THE NEANDERTHAL FACE IS NOT COLD ADAPTED
The papers...
The Neanderthal face is not cold adapted

• For more than a century it was assumed (with conviction!) that Neanderthals had larger facial sinus when compared to modern humans.

• For more than a century it was assumed that this was an adaptation to cope with cold climate.
The Neanderthal face is not cold adapted

- In mammals leaving in cold environment the opposite pattern is observed (i.e. smaller sinus)
- The same is true for rats artificially raised in cold laboratories
- Think in Eskimo cranium (opposite bauplan of a Neanderthal)
The Neanderthal face is not cold adapted

- The very assumption that Neanderthals has larger sinus has never been quantitatively addressed.
The Neanderthal face is not cold adapted

- The very assumption that Neanderthals has larger sinus has never being quantitatively addressed.

- Controlling for cranial size since not doing it result in “making correlations between the variables inevitable but not necessarily informative.”
The Neanderthal face is not cold adapted

RESULTS:

• Neanderthal maxillary and frontal sinuses are not substantially different from those of recent European *H. sapiens*.

• “COLD” [Ferrasie1, Quina5, Spy1, Chapelle1] and “COOL” [Shanidar1, Guattari1, Forbes1, Krapina3?, Tabun] Neanderthal maxillary and frontal sinuses are not substantially different from each other.

  ➢ *Elimination of “complicated hypothesis concerning the selective advantages of structures that do not need to be explained”*

  ➢ The Neanderthal face is not cold adapted
The Neanderthal face is not cold adapted

1. Rae et al., (2011) didn`t choose anatomical relevant regions.

2. Rae et al., (2011) sample strategy was not appropriate.
The Neanderthal face is not cold adapted?

1. Rae et al., (2011) didn`t choose anatomical relevant regions.
   - True, nose is the real “hot spot” for climatic selection
   - False, this was a classic assumption. Not something invented by Rae et al., (2011)
The Neanderthal face is not cold adapted?

2. Rae et al., (2011) sample strategy was not appropriate.
   - Assuming data is OK the criticism is not valid. Rae et al., were “lucky” to pick up the upper extreme in human populations.

   - The significant different between the Y-intercept of the regressions is irrelevant to the discussion (even the slope would also be irrelevant).
THE EVOLUTION OF HUMAN CRANIA

- The myth of plasticity

- Natural selection vs drift
The myth of cranial plasticity
Franz Boas: founding the myth

Changes in the Bodily form of descendants of Immigrants (1912)
Offspring of Europeans born in the US had a different cranial morphology compared to the parental generation.

- Cranial morphology is very plastic
- Little genetic basis
- **Not useful for ancestrally inference**
  - I.e. phylogeny studies
Franz Boas: deeply embebed

Changes in the Bodily form of descendants of Immigrants (1912)

Offspring of Europeans born in the US had a different cranial morphology compared to the parental generation.

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Bogin (1999:288):

“Boas (1912) showed that migration from southern Europe to New York changed the shape of the skulls from the brachycephalic shape of parents to the dolicocephalic shape of their children in one generation. **Given these caveats, there is little support for an adaptative or evolutionary explanation for head shape in any human population**.”
Charles Davenport: was he serious?

Post-natal development of the head (1940:198):
Charles Davenport

Post-natal development of the head (1940:198):
Charles Davenport

Post-natal development of the head (1940:198):

“The activity of boys jumping, especially off high places, may cause a depression of the skull”
See Barry Bogin for a recent reproduction (Patterns of Human Growth, 1999:288):

“... other cultural practices, such as normative sleeping positions for infants and children can alter head shape during growth”.

Dolichocephaly

Brachycephaly
Cultural anthropology: still in early 20th century

Michael Frachetti (Migration Concepts in Central Eurasian Archaeology, 2011:205):

“... Long held as an effective method for distinguishing regional displacements of populations, craniometric analyses increasingly appear to reinforce circular argumentation and do not introduce an independent assessment of regional genetic affinity”.
Subsistence strategy: masticatory approach

Carlson and Van Gerven 1977 (see also Carlson 1976, Van Gerven 1976)

Post-Pleistocene Brachycephalization
Subsistence strategy: masticatory approach

See Clark Larsen (1997:227) for a recent reproduction: “... alterations in mechanical loading produce shifts in masticatory behavior that result in distinctive craniofacial morphological changes”.

If subsistence has a dramatic effect on the evolution of cranial morphology this implies that any signature of past population history has being effectively erased and therefore craniometric data cannot be used as a proxy of genetic relationships.

There is no question concerning the potential for plasticity of human cranium.
The question is: DOES THIS POTENTIAL ACTUALLY PLAYED A WHOLE IN CRANIAL EVOLUTION?
The question is:
DOES THIS POTENTIAL ACTUALLY PLAYED A CRUCIAL WHOLE IN CRANIAL EVOLUTION?

The answer is: NO.
Cranial plasticity re-evaluated

Geographical pattern is also present among very young individuals (Viarsdottir et al., 2002; Ackermann et al., 2005; Bulygina et al., 2006).

- Therefore, post-natal environment is not the main factor explaining cranial variation among modern humans.
Cranial plasticity re-evaluated

The Influence of Masticatory Loading on Craniofacial Morphology: A Test Case Across Technological Transitions in the Ohio Valley

Carolina Paschetta,1 Soledad de Azevedo,1 Lucía Castillo,2 Neus Martínez-Abadías,3 Miquel Hernández,3 Daniel E. Lieberman,4* and Rolando González-José1*

• Relative reduction of the temporal fossa

and

• A displacement of the attachment of the temporal muscles.
Cranial plasticity re-evaluated

Every study so far failed to show homoiology on cranium is capable of obliterating population history signal.

Hominin homoiology: An assessment of the impact of phenotypic plasticity on phylogenetic analyses of humans and their fossil relatives

Mark Collard a,b,*, Bernard Wood c,d,1

Revisiting the homoiology hypothesis: the impact of phenotypic plasticity on the reconstruction of human population history from craniometric data

Noreen von Cramon-Taubadel

Department of Anthropology, University of Kent, Marlowe Building, Canterbury, CT2 7NR, UK

Cautionary note: even for mandible this can be the result of either plasticity or natural selection and therefore is not possible to be sure the obliteration is due to homoiologies.
Boas` debate revisited

Changing Times, Changing Faces: Franz Boas`s Immigrant Study in Modern Perspective

Corey S. Sparks
Richard L. Jantz

New Answers to Old Questions: Did Boas Get It Right?

Heredity, Environment, and Cranial Form: A Reanalysis of Boas`s Immigrant Data

Clarence C. Gravlee
H. Russell Bernard
William R. Leonard

Commentary

Head to head with Boas: Did he err on the plasticity of head form?

Ralph L. Holloway*
Department of Anthropology, Columbia University, New York, NY 10027

A reassessment of human cranial plasticity: Boas revisited

Corey S. Sparks* and Richard L. Jantz*
*Department of Anthropology, Pennsylvania State University, 408 Carpenter Building, University Park, PA 16802; and "Department of Anthropology, University of Tennessee, 220 South Stadium Hall, Knoxville, TN 37996

Boas`s Changes in Bodily Form: The Immigrant Study, Cranial Plasticity, and Boas`s Physical Anthropology

Clarence C. Gravlee
H. Russell Bernard
William R. Leonard

Exchange across Difference

Wiley-Liss Plenary Symposium

Boas and Beyond: Migration and Cranio metric Variation

John H. Relethford*
Department of Anthropology, State University of New York College at Oneonta, Oneonta, New York 13820

DID BOAS GET IT RIGHT OR WRONG?

From the Editors
The myth of cranial plasticity

Summary:

1. Cranial plasticity is not an important agent in the evolution of modern human crania.

2. It is hard to imagine a specie that is exposed to a wider range of environments (climate, vegetation, etc... but also culture) than Homo sapiens.
Natural selection or genetic drift?
Natural selection or genetic drift?

If Natural Selection -> Potential for homoplasia. Useless for phylogenetic studies.

If Drift -> Good proxy for neutral molecular markers. Very good for phylogenetic studies.
Genetic base of cranial morphology

There is absolute no question on the power of natural selection to drive phenotypical evolution.

- Incompatibility between morphological and molecular tree for mammals.

- Among primates the case of Baboons and Mangabeys.

Diagram:

- Macaca
- Theropithecus
- Cercopithecus
- Lophocebus
- Mandrillus
- Papio

- Cercopithecus
  - Mandrillus
    - Theropithecus
    - Lophocebus
    - Papio
W.W. Howells: *Cranial Variation in Man*

In 1970's Howells start his fundamental work on validating craniometric as a valid tool for inferring biological relationship among modern human populations.

- Geographical logic is indeed very clear


Something is wrong!

IS IT POSSIBLE THAT SUCH A PLASTIC STRUCTURE WOULD PRESENT THIS KIND OF PATTERN?


Genetic base of cranial morphology

The close relationship between morphological and neutral genetic variation was first suggested by studies that demonstrated that craniometric traits, like many other phenotypic traits, have moderate heritability \( (h^2=0.55) \).

Genetic base of cranial morphology

Direct comparison of dissimilarity matrix based on neutral genetic markers and based on phenotype.

(Cheverud, 1988; Roseman, 2004; Perez et al., 2007).
Genetic base of cranial morphology

Direct comparison of dissimilarity matrix based on neutral genetic markers and based on phenotype.

Genetic distances based on 120 classical polymorphism

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Cavalli-Sforza et al., 1997
Genetic base of cranial morphology

Mainly under a additive poligenic system without dominance

\[ V_P = V_G + V_E + V_{GE} \]
\[ V_G = V_A + V_D + V_I \]

ADDITIVE VARIANCE
A = 4; a = 2
B = 6; b = 3
Then->
AABB = 20 (4+4+6+6)
AaBb = 15 (4+2+6+3)
aabb = 10 (2+2+3+3)
Genetic base of cranial morphology

EVOLUTION OF CRANIAL SHAPE IS DRIVEN BY THE TRADITIONAL MICRO-EVOLUTIONARY FORCES:
- Migration (gene flux)
- Natural Selection
- Drift
- Mutation
- Non-random mating

ADEQUATE TO BE INVESTIGATED USING TOOLS OF QUANTITATIVE GENETICS
(Lande`s, Blangero, Falconer etc...)
Global apportionment of craniometric variability

- **Fst for Neutral Molecular Markers:** ~ 0.15 (Lewontin, 1972; Barbujani et al. 1997; Bowcock et al. 1991; Rosenberg et al., 2002)

- **Fst for Craniometric data (Howells` database):** ~ 0.15 (Relethford 1994, 2002, But see Roseman and Weaver, 2006)

- **Fst for Skin Color:** ~ 0.85

<table>
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- **Fst for Skin Color:** $\sim 0.85$

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**EVOLUTION OF CRANIAL MORPHOLOGY IN MODERN HUMAN, IN GLOBAL SCALE, IS MAINLY DRIVEN BY DRIFT.**

- Genetic basis behind cranial shape.
- Can be used to infer population history!
Isolation by distance

Local and regional spatial variation of cranial morphology behaves according to the expected under a “Isolation by distance” model, like neutral genetic systems (Relethford, 2004, 2008; Roseman 2004; Harvati and Weaver 2006)
Isolation by distance

Local and regional spatial variation of cranial morphology behaves according to the expected under a “Isolation by distance” model, like neutral genetic systems (Relethford, 2004, 2008; Roseman 2004; Harvati and Weaver 2006)

The main force driven modern human cranial evolution is genetic drift.
Climate signatures in cranial evolution

- The influence of the climate is limited to the face, specially the nasal area (but see Holton and Franciscus).
- Even so, is only present at extremely cold environments.
- Therefore, in a global scale did not played a major whole on modern human cranial evolution.

LITERATURE IS VERY CONFUSE AND CONTRADICTORY:
- Beals, 1984; Roseman, 2004; Bernal et al, 2006; Harvati and Weaver, 2006; Hubbe et al., 2009; Betti et al., 2011; Noback et al., 2011)
Modern Human Cranial Evolution

SUMMARY:

• Drift is the main evolutionary force behind cranial evolution.

• Other agents like gene flux, developmental plasticity and natural selection took place in small proportion and only in localized spatial scale.
Back to today`s paper: Neanderthals too?

Were neandertal and modern human cranial differences produced by natural selection or genetic drift?

Timothy D. Weaver a,b,*, Charles C. Roseman c, Chris B. Stringer d

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Close correspondence between quantitative- and molecular-genetic divergence times for Neandertals and modern humans

Timothy D. Weaver*, Charles C. Roseman5, and Chris B. Stringer5

“... Neanderthal and modern human crania may simply represent two outcomes from a vast space of random evolutionary possibilities”. 
All old world monkeys?!??!?!?!?!


“The initial diversification of the group was generated by natural selection, but at the level of genus and species genetic drift is the predominant process, with the exception of the cercopithecines where there is evidence for natural selection”.