

# FIELDS ARRANGED BY PURITY

→  
MORE PURE

SOCIOLOGY IS  
JUST APPLIED  
PSYCHOLOGY

PSYCHOLOGY IS  
JUST APPLIED  
BIOLOGY.

BIOLOGY IS  
JUST APPLIED  
CHEMISTRY

WHICH IS JUST  
APPLIED PHYSICS.  
IT'S NICE TO  
BE ON TOP.

OH, HEY, I DIDN'T  
SEE YOU GUYS ALL  
THE WAY OVER THERE.



SOCIOLOGISTS

PSYCHOLOGISTS

BIOLOGISTS

CHEMISTS

PHYSICISTS

MATHEMATICIANS

# Origins of Genius

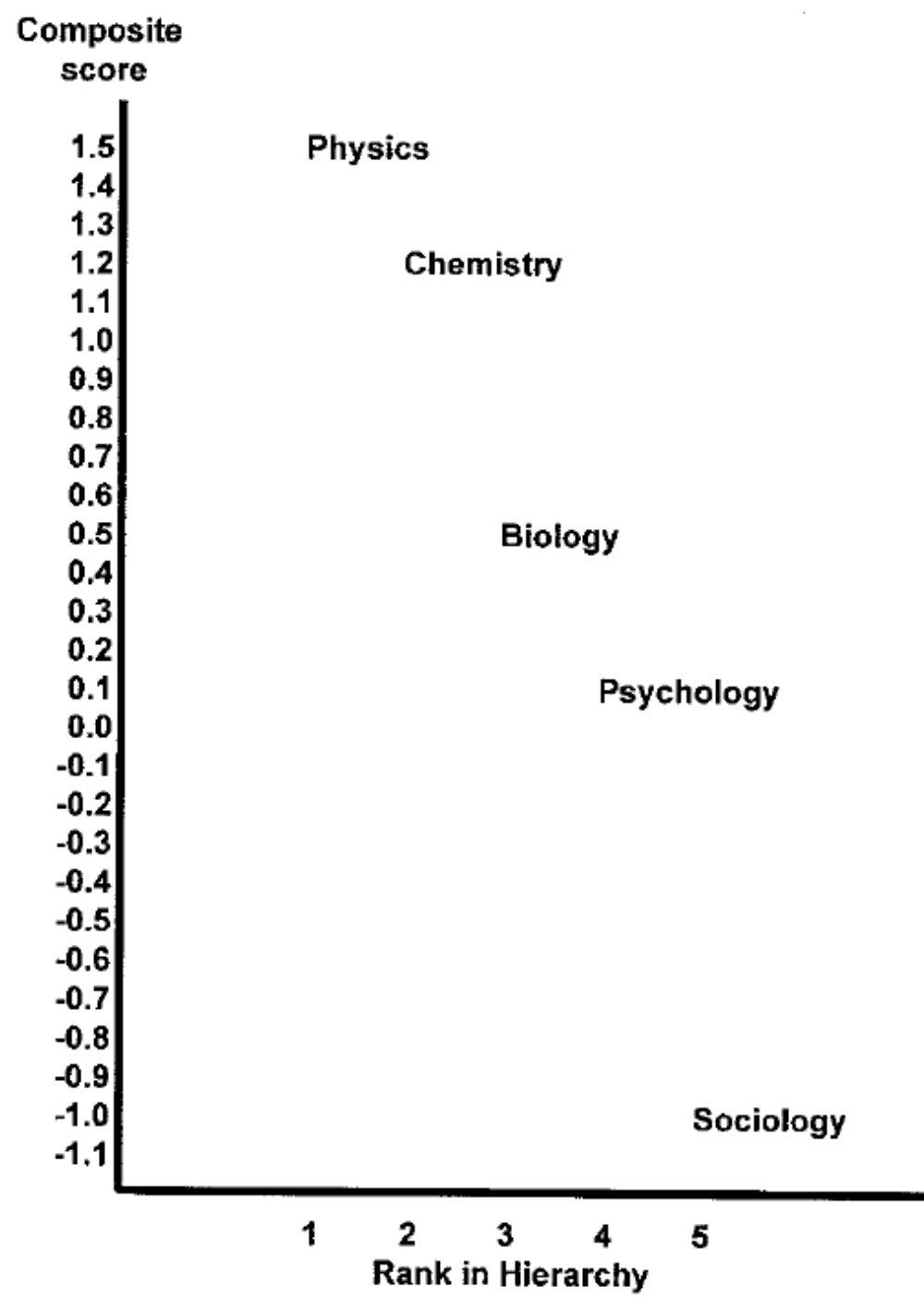
Creativity in the Sciences and the Arts

# Overall plan

- First, I treat the traditional Comtean hierarchy of the sciences
- Second, I elaborate the hierarchy
  - By *extrapolating* it into the humanities and arts
  - By *interpolating* it within single scientific and artistic domains
- Third, I show how a domain's placement in the hierarchy corresponds to the typical disposition and development of creators who achieve eminence in that domain
  - That is, the essential features of the domain closely parallel the expected profiles and biographies of eminent creators in the domain

# Comtean hierarchy of the sciences

- Auguste Comte's original concept
  - The pure sciences can be arranged in an "hierarchical" order
    - astronomy
    - physics
    - chemistry
    - biology
    - sociology
  - This order reflected historical development, which is itself based on the complexity of the phenomena that define the science's subject matter
    - Thus, sociology as the most complex was the very last to emerge (and be named)
    - N.B.: pure mathematics omitted because it has no empirical subject matter
- Although Comte's argument was purely speculative, recent empirical research offers validation: e.g. Simonton (2004, 2015)



# Comtean hierarchy of the sciences

- Positive correlates:
  - Peer evaluation consensus
  - Citation concentration
  - Early impact rate
  - Citation immediacy
  - Obsolescence rate
  - Graph prominence
  - Paradigm development
  - Anticipation frequency
  - Multiples probability
  - Rated disciplinary “hardness”
- Negative correlates:
  - Theories-to-laws ratio
  - Consultation rate
  - Lecture disfluency ("uh," "er," "um")
- N.B.: Correlations range from
  - Min = .64 (anticipation frequency)
  - Max = .99 (theories-to-laws ratio, consultation rate, rated hardness)
  - Median = .92 (peer evaluation consensus)
  - Most coefficients reflect perfect ordinal agreement

# Comtean hierarchy of the sciences

- Finally, the graph has been largely replicated using alternative bibliometric indicators of consensus (Fanelli & Glänzel, 2013):
  - Positive indicators
    - number of authors
    - relative title length
    - sharing of references (intensity)
  - Negative indicators
    - length of article
    - number of references
    - diversity of sources
    - use of first person
    - sharing of references (degree)
- “With three minor exceptions, all bibliometric parameters placed the biological sciences between the physical and the social, and placed the biological-hard sciences before the biological-soft”

Significantly, the hierarchical arrangement is even consistent with scientists' own perceptions of the role of *objectivity* in their domains

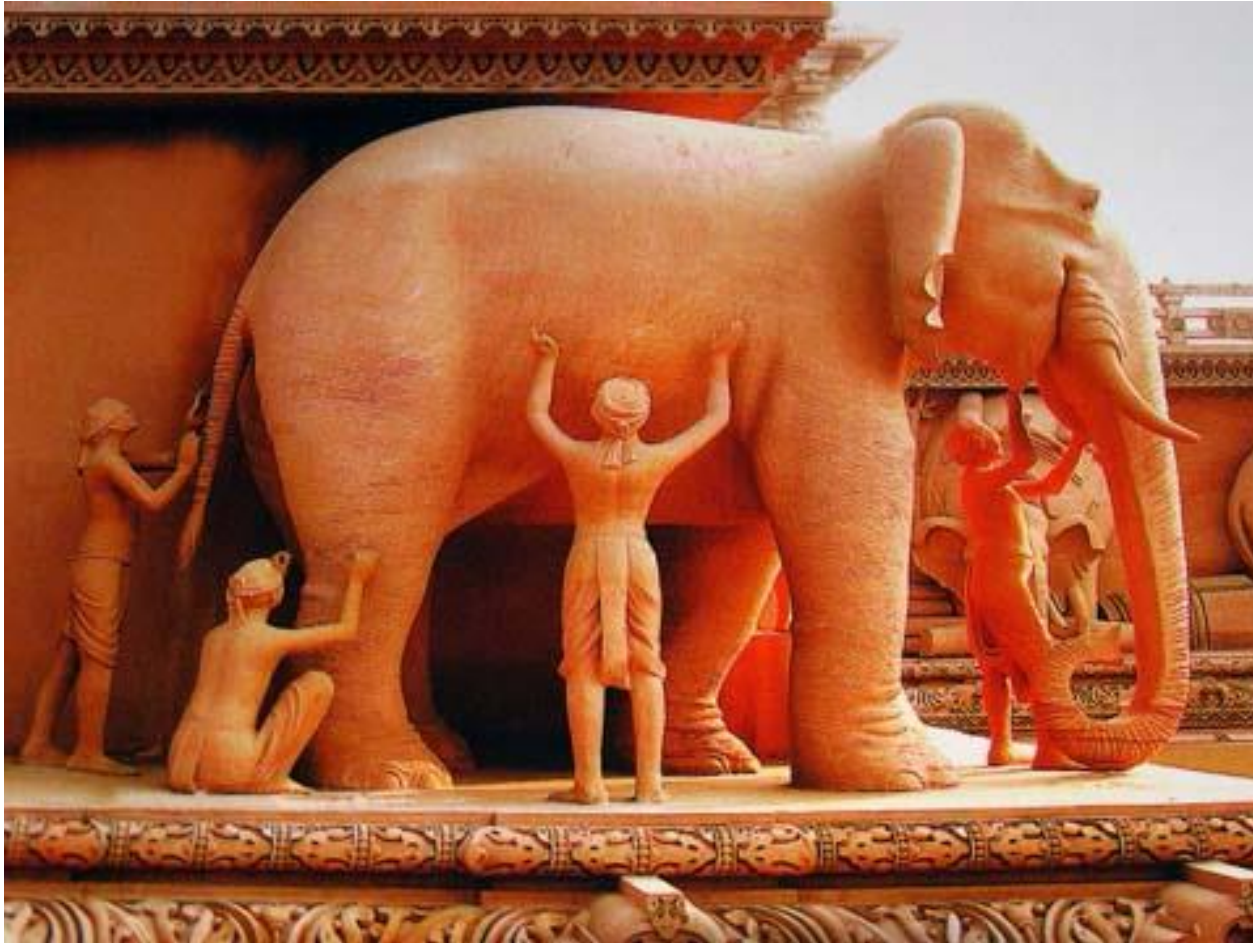
<b>Prpić (2008)</b>	<b>Natural scientists N = 310</b>	<b>Social scientists N = 167</b>
Objectivity as the property of the research process	69.0%	54.8%
Objectivity as the researcher's impartiality and nonsubjectivity	33.6%	54.7%
Objectivity as attainable and attained	76.2%	52.5%
Objectivity as its complete realization doubtful	20.4%	30.3%
Objectivity as impossible or nonexistent	3.4%	17.2%



# Comtean hierarchy of the sciences

- Despite the multiplicity of placement indicators, most appear to be proxies for two more fundamental domain attributes, namely
  - *Complexity* of the phenomena defining the domain, as in Comte's original formulation of the hierarchy, and
  - *Consensus* of those active in the domain on what constitutes a bona fide contribution to their understanding of those phenomena
- Yet given the information-processing limitations of the human brain the second largely follows as a corollary of the first
  - To see how, let us turn to the well-known parable of ...

# The five blind men and the elephant



The one who felt

The leg thought it was a pillar

The belly thought it was a wall

The ear thought it was a fan ...

The tail thought it was a rope

The tusk thought it was a solid pipe

- Tirumular

# Comtean hierarchy of the sciences

- The consensus of the five blind men would have been much greater if they had been given a snake rather than an elephant because the snake would have represented a less complex phenomenon for them to handle (both in terms of size and shape)
- Given this interpretation, then the sciences can be arrayed along a dimension from the low-complexity/high-consensus domains to the high-complexity/low-consensus domains
  - “low-complexity” means *relatively* low, for *no* science is “simple”
  - This increased complexity is what renders perfect reductionism impossible (contrary to what the earlier cartoon implied)
- This arrangement then can be both extrapolated to the humanities and arts and interpolated within scientific and artistic disciplines

# Elaboration of the hierarchy

- Extrapolation to the humanities and the arts
  - Phenomena complexity is higher and domain consensus lower in the humanities and arts, with the arts even further removed from the sciences
  - To offer two examples from indicators used earlier:
    - Obsolescence rate: psychology/sociology > history > English
    - Lecture disfluency: psychology/sociology < political science < art history < English
- Interpolation within domains in the arts and sciences
  - Apollonian formal/classic arts versus Dionysian expressive/romantic arts
    - Former far more restricted in content and expression than holds for the latter
  - paradigmatic versus non-paradigmatic sciences (Kuhn, 1970)
    - normal versus revolutionary paradigmatic sciences (Kuhn, 1970)
    - “hard” versus “soft” non-paradigmatic sciences

# Elaboration of the hierarchy

- Example: Psychology's split into "natural" versus "human" sciences:
  - Objectivistic versus Subjectivistic
  - Quantitative versus Qualitative
  - Elementaristic versus Holistic
  - Impersonal versus Personal
  - Static versus Dynamic
  - Exogenist versus Endogenist
- Above methodological and theoretical differences form a single factor, with the most famous psychologists allying with either one or the other (e.g., B. F. Skinner versus Jean Piaget) (Simonton, 2000; cf. Cohn, 1979)

# Correspondence with disposition and development of creators within a domain

- Given the supreme importance of complexity and consensus in describing the core nature of a creative domain, it should not be surprising that the creators who contribute to the domain will exhibit parallel dispositional traits and developmental experiences
- Even if research on this correspondence is incomplete, like a puzzle with not all pieces available, the empirical data available so far suggest a significant agreement
- This agreement is sketched out below, starting with disposition and then turning to development (cf. Simonton, 2009)
- N.B.: All associations are probabilistic, with overlapping distributions!

# Disposition and Domain

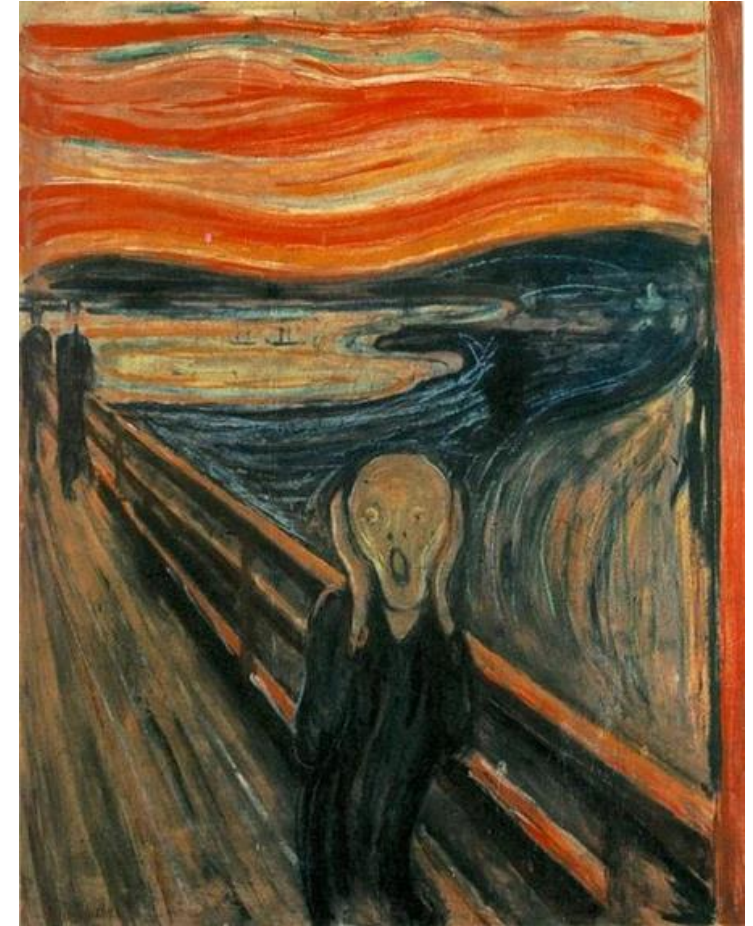
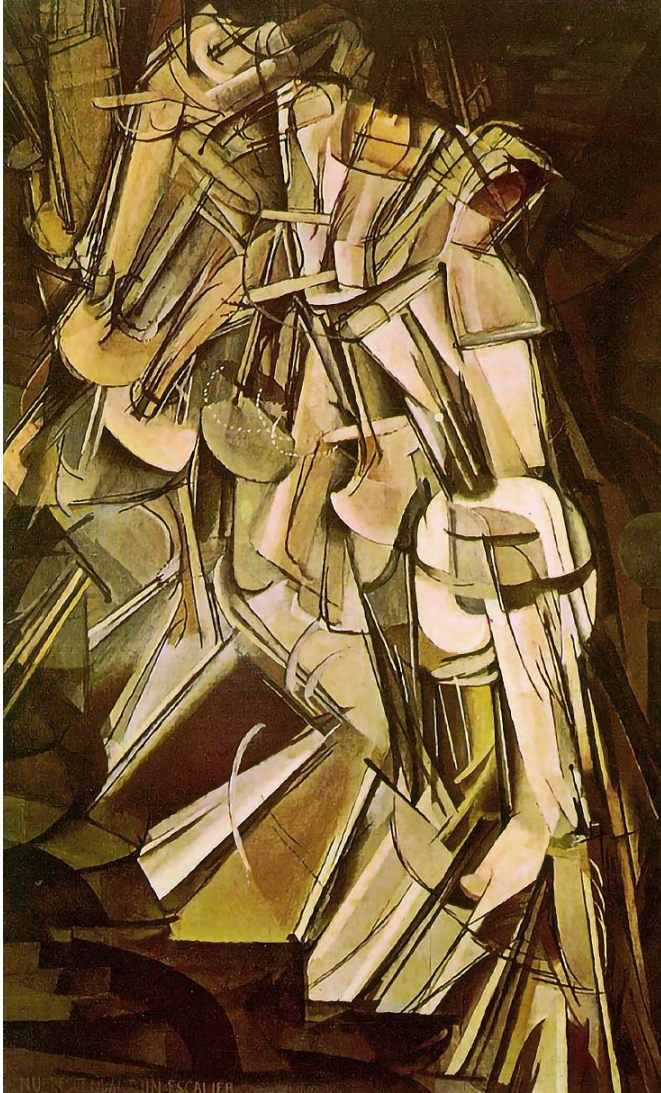
- Psychopathology/emotional instability:
  - “persons in professions that require more logical, objective, and formal forms of expression tend be more emotionally stable than those in professions that require more intuitive, subjective, and emotive forms” (Ludwig, 1998, p. 93)
  - because this association holds both across and within domains a fractal pattern of “self-similarity” results at various levels of “magnification”:

Magnification		Domains	
X 1	Sciences	<	Arts
X 2	Natural sciences	<	Social sciences
X 2	Formal arts	< Performing arts	< Expressive arts
X 3	Nonfiction	< Fiction	< Poetry
X 4	Formal style	< Symbolic style	< Emotive style

- Historiometric, psychometric, and psychiatric data largely support this prediction



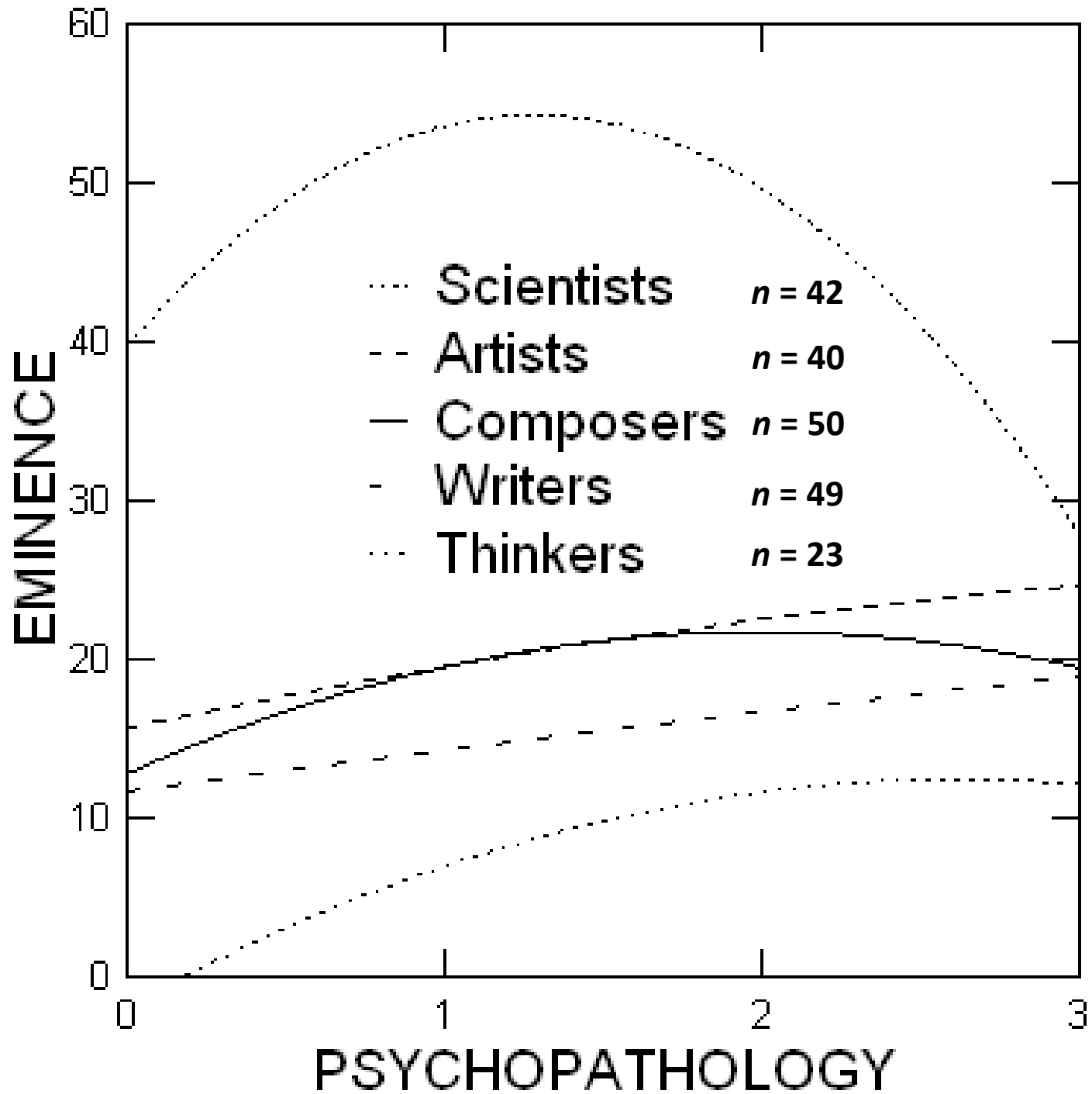
# Illustrations: formal, symbolic, and emotive styles





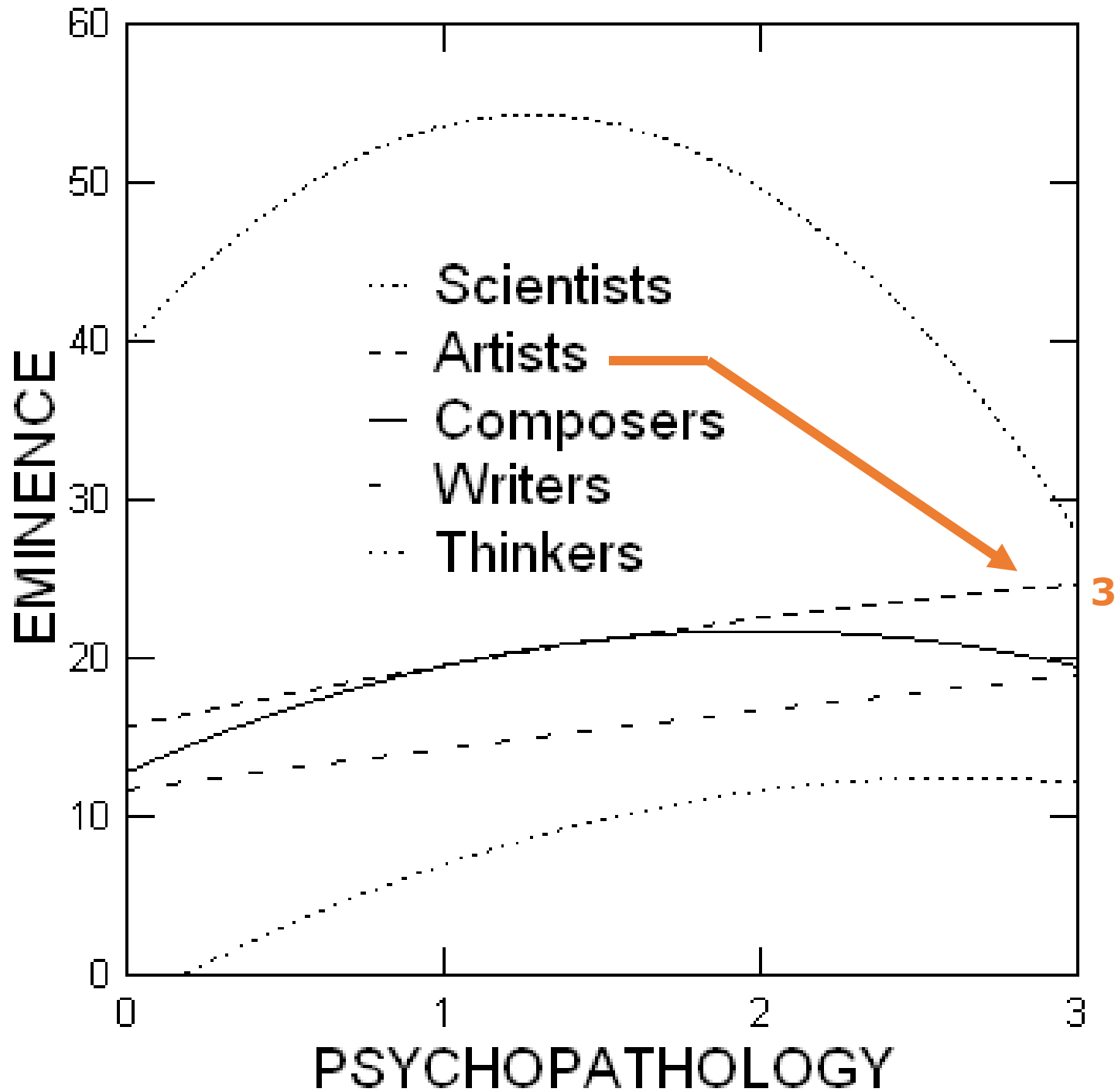
# Disposition and Domain

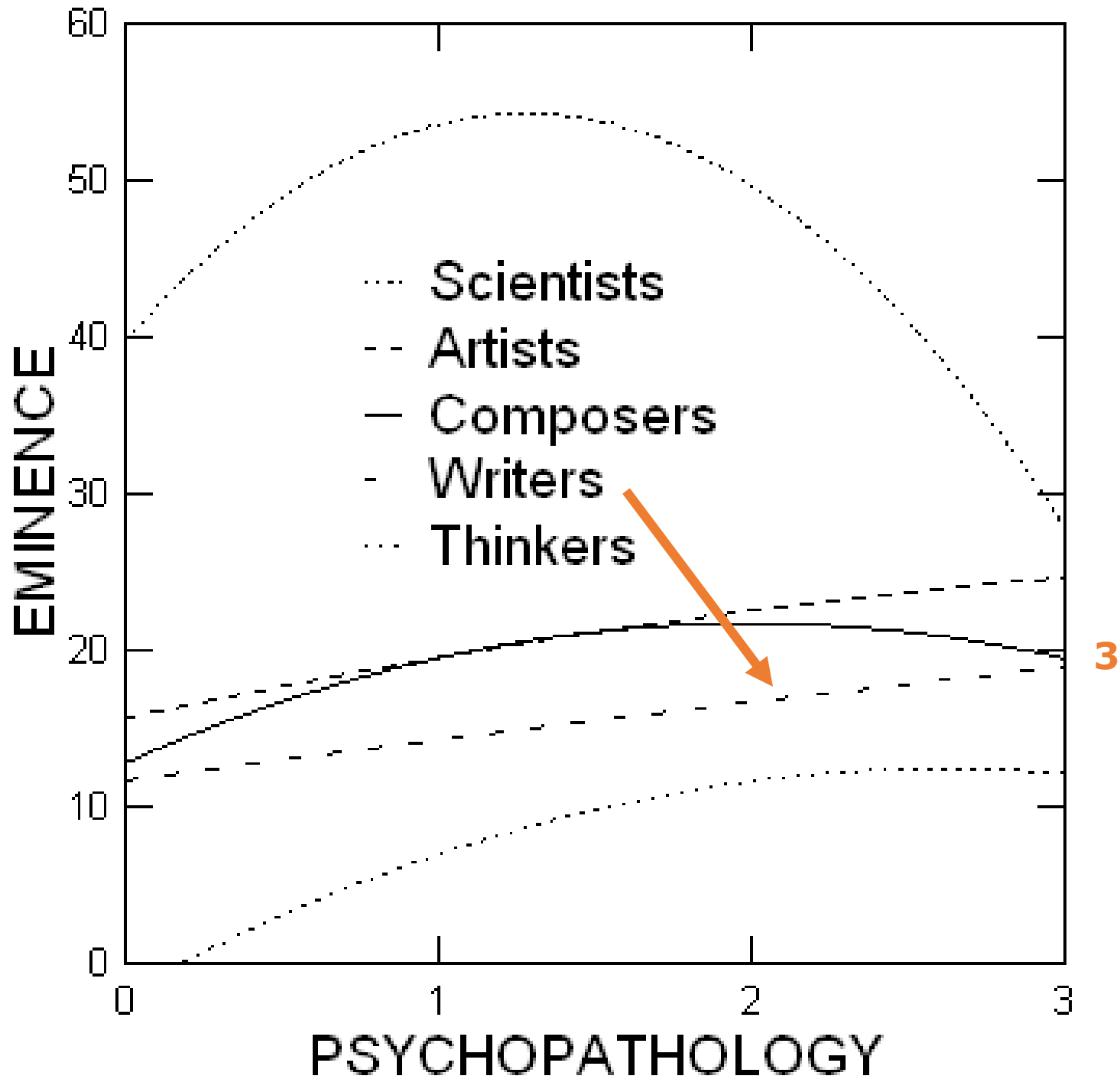
- The foregoing results imply that each domain of creative achievement may feature an optimal level – or “sweet spot” – where emotional instability, or psychopathology, might exert the maximal relation with a creator’s achieved eminence
- That optimum, of course, presumes that psychopathology is itself a continuous variable that ranges from subclinical symptoms to more maladaptive mental illness
- Evidence for this domain-contingent inverted-U relation was demonstrated in a study of 204 creative geniuses (Simonton, 2014)

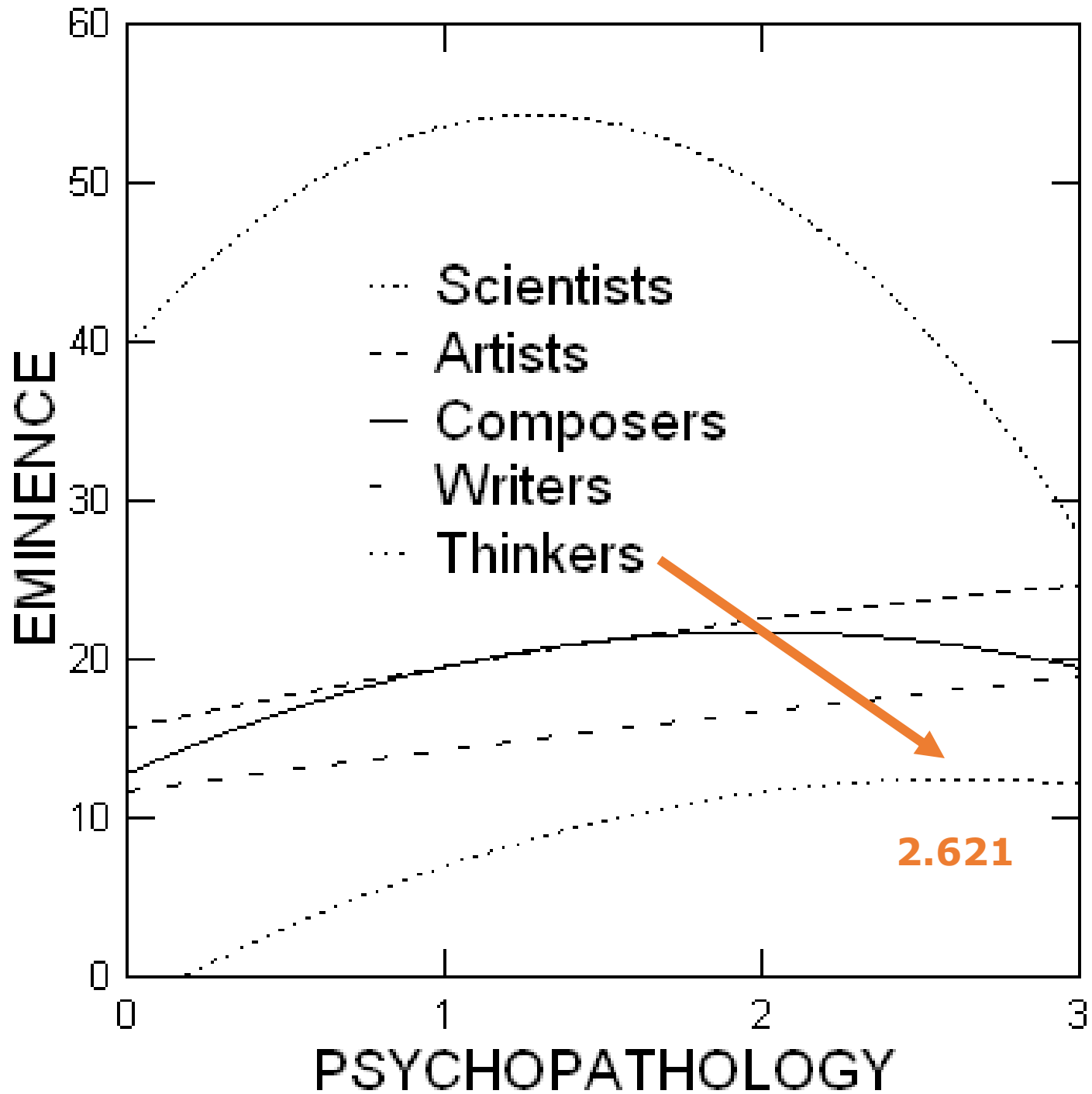


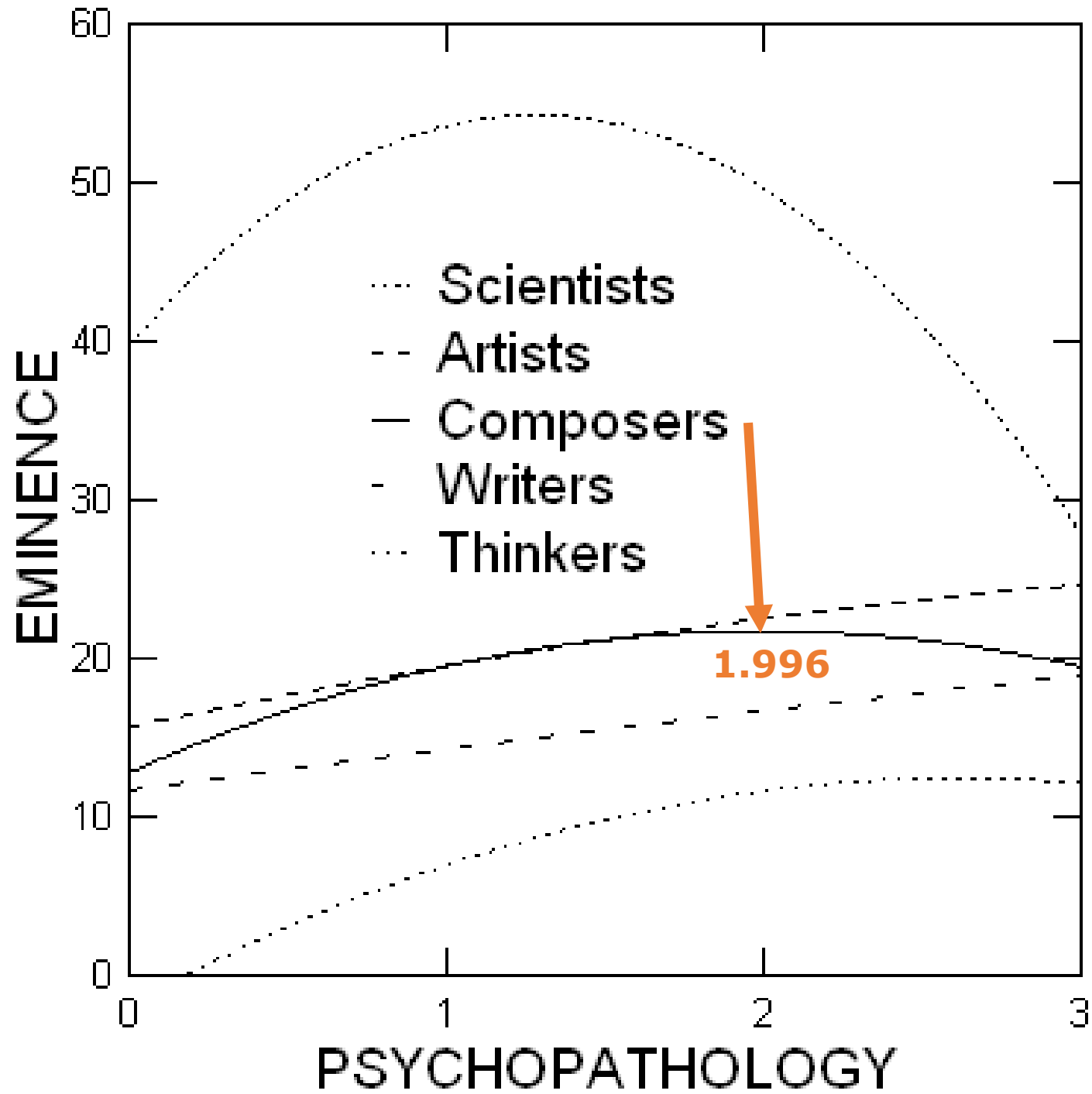
0 = None  
1 = Mild  
2 = Marked  
3 = Severe

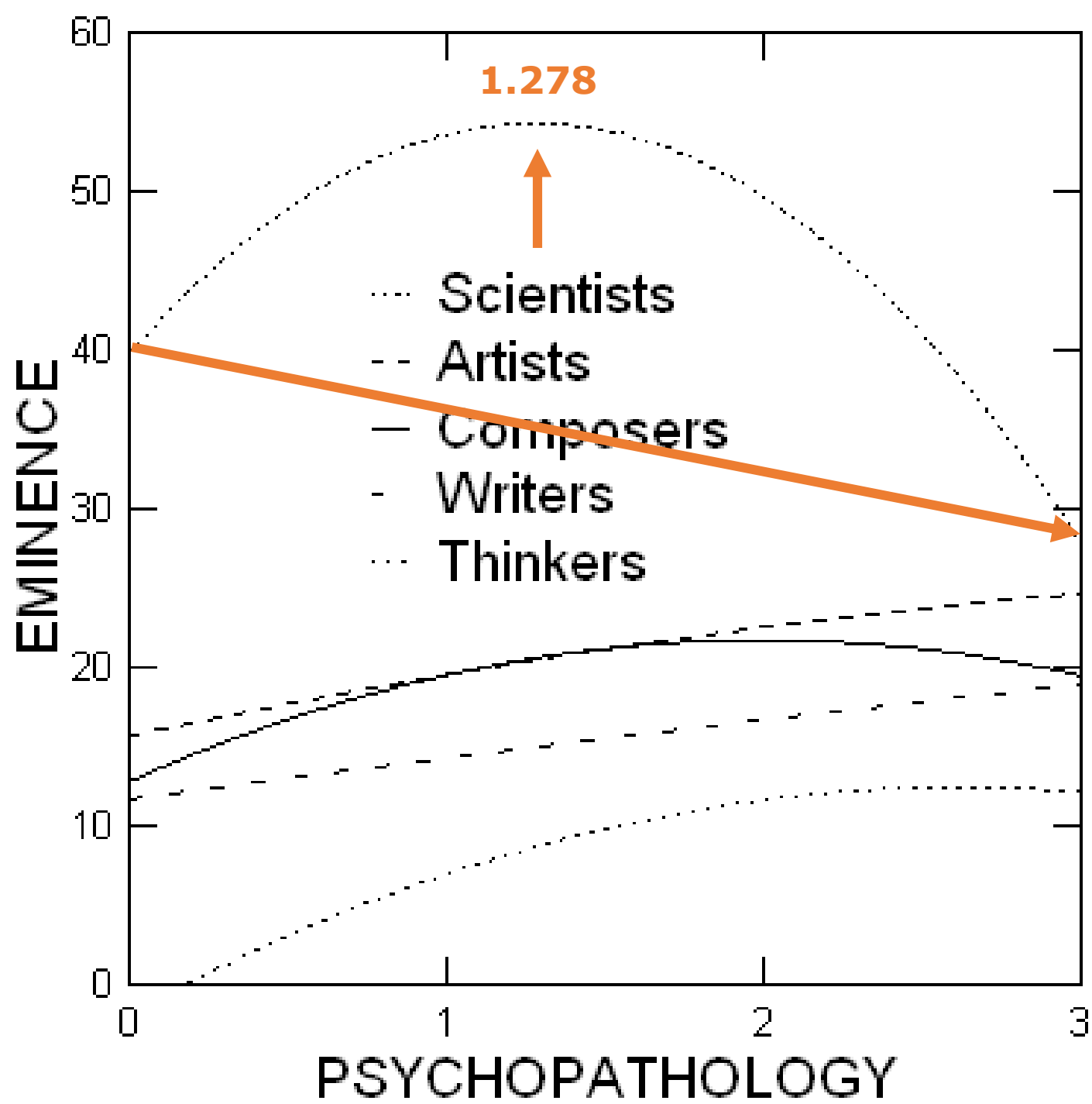
<b>Picasso</b>	77.32	<b>Braque</b>	27.08	<b>Rossetti</b>	7.94
<b>Cezanne</b>	50.30	<b>Turner</b>	25.74	<b>Derain</b>	7.71
<b>Monet</b>	40.70	<b>Mondrian</b>	23.51	<b>Ensor</b>	7.48
<b>van Gogh</b>	39.76	<b>Klee</b>	22.41	<b>Modigliani</b>	6.90
<b>Gauguin</b>	38.32	<b>Seurat</b>	22.19	<b>Hodler</b>	5.48
<b>Matisse</b>	38.30	<b>Corot</b>	21.62	<b>Schiele</b>	4.67
<b>Delacroix</b>	35.91	<b>Munch</b>	20.20	<b>Rivera</b>	4.50
<b>Manet</b>	33.52	<b>Daumier</b>	20.13	<b>Böcklin</b>	3.95
<b>Degas</b>	30.98	<b>Whistler</b>	19.93	<b>Menzel</b>	3.80
<b>Courbet</b>	30.83	<b>Pissaro</b>	18.55	<b>Cornelius</b>	2.41
<b>Kandinsky</b>	30.62	<b>Friedrich</b>	15.91	<b>Sargent</b>	1.99
<b>Renoir</b>	28.40	<b>Rousseau</b>	11.68	<b>Epstein</b>	1.35
<b>Ingres</b>	27.93	<b>Kokoschka</b>	9.38	<b>Cronbach's <math>\alpha = .95</math> using 11 reference works</b>	
<b>Rodin</b>	27.11	<b>Giacometti</b>	9.01		













## Writers

<b>Maupassant</b>	<b>Chekov</b>	<b>Balzac</b>	<b>Conrad</b>
	<b>France</b>	<b>Bennett</b>	<b>Dostoevsky</b>
	<b>Hauptmann</b>	<b>Brecht</b>	<b>Faulkner</b>
	<b>Melville</b>	<b>Camus</b>	<b>Gide</b>
	<b>Orwell</b>	<b>Dickens</b>	<b>Gogol</b>
		<b>Dumas (père)</b>	<b>Hemingway</b>
		<b>Flaubert</b>	<b>Hesse</b>
		<b>Galsworthy</b>	<b>Ibsen</b>
		<b>Gorky</b>	<b>Joyce</b>
		<b>Hardy</b>	<b>Kafka</b>
		<b>Hugo</b>	<b>Kipling</b>
		<b>Huxley (A)</b>	<b>Lawrence (DH)</b>
		<b>James (H)</b>	<b>Mann (T)</b>
		<b>Maugham (S)</b>	<b>Manzoni</b>
		<b>Pasternak</b>	<b>Proust</b>
	<b>Pirandello</b>	<b>Sartre</b>	
	<b>Shaw</b>	<b>Scott Fitzgerald</b>	
	<b>Thackeray</b>	<b>Stendhal</b>	
	<b>Trollope</b>	<b>Strindberg</b>	
	<b>Turgenev</b>	<b>Tolstoy</b>	
	<b>Zola</b>	<b>Waugh (E)</b>	
		<b>Wells</b>	
		<b>Wilde</b>	
<b>2.0%</b>	<b>10.0%</b>	<b>42.0%</b>	<b>46.0%</b>
<b>None</b>	<b>Mild</b>	<b>Marked</b>	<b>Severe</b>

Illustrations  
from  
Post (1994)

# Disposition and Domain

- Normal versus Revolutionary Science; i.e., paradigm preserving versus paradigm rejecting contributions ( $N = 76$ ; Ko & Kim, 2008)
- Psychopathology: Four levels, namely,
  - None, Personality Disorders, Mood Disorders, and Schizophrenic Disorders
- Achieved eminence (using Murray, 2003)
- Results:
  - For paradigm preserving scientists, psychopathology *negatively* correlated with eminence
  - For paradigm rejecting scientists, psychopathology *positively* correlated with eminence

# Disposition and Domain

- Examples involving dispositional traits besides psychopathology
  - Chemists < psychologists on 16 PF Factor M (Chambers, 1964): i.e., the latter more bohemian, introverted, unconventional, imaginative, and creative
  - Physical scientists less emotional, more factual, less rebellious, less verbal than social scientists (on TAT; Roe, 1952)
  - Integrative complexity of eminent psychologists (APA presidential addresses): Natural-science oriented < Human-science oriented (Suedfeld, 1985)
  - Mechanistic versus Organismic behavioral scientists (Johnson et al., 1988):
    - Former orderly, stable, conventional, conforming, objective, and realistic
    - Latter fluid, changing, creative, nonconforming, imaginative, autonomous, and individualistic
- In short, disposition corresponds to domain and subdomain

# Development and Domain

- Birth order:
  - Formal versus expressive arts:
    - Classical composers more likely to be firstborns (Schubert, Wagner, & Schubert, 1977)
    - Yet eminent creative writers more likely to be laterborns (Bliss, 1970)
  - Normal versus revolutionary sciences:
    - Eminent scientists more likely to be firstborns (Galton, 1874; Roe, 1953; Terry, 1989; intensified for women, see Simonton, 2008)
    - But scientific revolutionaries more likely to be laterborns (Sulloway, 1996, 2010); however this relation is moderated by pronounced parent-offspring conflict, age spacing, early parental loss and surrogate parenting, gender and ethnicity, etc.

# Development and Domain

- Family background of Nobel laureates (Berry, 1981; omitting physiology or medicine):
  - Father academic professional: physics 28%, chemistry 17%, literature 6%
  - Father lost by age 16: physics 2%, chemistry 11%, literature 17%
  - 30% of literature laureates “lost at least one parent through death or desertion or experienced the father’s bankruptcy or impoverishment” whereas “the physicists, in particular, seem to have remarkably uneventful lives” (p. 387; cf. Raskin, 1936)
- Rebelliousness toward parents: chemists < psychologists (Chambers, 1964)

# Development and Domain

- For 300+ 20<sup>th</sup> century eminent figures (Simonton, 1986):
  - fiction and nonfiction authors tend to come from unhappy home environments, whereas better home conditions produce scientists and philosophers
  - scientists have the most formal education, artists and performers the least, with poets least likely to have any special school experiences
- Formal education in 120 eminent scientists and 120 eminent writers:
  - Scientists > Writers (Raskin, 1936)

# Development and Domain

- Scientifically versus Artistically Creative Adolescents (Schaefer & Anastasi, 1968): family backgrounds
  - CrS < CrA diversity (foreign, mobility, travels)
  - CrS > CrA conventionality (parental hobbies, interests)
- Hence, similar results emerge when we look at giftedness rather than genius:
  - Development parallels domain

# Discussion

- Creators who attain eminence in low-complexity/high-consensus domains differ systematically in disposition and development from those who do so in high-complexity/low consensus domains
- Moreover, the correspondences are not random or arbitrary
  - That is, reasonable arguments can be made for each domain-creator match
    - Higher complexity in domain corresponds to more emotional instability in creator
    - Higher consensus in domain corresponds to more conventional background in creator
  - e.g., physics versus poetry; physicists versus poets
    - Cf. typical article in a physics journal with typical poem published in a literary magazine
    - Cf. rejection rates for submissions to physics versus literary publication venues
    - Cf. consensus on Nobel laureates in physics versus those in literature (e.g., Prudhomme, Eucken, and Heyse but *not* Tolstoy, Ibsen, Zola, Henry James, or Mark Twain)



# Discussion

- Yet the underlying causal basis remains largely unknown
  - No doubt both nature and nurture play a role
    - Nature means genetic endowment (e.g., talent development)
      - N.B.: artistic creativity more talent driven than scientific creativity (Simonton, 2008)
    - Nurture signifies experiential factors
      - e.g., “diversifying experiences that help weaken the constraints imposed by conventional socialization” (Simonton, 2000, p. 153), such as “unconventional backgrounds (e.g., cultural or religious minorities, sickly dispositions, early orphanhood, or financial trouble), ... [and/or] unconventional educational and training experiences (e.g., studies abroad, multiple mentors, voracious reading, and diverse hobbies” (Damian & Simonton, 2015, p. 625)
  - But the precise interplay between these variables and the domain-specific social context is likely extremely complex
  - After all, I’m a low-hierarchy psychologist trying to describe an elephant!

# Discussion

- Even so, I would like to close with a final issue: How does the magnitude of achieved eminence in a domain correspond to the degree that a creator's dispositional traits and developmental experiences are typical of colleagues in the same domain?
  - Are the most eminent the most typical of those in the domain? Or ...
  - Are the most eminent less typical? That is, either ...
    - More similar to those working in a domain higher in the hierarchy?
      - Such as reductionists?
        - e.g., evolutionary psychologists, behavior geneticists, and cognitive neuroscientists within psychology
    - More similar to those working in a domain lower in the hierarchy?
      - Such as more favorably disposed toward the arts?

# Discussion

- Some evidence suggests that the third possibility is the most likely, at least for dispositional traits
  - Introspective reports:
    - Max Planck's assertion that creative scientists "must have a vivid intuitive imagination, for new ideas are not generated by deduction, but by an artistically creative imagination."
  - Avocational interests and hobbies: Scientific creativity positively associated with involvement in the arts (Root-Bernstein et al., 2008):
    - Nobel laureates > RS & NAS > Sigma Xi & US public
  - Self-descriptions: Highly productive scientists see themselves as more original, less conventional, more impulsive, less inhibited, less formal, and more subjective (Van Zelst & Kerr, 1954) – aka more artistic

# Discussion

- Empirical evidence suggests that the third possibility is the most likely, at least for dispositional traits
  - EPQ psychoticism (subclinical symptoms indicator) positively correlates with:
    - scientific productivity and impact (Rushton, 1990; cf. Grosul & Feist, 2014)
    - artistic creativity and eminence (Götz & Götz, 1979a, 1979b)
  - Yet psychoticism associated with reduced latent inhibition (“defocused attention”)(Eysenck, 1995), which correlates positively with both
    - creative achievement in highly intelligent individuals (Carson, Peterson, & Higgins, 2003)
    - openness to experience (Peterson, Smith, & Carson, 2002), itself a correlate of
      - psychometric creativity (Harris, 2004; McCrae, 1987) and
      - behavioral creativity (Carson, Peterson, & Higgins, 2005; see also Carson, 2014)
  - Openness related to integrative complexity, hence ...

# Discussion

- Empirical evidence suggests that the third possibility is the most likely, at least for dispositional traits
  - Among APA presidents, integrative complexity of their addresses correlated positively with disciplinary eminence by multiple criteria (Suedfeld, 1985)
  - More broadly, for 99 full professors of physics, chemistry, or biology at major research universities (31 of them NAS members; Feist, 1994):
    - Higher integrative complexity when speaking about their research associated with
      - higher peer ratings in eminence,
      - higher citations
    - Higher integrative complexity when speaking about their teaching associated with
      - fewer works cited

# Discussion

- But why doesn't the third option hold for developmental experiences?
- Perhaps partly because of the recruitment pipeline?
  - e.g., importance of formal education in development of scientific talent
    - Even Albert Einstein felt compelled to get his doctorate despite once telling his best friend "I shall not become a Ph.D.... the whole comedy has become a bore to me."
- The elephant again!
- In any event, let me end with some exemplars of the creative geniuses who characterize the hierarchy of domains

