

February 2–19, 2010

CLASSES 5–10: COGNITIVE REVOLUTION, ETHOLOGY & POS

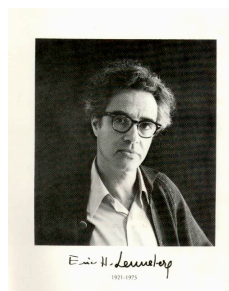
COGNITIVE REVOLUTION, BEHAVIORISM, AND ETHOLOGY

- empiricism/rationalism, computation/mathematics, cognitive science, also **ethology**
- Chomsky (1959): – essentially equates behaviorism with empiricism, goes **Cartesian**
 – **competence** vs. performance (= internalism vs. externalism)
- Pavlov, Skinner (behaviorism) **stimulus** → **response**; reward/punishment
- problems w.r.t. language:
 - non-obvious **stimuli** (e.g. abstract nouns)
 - non-obvious **reward/punishment**
 - happens way **too fast** (20 words per day)
 - **negative feedback** is useless (“other one spoon”)
 - child’s role is totally overlooked; **not human-specific**
 - only the observable/measurable is **scientific**
 - **mental states** are totally inadmissible



Chomsky’s suggested **replacement for behaviorism** (“innateness”).

- **ethologists**: Lorenz, Tinbergen, von Frisch, Lenneberg, Hubel & Wiesel



- learning is heavily reliant on **instincts** (name some)
- other **factors**: imprinting, maturation, critical/sensitive period
- for **language**: very, very early phoneme discrimination, accent
- songbirds, kitten **vision** (humans too)
- **environment**: *Welt*, *Umwelt* (“constructed” or “relativized”)
- extended **phenotype** of Dawkins
- **niche** of Lewontin
- Tinbergen’s **Four Questions**
- Chomsky’s **Five Questions**



PHILOSOPHICAL INFLUENCES ON COGNITIVE SCIENCE

Rationalism (→ ethology, cognitive science)

- **protagonists** (late 16th/early 17th century): Descartes, Spinoza, Leibniz



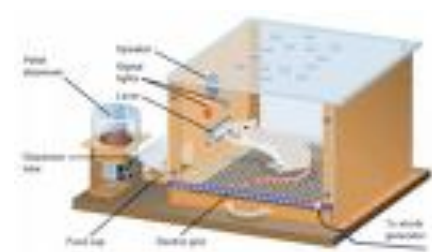
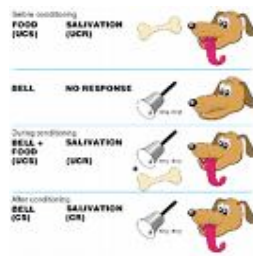
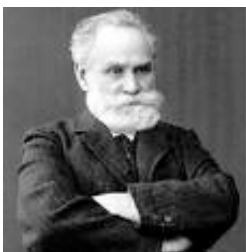
- Descartes (1596–1650):
 - language as what separates us from animals
 - mechanical explanation (led to the emergence of Artificial Intelligence)
 - automata thought able to model other species, but not us because we’re creative and unpredictable (not stimulus-bound, cf. vervet calls)
- “infinite use of finite means” (quote from Humboldt) — **compositionality**
- ethology/cogsci tries to figure out what **internal representations** underlie this

Empiricism (→ behaviorism)

- **protagonists** (late 16th to early 18th century): Hobbes, Locke, Hume



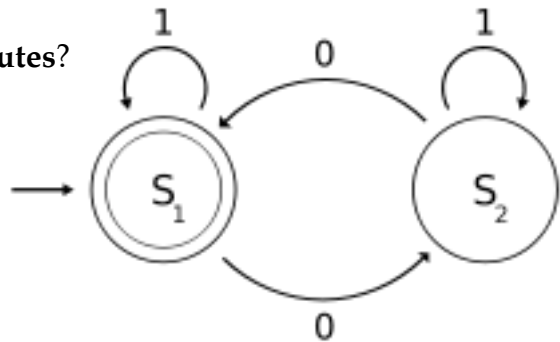
- emphasized influence of **environment**
- unlike Skinner, **didn’t deny** that internal/organism should be studied
- Hobbes (1588–1679):
 - thought = “reckoning”
 - computational/representational theory of mind: thought is math with words
 - ✓ type/token distinction
 - ✓ compositionality (ape signing is a total mess)
 - ✓ quantification
 - ✓ recursion



INFLUENCE OF MATHEMATICS ON COGNITIVE SCIENCE

Alan Mathison Turing (June 23, 1912 – June 7, 1954) tried to find definition of computing which was (in theory) implementable.

- what does a computer do when he/she/it **computes**?
- **requires** (may not be efficient, but is sufficient):
 - piece of paper (tape/memory) — infinite
 - symbols written on the tape — 1, 0, blank
 - finite set of instructions
 - ✓ write something on blank square
 - ✓ replace one symbol with another
 - ✓ move to the next square



Claude Elwood Shannon (April 30, 1916 – February 24, 2001) was concerned with representations and (widely acknowledged as the father of) information.

- information **requires**: source, recipient, shared format
- **definition** of information:
 - reduction of uncertainty in what you know
 - selection from among possibilities which you already have
 - requires a lot of prior/innate knowledge/representations
 - ✓ example: thermometer
 - ✓ learning is not getting new knowledge.
 - ✓ sensitivity to the information must be in your nature
 - ✓ tie this to Umwelt, “constructed” / “relativized” environment

ASPECTS (OF THE THEORY OF SYNTAX, CHOMSKY 1965)

Center embedding (memory limitations; no principled cut)

- (1) a. A man that a woman loves.
- b. A man that a woman that a child knows loves.
- c. A man that a woman that a child that a bird saw knows loves.
- d. A man that a woman that a child that a bird that I heard saw knows loves.

Compare to *The cat that caught the rat that ate the cheese.*

HUMBOLDT WAS A BIOLINGUIST

Friedrich Wilhelm Christian Karl Ferdinand Freiherr von Humboldt (June 22, 1767 – April 8, 1835) government functionary, diplomat, philosopher, founder of Humboldt Universität in Berlin, friend of Goethe and in particular of Schiller, is especially remembered as a linguist who made important contributions to the philosophy of language and to the theory and practice of education.



“infinite use of finite means” (von Humboldt 1836: 70)

Language [...] must be looked upon as being an immediate given in mankind. [...] Language could not be invented or come upon if its archetype were not already present in the human mind. For man to understand but a single word truly, not as a mere sensuous stimulus (such as an animal understands a command or the sound of the whip) but as an articulated sound designating a concept, all language, in all its connections, must already lie prepared within him. *(Humanist, 239–240)*

The whole of language lies within each human being, which only means that each of us contains a striving, regulated by a definitely modified capacity, which both stimulates and restricts, gradually to produce the entire language, as inner or outer demands dictate, and to understand it as it is produced by others. *(Humanist, 290–291)*

A further proof that children do not mechanically learn their native language but undergo a development of linguistic capacity is afforded by the fact that all children, in the most different imaginable circumstances of life, learn to speak within a fairly narrow and definite time span, just as they develop all their main capacities at certain definite growth stages. *(Humanist, 292)*

EVIDENCE FOR UG

- **critical period:** Genie vs. Isabel, perception, accents, NSL, ABSL, creoles
- **double-dissociations:** Williams vs. Down’s, SLI, savantism
- **weird stuff** kids can do — no such thing as a preverbal child!
 - distinguish mother’s voice in utero
 - when born, distinguish story mother told in utero
 - distinguish 2 languages, even non-maternal, in utero
 - very early phonological sensitivity
- some stuff is **non-specific** to language
 - parallels with passerine learning (babbling, critical period)
 - mammalian/general biases

CHOMSKY HIERARCHY

- finite-state automata (**FSAs**):
 - a. The man left.
 - b. The very tall man left.
 - c. The very, very, very, very tall man left.
- loop creates **infinity**

- phrase-structure grammars (**PSGs**)
 - **nested** dependencies
either/or, anti-missile missile
The mouse the cat chased squeaked.
 - phrase-structure rules (**PSRs**) for mirror-image language
(bb, aa, abba, baaaab)
reduplicating language
 - Hauser on **humans vs. monkeys** on FSAs vs. CFGs
 - **context-sensitive** rules
 - FSA **overgenerates** — counterintuitive
 - **cross-serial** dependencies
- (2) a. John must talk.
b. John must be talking.
c. John is talking.
d. John has talked.
e. John must have talked.
f. John must have been talking.

- Aux → (*must* ∅) (*have -en*) (*be -ing*) VP
- task: come up with other modals — anything else like *have* or *be*? (**hierarchy!**)

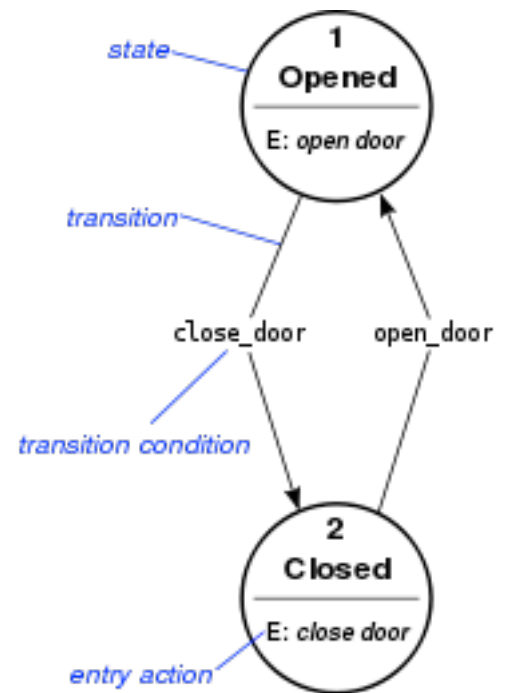
POVERTY OF (THE) STIMULUS

The **poverty of the stimulus (POTS)** is one of many [arguments](#) which claims that [natural language](#) grammar is [unlearnable given the relatively limited data](#) available to children learning a language, and therefore that this knowledge is supplemented with some sort of innate linguistic capacity. As such, the argument strikes against [empiricist](#) accounts of [language acquisition](#) and is usually construed as being in favor of [linguistic nativism](#). Nativists claim that humans are born with a specific representational adaptation for language that both funds and limits their [competence](#) to acquire specific [types](#) of [natural languages](#) over the course of their cognitive development and linguistic maturation. The basic idea informs the teachings of [Socrates](#), [Plato](#), and the [Pythagoreans](#), pervades the work of the [Cartesian linguists](#) and [Wilhelm von Humboldt](#), and surfaces again with the contemporary linguistic theories of [Noam Chomsky](#). The argument is now generally used to support theories and hypotheses of [generative grammar](#). The name was coined by Chomsky in his work *Rules and Representations*.^[1] The thesis emerged out of several of Chomsky's writings on the issue of [language acquisition](#). The argument has long been controversial within linguistics, forming the empirical backbone for the theory of [universal grammar](#).

Get acquainted with the additional reading(s) and **discuss POS** in class.

References

- von Humboldt, W. 1836. *Über die Verschiedenheit des menschlichen Sprachbaues und ihren Einfluss auf die geistige Entwicklung des Menschengeschlechts*. Berlin: F. Dümmler. [Parts are translated into English in M. Cowan, *Humanist without Portfolio*, Detroit: Wayne State University Press (1963).]



Harvey (1628) revolutionized physiological thinking when he showed that the heart circulates the blood and that its structure suits it to perform this function. Before Harvey, the modern conception of an organ as something whose particular structure enables it to perform a particular function did not exist. Physiological thinking centered not on organs but on humors. Humors had properties and they had effects. Pathological conditions were thought to arise from an excess or deficiency in one or more of them. [Hamlet suffered from an excess of black bile, which was the cause of his melancholy — Boeckx 2010: 24] But they did not have specific and limited functions. Much less did they have a structure that enabled them to perform a specified function. **Organs, by contrast, have specific and distinct functions and a structure that enables them to perform them.** (Gallistel 2007: 1)

From a computational point of view, the notion of a general purpose learning process (for example, associative learning), makes no more sense than the notion of a general purpose sensing organ — a bump in the middle of the forehead whose function is to sense things. There is no such bump, because picking up information from different kinds of stimuli—light, sound, chemical, mechanical, and so on—requires organs with structures shaped by the specific properties of the stimuli they process. The structure of an eye — including the neural circuitry in the retina and beyond — reflects in exquisite detail the laws of optics and the exigencies of extracting information about the world from reflected light. The same is true for the ear, where the exigencies of extracting information from emitted sounds dictates the many distinctive features of auditory organs. **We see with eyes and hear with ears — rather than sensing through a general purpose sense organ — because sensing requires organs with modality-specific structure.** (Gallistel 2007: 3)

[It is quite easy, in his view, to — Chomsky 2002: 51] **conceive of a machine so constructed so that it utters words, and even words which correspond to bodily actions causing a change in its organs** (for instance, if you touch it in one place it asks what you want of it; if you touch it in another place it cries out that you are hurting it, and so on). **But it is not conceivable that such a machine should produce different arrangements of words so as to give an appropriately meaningful answer to whatever is said in its presence, as the dullest of men can do.** (Descartes, *Methods*: 39)

Peirce regarded inductive processes as rather marginal to the acquisition of knowledge; in his words, **“Induction has no originality in it, but only tests a suggestion already made.”** To understand how knowledge is acquired, in the rationalist view that Peirce outlined, we must penetrate the mysteries of what he called “abduction,” and we must discover that which “gives a rule to abduction and so puts a limit upon admissible hypotheses.” Peirce maintained that **the search for principles of abduction leads us to the study of innate ideas**, which provide the instinctive structure of human intelligence. But **Peirce was no dualist in the Cartesian sense**; he argued (not very persuasively, in my opinion) that **there is a significant analogy between human intelligence, with its abductive restrictions, and animal instinct.** Thus, he maintained that man discovered certain true theories only because his “instincts must have involved from the beginning certain tendencies to think truly” about certain specific matters; similarly, **“You cannot seriously think that every little chicken that is hatched, has to rummage through all possible theories until it lights upon the good idea of picking up something and eating it. On the contrary, you think that the chicken has an innate idea of doing this; that is to say, that it can think of this, but has no faculty of thinking anything else . . . But if you are going to think every poor chicken endowed with an innate tendency towards a positive truth, why should you think to man alone this gift is denied?”** (Chomsky 2006: 80–81)

Additional references

- Chomsky, N. 2002. *Cartesian Linguistics: A Chapter in the History of Rationalist Thought*, 2nd edn., with a new introduction by James McGilvray. Christchurch: Cybereditions. [1st edn.: Harper & Row, 1966; 3rd edn.: CUP, 2009]
- Chomsky, N. 2006. *Language and Mind*, 3rd edn. Cambridge: CUP.