The magical number two, plus or minus:
Some comments on dual-process theories

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Introduction: Mechanistic Psychology

- A central assumption of cognitive science: Minds are mechanisms.
  - Complex systems decomposable into functionally characterizable subsystems (Cummins; Bechtel)

- A central explanatory objective: Identify the systems from which our minds are composed.

- Two central questions:
    - What subsystems are there?
    - What properties do they possess?

Dual-process theories appear to offer (partial) answers to these questions.

- Not one, but a family of related proposals
  - Evan, 19984; Evan & Over, 1996; Haidt, 2001; Sloman, 1996; Stanovich, 1999…

- Differ is various respects.
  - Domain of phenomena they are centrally concerned to explain
    - Learning, memory, reasoning etc.
  - Properties attributed to cognitive processes

Focus of Talk

- How should we characterize the dual-process thesis?

- More precisely: Is there a distinctive, and plausible dual-process theory of cognition that we should adopt?

Overview

I. Characterizing the dual-process theory

II. Two versions of the dual-process theory

III. Dual-process theory as a theory of cognitive particulars
- Argue that this is implausible given what we know.

IV. Dual-process theory as a theory of cognitive kinds
- Argue that we currently have no reason to reject this view.

I. What is dual-process theory?

- Aim: Distinguish what I think is an interesting and important hypothesis from some other rather less interesting claims.

What dual-process theory is not (1)

- Dual-process theory ≠ Mere claim that we can produce *some* bipartite division of cognitive processes.

- It's hard to see any interesting issue here.
  - There are lots of ways of cutting up processes.
    - Applies to processes quite generally
      - » Granularity Problem: How many processes there are depends on the granularity of the distinctions one draws.

Rather, dual process theories characterize processes in terms of a standard menu of distinctions.

Note: There is variation between formulations, but significant overlap

S1	S2
Associative	Rule-based
Heuristic	Analytic
Parallel	Serial
Automatic	Controlled
Unconscious	Conscious
Low demands on cognitive capacity	High demands on cognitive capacity
Relatively fast	Relatively slow
Contextualized	Decontexualized
Evolutionary Old	Evolutionary new
Conserved across species	Unique to humans

What dual-process theory is not (2): Single & Covariant Factors

- Dual-process theory ≠ Mere claim that cognitive processes can be divided in terms of *single* dichotomies on this menu.
  - Some processes are more automatic than others
  - Some relatively fast; others relatively slow
  - Some more accessible to consciousness; others less so.
  - Some associative, some not…

  - Some of these distinctions are perhaps more interesting than others.

  - But it should be relatively uncontentious that some such distinctions can be drawn.

…Dual-process theory makes a far more interesting claim than this.

- It is committed to the claim that such distinctions *line-up.*
  - Processes that exhibit one property also tend to possess the others.
    - Not invariably but very typically.

- S1 and S2 properties form *clusters*
    - Some processes exhibit the S1 cluster
    - Others exhibit the S2 cluster

…So what?
Systems & Processes

- Why would it matter if S1-properties and S2-properties tend to cluster?

- One Reason: Provides the basis for an argument for the existence of a distinction between cognitive *systems*:
  - Members of the S1 (or S2) property cluster are logically independent.
    - It's logically possible to have one without the others.
  - How then do we explain their tendency to covary?

- Familiar strategy: Posit some underlying division between mechanisms that explains the tendency for the properties of cognitive processes to cluster in this way.

A philosophically more loaded way to put the point: The identification of natural kinds

- That S1 & S2 properties cluster would provide good reason to posit distinct *natural kinds*
  - Natural kind ≈ Homeostatic cluster (Boyd & Griffiths)
    - Roughly: An underlying causal mechanism –a 'causal essence'— whose operation explains the covariation of some set of characteristic features.

- According to dual-process theory: There is a distinction between cognitive *systems*
  - Helps explain the characteristic clustering of properties

So: Dual-process theory comprises of two claims

1. Cognitive processes tend to exhibit either the S1 or the S2 property cluster
2. There is a division in our cognitive architecture --a division between cognitive systems-- that explains this clustering.

- Note: 1 can be held without 2; but canonically they go together.

> "…it is only in recent years that cognitive scientists have proposed the striking and strong claim that there are two quite distinct cognitive systems underlying thinking and reasoning. (Evans, 2003)

This is an important and substantive thesis.

- If correct, dual-process theory would identify one important distinction between the systems on which cognition depends.

- This would contribute to a central project of cognitive science: decomposing cognition into psychologically interesting sub-systems.

II. Two versions of dual-process theory: Type and tokens

- Version 1: dual-process theory is a theory of cognitive particulars --*token* systems.
  - Each mind contains two *particular* cognitive systems:
    - System 1 (AKA heuristic system, implicit system, associative system …
    - System 2. (AKA analytic system, explicit system, rule-based system …

• Version 2: Dual-process theory is a theory of cognitive kinds --system *types*

- Each mind is comprised of two *kinds* of cognitive system:
    - Systems of type-1 are characterized by their possession of the S1 cluster
    - Systems of type-2 are characterized by their possession of the S2 cluster

- Q: Is either of these proposals plausible?

III. Dual-process theory as a theory of cognitive particulars

- This proposal might come in a variety of different forms.

- General worry: Even assuming that there are two kinds of cognitive system, it's implausible that there are only two particular systems.

  – Consider a range of proposals

Version 1: Our minds contain exactly two, particular cognitive systems.

- Literally construed, this is a strawman.

- A General Worry: Functional Decomposition
  - Cognitive science is wedded to an explanatory strategy which involves functional decomposition
  - Large cognitive systems decompose into hierarchically organized *subsystems*.

- On any plausible story there will be a *huge* number of such subsystems.
  - E.g.: Functional decomposition of the vision system

Version 2: Levels Constraint

- Obviously, there are lots of possible responses to this worry.

- Among the more plausible: Relativize dual-process theory to a specific level of decomposition
  - Dual-process theory does not claim there are exactly two systems in total.
  - It claims that there are two systems *relative to some level of decomposition.*
    - Note: This level of decomposition will presumably be quite abstract

Problem: Still not plausible

- Even at quite abstract levels of decomposition, it's not plausible that our minds contain only two systems.

- On any plausible decomposition of the human mind, there are likely to be a great many systems for a range of different cognitive functions, including:
    - Perception, Memory, Emotion, Language …perhaps many others

- Not plausible to treat all these devices as constituting just two systems
    - At least one would be wildly heterogeneous in character.

Version 3: Domain Restrictions

- Deny: Dual-process theory is a claim about cognition in general.
- Reformulate as a thesis about some specific domain of cognition: Reasoning.
- Claim: Relative to some appropriate level of decomposition, there are exactly two *reasoning* systems.
- This seems close to the spirit of some versions of dual-process theory
  - "The Empirical Case for Two Systems of Reasoning" Sloman

Problem 1: What's a reasoning system?

- It's not clear what the content of the claim is since it's unclear what counts as a reasoning system
  - Option1: Any inferential device is a reasoning system ✗
    - Includes too many cognitive systems
  - Option 2: Conscious deliberative inference (Haidt; many philosophers) ✗
    - Includes too little. Seems to exclude S1
  - Option 3: Any device involved in paradigmatic reasoning tasks ✗
    - Includes too much
      - perception, motor control, language, emotions and much more

Option 4: Reasoning system = central systems?

- A fudge: Though useful for heuristic purposes, it's hard to draw a precise distinction between central systems and non-central systems
  - Illustration: One standard way to draw this distinction in terms of systems that deploy conceptual representations and those that do not.
    - Tells us little absent a clear distinction between conceptual and non-conceptual representations.

- Perhaps the class of reasoning systems can be precisely delimited, but it's unclear how.

Problem 2

- Suppose we waive problem 1 and adopt a rough and ready ‘intuitive’ conception of central systems.

- Still seems there may well be too many devices.

- Plausible candidates:
  - Arithmetic --e.g. Accumulator and other devices
  - Theory of mind
  - Planning and/or decision-making
  - Categorization systems
  - …

- Again, you have a problem of heterogeneity.

One-way or Two-way Collapse?

- Some dual-process theorists readily admit the existence of lots of different systems involved in reasoning.
    - Stanovich 2004

- But perhaps this only shows that the (token) dual-process theory is *half wrong*.
  - There are many System 1
  - But there is a unique System 2.

Why suppose there's only one System 2?

- Stanovich: Reflective mind/Algorithmic mind

- Related issue concerning functional characterization of cognitive systems
  - On many versions of dual-process theory, System 2 is supposed to be implicated in a variety of cognitive tasks.
    - Planning, decision-making, deductive inference, cognitive control, construction of a self narrative, causal-mechanical reasoning, explanation.

- These processes appear to differ in ways that make it plausible they involve different particular systems

  - The tasks have importantly different functional characterizations

  - The computational demands are different
    - AI models for planning, deduction, causal reasoning etc. differ considerably.

- Furthermore: It seems that we get the main explanatory virtues of dual-process theory without adopting this strong single system-2 view.
  - Discuss later.

- Indeed: The view that there are multiple system 2's has a potential virtue.
  - Enables the application of dual-process models to different domains of cognition even where the posited S2-type systems are not identical.
    - E.g. Permits positing a Lieberman style System-C in the domain of social cognition even if it's not identical to the analogous system proposed in research on deductive reasoning.

IV. Dual-process theory as a theory of cognitive kinds

- The View: Our minds are comprised of two kinds of system:
    - Systems of type-1 possess the properties associated with S1.
    - Systems of type-2 possess the properties associated with S2.

Question: Is this view correct?

- Short Answer: Far too early to tell.

- Our current understanding of cognitive architectural issues is at best radically incomplete.

Dual process theories have many virtues

- Heuristic value in psychology (& philosophy)
  - Useful tool for thinking about functional decomposition.
  - Provides the option of explaining various phenomena as resulting from interaction effects between systems.
  - Opens up valuable options for conceptualizing and addressing issues about the nature and extent of human rationality.
    - The reason I became interested in dual process theories in the first place.

- Note: These are all virtues accrued on the cognitive kinds version of dual-process theory.

Moreover: Dual process models have proven explanatorily valuable in a variety of psychological domains.

- Belief bias (Evans)
- Patterns of interpersonal variation in performance on reasoning tasks (Stanovich & West)
- Cross-cultural data (Norenzayan, Nisbett)
- Social Cognition (Leiberman; Chaiken &Trope)

- Explanatory success lends support to the general proposal.
  - Note: These explanatory successes do not require a cognitive particulars version of dual-process theory.

…But: There are some quite general worries that need to be addressed

- Conclude by briefly considering three:
    - The Specification Problem
    - The Crossover Problem
    - The Unity Problem

1. The Specification Problem

- What precise characterization of the S1/S2 clusters ought we to adopt?
- Two Issues:
  - Conceptual Issue: How to characterize in a precise and appropriate way the various dichotomies involved in specifying dual process theories.
    - Often more than one possible distinction corresponding to each pair of labels.
      - Example: Automaticity (Moors and De Houwer)
  - Inclusion Issue: Which distinctions should figure in characterizing dual process theories?
    - Currently: Though there is substantial overlap, different theorists characterize the S1 and S2 property clusters different ways.
    - Revision to some and/or all these views may be required
      - Comparision with discussions of modularity.
        - » The construct ‘module’ has undergone a shift

2. The ‘Crossover’ Problem

- There appear to be ‘crossover’ processes:
  - They exhibit a combination of S1 and S2 properties

- Example: Evolutionary recency:
    - S1 processes: paradigmatically ancient and conserved across species.
    - S2 processes: paradigmatically recent and unique to humans.

  - Problem: There appear evolutionarily novel processes that possess many S1 properties.

Example: Judgments of Number Magnitude

- Assessing magnitude of numbers represented by familiar numeral systems.
  - Relatively fast
  - Automatic
    - Number Stroop: Even when number size is irrelevant to the task at hand, when presented with numerals in a familiar system we automatically access our sense of the numbers designated by those numerals and order them by number size. (Girelli et al. 2000).
  - But presumably evolutionary recent.
    - Process depends on access to systems of numerals.

Should crossovers lead us to reject dual process theories?

- No…So long as crossovers are not too numerous or extreme.

- Possibility 1: May require modification of the clusters.
    - Relatively modest revision would not, by itself, be reason to reject dual process accounts.
        - » Such modifications are commonplace in science
- Possibility 2: Tolerate exceptions without modifying property clusters.
    - Assuming system 1 and system 2 are natural kinds, elements in the S1 and S2 clusters won't be necessary conditions.
        - The presence of the system does not require all members of its associated property cluster occur.
    - In which case, claims about natural kinds can tolerate exceptions.

3. The Unity Problem

- To explain the clustering of S1 and S2 properties, it's not enough to posit distinct cognitive systems.
- We need to specify the underlying features of these systems which produce the clustering effect.

- Some possible options
  - Encapsulation & unencapsulation
  - Architectural division between Classical & connectionist systems
  - System 1 & Cycles of System 1 processes …

- But: At present we have no clear view what the relevant factors are.