Buffy Vampire Slayer Relationships ≠ BVSR

Creativity and Discovery as *Blind* Variation:

Donald Campbell's BVSR Theory after the Half-Century Mark

Background

- Donald T. Campbell
  - (1960): “Blind variation and selective retention in creative thought as in other knowledge processes” (*Psychological Review*)
- Historical antecedent:
  - Charles Darwin’s 1859 *Origin of Species*?
  - ***NO!***
  - Alexander Bain’s 1855 *Senses and the Intellect*! (also Mach, 1896; Poincare, 1913)
- But need to define terms …

Creativity and Discovery

- Three criteria (cf. US Patent Law)
  - Original/Novel
  - Adaptive/Useful
  - Nonobvious/Surprising
- Hence: novelty, utility, surprise
  - e.g., Michelson-Morley null result:
    - Lorentz-Fitzgerald contraction hypothesis
      - versus
    - Einstein's special theory of relativity

Sightedness versus Blindness

- Let there be two ideational variants X and Y with probabilities p (X) > 0 and p (Y) > 0 let their utilities be u (X) and u (Y), the u's representing SR probabilities;
- then the variants are *sighted* if, say,
  - p (X) > p (Y) and u (X) > u (Y), *plus*
  - u (X) > u (Y) → p (X) > p (Y)
- i.e., variant probabilities and utilities are "coupled" (Toulmin, 1972)

Sightedness versus Blindness

- But if p (X) ≈ p (Y) although u (X) ≠ u (Y);
- or if p (X) > p (Y) although u (X) < u (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

Sightedness versus Blindness

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

Blind-Sighted Continuum

- Quantitative rather than qualitative trait
- Two sources
  - *Imperfect pre-selection*:
    - admission of false positives: $p(Z) > 0$ but $u(Z) = 0$
    - omission of false negatives: $p(Z) = 0$ but $u(Z) > 0$

Blind-Sighted Continuum

- Quantitative rather than qualitative trait
- Two sources
  - *Imperfect pre-selection*
  - *Partial coupling*: surviving variants may vary in degree of decoupling:
    - e.g., *u* (X) = 1 and *u* (Y) = 0 leads to the weak expectation or “hunch” that *p* (X) > *p* (Y) but not that *p* (X) = 1 and *p* (Y) = 0
- Although theoretically orthogonal, the two sources probably correlated

BVSR Manifestations

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

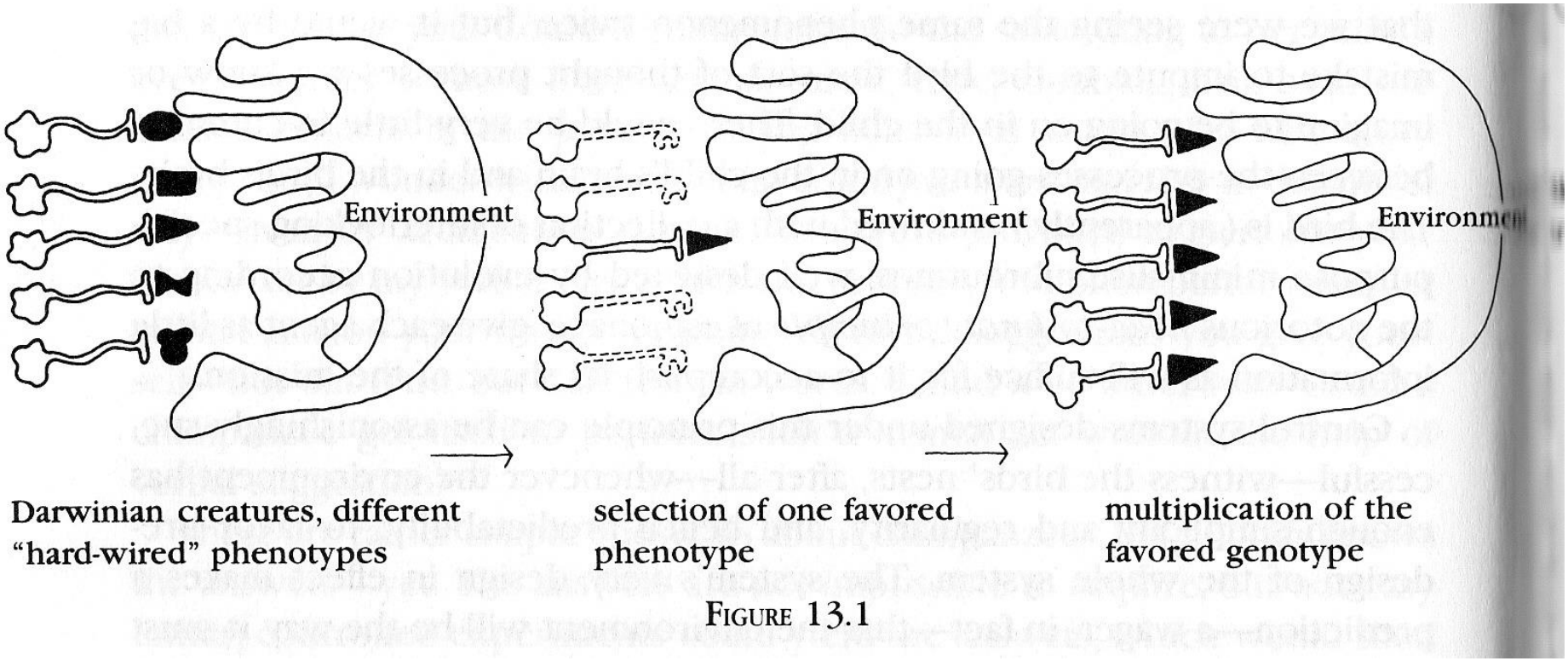
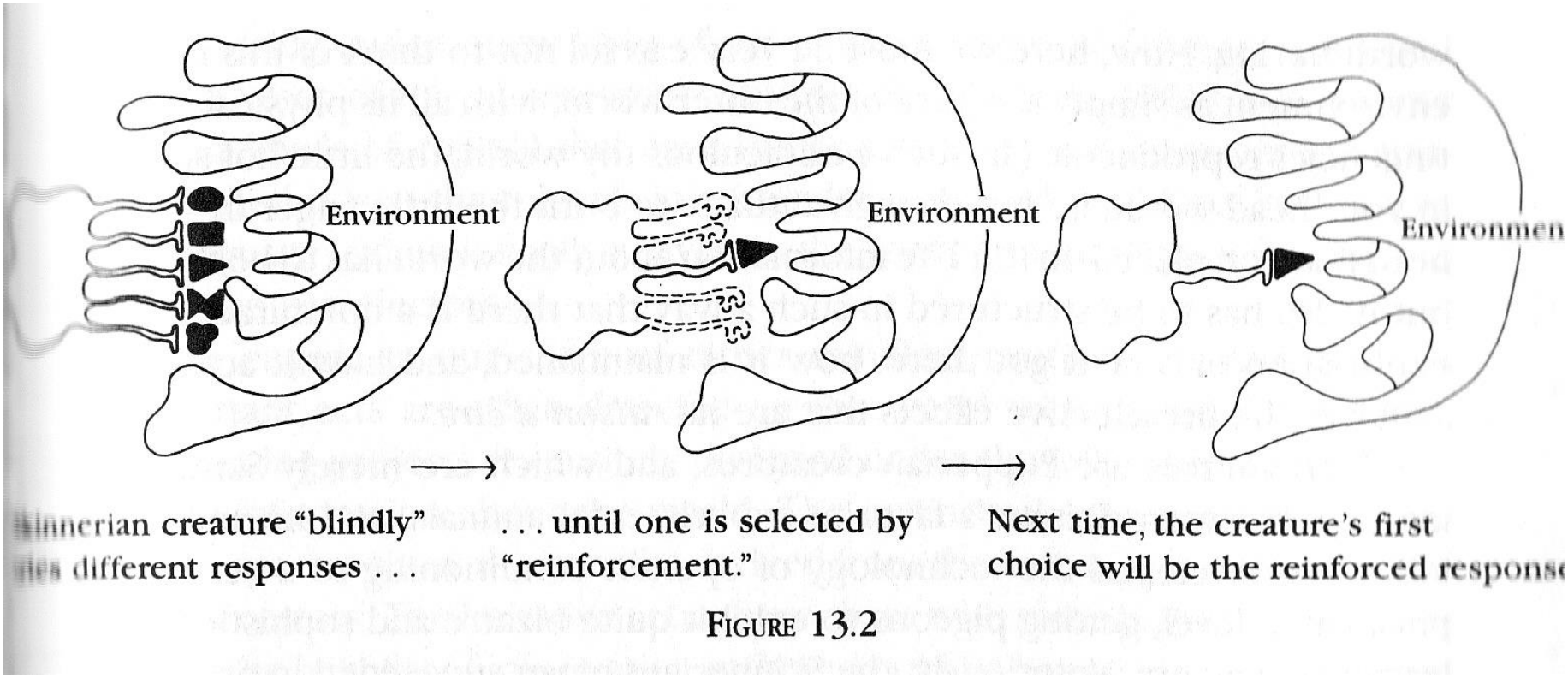


FIGURE 13.1

Selection simultaneous and external



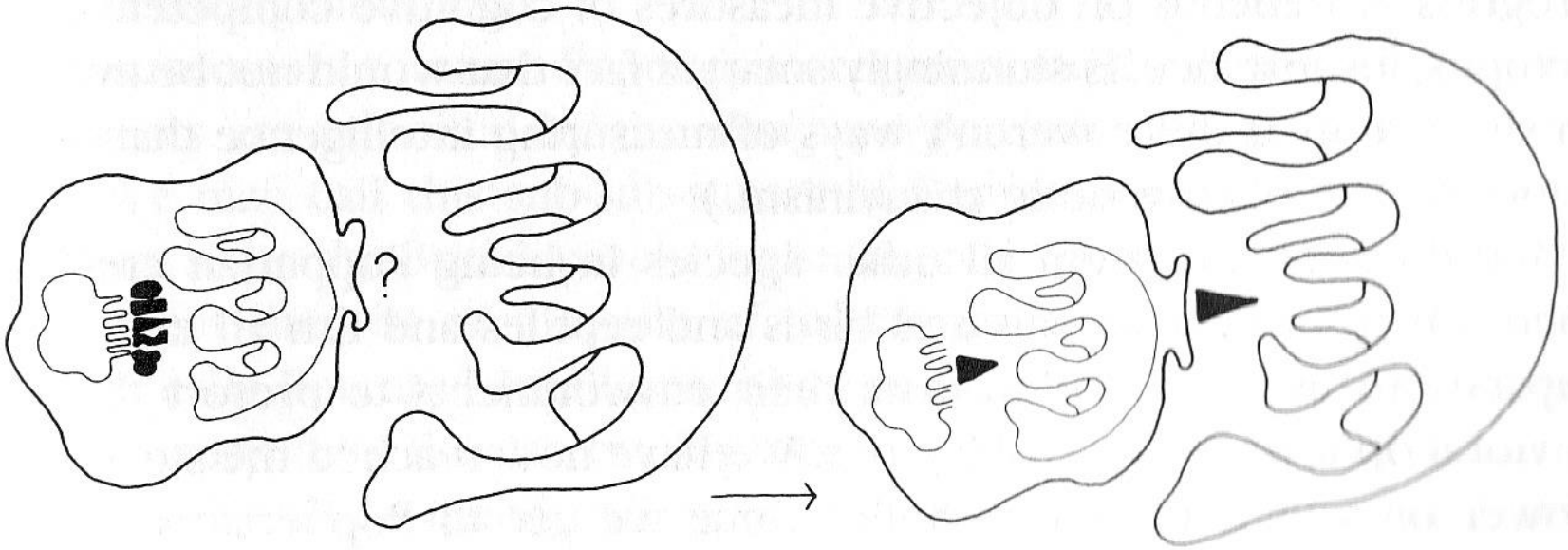
Skinnerian creature "blindly" tries different responses . . .

. . . until one is selected by "reinforcement."

Next time, the creature's first choice will be the reinforced respons

FIGURE 13.2

Selection sequential and external

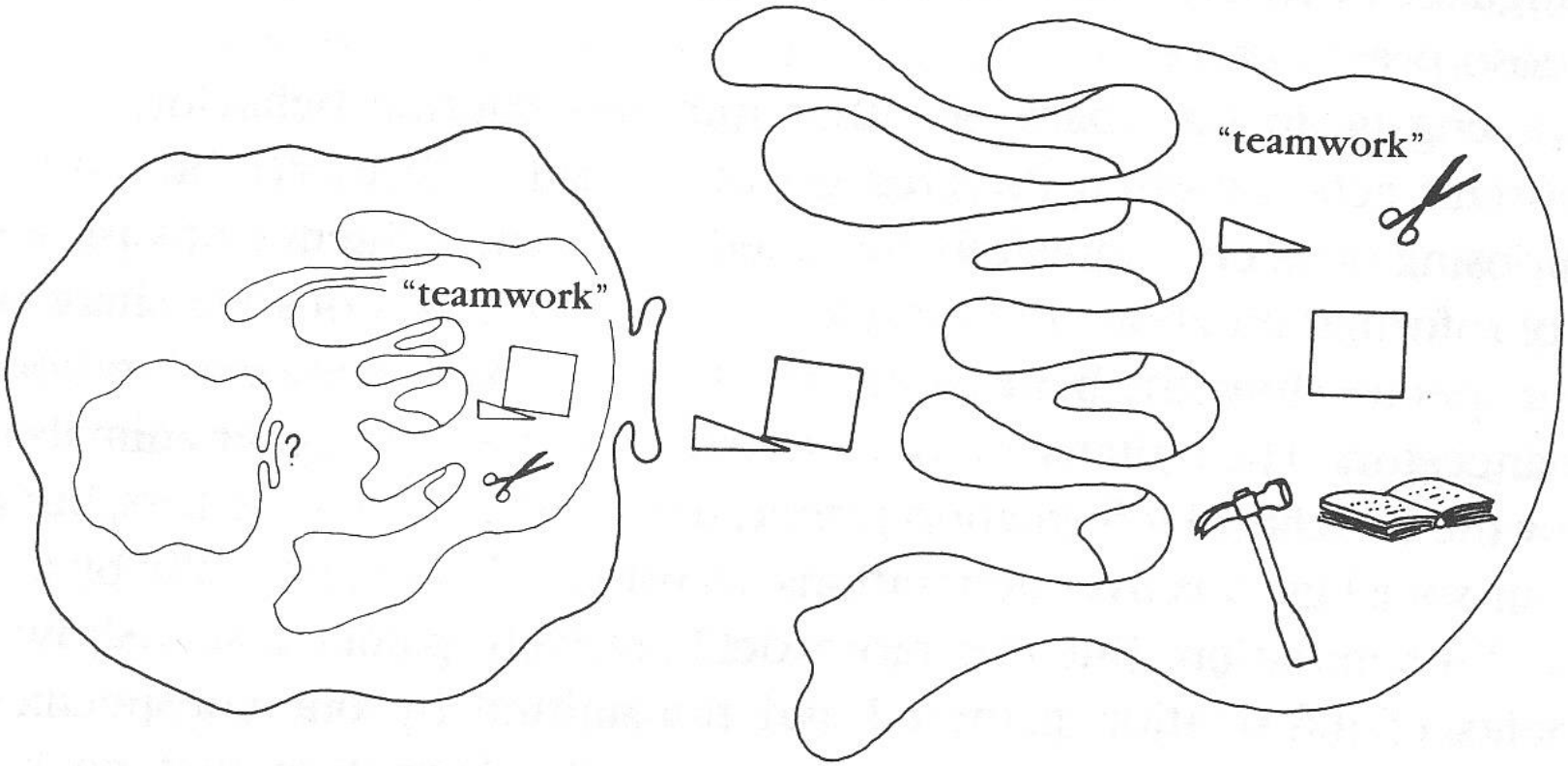


Popperian creature has an inner selective environment that previews candidate acts.

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

Richard Gregory (24 July 1923 – 17 May 2010) RIP

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
  - Systematic
    - 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 $u(\theta_t)$ are equal

Case 1: Intention

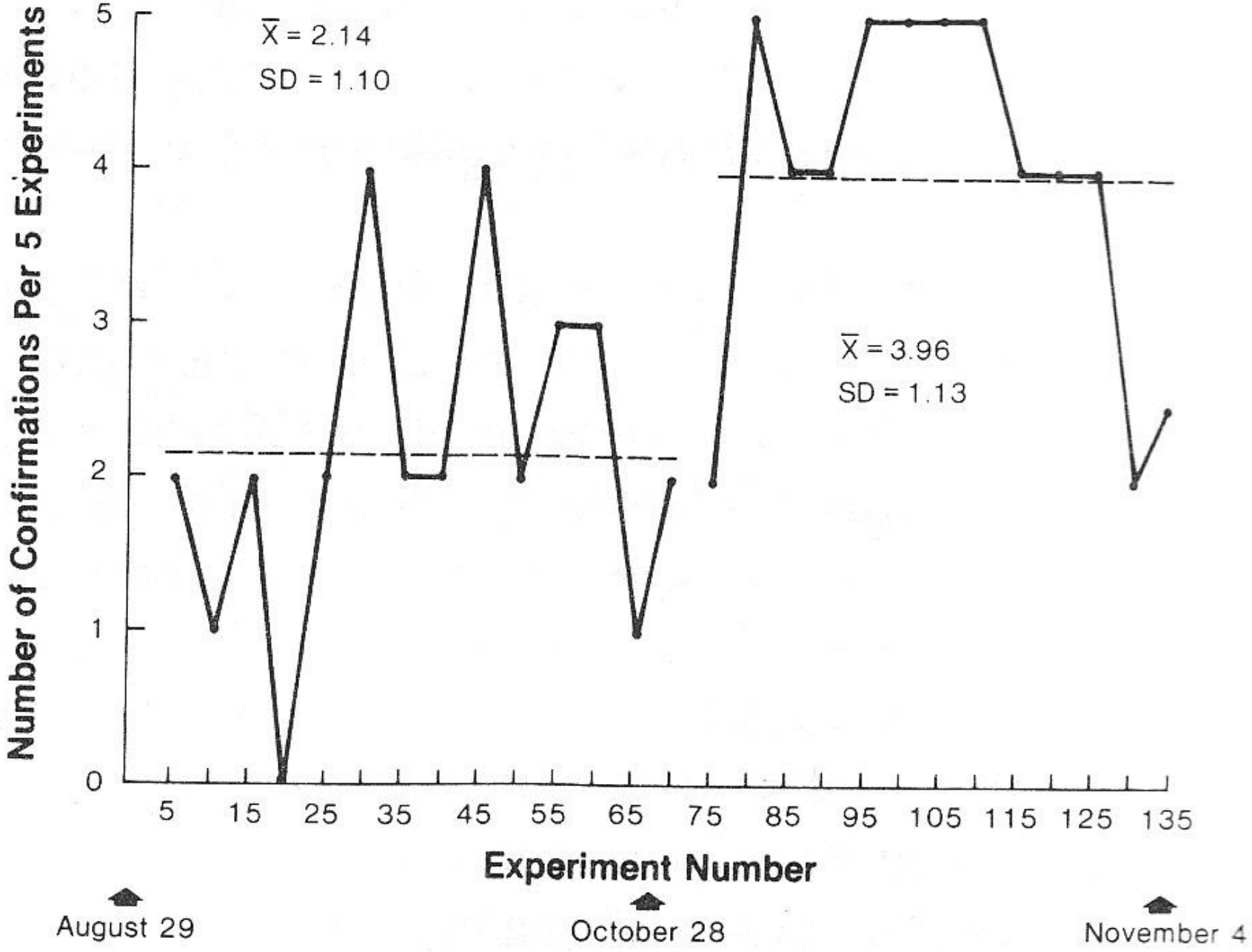
- Combinatorial operations
  - Systematic
    - Search scans and grids
    - Inductive discovery programs: BACON and Kepler's Third Law $P^2 = kD^3$ or $P^2/D^3 = k$
      - Three heuristics reduce the search by half,
      - skipping $P^2/D = k$ and $P^2/D^2 = k$ in route to
      - $P/D = k$, $P/D^2 = k$, and, finally, $P^2/D^3 = k$,
      - with corresponding fitness values
      - $u\ (P/D) = 0$, $u\ (P/D^2) = 0$, and $u\ (P^2/D^3) = 1$
      - yielding some degree of decoupling

Case 1: Intention

- Combinatorial operations
  - Systematic
  - 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, 2004, p. 226)

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


Number of Confirmations Per 5 Experiments
5
4
3
2
1
0
$\bar{X}$ = 2.14
SD = 1.10
$\bar{X}$ = 3.96
SD = 1.13
5
15
25
35
45
55
65
75
85
95
105
115
125
135
Experiment Number
August 29
October 28
November 4

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)

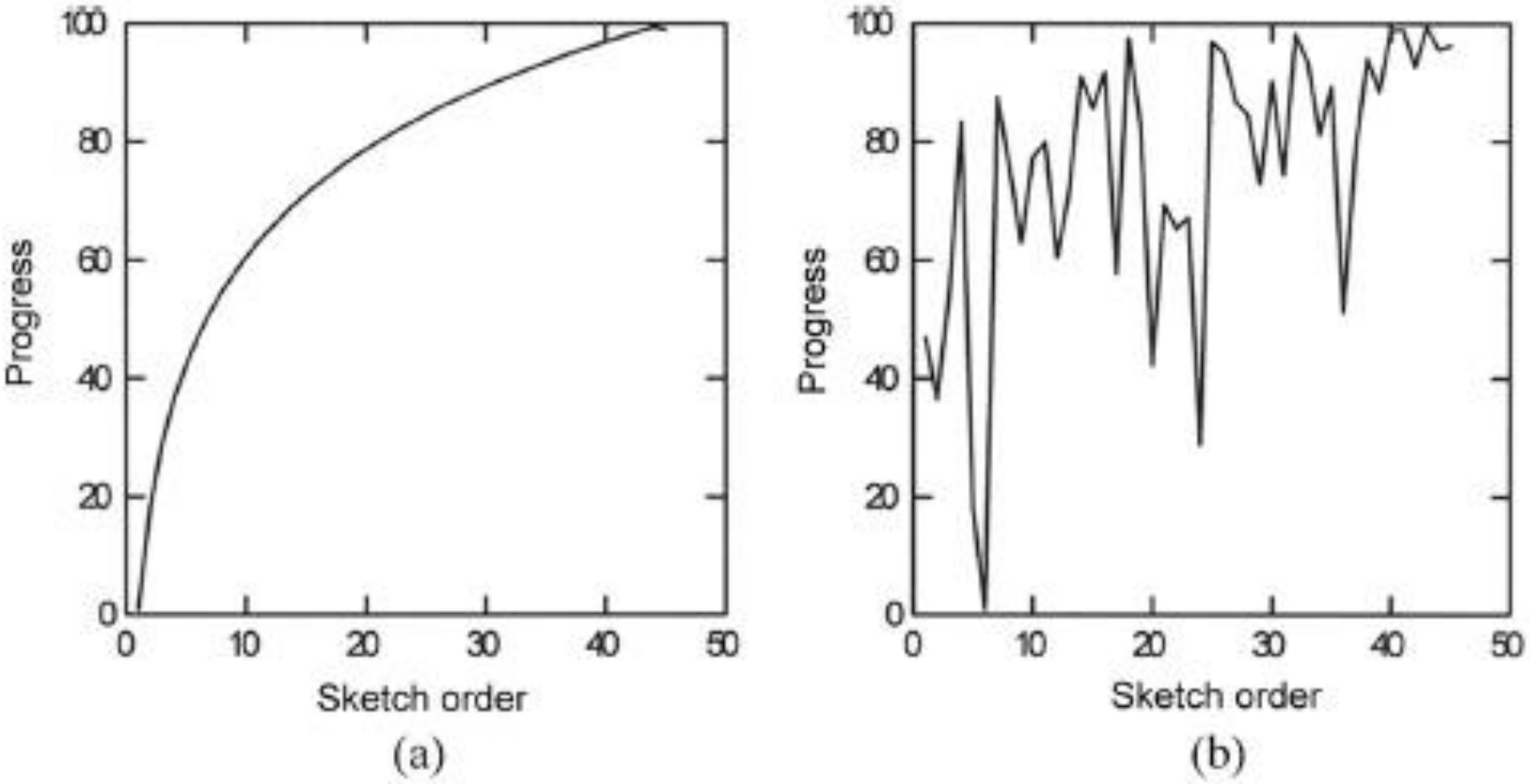
“I only succeeded in solving such problems after many devious ways, by the gradually increasing generalisation of favourable examples, and by a series of fortunate guesses. I had to compare myself with an Alpine climber, who, not knowing the way, ascends slowly and with toil, and is often compelled to 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

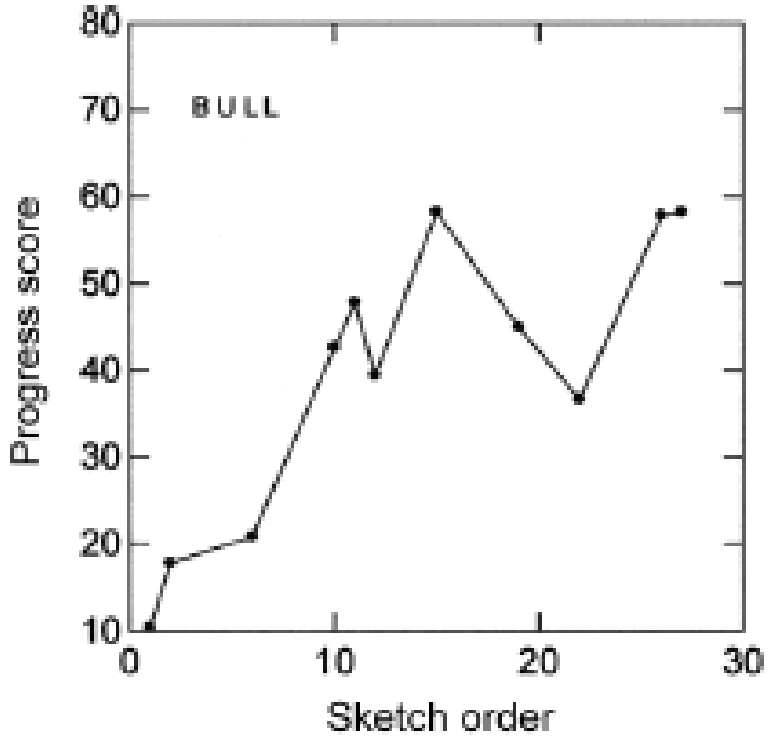
e.g., the 45 *Guernica* Sketches

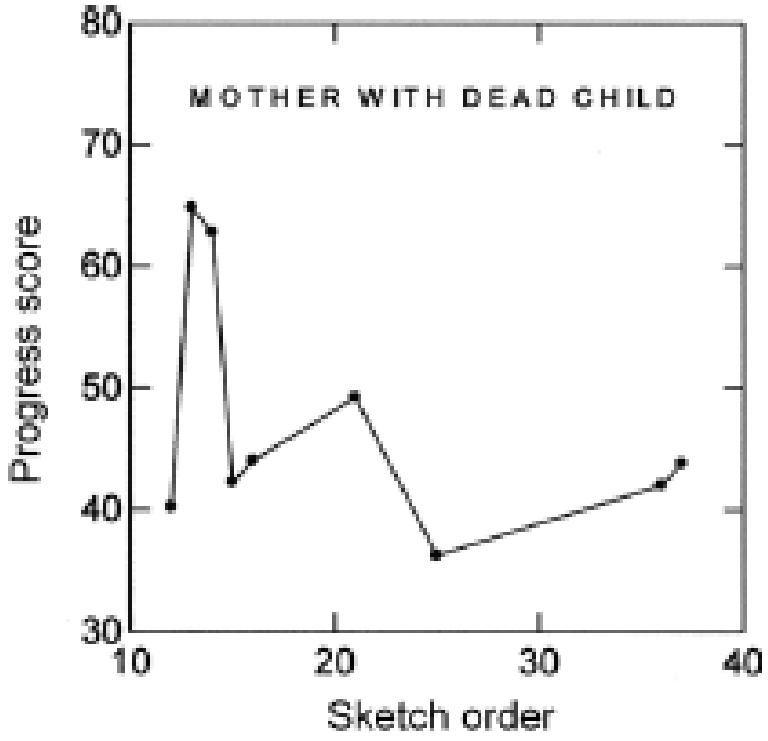
...

Monotonic versus Nonmonotonic



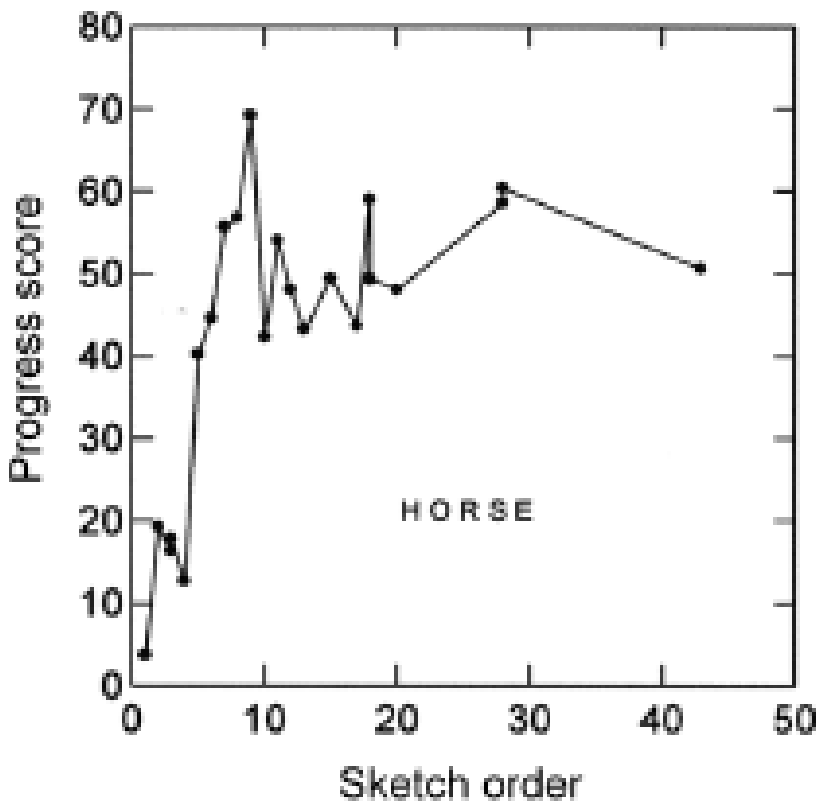
i.e., sighted honing vs. blind search

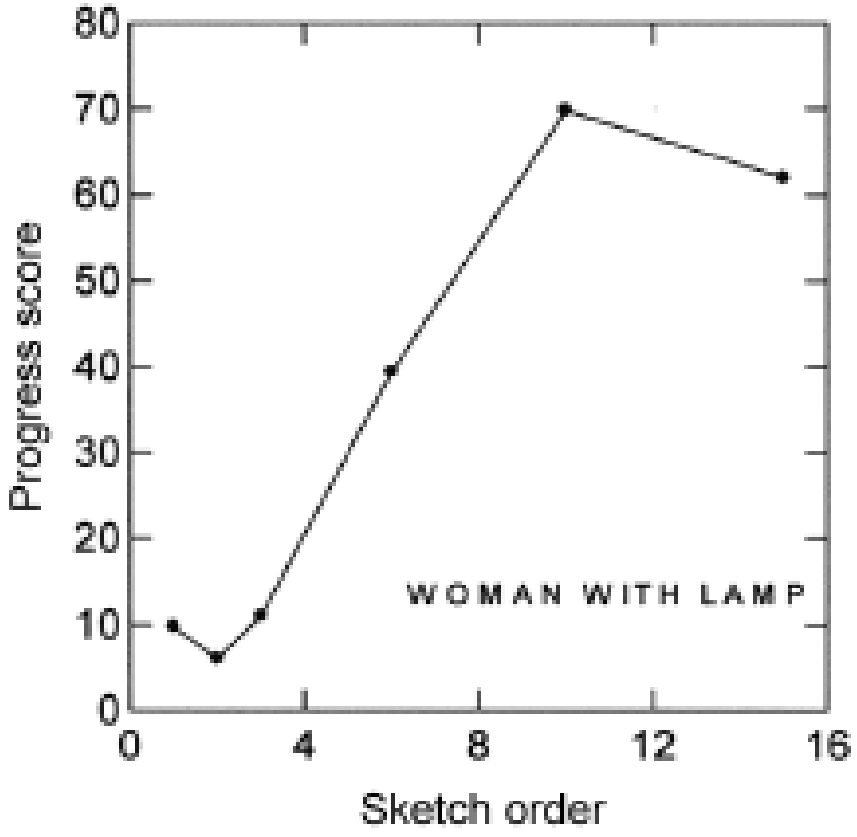


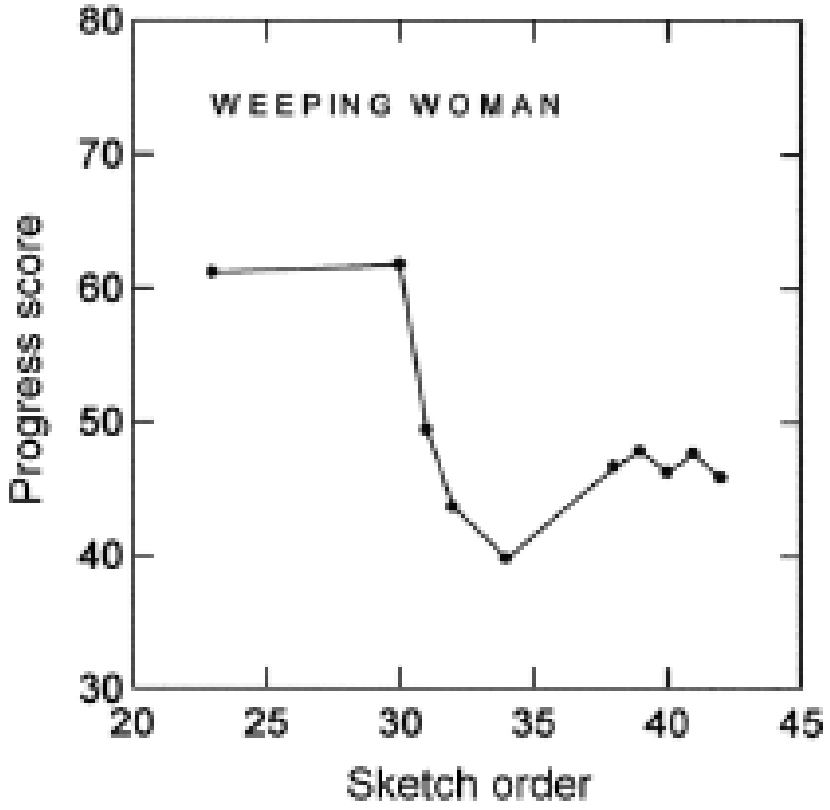


N.B.: "Progress score" = an estimate of *w*


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

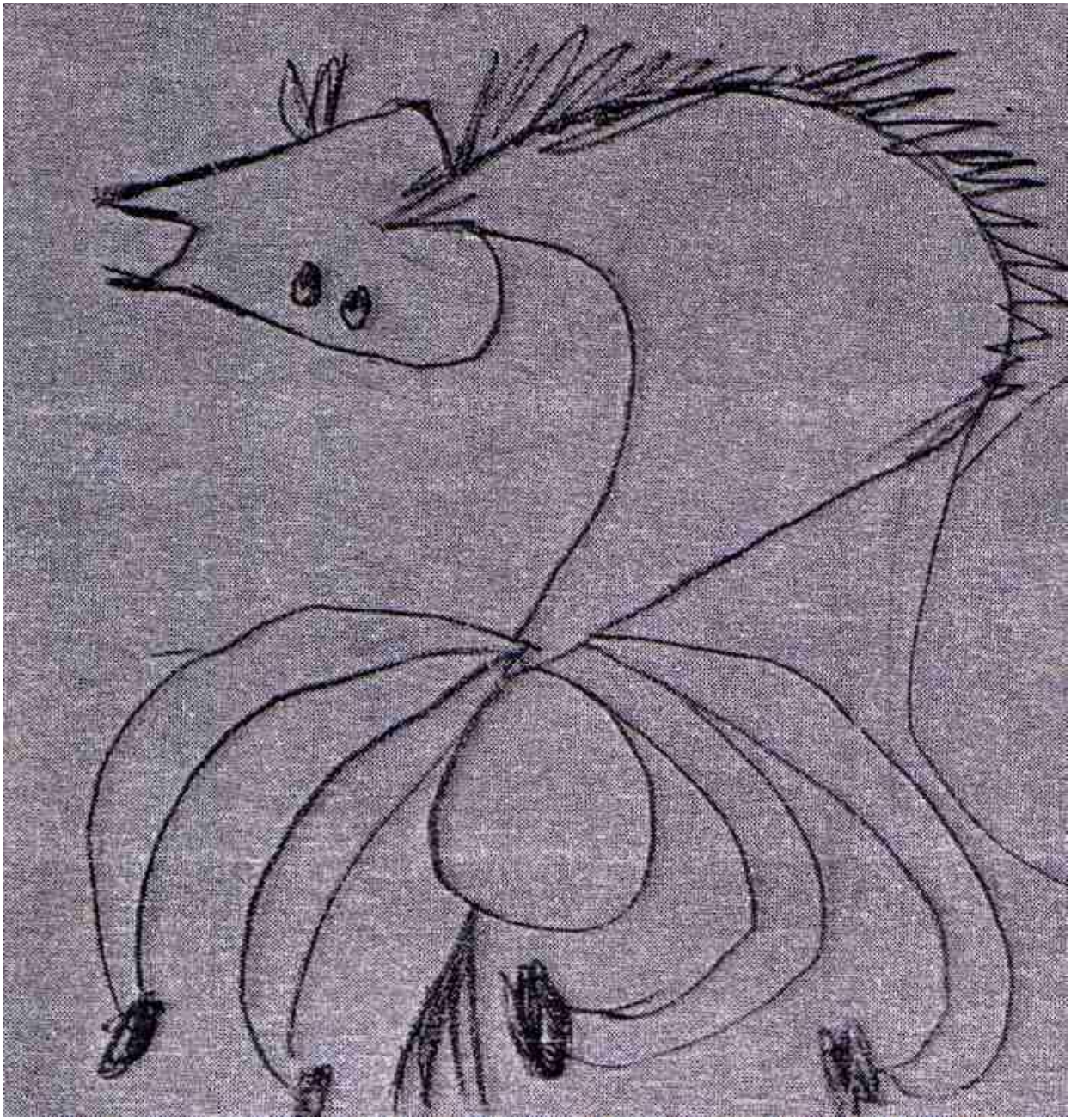

Progress score
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
Sketch order
HORSE

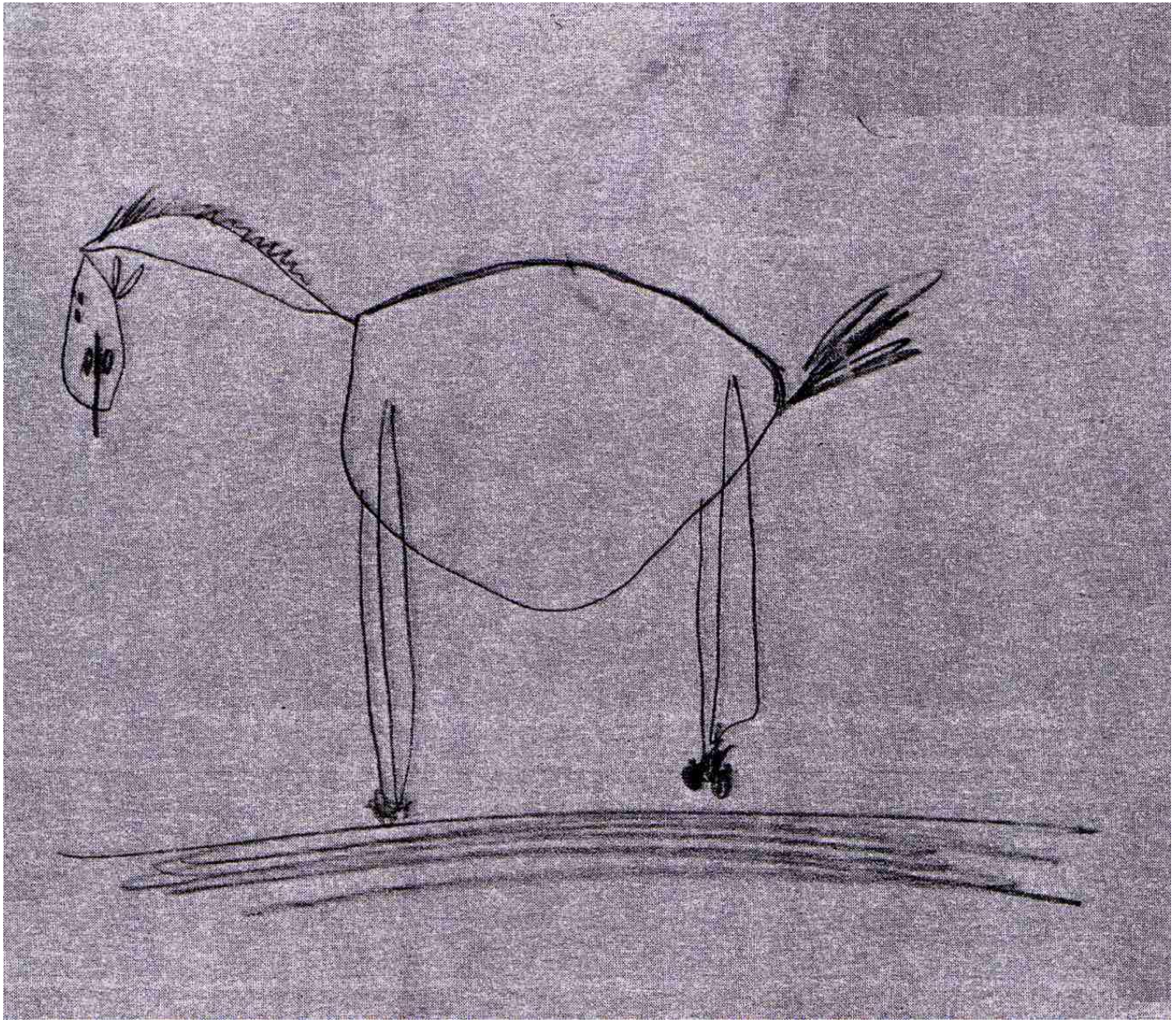

WOMAN WITH LAMP
Progress score
Sketch order
0
10
20
30
40
50
60
70
80
0
4
8
12
16

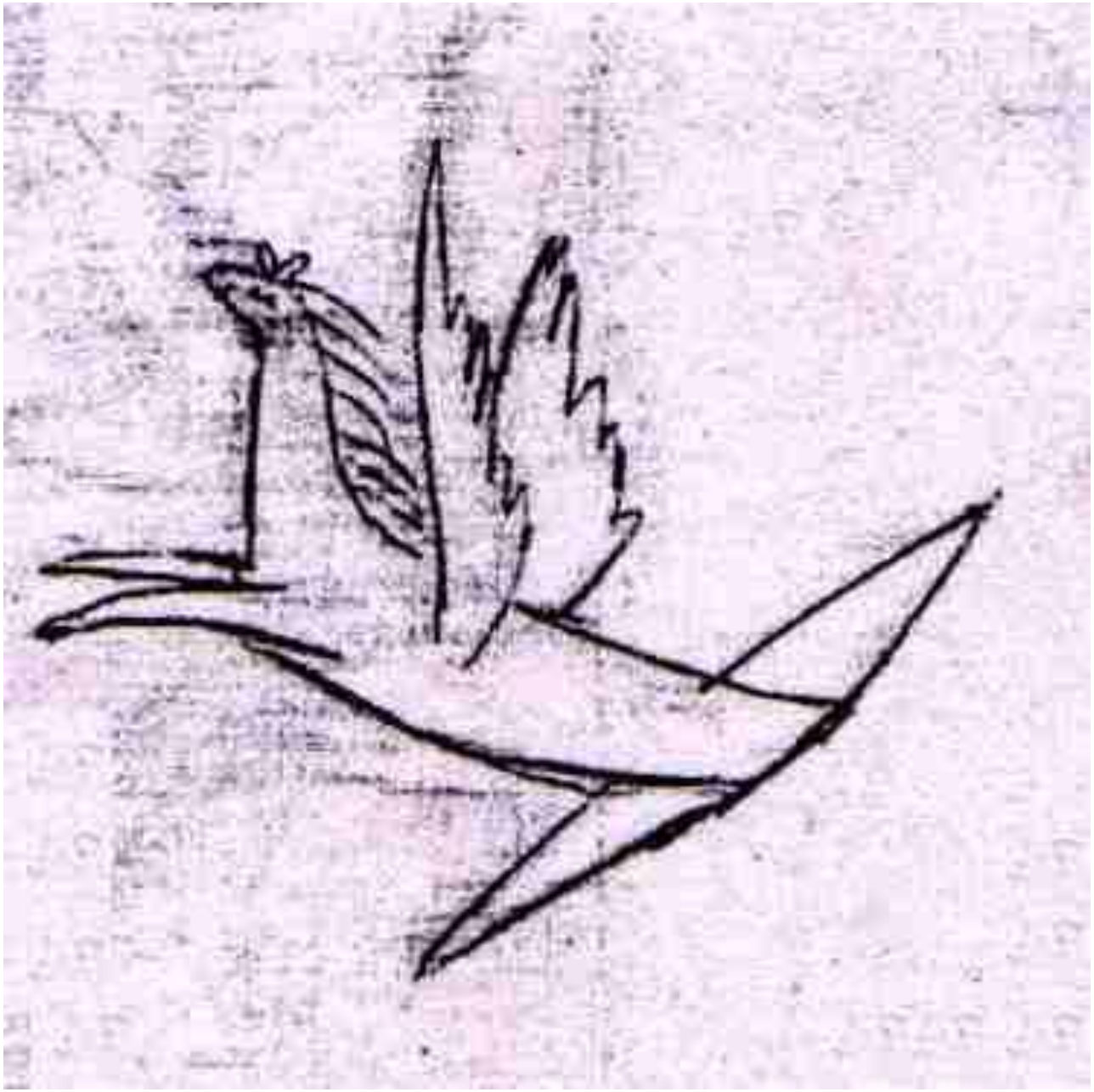

WEEPING WOMAN
Progress score
Sketch order
30
40
50
60
70
80
20
25
30
35
40
45

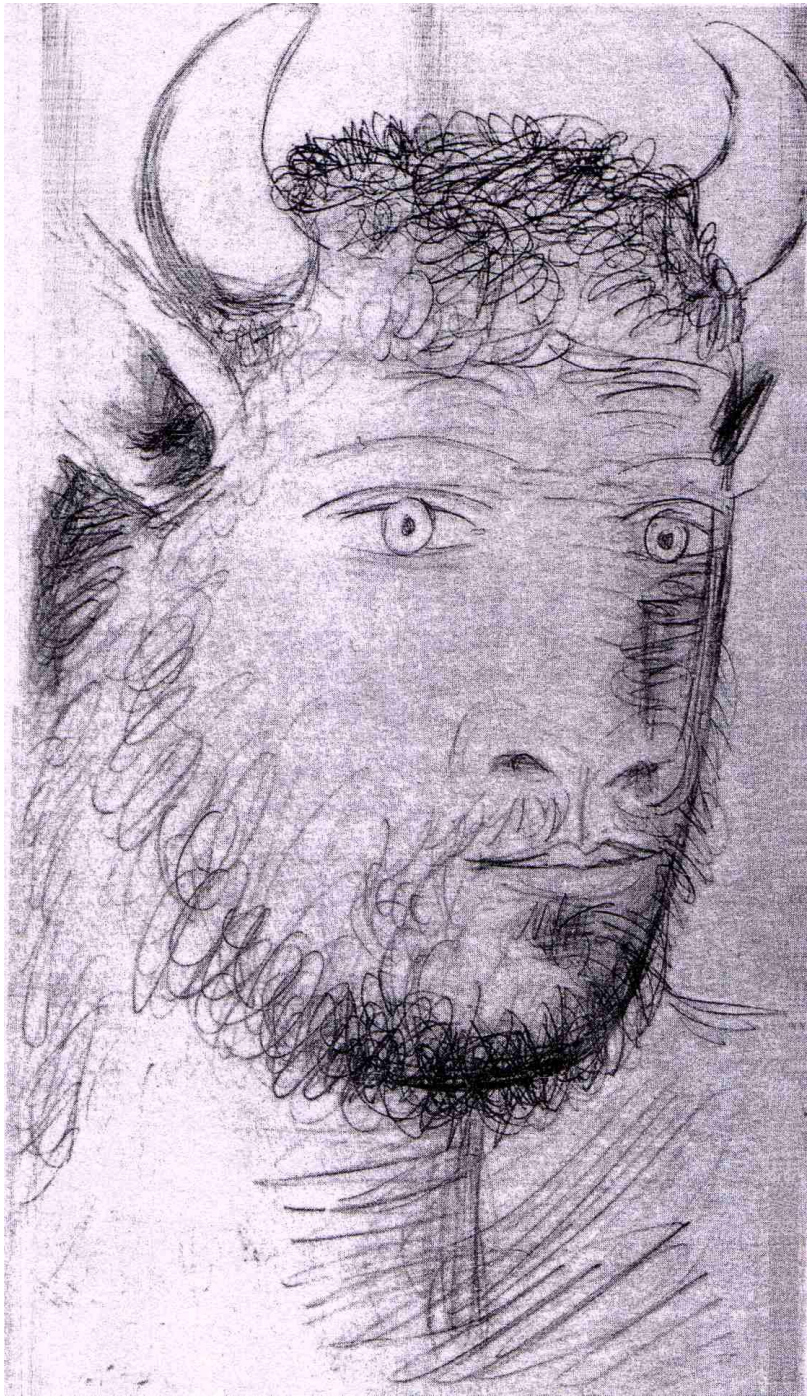
Or less abstractly …

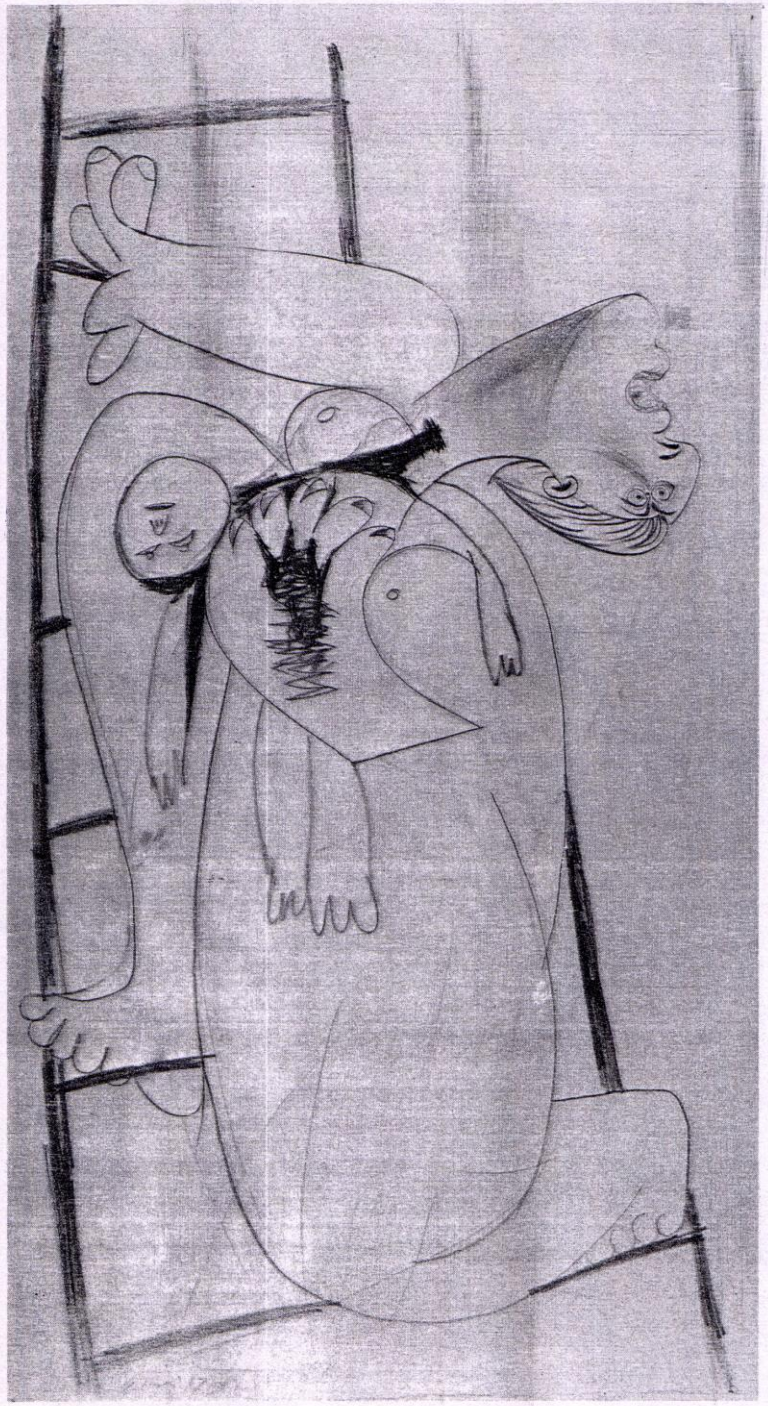
*a few of the more **blind** variants*

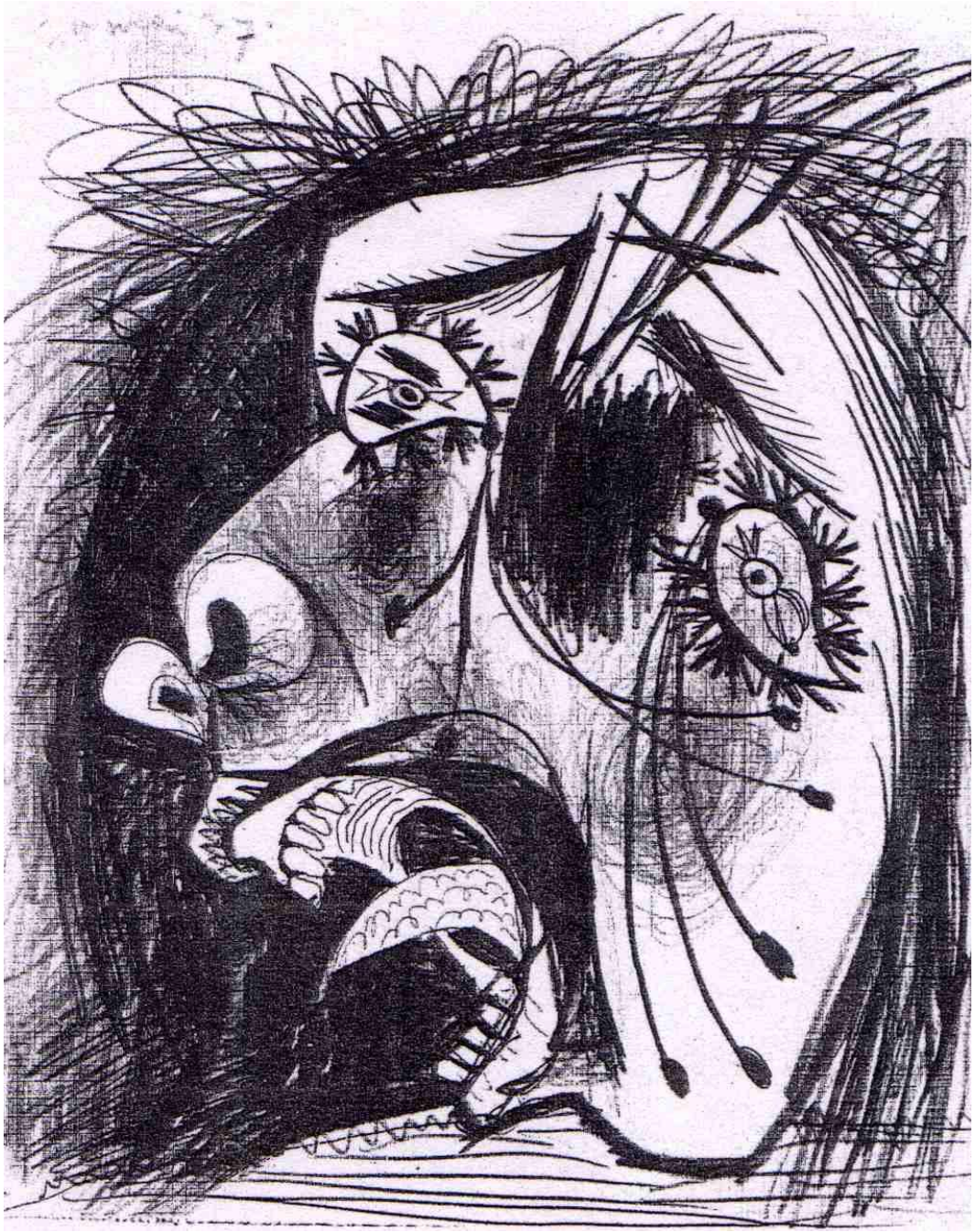


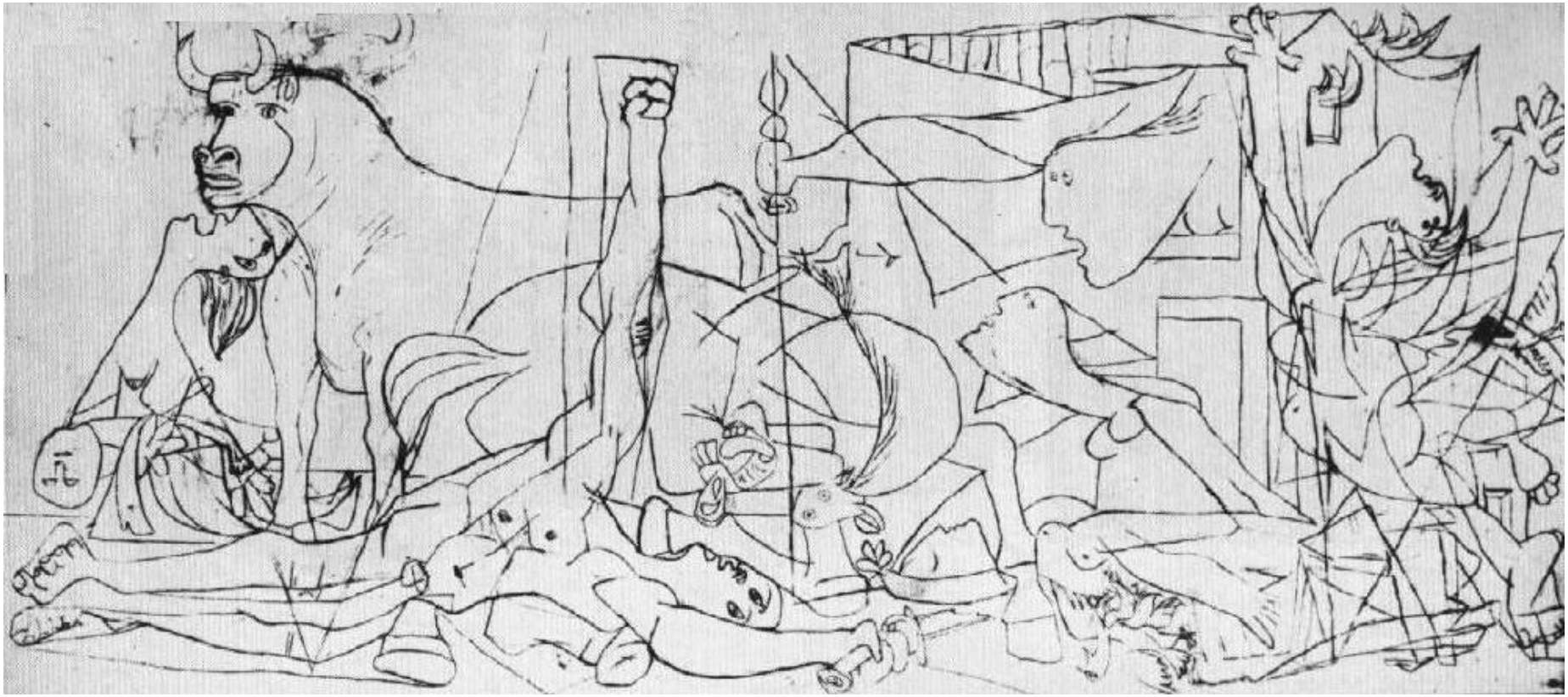






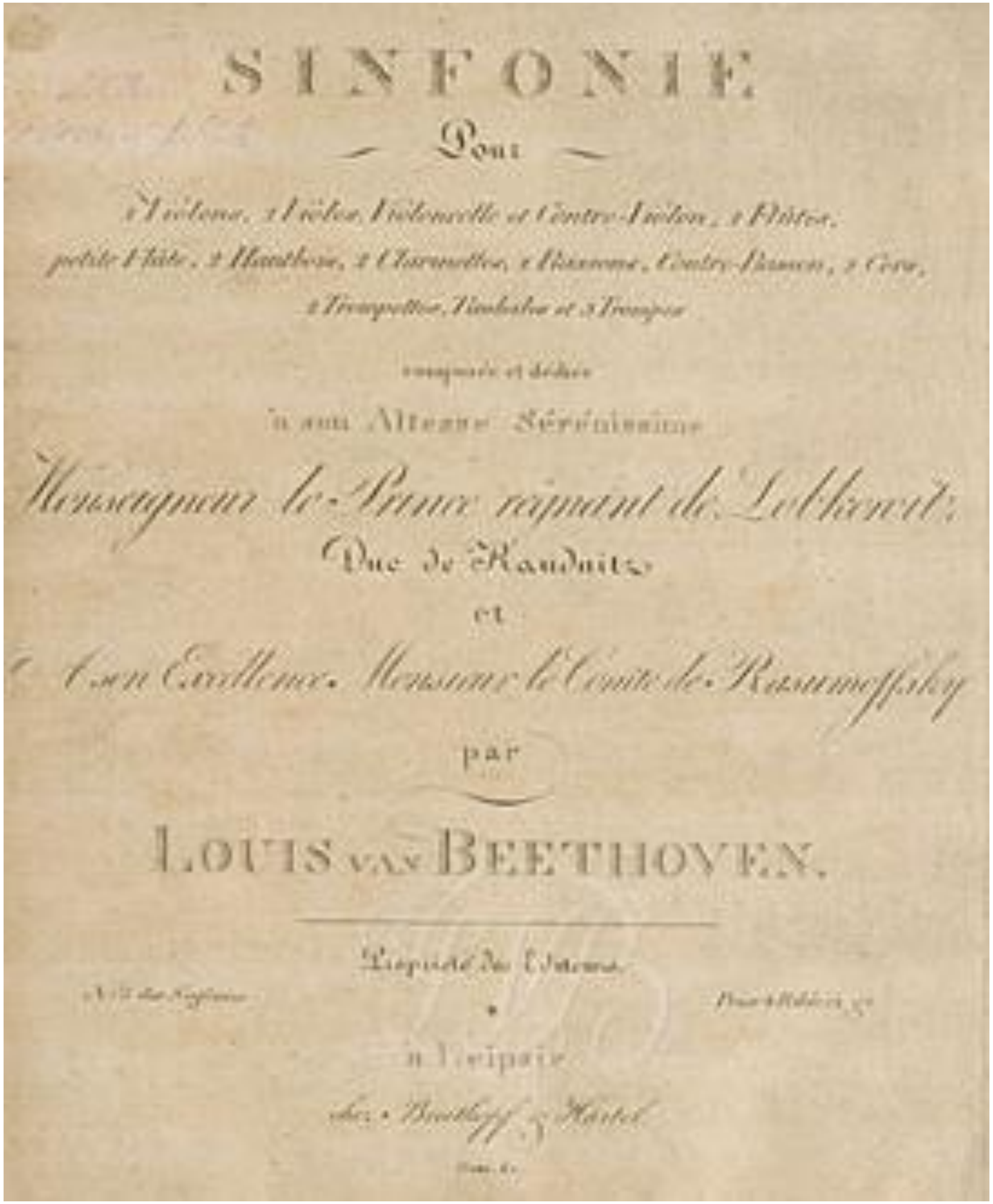






N.B.:

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”


SINFONIE

Pour

2 Violons, 2 Violes, Violoncelle et Contre-Violon, 2 Flûtes,
petite Flûte, 2 Hautbois, 2 Clarinettes, 2 Bassons, Contre-Basson, 2 Cors,
2 Trompettes, Timbales et 3 Trompes

composée et dédiée

à son Altesse Sérénissime

Monseigneur le Prince régnant de Lobkowitz
Duc de Raudnitz

et

à son Excellence Monsieur le Comte de Rasumoffsky

par

LOUIS VAN BEETHOVEN.

Propriété des Editeurs.

à Leipsic

chez Breitkopf & Härtel

Case 2: Implication

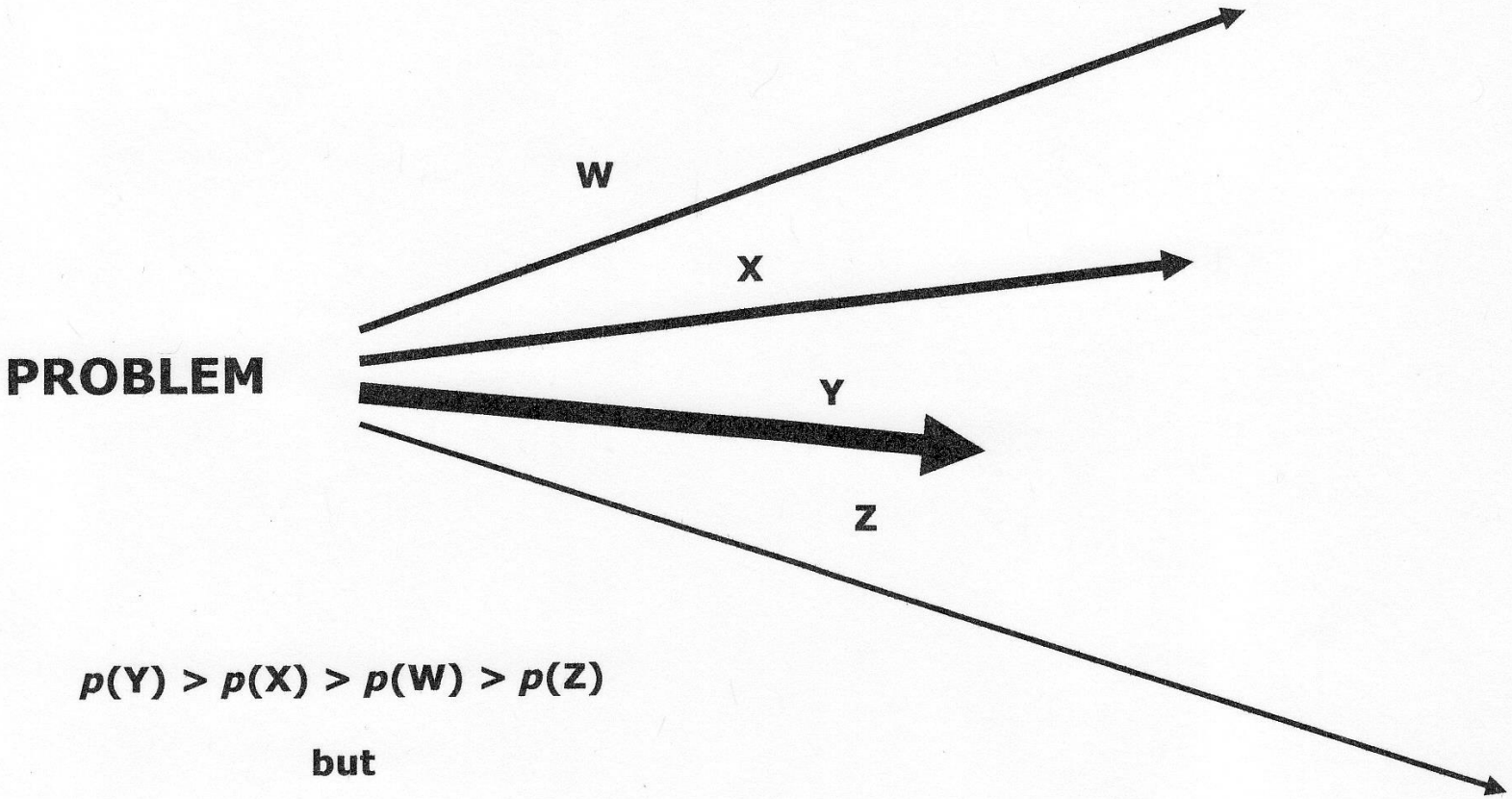
- Processes that should yield blindness:

“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 individually and collectively decoupled

ASSOCIATIVE CHAINS



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

but

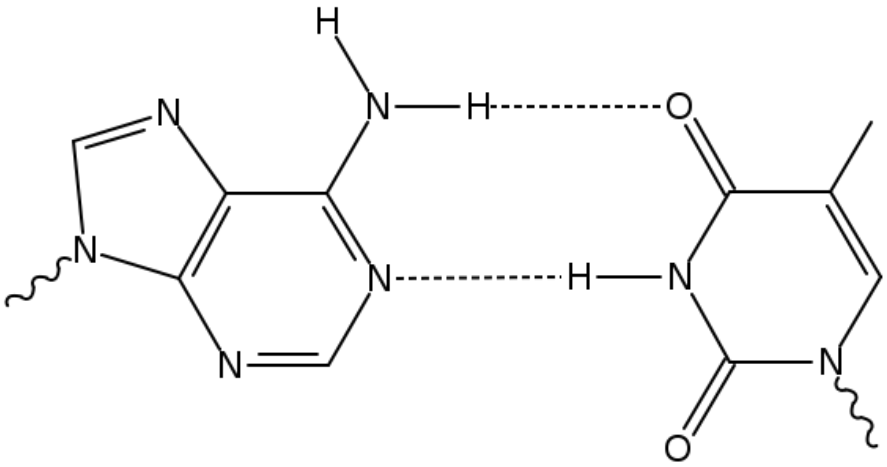
$w(Z) > w(W) > w(X) > w(Y)$

Case 2: Implication

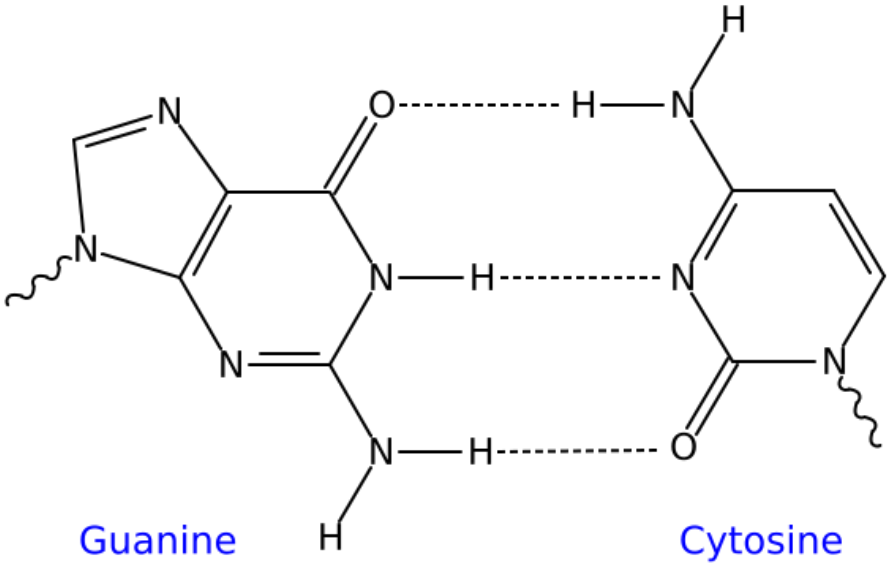
- Processes that should yield blindness
  - Associative richness
  - Defocused attention (e.g., reduced latent inhibition & negative priming):
    - enhanced “opportunistic assimilation”
    - reduced “functional fixedness”
    - enhanced susceptibility to “pseudo serendipity”

Case 2: Implication

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



Adenine Thymine



Guanine Cytosine

Case 2: Implication

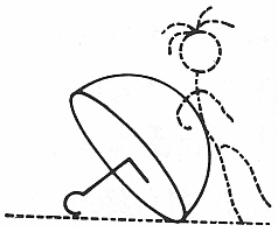
- Processes that should yield blindness
  - Associative richness
  - Defocused attention
  - Behavioral/Cognitive “tinkering”
    - e.g., James Watson’s molecular models
    - e.g., Albert Einstein’s “combinatorial play”

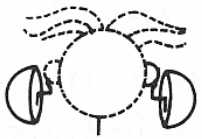
“Ideas rose in clouds; I felt them collide until pairs interlocked, so to speak, making a stable combination.”

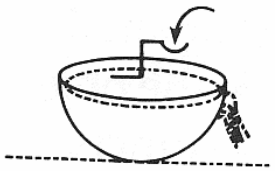
- Henri Poincaré

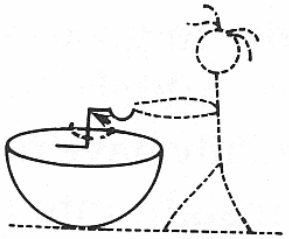
Case 2: Implication

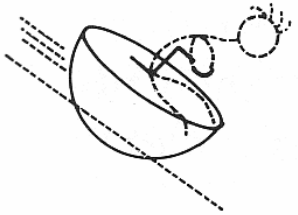
- Processes that should yield blindness
  - Associative richness
  - Defocused attention
  - Behavioral/Cognitive “tinkering”
    - e.g., James Watson’s molecular models
    - e.g., Albert Einstein’s “combinatorial play”
    - cf. Geneplore model (Finke, Ward, & Smith, 1992)

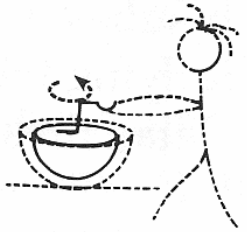


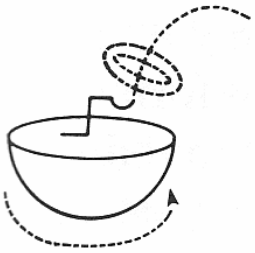












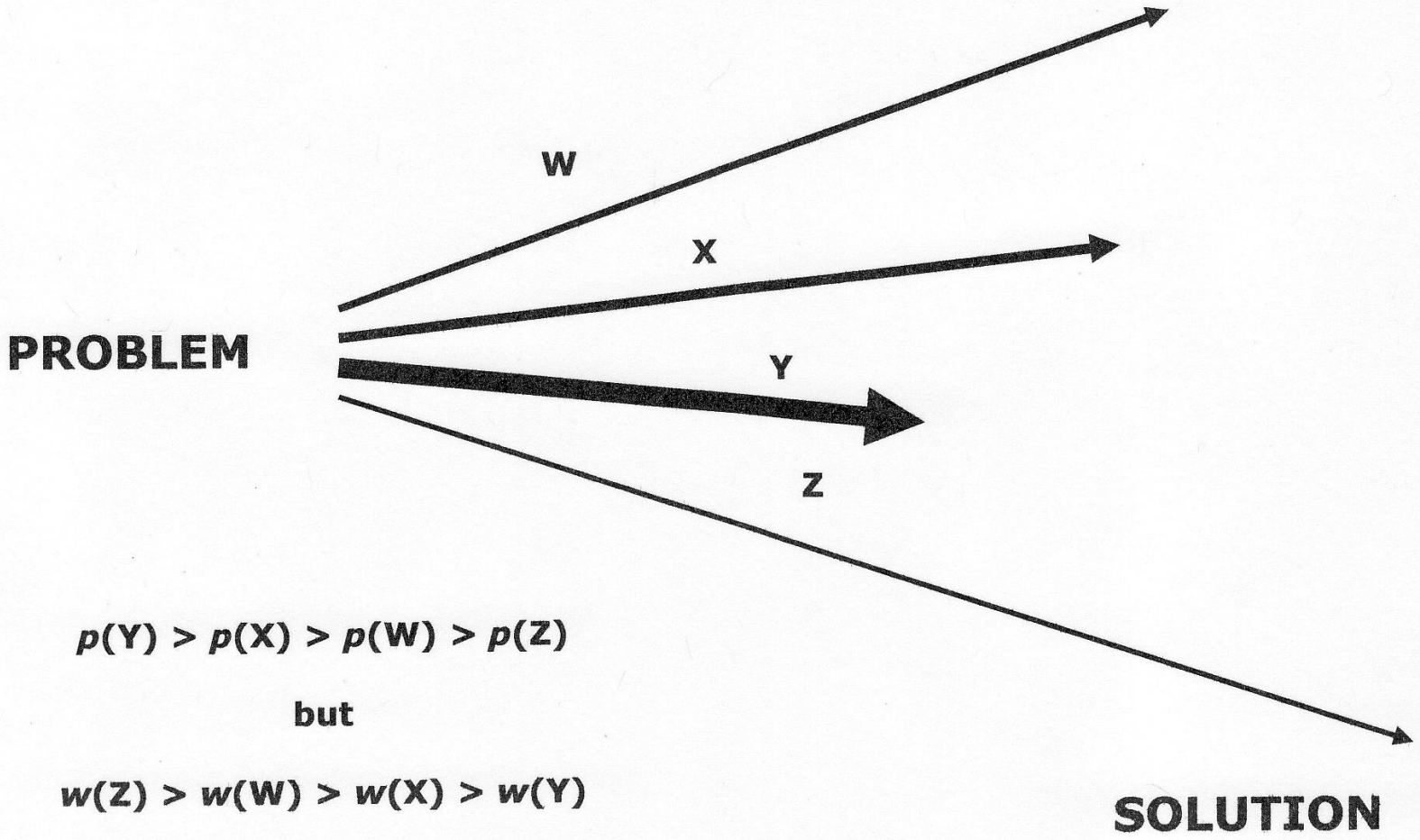
Case 2: Implication

- 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

- *Algorithmic methods*: perfect coupling
- *Heuristic methods*: 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



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

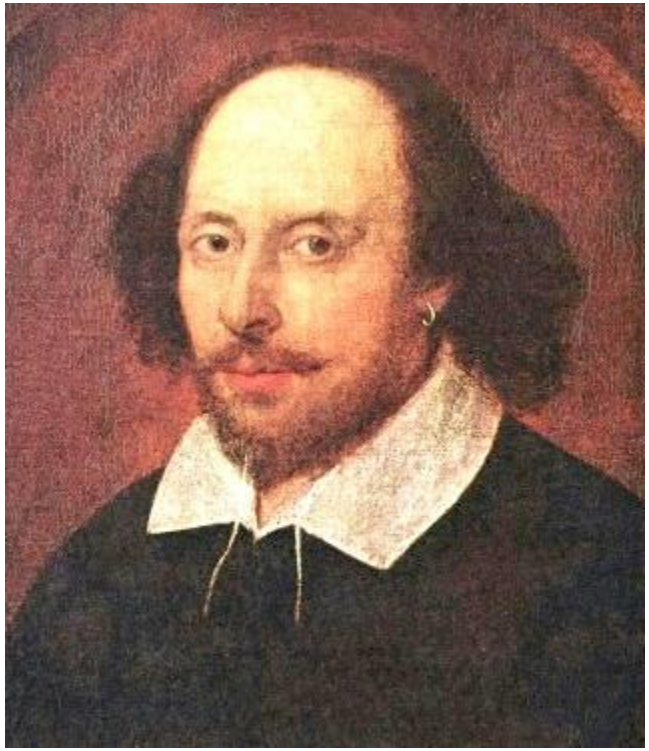
but

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

Misconceptions

- BVSR depends on an isomorphic analogy with biological evolution
- BVSR denies volition or purpose
- BVSR rejects domain-specific expertise
- BVSR assumes ideational randomness

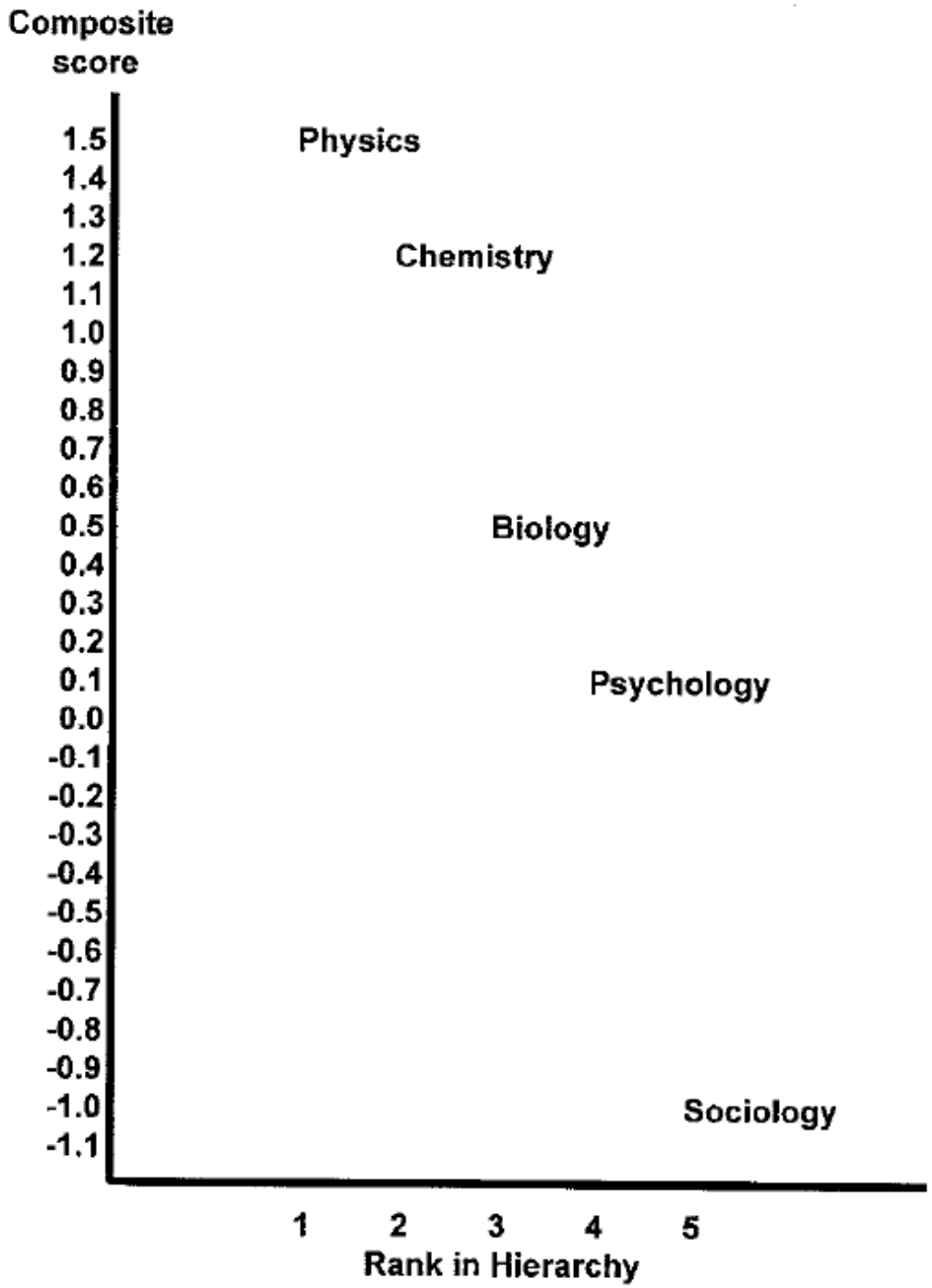
=



?! LOL

Contributions

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


Composite score
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
-1.1
Physics
Chemistry
Biology
Psychology
Sociology
1
2
3
4
5
Rank in Hierarchy

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

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

- Albert Einstein