memory Processes - The Human Memory. (n.d.). Retrieved March 5, 2019, from http://www.human-memory.net/processes_recall.html

Memory: The 5 Types Everyone Has and What They Do | Reader’s Digest. (n.d.). Retrieved March 5, 2019, from https://www.rd.com/health/wellness/memory-types/

Mišić, B. (2014, December 4). A Network Convergence Zone in the Hippocampus (J.Daunizeau, Ed.).Retrieved from NCBI website: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4256084/

Patterson, K., & Lambon Ralph, M. A. (2016). Chapter 61 - The Hub-and-Spoke Hypothesis of Semantic

Memory. In G. Hickok & S. L. Small (Eds.), Neurobiology of Language (pp. 765–775). San Diego: Academic Press. https://doi.org/10.1016/B978-0-12-407794-2.00061-4

Pedersen, Traci. "Theory of Mind." Encyclopedia of Psychology, June 17, 2016. https://psychcentral.com/encyclopedia/theory-of-mind/.

Physician, A. B.-C. (n.d.). Why Theory of Mind Is Important for Social Relationships. Retrieved March 5, 2019, from https://www.verywellmind.com/theory-of-mind-4176826

Ralph, M. A. L. (2001). Semantic memory is impaired in both dementia with Lewy bodies and dementia of Alzheimer's type: a comparative neuropsychological study and literature review. Journal of Neurology, Neurosurgery & Psychiatry, 70(2), 149–156. https://doi.org/10.1136/jnnp.70.2.149

Rogers, T. T., Lambon Ralph, M. A., Garrard, P., Bozeat, S., McClelland, J. L., Hodges, J. R., & Patterson, K. (2004). Structure and deterioration of semantic memory: a neuropsychological and computational investigation. Psychological Review, 111(1), 205–235. https://doi.org/10.1037/0033-295X.111.1.205

Saffran, E. M., & Schwartz, M. F. (1994). Of cabbages and things: Semantic memory from a neuropsychological perspective—A tutorial review. In Attention and performance 15: Conscious and nonconscious information processing (pp. 507–536). Cambridge, MA, US: The MIT Press.

Semantic and Associative Priming in a Distributed Attractor Network. (n.d.). Retrieved March 5, 2019, from http://www.cnbc.cmu.edu/~plaut/papers/html/Plaut95CogSci/main.html

Semantic Variant Primary Progressive Aphasia. (n.d.). Retrieved March 5, 2019, from https://memory.ucsf.edu/semantic-variant-primary-progressive-aphasia

Snowden, J. S., Goulding, P. J., & Neary, D. (1989). Semantic dementia: A form of circumscribed cerebral atrophy. Behavioural Neurology, 2(3), 167-182.

Templer, V., & Hampton, R. (2013). Episodic Memory in Nonhuman Animals. Current Biology, 23(17). doi:10.1016/j.cub.2013.07.016

Two-streams hypothesis. (2019). In Wikipedia. Retrieved from https://en.wikipedia.org/w/index.php?title=Two-streams_hypothesis&oldid=880464981

van Maanen, L., & van Rijn, H. (2007). An accumulator model of semantic interference. Cognitive Systems Research, 8(3), 174–181. https://doi.org/10.1016/j.cogsys.2007.05.002

White, P. A. (2017, March 24). Perceptual impressions of causality are affected by common fate.

Young, M. E. (2005). Causal impressions: Predicting when, not just whether. In *Memory & Cognition*. (Excerpted from *Memory & Cognition*, 2005)

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