9.85 Cognition in Infancy and Early Childhood

Lecture 3: Theoretical perspectives in developmental psychology II: Post-Piaget

Vast range of psychological theories

- Clinical/psychodynamic
- Biological/evolutionary
- Socio-cultural
- Cognitive

Clinical/psychodynamic

- **Did play**
- Attention deficit
- Hyperactive
- Obsessive compulsive

- **Didn't play**
- Repressed

Biological/evolutionary

- **Did play**
- Exploration is adaptive; might be food inside
- Have motor abilities to manipulate small objects

- **Didn't play**
- Caution is adaptive; might be dangerous
- Too much energy expenditure

Sociocultural

- **Did play**
- Environment fosters creativity, independence, initiative.

- **Didn't play**
- Environment encourages waiting to be told what to do.

Cognitive

- **Did play**
- Object was novel in this context -- fostered curiosity.
- Saw someone else do it -- learned by imitation.

- **Didn't play**
- Already know everything there is to know about playdough.
- Saw other people waiting -- learned by imitation.

Moral #1: Different theoretical perspectives

- Are not necessarily in conflict with each other -- focus on different levels of analysis.
- May be useful because they raise different types of questions.
- But are only distinguishable if they make different predictions.

Moral # 2

- If this were a preschool classroom … how many of you would have found the contents of the playdough ball?
- Actively question and explore -- even the things you think you already know.
- "The greatest obstacle to discovery is not ignorance but the illusion of knowledge" (Daniel Boorstin)

Current theoretical approaches

- **Connectionism (Bates, Elman, Karmiloff-Smith, Johnson)**
- Dynamic systems (Thelen, Smith)
- Information processing (Case, Klahr, Siegler)
- Biological maturation/(Diamond, Neville)
- Core knowledge/modularity nativism (Leslie, Spelke, Carey)
- Theory theory (Carey, Gelman, Gopnik, Meltzoff, Wellman)

If X is any type of knowledge

- Questions developmental psychologists ask:
  - Is X **innate** or **learned**?
  - If X is learned -- when and how?
  - Are the processes that lead to knowing X **specific** to the **domain** of X or **domain- general?**
  - Does knowledge of X **change** through development or is there **continuity** with adult knowledge?
  - Is knowledge of X **universal** or **culturally specific**?

Connectionism

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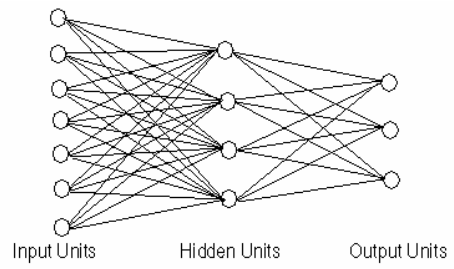
Connectionism



Connectionism

- Input units respond to environment
- Hidden units can be activated or inhibited by patterns of input
- Patterns of activation are “reinforced” (strengthened) until desired output is achieved.

Connectionism

- More influential in developmental psychology than other areas of cognitive science?
- Aim to provide “error-driven, self-organizing, and constructivist learning systems” (Johnson & Munakata, 2005)
- Tries to account for representational change in response to evidence.
- Start with domain-general processes which become domain-specific through learning.

Connectionism: Virtues

- Self-organizing (that is, it has to compare real output to desired output and adapt but doesn’t need a rule for how to get from I to O)
- Accounts for graded responses and sensitive to subtle statistical regularities (an albino tiger is still a tiger).
- “graceful” degradation -- doesn’t fall apart if a “rule” is wrong.

Connectionism: Objections

- Associationism by another name?
- Or symbolic processing by another name? (can only account for higher cognition by implementing symbolic processing).
- Systematicity debate (Fodor, Pylyshyn)
- Connectionist models “John loves Mary” v. “Mary loves John”

Connectionism and developmental research

- Do children learn from statistical regularities? Yes.
- Training*: tupiro*, *golabu*, *bidaku*, and *padoti* but the only cues to word boundaries were the transitional probabilities between syllable pairs (presented as *bidakupadotigolabubidaku*)which were higher within words (1.0 in all cases, for example, *bida*) than between words (0.33 in all cases, for example, *kupa*).
- Test: Listened to "words" *tupiro*, *golabu* and "nonwords", *dabiku*, and *tipado*, that contained the same syllables heard during familiarization but not in the order in which they appeared as word. 8-month-olds distinguished. (Saffran, Aslin & Newport, *Science*, 1996)

Connectionism and developmental research

- But do statistical regularities explain children’s learning?
- Training*:* ABA grammar, such as "ga ti ga" and "li na li." In condition ABB, infants were familiarized with a comparable speech sample in which all training sentences followed an ABB grammar, such as "ga ti ti" and "li na na"
- Test: "wo fe wo" or "wo fe fe". Half the test trials were constructed from the same grammar as the one with which the infant was familiarized (an ABA test sentence for infants trained in the ABA condition and an ABB sentence for infants trained in the ABB condition), and half the test trials were "inconsistent sentences" that were constructed from the grammar on which the infant was not trained. (Marcus, Vijayan, Bandi Rao, S. and Vishton, *Science*, 1999).

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Information-processing

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Information-processing theories

- Focus on cognitive activities (encoding, comparing, storing, attending) rather than cognitive structures.
  - Asks what does the system do first, second, third? How much time does each step take?
  - "Neo-Piagetians" but focus on changes in children's procedures rather than conceptual change per se.

Information processing

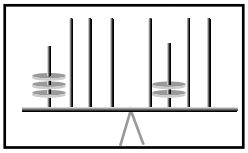
- Explicitly about symbol manipulation and rule-learning.
- Talks about models for organizing information: scripts, frames, flow charts, etc.

Information processing

- Information processing methods
  - Response times -- assume more steps of information processing take more time. (e.g., children mentally rotate objects more slowly -- 7° /msec than adults 4° /msec)
  - Eye movement -- as index of attentional control (e.g., older children scan more systematically than younger children)
  - Microgenetic approach (Siegler)
    - Span a period of change
    - Density of observations is high relative to rate of change
    - Trial by trial analyses
  - Error analyses. You can tell the rules children are using by the errors they make (e.g., balance beam problems

Information processing

- Example
  - Rule 1: only number of weights
  - Rule 2: if two sides have equal weight, consider distance from fulcrum as well.
  - Rule 3: consider both weight and distance (but don't know what to do if one side has more weight and the other is further out).
  - Rule 4: compute torque



Information processing

1. Balanced beam (Rules, 1, 2, & 3)
2. Only weight differs (Rules 1, 2, & 3)
3. Only distance differs (Rule 1 = balance; 2 & 3)
4. One side more weight (and goes down); other side more distance. (Rule 1, 2, 3 = chance)
5. One side more weight; other side more distance (and goes down) (Rule 1, 2 = fail; 3 = chance)
6. One side more weight, one more idstance and balances. (Rule 1, 2 = fail; 3 = chance)

Information-processing

- Virtues:
  - Detailed analyses of strategies
  - Detailed analyses of change
- Drawbacks:
  - "Information-processing changes" might result from conceptual ones (e.g., memory improves because you have more knowledge about a domain).
  - Blurs competence v. performance distinction (maybe children have conceptual knowledge but memory, motor limitations, ability to deploy multiple strategies, etc. masks it).
  - Pre-requisites to cognitive changes, not explanations of it. "Buying a telescope doesn't make you Gallileo" (Gopnik & Meltzoff, 1997)

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Core knowledge/Modularity nativism

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Everyone thinks some things are innate -- but what?

- Innate biological capacities
- Innate domain-general learning abilities
- Innate domain-specific knowledge
- Innate modules

Everyone thinks some things are innate -- but what?

- Innate biological capacities
- Innate domain-general learning abilities
- **Innate domain-specific knowledge**
- **Innate modules**

What's a domain?

- Good question …
- "A body of knowledge that identifies and interprets a class of phenomena assumed to share certain properties and to be of a distinct and general type. A domain functions as a stable response to a set of recurring and complex problems faced by the organism." (Hirschfeld & Gelman, 1994)

What's a domain?

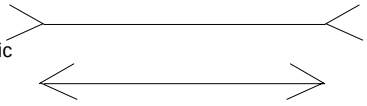
- Physics, psychology, biology
- Language, vision, spatial relations
- Chess?

- For practical purposes, believing that cognition is domain specific means:
- believing that there are distinct ways of acquiring and organizing knowledge that may reflect real differences in the structure of the input (e.g., the external world).

What's modularity?

Fodor (1983) popularized the idea and specified that modules are:

- innate
- domain-specific
- fast
- encapsulated



- Argued for a modular account of vision, language processing, etc.

Distinguishing nativism, modularity and domain-specificity

- Modules are innate, domain-specific, fast, and encapsulated BUT . . .

- There might be innate abilities that are neither modular nor domain-specific (e.g., memory; logic)
- And there might be domain-specific knowledge that is neither modular nor innate (e.g., you can learn domain-specific knowledge).

Why believe critical aspects of cognition are innate?

- <u>Empirical reasons</u>
  - Phylogenetic/evolutionary evidence
  - Ontogenetic evidence (revolution in our understanding of infant cognition)

Why believe critical aspects of cognition are innate?

- <u>Theoretical reasons</u>
- Poverty of the stimulus
  - more information in the inference than in the evidence)
  - One event follows another; but we never can observe any tie between them. (Hume on causality)
  - evidence is logically open to many alternative construals
    - 1,2,3,4,5 . . .what comes next?
    - 126
    - (k-1)(k-2)(k-3)(k-4)(k-5)+k

What are the candidates for innate knowledge?

- Fodor argued specifically for distinguishing perceptual (peripheral) modularity (things like language and vision) and cognitive (central) modularity ("modularity gone mad").
- However, many developmental researchers have argued for the plausibility of modular approaches to central (e.g., higher-order cognitive) processing.

Example:Leslie: core architecture for the cognition of agency

Properties of agents	Processing device	Level of understanding
mechanical	ToBY	"agents and objects"
actional	ToMM1	"agents and action"
cognitive	ToMM2	"agents and attitudes"

Nativist modularity

- Proposes ages when modules "come on-line"
- Maturational theory; largely independent of interaction with environment
- No explanation of why these modules should come online when they do.

Core knowledge hypothesis

- "We argue that human reasoning is guided by a collection of innate domain-specific systems of knowledge. Each system is characterized by a set of core principles that define the entities covered by the domain and support reasoning about those entities …

Core knowledge hypothesis

- … Learning on this view consists of an enrichment of the core principles, plus their entrenchment, along with the entrenchment of the ontology they determine." (Carey & Spelke, 1994)

Modularity nativism v. Starting-state nativism

- **Modularity-nativism**: representations that are generated by modules are indefeasible.
- **Starting-state nativism:** "child is innately endowed with a particular set of representations and rules operating on these representations . . .(but) such innate structures (are) defeasible; any part of them could be, and indeed will be, altered with new evidence." (Gopnik & Meltzoff, 1997).

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What might make knowledge theory-like?

- Structural features
  - Abstract (not just the evidence)
  - Coherent (changes to one part of theory can affect other parts of the theory)
  - Ontologically committed (categories are defined by the theory)
  - Causal (supports prediction, explanation, intervention and counterfactual claims)
- Functional and dynamic features
  - Defeasible/revisable with evidence

Why might theory of mind be a theory?

1. Abstract -- go beyond evidence (e.g., beyond behavior -- "she **wants** the kitty" "she **thinks** its under the piano")
2. Ontologically committed -- makes commitments about the kinds of things there are in the world (agents and non-agents; desires, intentions, beliefs …)
3. Coherent -- developmental changes are logically related to one another

16-month-olds understand differences in perspective (the picture's a cat to me but a dog to you)

2-year-olds differences in desire (cookie stayed the same but I don't want it anymore)

4-year-olds understand differences in belief (object stayed the same but beliefs changed)

Why might theory of mind be a theory?

4. Causal -- Support prediction ("she'll look under the piano"), explanation ("she's sad because she wants her cat and didn't find him.") and intervention ("because I hid the kitty in the basket").
5. Influenced by evidence -- (training studies and older but not younger siblings facilitate false belief understanding)

Comparing theories?

- Are modularity nativism and theory theory working at comparable levels of explanation?
- Do they make different predictions?
  - Should you expect domain-specific deficits?
  - Should you expect specialized neural architecture?
  - Should you expect convergence?