Human skull study causes evolutionary headache

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Scientists studying a unique collection of human skulls have shown that changes to the skull shape thought to have occurred independently through separate evolutionary events may have actually precipitated each other.

Researchers at the Universities of Manchester and Barcelona examined 390 skulls from the Austrian town of Hallstatt and found evidence that the human skull is highly integrated, meaning variation in one part of the skull is linked to changes throughout the skull.

The Austrian skulls are part of a famous collection kept in the Hallstatt Catholic Church ossuary; local tradition dictates that the remains of the town's dead are buried but later exhumed to make space for future burials. The skulls are also decorated with paintings and, crucially, bear the name of the deceased. The Barcelona team made measurements of the skulls and collected genealogical data from the church's records of births, marriages and deaths, allowing them to investigate the inheritance of skull shape.

The team tested whether certain parts of the skull – the face, the cranial base and the skull vault or brain case – changed independently, as anthropologists have always believed, or were in some way linked. The scientists simulated the shift of the foramen magnum (where the spinal cord enters the skull) associated with upright walking; the retraction of the face, thought to be linked to language development and perhaps chewing; and the expansion and rounding of the top of the skull,

associated with brain expansion. They found that, rather than being separate evolutionary events, changes in one part of the brain would facilitate and even drive changes in the other parts.

"We found that genetic variation in the skull is highly integrated, so if selection were to favour a shape change in a particular part of the skull, there would be a response involving changes throughout the skull," said Dr Chris Klingenberg, in Manchester's Faculty of Life Sciences

"We were able to use the genetic information to simulate what would happen if selection were to favour particular shape changes in the skull. As those changes, we used the key features that are derived in humans, by comparison with our ancestors: the shift of the foramen magnum associated with the transition to bipedal posture, the retraction of the face, the flexion of the cranial base, and, finally, the expansion of the braincase.

"As much as possible, we simulated each of these changes as a localised shape change limited to a small region of the skull. For each of the simulations, we obtained a predicted response that included not only the change we selected for, but also all the others. All those features of the skull tended to change as a whole package. This means that, in evolutionary history, any of the changes may have facilitated the evolution of the others."

Lead author Dr Neus Martínez-Abadías, from the University of Barcelona's, added: "This study has important implications for inferences on human evolution and suggests the need for a reinterpretation of the evolutionary scenarios of the skull in modern humans."

More information: Martínez-Abadías, N.; Esparza, M.; Sjövold, T.; González-José, R.; Santos, M.; Hernàndez, M.; Klingenberg, C.P.

"Pervasive genetic integration directs the evolution of human skull shape". *Evolution*, November 2011, DOI: 10.1111/j.1558-5646.2011.01496.x