ON THE USE OF TWO-BLOCK PARTIAL LEAST SQUARES WITH LINEAR MEASUREMENTS FOR STUDYING INTEGRATION PATTERNS BETWEEN THE NEUROCRANIUM AND THE SPLANCHNOCRANIUM IN EXTANT HOMINOIDS AND EXTINCT HOMININS

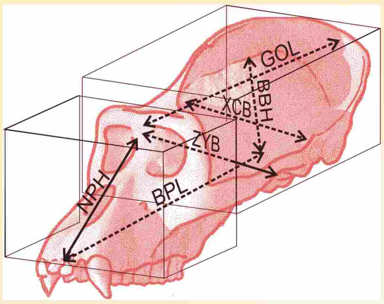
PÉREZ-CLAROS[1], Juan; JIMÉNEZ-ARENAS[2], Juan; PALMQVIST[1], Paul & MARTÍN-SERRA[1], Alberto

1) University of Malaga, Malaga, Spain 2) University of Granada, Granada, Spain

Many biological structures that interact in development and/or function tend to evolve in a concertedly fashion becoming integrated forming modules. The two most prominent modules of the mammalian cranium are the cerebral capsule (i.e., the neurocranium) and the face (i.e., the splanchnocranium), as inferred from both developmental processes and functional reasons.

The relative importance of both cranial complexes has been estimated here by means of their relative sizes, which were measured in the five extant hominoid species and also in a huge sample of extinct hominins using six standard cranial measurements as proxies of the length, width, and height of each cranial module.

Variables



Splanchnocranium:
Basion-prosthion length (BPL)
Nasion-prosthion height (NPH)
Bizygomatic breadth (ZYB)

Neurocranium:
Glabella-opistocranion length (GOL)
Basion-bregma height (BBH)
Maximum biparietal cranial breadth (XCB)

Material

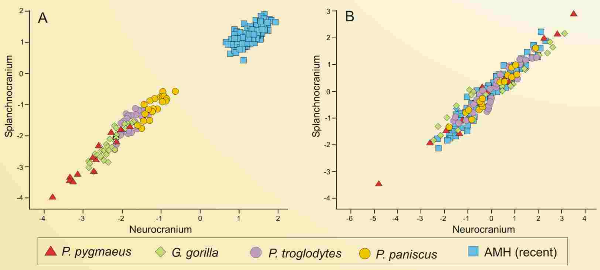
Group	n	Collection
AMH (recent adult)	141	PALUG; Howells (1973; 1989; 1995) Brown (on line)
AMH (Pleistocene adult)	20	(Jacob 1967; Riquet 1970; Vandermeersch 1977; White et al. 2003)
AMH (adult toothless)	13	AIMUZ
AMH (recent juvenile)	5	Brown (on line)
AMH (microcephalic)	4	AIMUZ; PALUG (Hrdlicka 1943; Poulianos 1975)
P. paniscus	20	RMCA
P. troglodytes (adult)	54	AIMUZ; RMCA
P. troglodytes (juvenile)	5	AIMUZ; RMCA
G. gorilla (adult)	29	AIMUZ
G. gorilla (juvenile)	4	AIMUZ
P. pygmaeus	14	AIMUZ
Fossil Hominins	28	see Table 2

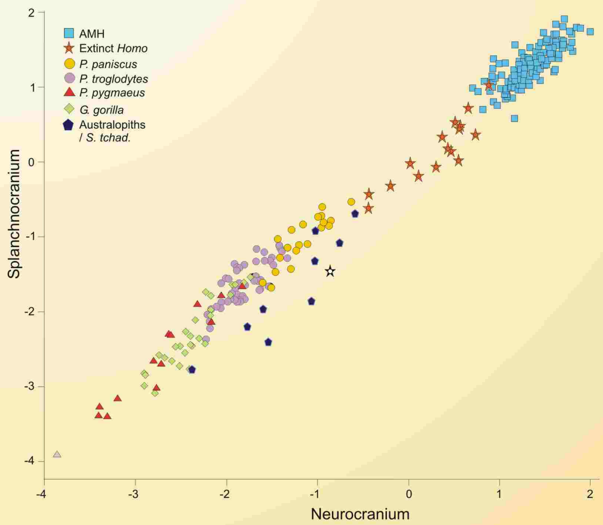
AIMUZ = Anthropological Institute and Museum, University of Zurich.
RMCA = Royal Museum of Central Africa, Tervuren, Belgium.
PALUG = Physical Anthropology Laboratory, University of Granada, Spain.

Specimen	Abbreviation	Taxa	Date (kyrs)
TM 266-01-060-1	TM266	*Sahelanthropus tchadensis*	7000 (a)
KNM-WT 17000	WT17000	*Paranthropus aethiopicus*	2520 (b)
AL 444-2	AL444-2	*Australopithecus afarensis*	3200 (c)
Sts 5	Sts5	*Australopithecus africanus*	2010 (d)
Sts 71	Sts71	*Australopithecus africanus*	2010 (d)
KNM-ER 406	ER406	*Paranthropus boisei*	1580 (b)
OH 5	OH5	*Paranthropus boisei*	1830 (b)
SK 48	SK48	*Paranthropus robustus*	1775 (e)
DNH 7	DNH7	*Paranthropus robustus*	1750 (f)
KNM-ER 1470	ER1470	*Homo rudolfensis*	2058 (q)
KNM-ER 1813	ER1813	*Homo habilis*	1650 (g)
OH 24	OH24	*Homo habilis*	1800 (h)
D 3444	D3444	*Homo georgicus*	1815 (i)
D 2700	D2700	*Homo georgicus*	1815 (i)
D 2282	D2282	*Homo georgicus*	1815 (i)
D 4500	D4500	*Homo georgicus*	1815 (i)
KNM-WT 15000	WT15000	*Homo ergaster*	1500 (k)
Stw 53	Stw53	*Homo* sp	1650 (l)
Sangiran 17	Sang17	*Homo erectus*	800 (k)
Kabwe	Kabwe	*Homo rhodesiensis*	300 (k)
SH Cranium 5	SH5	*Homo heidelbergensis*	350 (m)
Steinheim	Steinh	*Homo heidelbergensis*	250 (n)
Petralona	Petr	*Homo heidelbergensis*	252.5 (o)
Shanidar I	Shan1	*Homo neanderthalensis*	100 (k)
La Chapelle	LaCh	*Homo neanderthalensis*	52 (k)
La Ferrasie I	LaFerr1	*Homo neanderthalensis*	72 (k)
LB-1	LB1	*Homo floresiensis*	18 (p)

Method: two-blockpartial least squares

Non-pooled (A) and pooled within-species (B) 2B-PLS plots of the face vs. the neurocranium for size-scaled adults of the living species





Results and Conclusions

Several two-block partial least-squares analyses (2B-PLS) were performed for adults of the extant and extinct species. Each species exhibited a distinct relationship between the relative sizes of their modules.

When cranial size was removed, ontogenetic and evolutionary integration run in the same direction, which indicates that the relative sizes of the splanchnocranium and the neurocranium relate inversely both within and between species.