Rethinking Psychological Adaptationism
(or)
What (Really) Went Wrong with Pinker’s Mind?

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Abstract: I evaluate the adaptationist program of Evolutionary Psychology as applied to human behavior, and claim that the massive domain-specific view of cognition that it postulates is misleading. I argue for the computational feasibility of an interactionist-constructivist program. Within this new framing, the epistemic role of models of behavior described at a high-level of abstraction is analyzed.
Talk Outline

- A Trip to Marr’s Levels
- EP = Adaptationism + Cognitivism
- Human mate choice: A Case Study ????
- The Troubles with EP
- Tomasello’s Naturalistic Constructivism
- Bringing Life to Cognition
- A Crash Tour of the Human Brain
- Self-Organization, criticality, and globally distributed representations
- Back to the Basics: Lessons Learned
- Addendum: Toolboxes, Heuristics, and ABC (DEFG ⋅⋅ + ∞)
- Summary: Major Claims/Ideas
A Trip to Marr’s Levels

How to convert a reverse-engineering problem into an iterative set of direct engineering problems (Braithenbergs principle: up-hill discovery and down-hill invention)

• (Lv1) The Computational — Functional Specification and Decomposition (declarative mapping)
  – (Lv1.5) Hierarchical decomposition — function composition view
  – Modularity — Divide-to-Conquer principle
  – (↔) Blurs Tinbergen’s functional and causal levels of behavior analysis

• (Lv2) The Algorithmic — Formal description of implementation of function
  – Warrant: Church-Turing principle of computational equivalence

• (Lv3) The Implementation — Structure and Dynamics of a Physical System
  – Biological systems have complex structure and dynamics
  – They are not structurally programmable (M. Conrad)

Pragmatic Question: What functions to consider in the first place?
**EP = Adaptationism + Cognitivism**

- Contents of **Human mind** =
  \[ \sum \text{domain-specific adaptive problem solvers} + \epsilon \]

- Psychological mechanisms tuned (mainly) to:
  Environment of Evolutionary Adaptation (EEA/ERA)

- Analogies: Body Organs \(\mapsto\) Mental Organs; Darwinian Algorithms

- Rationalization (1): Domain-specific problem solver can exploit the constraints inherent to the problem

- Rationalization (2): Internal constraints are required to know what to attend and what to do

- Methodology: Reverse engineering by evolutionary functional analysis and task-decomposition

- Culture = Evoked Culture + Epidemiological Culture

- Vision(!): **The Cognitive Map of the Human Mind**

- **Hidden Assumption**: Function implies design (even if blind)
Human mate choice: A Case Study

(1)

How can agent-based modeling help test the Vision?

- Environment: Easy to abstract “possible” EEAs

- Agents: Assume bounded rational agents with plausible psychological mechanism, but still using an inclusive-fitness maximization heuristic in the background (as in animal behaviour ecology)

- Population: Easy to relate individual-level decision rules with population-level patterns (e.g. to explain cultural variation and historical developments)

- Epistemically: Provide (formal) unified theories of human social behaviour
Human mate choice: A Case Study ? (2)

A Family of Models:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P$</td>
<td>population size/2</td>
<td>50</td>
</tr>
<tr>
<td>$L$</td>
<td>reproductive lifetime</td>
<td>200</td>
</tr>
<tr>
<td>$\mu, \sigma^2$</td>
<td>quality distribution</td>
<td>10, 4</td>
</tr>
<tr>
<td>$Y$</td>
<td>meeting rate</td>
<td>.1 – 1</td>
</tr>
<tr>
<td>$K$</td>
<td>courtship time</td>
<td>5 – 50</td>
</tr>
</tbody>
</table>

Key:
- Female
- Male
- Dating
- Mating
- Knows
Human mate choice: A Case Study

(3)

- Fitness Function: \( F(q_m, t) = q_m \times \frac{L-t}{L} \)

- Decision Rules:
  - Partner switching:
    \[ F(q_a, t + K_i) > F(q_d, t + K_i - c_t) \]
  - Partner acceptance/Aspiration level setting:
    \[ q_{i_{new}}^{*} = q_{i_{old}}^{*} \cdot (1 - \alpha) + \omega \cdot q_j \cdot \alpha \]
  - Aspiration level dropping with time:
    \[ t_{max} = \tau \cdot \frac{L-t}{L} \cdot (1 - \frac{q_b}{q^{*}}) \]
Human mate choice: A Case Study?

Some Robust Empirically Validated Results:

- Mean correlation of qualities in mated pairs (.6 – .8)
- Mean number of alternatives seen before settling with the last date (2 – 10)
- Percentage of individuals in the population that are able to mate (≥ 90%)
- (!) Distribution of age at mating (marriage) time (right-skewed bell-curve)
Human mate choice: A Case Study?

(5)

Can we process to refine more the cognitive map of mate choice?

- Where to stop in the functional decomposition?
- Will we overfit?
- Will the model be robust and generalize?
- How to account for some much “tactical” individual variability for the strategies that we abstracted?
- Do individual use the same information for the same problems?
The Troubles with EP

(Straw Man objections)

- Evolutionary models provide only post hoc (and/or) untestable explanation (EEA = ???)

- (Elman’s et al.) Mapping from Genes to Behavior is complex; shortage of internal constraints (DNA or otherwise)

- Culture has an important role in Behavior (maybe even more than genes)

- (Fodor’s:) Abductive reasoning and integration of information suggests non modular encapsulation

- Can not account for so much human cultural and individual differences (Gene-Culture Coevolutionary models)

- (Gould’s:) Novel behavior (exaptations!!) are much more abundant than EEA relevant behavior

- (Reed’s:) Computational mechanisms can not account for fine-grain behavior accommodation to environmental structures in the econiches

- (WWW:) What is the grain of a module?

(More Serious objections)
Tomasello’s Naturalistic Constructivism

- **Puzzle:** Human recency and sophistication incompatible with pace of evolution; Why and How?? chimp ≈ (98%) humans ⇒ huge behavioral and cognitive gap

- **Ratchet effect:** Ability to preserve individual and cooperative innovations, and generate a cumulative material and symbolic culture

- Social empathy (Dennett’s intentional stance): (small) Set of socio-cognitive skills (modules!?) for triadic interactions such as shared attention, social referencing, and perspective taking ⇒

- Development of new skills: True imitation (not just behavior emulation), self-awareness, language, self-regulation, cooperative team work, meta-cognition

- **Cultural line of development vs. individual line of development** (Vygotsky)

- Chomsky’s UG or inductive learning?
  
  e.g. verb islands: \[
  \begin{cases}
  \text{throw } X, \\
  \text{drop ball (holophrases), but not drop } X
  \end{cases}
  \]
Bringing Life to Cognition (1)

- Cognition is a phenomenon of life
- Life is self-organized, not externally engineered
- Environment “perturbs” the organism
- Structural couplings are recurrent and have structure
- Observer’s representations do/may not correspond to internal representations
Bringing Life to Cognition (2)

- Brunswik’s two lens model (vs.)
- Keijzer’s interacting multi-level dynamics

(insert figures)
A Crash Tour of the Human Brain

- Few anatomically differentiated large scale structures
- The Cortex has the same topological and computational structure all over
- The Cortex is an unsupervised learning organ (information statistical partitioning)
- Functional specialization is self-organized
- Sensorimotor afferents and efferents, and topological relation determines the function specialization
- All parts of the cortex are (essentially) plastic all through
- Minimal(!?) behavior control circuits in the lower brain structures (e.g. brain stem, and basal ganglia)
- Limbic System modulates motivation and attention through circulation of value
Self-Organization, criticality, and globally distributed representations

- Self-Organized Critical Systems: Complex dynamical systems that locally self-organize to critical (high susceptibility, non linear) states

- SOC Systems generate events at all scales according to power law (1/f)

- Consequence: Small local events can have global consequences \(\Rightarrow\) effective transmission of information/energy at long distances

- Neurons regulate synaptic influence to maintain total activity constant (with a time delay)

- Experimental finding: behavior exhibits power law distributions in RT

- Conjecture: Representation are not only distributed (PDP), they are (theoretically) globally distributed — holistic view of the brain
Back to the Basics: Lessons Learned

- High-level behavior invariants (e.g. as captured by micro \(\rightarrow\) macro models), can have underlying complex structure and dynamics

- Evolutionary insights can guide in identifying some plausible constraints, but \ldots

- Many (if not most) model constraints will typically have limited (individual, cultural, ecological, historical) scope; therefore, models have always delimited applicability — there is no fixed and permanent cognitive map; i.e. cognition is an historical contextualized process

- High-level ontologies may be more or less aligned with lower-level ontologies; in all cases, they are different from the lower-level ontologies (which are usually less intuitive)

- High-level behavior theories need to balance many tradeoffs: simplicity, accuracy, explanatory power (breadth, and depth); model simplicity (per se) leads to theoretical fragmentation, and tends to make models hard to falsify \(\rightarrow\)

- (Need to learn more about philosophy and sociology of science! :)
Addendum: Toolboxes, Heuristics, and ABC (DEFG\ldots + \infty)

- Recovery of the role (some) environmental structures, but\ldots

- *Ontological complexity* is infinite and immeasurable (Bunge, 1963 — *The myth of simplicity*)

- *Semiotic complexity* is finite (e.g. Kolmogorov’s MDL)

- Environmental structures are accommodated by the CNS, they do not bind to an existing pool of internal (algorithmic structures)

- Discovering new environmental structures by CNS is tantamount to using them, i.e. is to establish a new sensorimotor coupling

- Assuming internal structures (e.g. algorithms, heuristics) that match external structures, leads to: the problem of genesis and/or excessive massive modularity, infinite regress of the meta level (*the homunculus problem*), \ldots

- How can this be avoided? Change the ontology of the mechanisms: from *heuristics* to *living control systems*, having scalability and adaptability of complete agents in mind (Keijzer’s: *SAB research taken even more seriously*)
Summary: Major Claims/Ideas

1. The study of the structure of the CNS through evolutionary functional analysis, and an algorithmic characterization of behavior control systems is problematic. The idea that we can obtain more and more intelligence with more and more pre-fixed, modular, domain-specific design (“biological incrementalism”) is most likely wrong.

2. In social species with long juvenile/immaturity periods (most notably mammals, and humans as an extreme case), evolution tends to exploit interspecific interactions and other sources of environmental structure to support the development of adaptive behaviors, without requiring an excessive and unrealistic number of internally pre-specified constraints on CNS function and architecture (genetically, or otherwise). Thus the range of functional behaviors that an organism can produce is theoretically unbounded, contingent on the environmental structures it encounters and how they are accommodated by the CNS.

3. Brains are best characterized as complex dynamical systems, that locally self-organizes to a critical state in order to produce global distributed perceptual, motor control, and linguistic representation. Models (or verbal theories) of human functional behavior when focused on a high-level of abstraction (as done in EP), can still be very useful when trying to capture societal, macro-level, phenomena. A caveat, though: a simple correspondence between the models and the underlying mechanisms producing behavior is unwarranted.