Frank and Ernest

Creativity and Discovery as *Blind* Variation (and Selective Retention)

Tautological Identity, Heuristic Metaphor, or Patent Absurdity?

Background

- Charles Darwin: nontelelogical “spontaneous variation” subject to either
  - natural selection (*Origin of Species,* 1859) or
  - sexual selection (*Descent of Man,* 1871)
- Early applications to creativity and genius
  - Francis Galton (1869): *Hereditary Genius*
    - “natural ability” ≈ Darwinian fitness
  - William James (1880): “Great men, great thoughts, and the environment” (*Atlantic Monthly*) ⟶

“social evolution is a resultant of the interaction of two wholly distinct factors: the individual, deriving his peculiar gifts from the play of psychological and infra-social forces, but bearing all the power of initiative and origination in his hands; and, second, the social environment, with its power of adopting or rejecting both him and his gifts”

But Galton and James conceived the individual genius or creator as the unit of selection rather than the idea or thought trial

Background

- Donald T. Campbell
  - (1960): “Blind variation and selective retention in creative thought as in other knowledge processes” (*Psychological Review*)
  - (1974): “Evolutionary epistemology” (*The philosophy of Karl Popper*)

Background

- Simonton
  - (1988): *Scientific genius: A psychology of science*
  - (1999): “Creativity as blind variation and selective retention: Is the creative process Darwinian?” (*Psychological Inquiry)* – target article
  - (1999): *Origins of genius: Darwinian perspectives on creativity*
  - (2007): “The creative imagination in Picasso’s *Guernica* sketches: Monotonic improvements or nonmonotonic variants?” (*CRJ)* – target article
  - (2009): “Creativity as a Darwinian phenomenon: The blind-variation and selective-retention model” (chapter in *The idea of creativity*)

Background

- Other proponents:
  - Popper (1974-1984)
  - Stein & Lipton (1989)
  - Kantorovich (1993)
  - Staw (1990)
  - Cziko (1998)

Background

- Some opponents:
  - Perkins (1994)
  - Sternberg (1998)
  - Dasgupta (2004)
  - Gabora (2005)
  - Kronfelder (in press)

Concepts

- *Variants*: two or more alternative proteins, enzymes, morphologies, antibodies, neurons, behaviors, ideas, etc.
- *Blind variation*: variants unjustified, undirected, unguided, haphazard, unconstrained, random, serendipitous, etc.
- *Selective retention*: variant satisfies approximately consistent and/or stable fitness criteria (natural, sexual, antigenic, scientific, aesthetic, stylistic, etc.)

Definitions

- Sightedness versus blindness
- Let there be two potential variants X and Y with probabilities *p* (X) and *p* (Y) and
- let their fitness values be *w* (X) and *w* (Y);
- then the variants are *sighted* if, say,
  - *p* (X) > *p* (Y) and *w* (X) > *w* (Y), *plus*
  - *w* (X) > *w* (Y) → *p* (X) > *p* (Y)
- i.e., variant probabilities and fitness values are “coupled” (Toulmin)

Definitions

- But if p (X) ≈ p (Y) although w (X) ≠ w (Y);
- or if p (X) > p (Y) although w (X) < w (Y);
- then the variants are *blind*
- i.e., variant probabilities and fitness values are “decoupled”
- Two simple examples:
  - Fork in the road dilemma
  - The two-strings problem

Definitions

- N.B.:
  - If w (X) > w (Y) and p (X) > p (Y)
- but
  - w (X) > w (Y) does ***not imply*** p (X) > p (Y)
- then decoupling or blindness still applies
- e.g., the “lucky guess”

Definitions

- Creativity = “adaptive originality”
- Thus, *C* = *O* X *A*, where *C* is *creativity, O* is *originality,* and *A* is *adaptiveness*
- and where all three are ratio scales (i.e., if either *O* = 0 or *A* = 0 or both, then *C* = 0)
- Hence, intrinsic relation to BVSR
  - BV → *O* then
  - SR → *A*
- N.B.: This generic definition also encompasses (most) discoveries and (all) inventions

Manifestations

- Three main manifestations:
  - Biological evolution
  - Operant conditioning
  - Creative problem solving
- e.g., Dennett's "creatures":
  - Darwinian
  - Skinnerian
  - Popperian and Gregorian

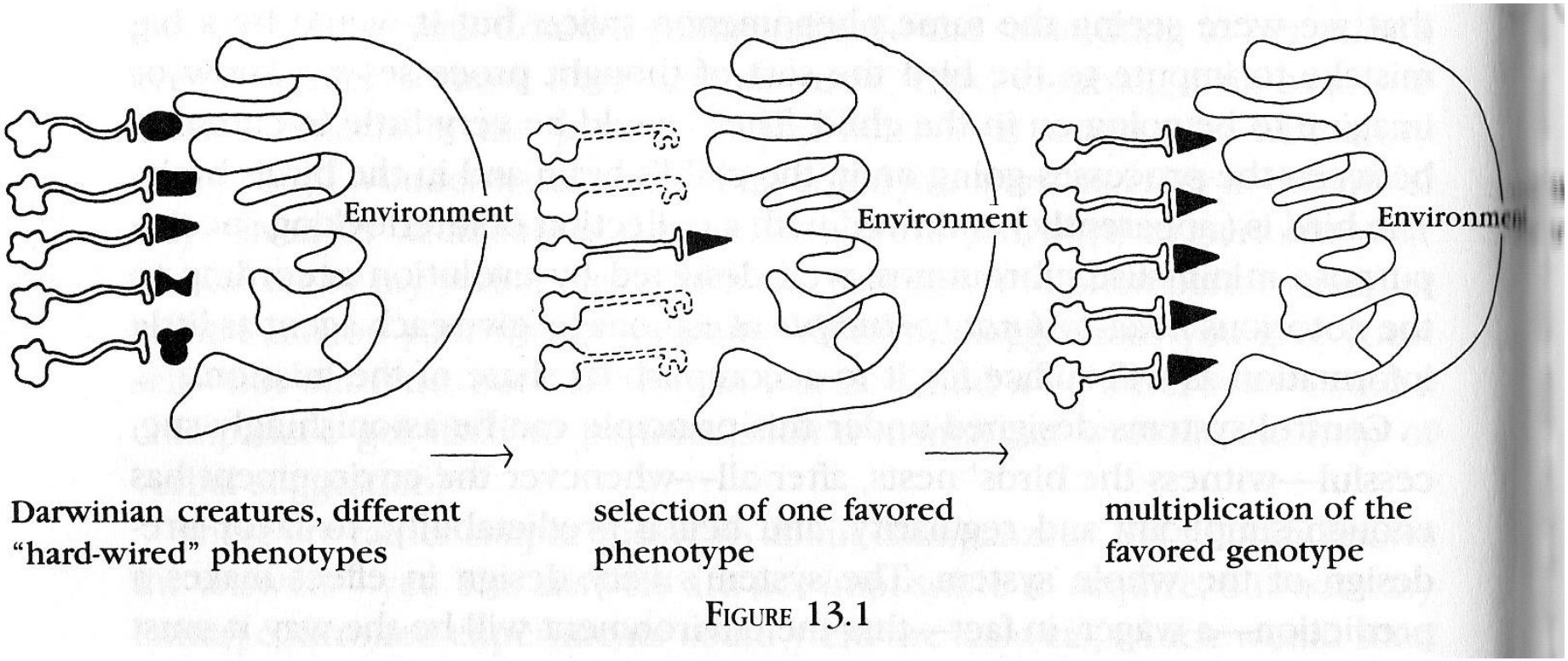


FIGURE 13.1

Selection simultaneous and external

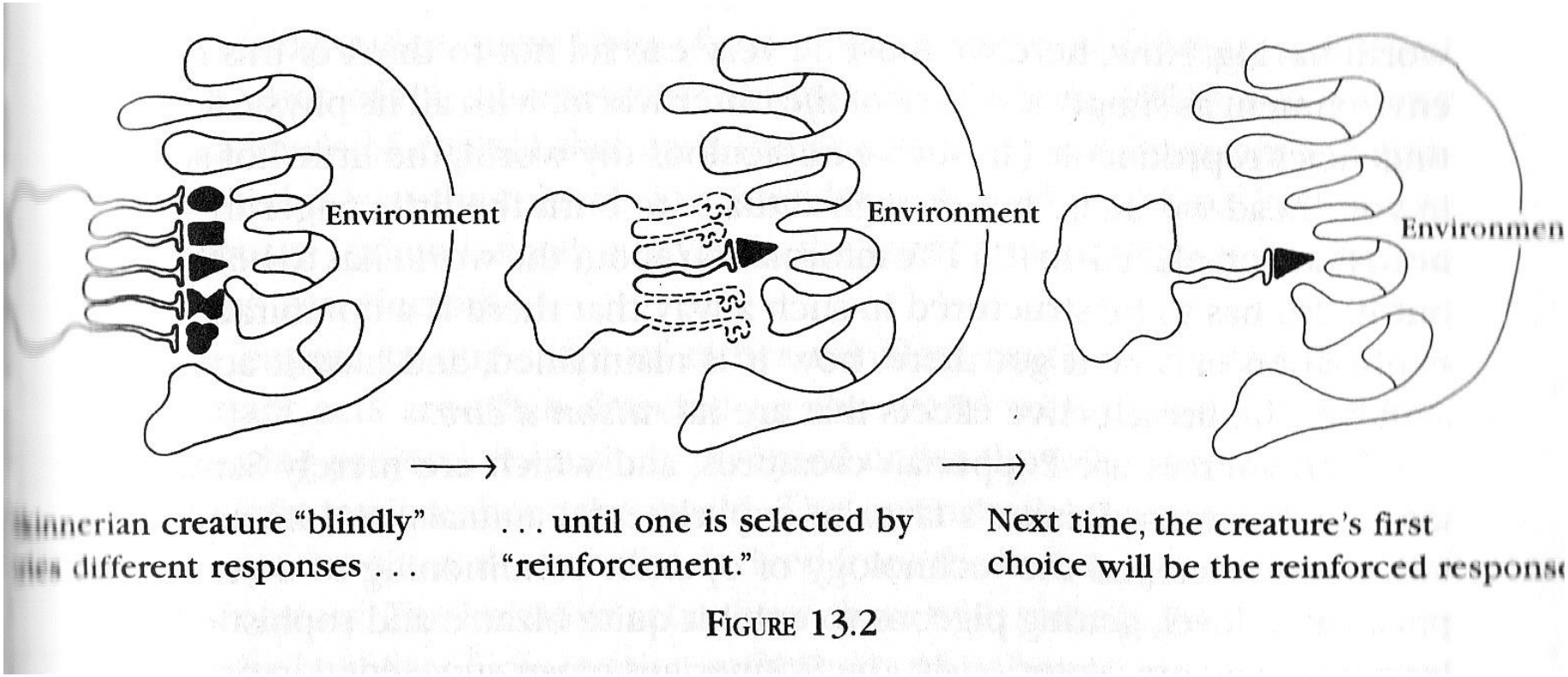
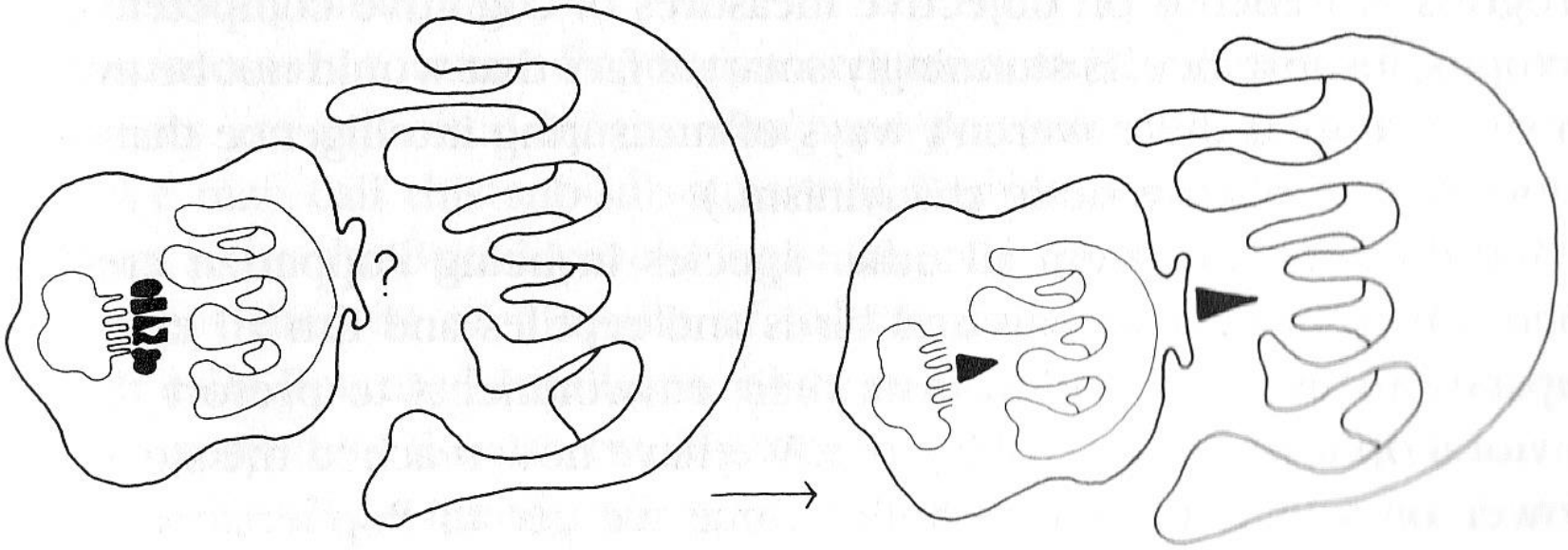


FIGURE 13.2

Selection sequential and external

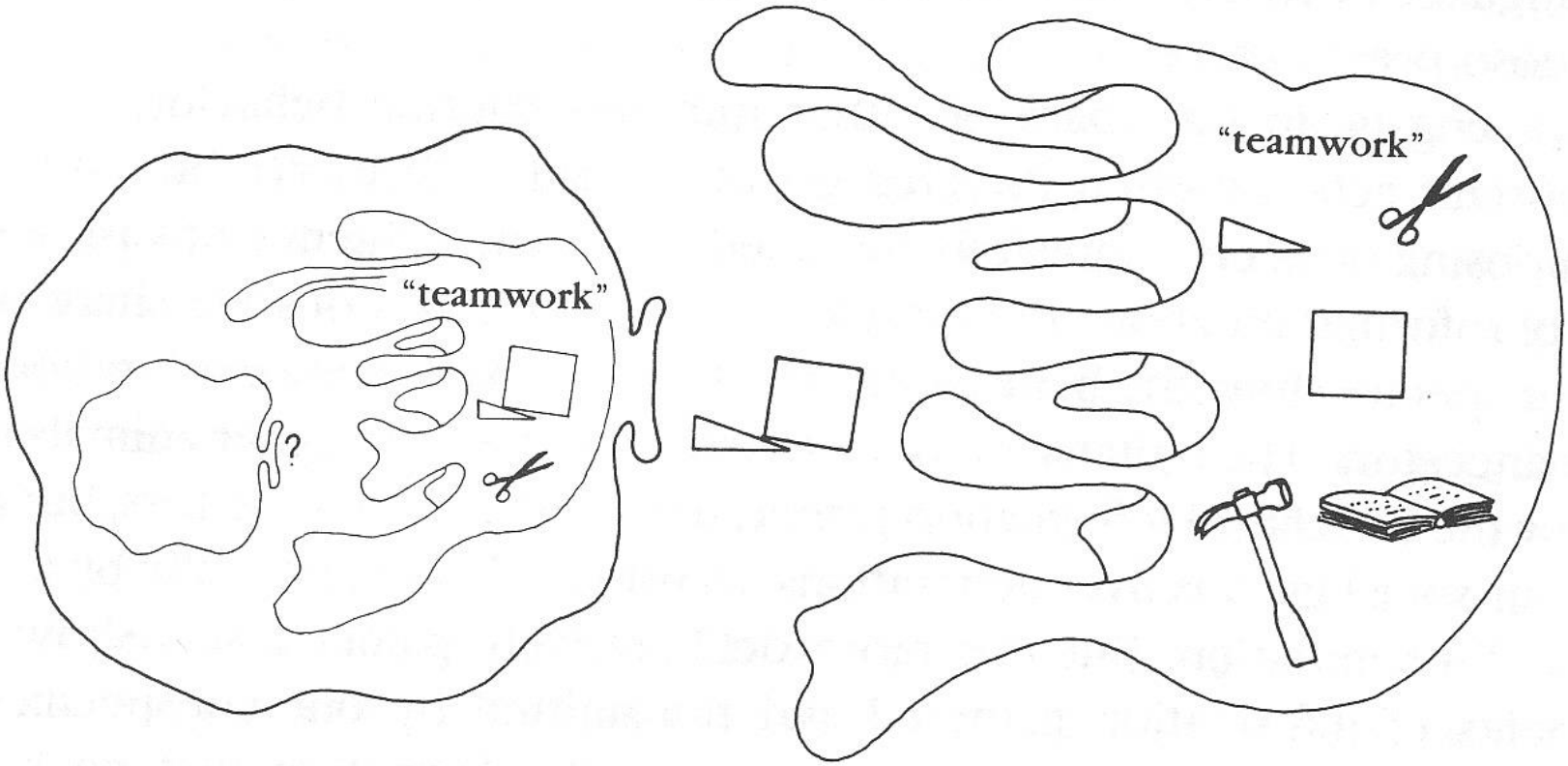


Popperian creature has an inner selective environment that previews candidate acts.

First time, the creature acts in a foresightful way (better than chance).

FIGURE 13.3

Selection sequential and internal



Gregorian creature imports mind-tools from the (cultural) environment; these improve both the generators and the testers.

Selection sequential and internal

Identification

- How does one determine whether a process generates blind variations?
  - Case 1: The variations are blind by intention
    - i.e., the BV mechanism is so designed *a priori*
  - Case 2: The variations are blind by implication
    - The variations themselves have the immediate properties of blindness
    - The underlying variation processes have the qualities that would be expected to yield blindness

Case 1: Intention

- Combinatorial operations
  - Deterministic
    - Inductive discovery programs:

Case 1: Intention

- Combinatorial operations
  - Deterministic
    - Inductive discovery programs: BACON's discovery of Kepler's Third Law $P^2 = kD^3$ or $P^2/D^3 = k$
      - » $P/D \neq k$, i.e., $w\,(P/D) = 0$
      - » $P^2/D \neq k$, i.e., $w\,(P^2/D) = 0$
      - » $P/D^2 \neq k$, i.e., $w\,(P/D^2) = 0$
      - » $P^2/D^2 \neq k$, i.e., $w\,(P^2/D^2) = 0$
      - » $P/D^3 \neq k$, i.e., $w\,(P/D^3) = 0$
      - » … …
      - » $P^2/D^3 = k$, i.e., $w\,(P^2/D^3) > 0$
    - Because parsimony ≠ sightedness, *p* decoupled from *w*

Case 1: Intention

- Combinatorial operations
  - Deterministic
    - Inductive discovery programs
    - Search scans and grids
      - e.g., radar, where
      - for all $0 \leq \theta_t \leq 2\pi$
      - all $p(\theta_t)$ are exactly equal
      - yet not all $w(\theta_t)$ are equal

Case 1: Intention

- Combinatorial operations
  - Deterministic
  - Stochastic
    - Evolutionary algorithms (genetic algorithms, evolutionary programming, genetic programing)
    - Aleatoric art and music
    - Probably all programs that simulate creativity:
      - “a convincing computer model of creativity would need some capacity for making random associations and/or transformations … using random numbers” (Boden, 1991, p. 226)

Case 1: Intention

- Thought questions:
  - Why is it that the only computer programs to simulate creativity and/or discovery all seem to require some kind of *blind* variation, whether deterministic or stochastic?
  - If computer simulations require blindness, does that imply that human creativity and/or discovery must operate in the same manner?
  - Or could computer blindness constitute a paradoxical proxy for human sightedness?

Case 2: Implication

- Variations with properties of blindness
  - Superfluity (too many diverse, even incommensurate variants)
    - “the world little knows how many of the thoughts and theories which have passed through the mind of a scientific investigator have been crushed in silence and secrecy by his own severe criticism and adverse examinations; that in the most successful instances not a tenth of the suggestions, the hopes, the wishes, the preliminary conclusions have been realized”
      – Michael Faraday

Case 2: Implication

- Variations with properties of blindness
  - Superfluity
    - Precaution:
      - Although superfluity implies BV,
      - the absence of superfluity does not imply not-BV

Case 2: Implication

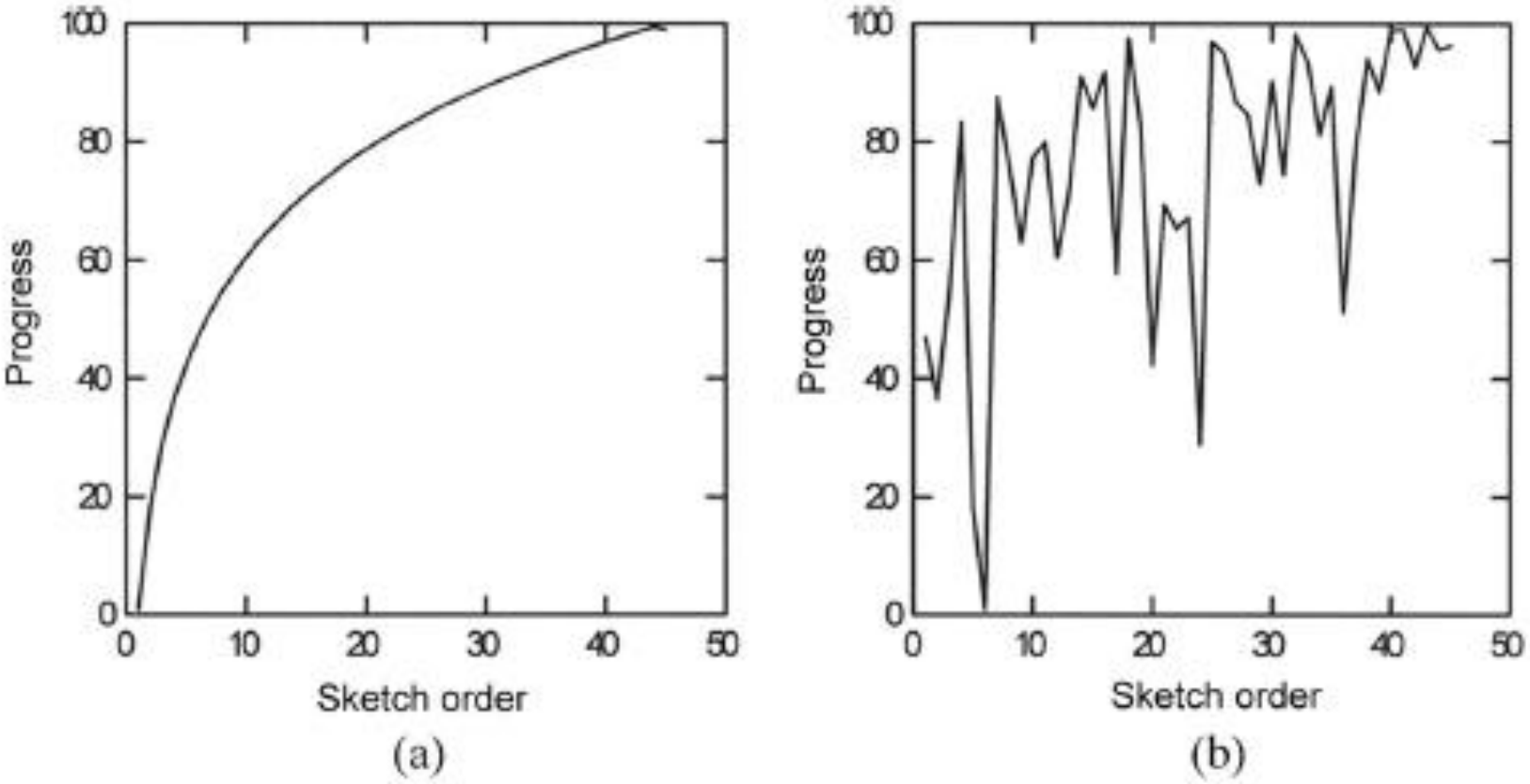
- Variations with properties of blindness
  - Superfluity
  - Backtracking (too many rejected variants; absence of asymptotic honing)

“I only succeeded in solving such problems after many devious ways, by the gradually increasing generalisation of favourable examples, and by a series of fortunate guesses. I had to compare myself with an Alpine climber, who, not knowing the way, ascends slowly and with toil, and is often compelled to retrace his steps because his progress is stopped; sometimes by reasoning, and sometimes by accident, he hits upon traces of a fresh path, which again leads him a little further; and finally, when he has reached the goal, he finds to his annoyance a royal road on which he might have ridden up if he had been clever enough to find the right starting-point at the outset. In my memoirs I have, of course, not given the reader an account of my wanderings, but I have described the beaten path on which he can now reach the summit without trouble.”
- Hermann von Helmholtz

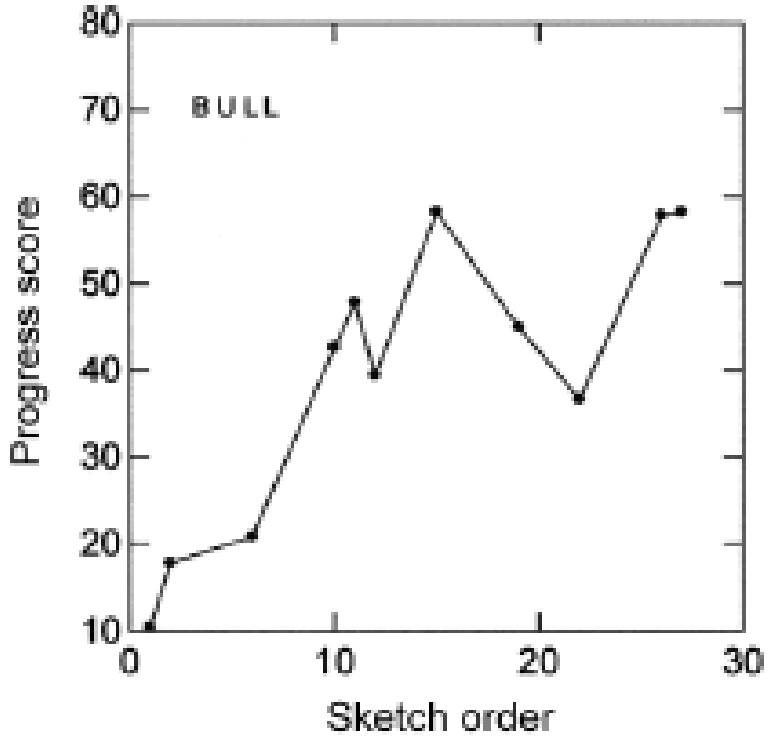
e.g., the 45 *Guernica* Sketches

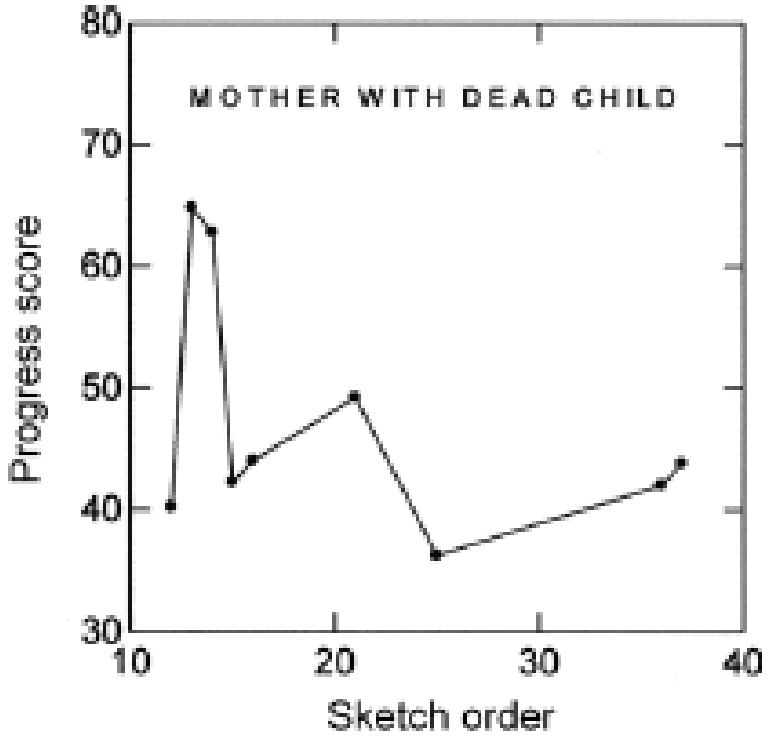
...

Monotonic versus Nonmonotonic



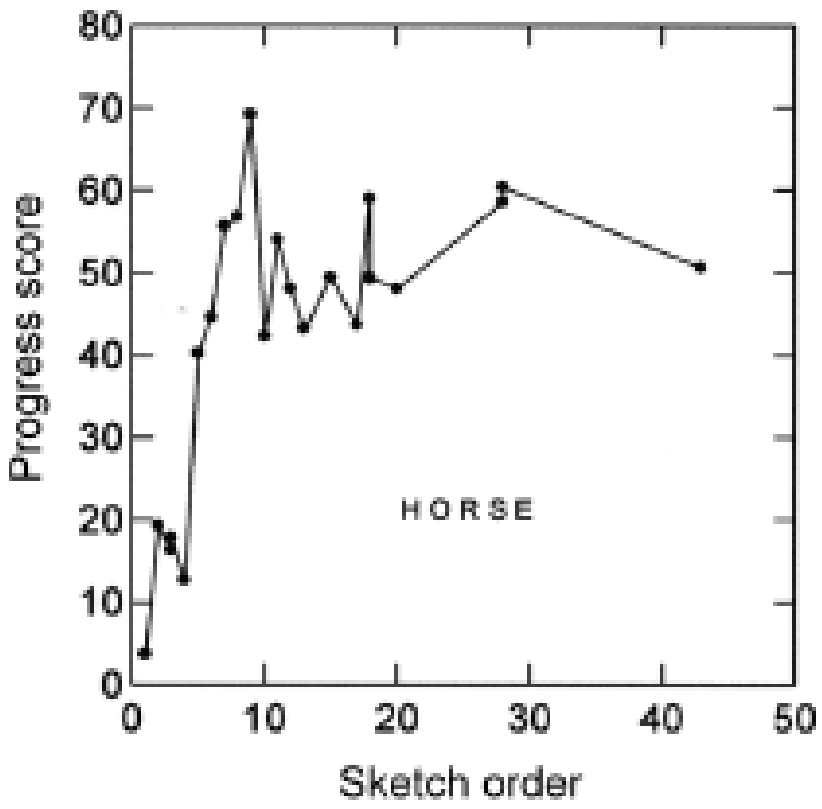
i.e., guided approximation vs. unguided search

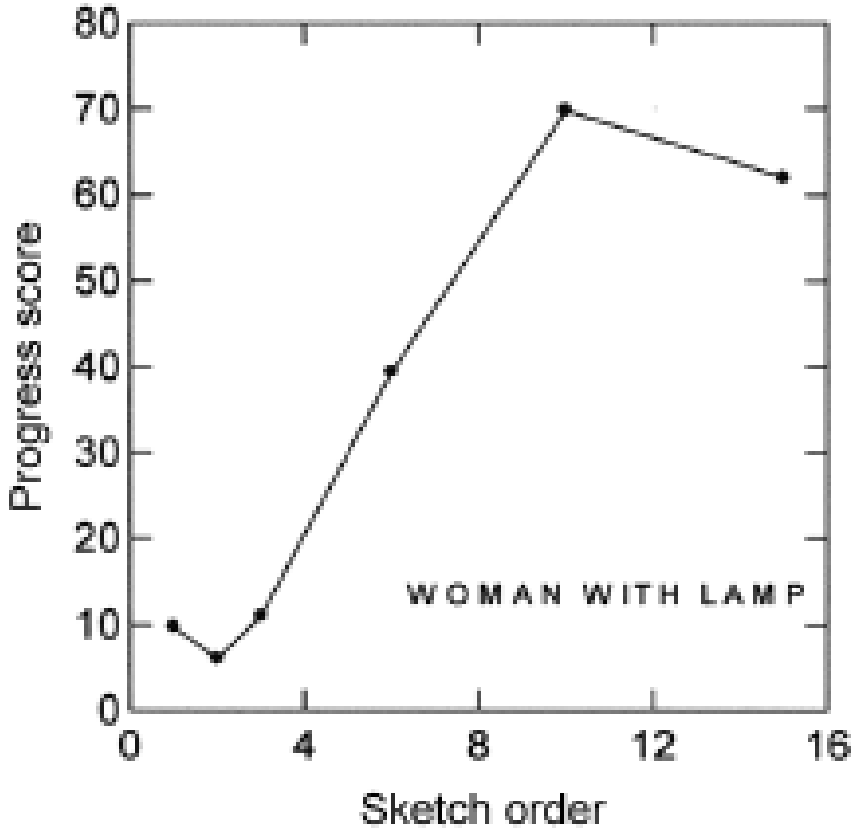


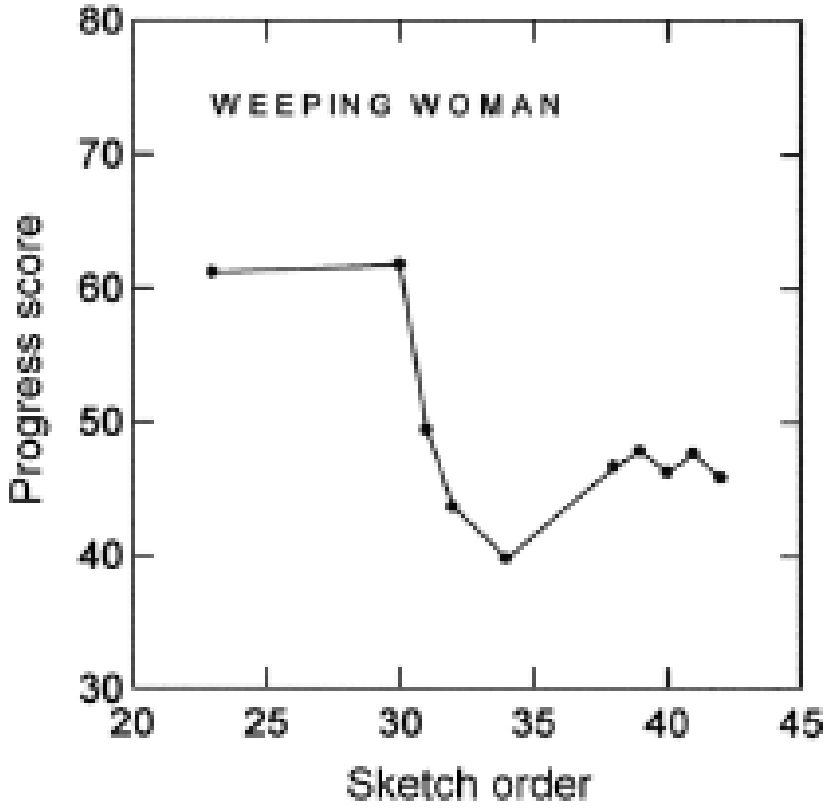


N.B.: "Progress score" = an estimate of *w*


Progress score
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
Sketch order
WARRIOR

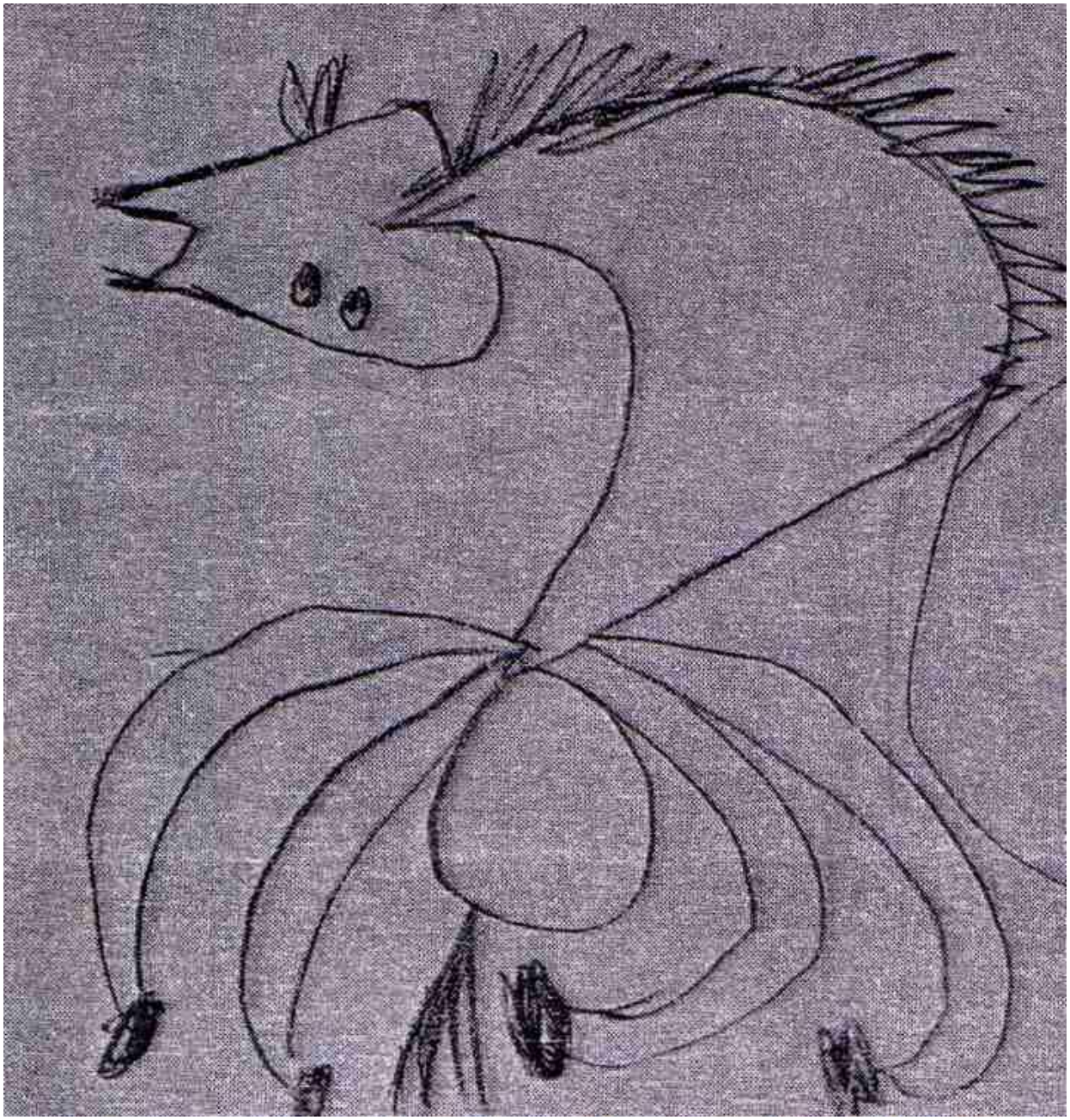

Progress score
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
Sketch order
HORSE

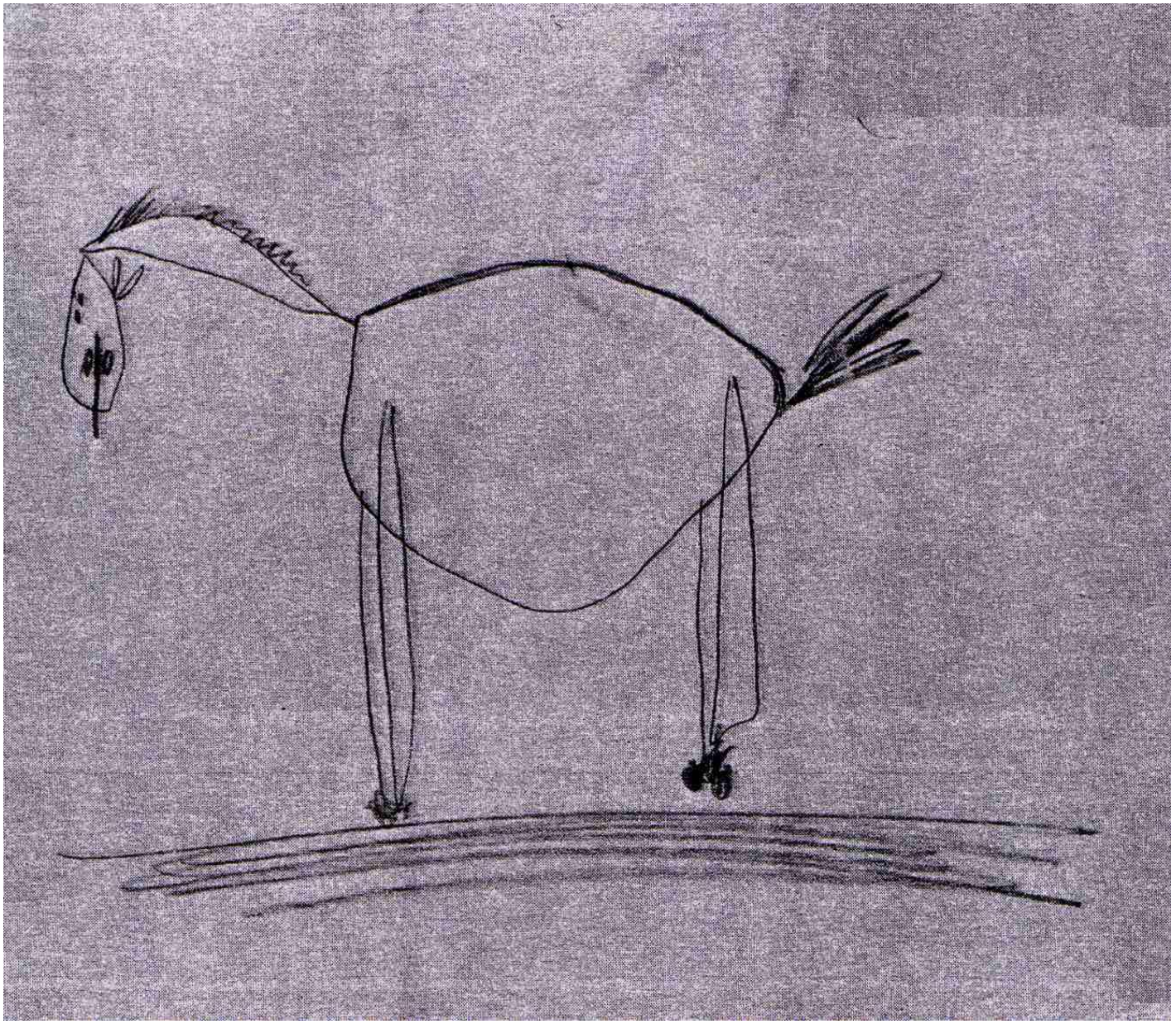

WOMAN WITH LAMP
Progress score
Sketch order
0
10
20
30
40
50
60
70
80
0
4
8
12
16

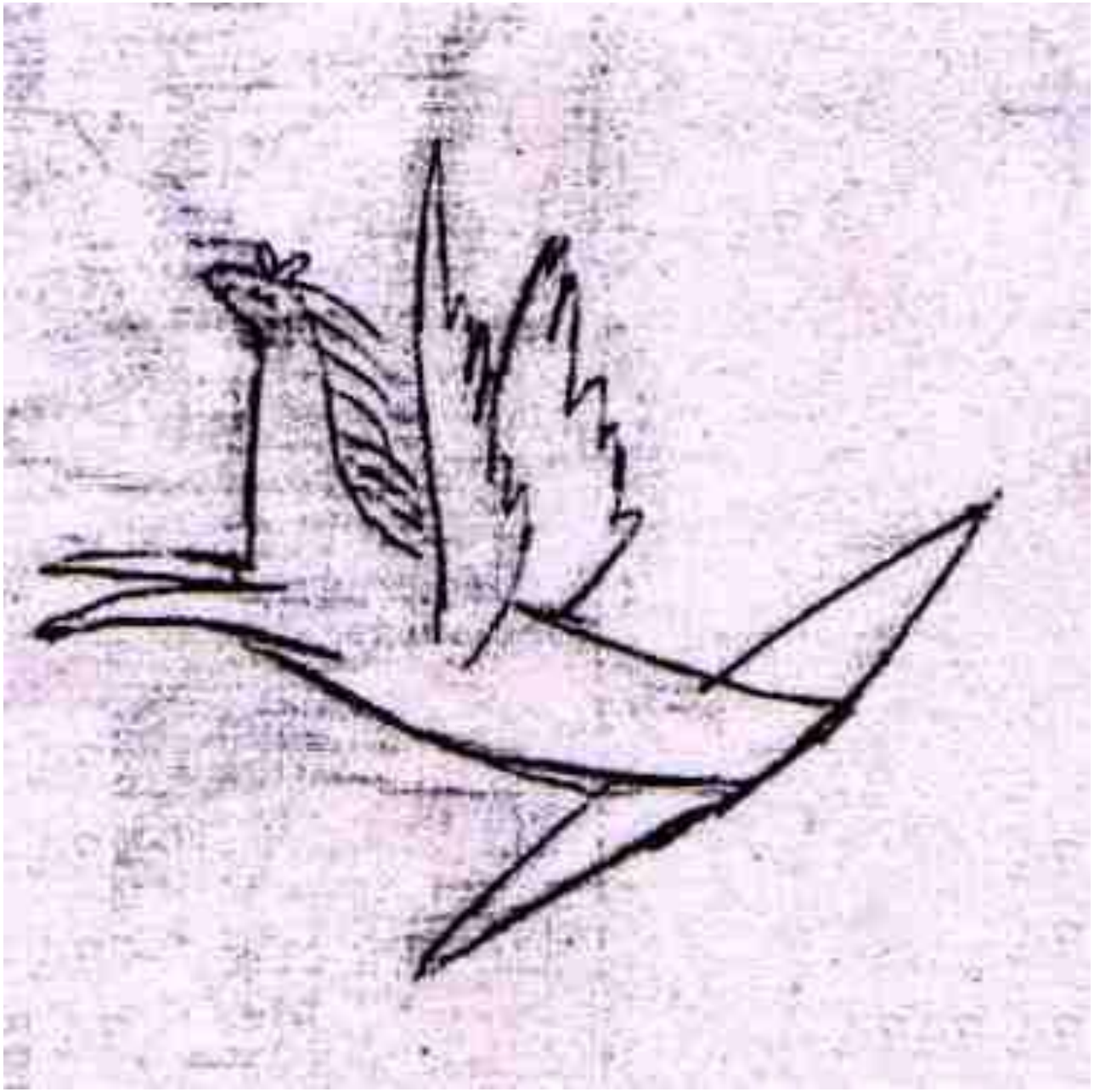

WEEPING WOMAN
Progress score
Sketch order
30
40
50
60
70
80
20
25
30
35
40
45

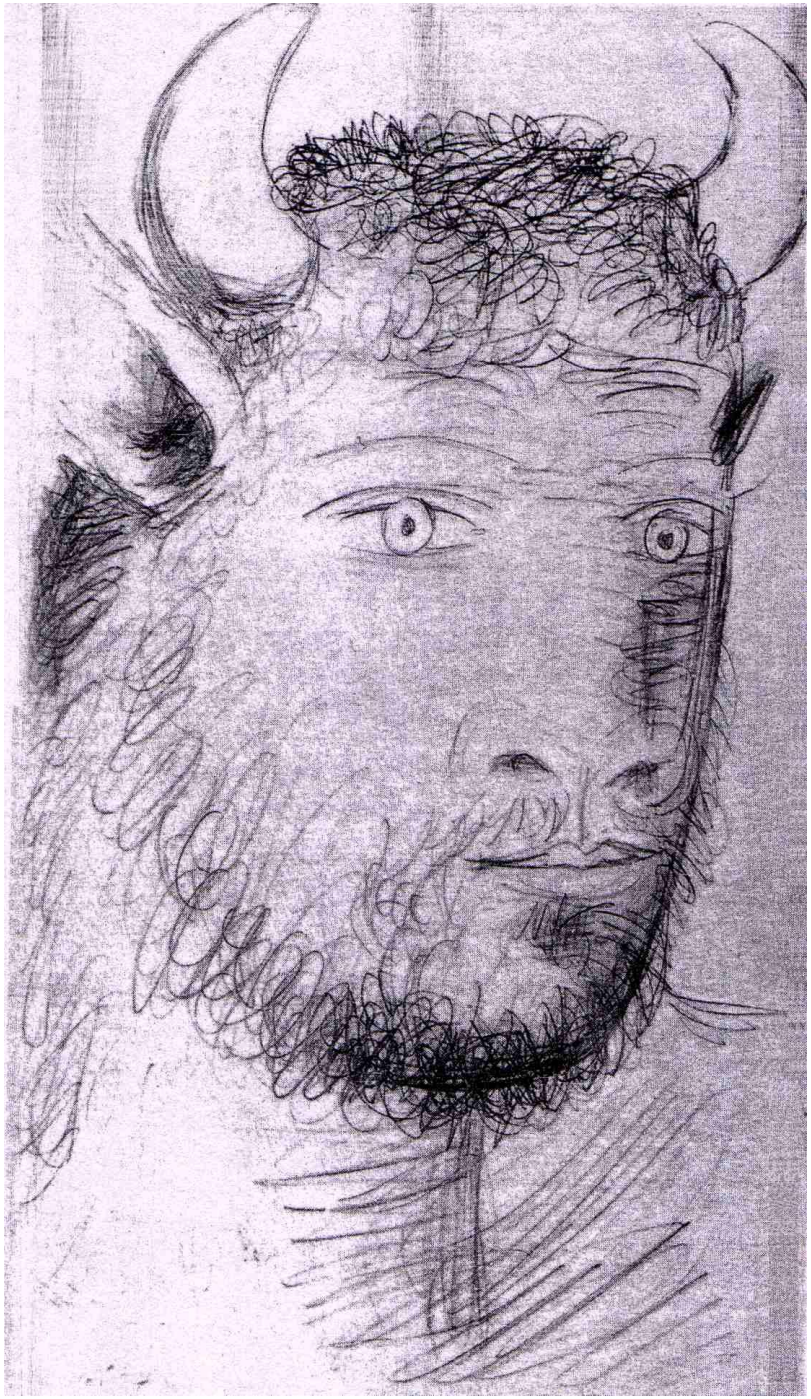
Or less abstractly …

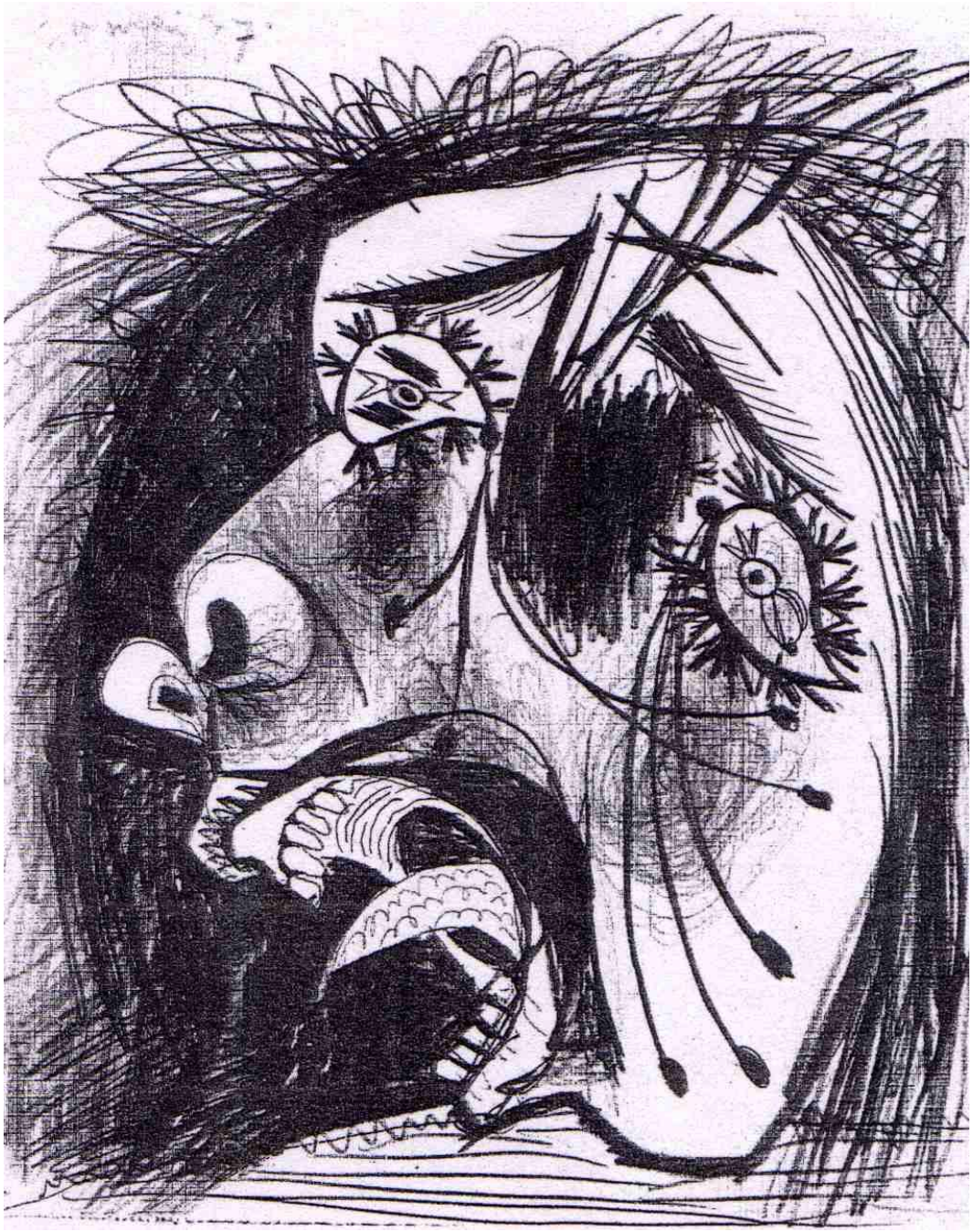
*a few of the more **blind** variants*

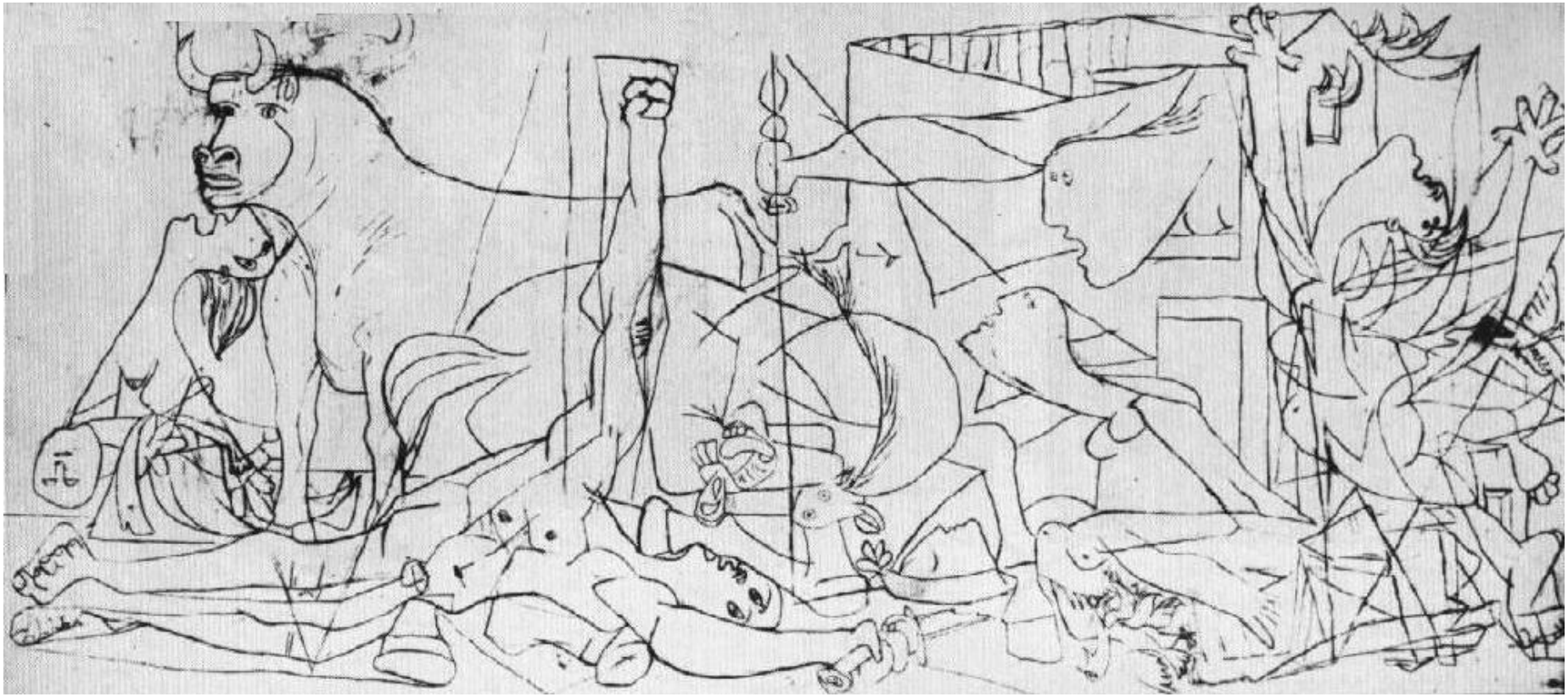












N.B.:

The higher the proportion of backtracks the higher the likelihood that even the more adaptive variants lacked sightedness; every “you’re getting colder” implies that every “you’re getting warmer” might have been a “lucky guess”

Case 2: Implication

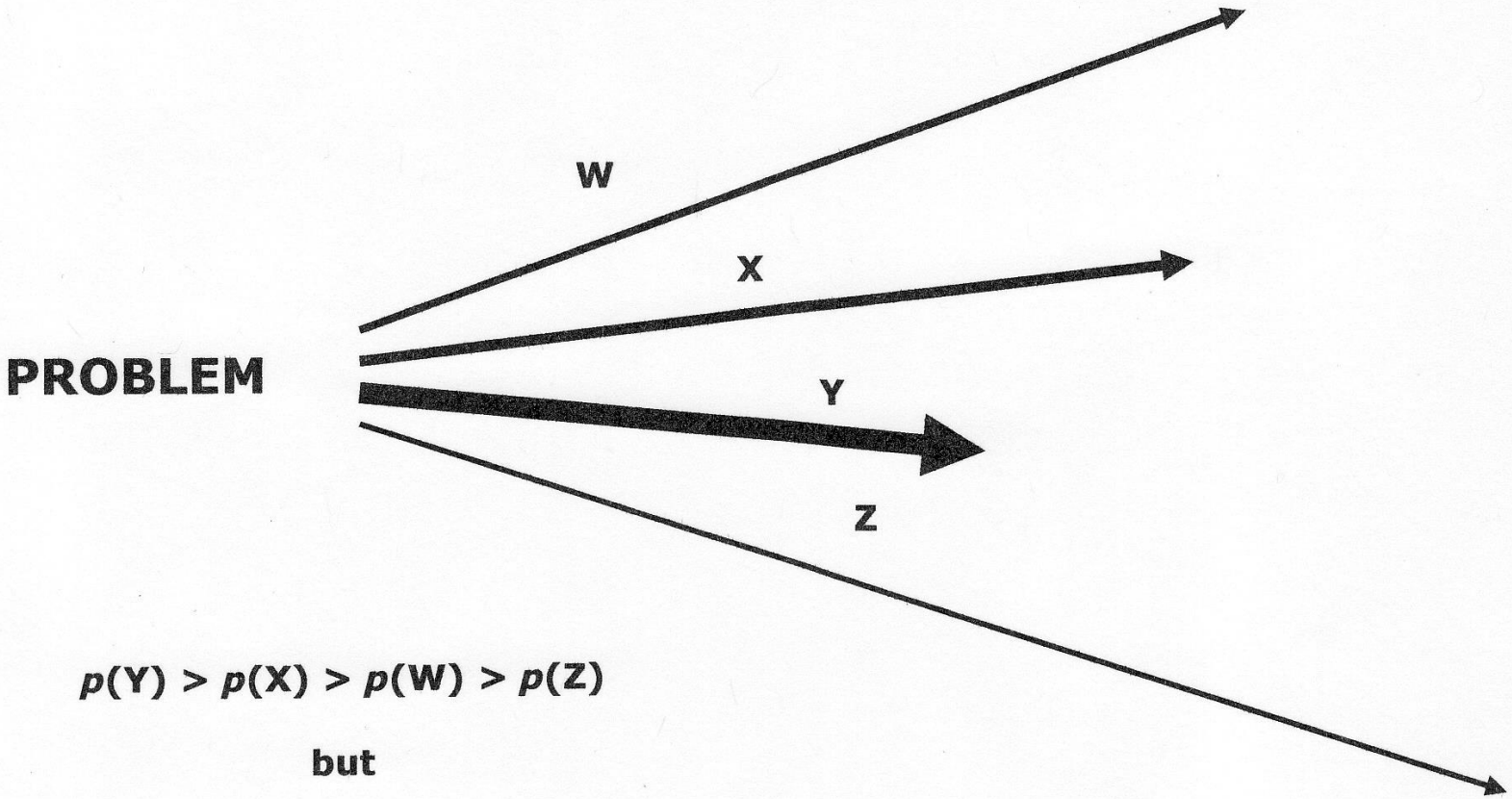
- Processes that should yield blindness:

“Instead of thoughts of concrete things patiently following one another in a beaten track of habitual suggestion, we have the most abrupt cross-cuts and transitions from one idea to another, the most rarefied abstractions and discriminations, the most unheard of combination of elements, the subtlest associations of analogy; in a word, we seem suddenly introduced into a seething caldron of ideas, where everything is fizzling and bobbling about in a state of bewildering activity, where partnerships can be joined or loosened in an instant, treadmill routine is unknown, and the unexpected seems only law.” - William James

Case 2: Implication

- Processes that should yield blindness
  - Associative richness:
    - remote associations (Mednick)
    - unusual associations (Gough)
    - divergent thinking (e.g., unusual uses; Guilford)
    - primary process/primordial cognition (Kris/Martindale)
    - allusive/over-inclusive thinking (Eysenck et al.)
    - Janusian and homospatial imagery (Rothenberg)
    - clang associations (Galton)
  - all supporting or stimulating “spreading activation” in which associative strengths are decoupled from outcome fitness

ASSOCIATIVE CHAINS



$p(Y) > p(X) > p(W) > p(Z)$

but

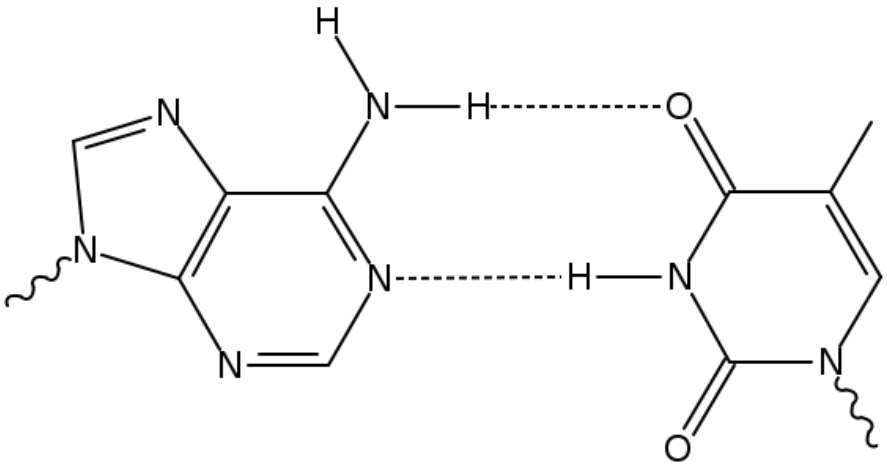
$w(Z) > w(W) > w(X) > w(Y)$

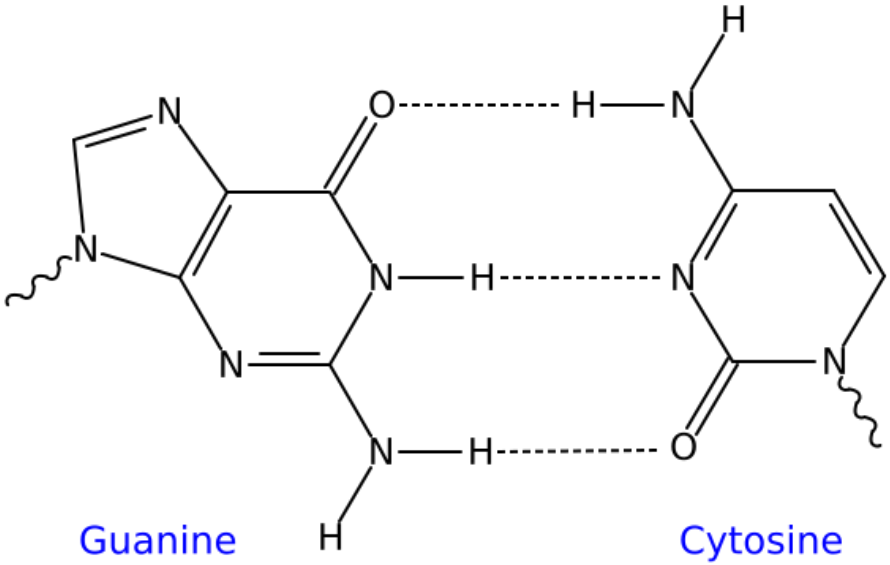
Case 2: Implication

- Processes that should yield blindness
  - Associative richness
  - Defocused attention (e.g., reduced latent inhibition & negative priming):
    - enhanced “opportunistic assimilation”
    - reduced “functional fixedness”
    - enhanced susceptibility to “pseudo serendipity”

Case 2: Implication

- Processes that should yield blindness
  - Associative richness
  - Defocused attention
  - Behavioral/Cognitive “tinkering”
    - e.g., James Watson’s cardboard molecular models


H
N
H
O
N
N
N
H
N
N
O
Adenine
Thymine


H
N
O
H
N
N
H
N
N
N
N
H
O
H
Guanine
Cytosine

Case 2: Implication

- Processes that should yield blindness
  - Associative richness
  - Defocused attention
  - Behavioral/Cognitive “tinkering”
    - e.g., James Watson’s molecular models
    - e.g., Albert Einstein’s “combinatorial play”

“Ideas rose in clouds; I felt them collide until pairs interlocked, so to speak, making a stable combination.”

- Henri Poincaré

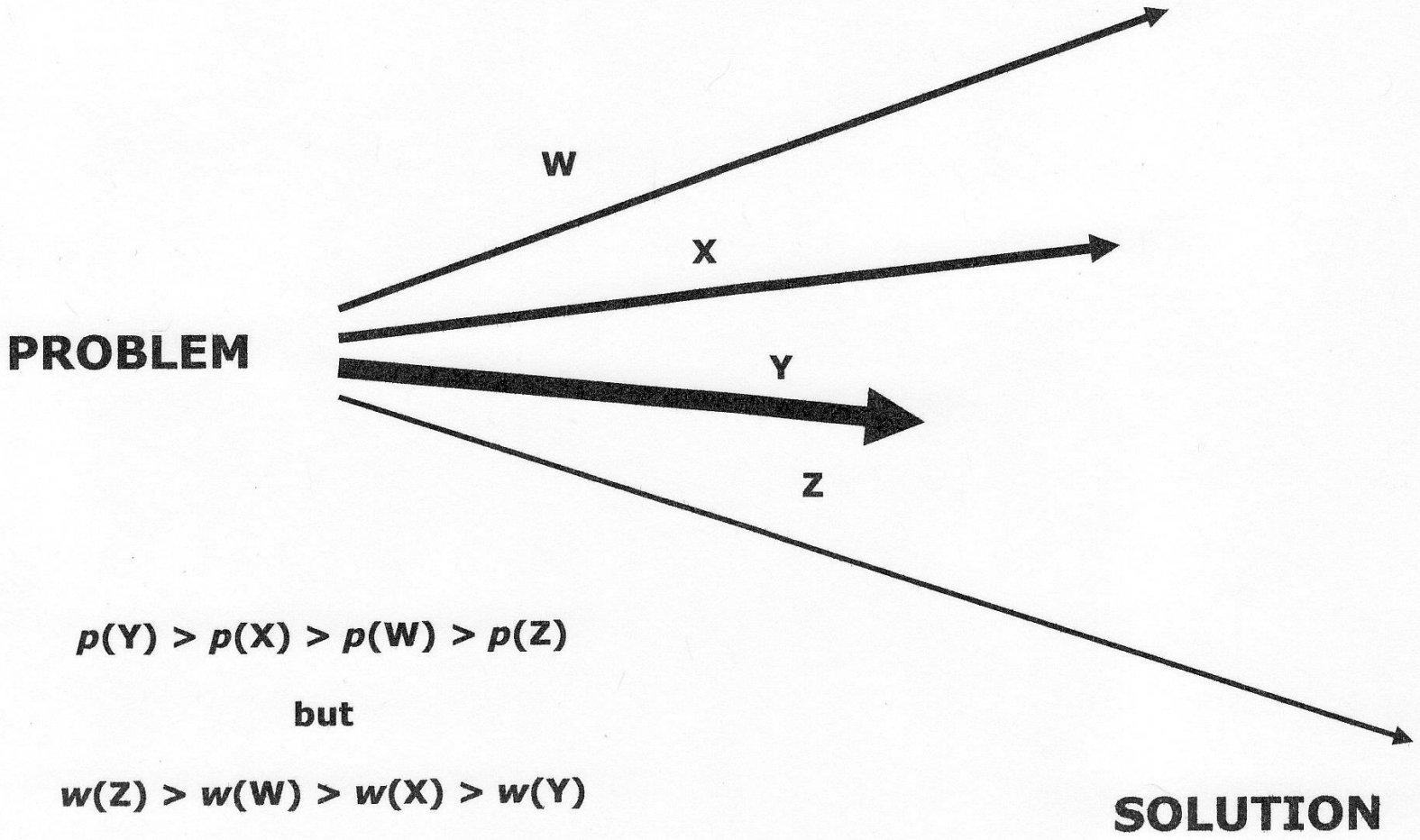
Case 2: Implication

- Processes that should yield blindness
  - Associative richness
  - Defocused attention
  - Behavioral/Cognitive “tinkering”
    - e.g., James Watson’s molecular models
    - e.g., Albert Einstein’s “combinatorial play”
    - cf. Geneplore model (Finke, Ward, & Smith, 1992)
  - Heuristic searches under extreme uncertainty

Heuristic Searches

- *Algorithms*: (near) perfect coupling
- *Heuristics*: means-end analysis, hill climbing (steepest ascent), working backwards, analogy, trial-and-error, etc.
- Continuum from *well-defined* to *ill-defined* problem spaces: progression from “strong” to “weak” methods; increased decoupling
- *Trial-and-error meta-heuristic*: generate and test all heuristics until solution obtains

TRIAL HEURISTICS



$p(Y) > p(X) > p(W) > p(Z)$

but

$w(Z) > w(W) > w(X) > w(Y)$

Misconceptions

- BVSR denies creative purpose
  - ***I answer that …***
- BVSR denies domain expertise
  - ***I answer that …***
- BVSR requires ideational randomness
  - ***I answer that …***
- BVSR requires an isomorphic analogy
  - ***I answer that …***

Contributions

- Exploratory: Generative Metaphor
  - Inspired and continues to inspire original research on creativity and discovery
    - e.g. the *Guernica* sketches
    - e.g. disciplinary hierarchies

Contributions

- Exploratory: Generative Metaphor
  - Inspired and continues to inspire original research on creativity
- Explanatory: Inclusive Framework
  - Provides overarching theory that can encompass a diversity of models, including …
- Predictive: Combinatorial Models
  - e.g., creative productivity & multiple discovery

Residual Issues

- How does BV relate to creativity
  - sine qua non? if so, then logical or empirical?
  - originality directly proportional to BV?
  - or only probabilistic?
    - larger the *O* in *C* = *O* X *A*,
    - the higher the probability of BV involvement?
- What is the status of:
  - anomalies and serendipitous discoveries?
  - internal representation tests?

“If we knew what we were doing it wouldn't be research.”

- Albert Einstein