

Anthropology 458
CRANIOFACIAL BIOLOGY

Spring 2004

Instructor:

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Class times: TTh 11:30 – 1pm
Office Hours: Tues. 4 – 6pm and by appt.

Structure and goals of the course: After completing this course, students will be knowledgeable in the terminology and basic literature associated with craniofacial growth, function and phylogeny. Discussions will center around how hypotheses about craniofacial growth, function and phylogeny are generated and tested; paleoanthropological applications of craniofacial biology, especially related to life history inferences about growth, diet and speech; and how integration between different parts of the head during development and evolution influences craniofacial morphology in primates and hominids.

Grading:

This course is a seminar based on a discussion of assigned readings. Grades will be determined by class participation (~20%), 3 short (10-15 minute) presentations in class (~30%), and a final paper (~50%). Students are expected to read articles in advance of class and come prepared with questions and comments; in addition, graduate students will be expected to undertake extra reading assignments, as listed. Attendance is required.

Introduction

Tuesday	Jan. 20	Introduction
Thursday	Jan. 22	Skull anatomy, muscle and bone

PART I: Growth and Development

Tuesday	Jan. 27	Embryology
Thursday	Jan. 29	Competing concepts of craniofacial growth
Tuesday	Feb. 3	Neurocranial growth
Thursday	Feb. 5	Facial and basicranial growth
Tuesday	Feb. 10	Hominid craniofacial growth
Thursday	Feb. 12	Dental morphology, wear, attrition
Tuesday	Feb. 17	Dental development
Thursday	Feb. 19	Life history inferences from dental eruption patterns
Tuesday	Feb. 24	Life history inferences from dental histology

PART II: Function

Thursday	Feb. 26	Occlusion, mastication
Tuesday	Mar. 2	Introduction to biomechanics
Thursday	Mar. 4	Craniofacial biomechanics I

Tuesday	Mar. 16	Craniofacial biomechanics II
Thursday	Mar. 18	Hominid craniofacial biomechanics
Tuesday	Mar. 23	Chewing, vocalization, speech
Thursday	Mar. 25	Hominid speech

PART III: Phylogeny and Evolution

Tuesday	Mar. 30	Craniofacial genetics
Thursday	Apr. 1	Integration
Tuesday	Apr. 6	Constraint
Thursday	Apr. 8	Constraints on primate craniofacial architecture
Tuesday	Apr. 13	No class (Passover)
Thursday	Apr. 15	No class (AAPA meetings)
Tuesday	Apr. 20	Scaling, heterochrony
Thursday	Apr. 22	Brain evolution
Tuesday	Apr. 27	Cranial base architecture
Thursday	Apr. 29	Evolution of modern human skull form

PART I GROWTH AND DEVELOPMENT

Jan. 22 Skull anatomy, muscle and bone

Aiello, L. & Dean, C. (1990). The microanatomy of muscle and bone. In *Human Evolutionary Anatomy*, pp. 19-32. Academic Press, London.

Enlow, D.H. (1990). Introductory concepts of the growth process. In *Handbook of Facial Growth*, 3rd ed., pp. 25-57. Saunders, Phila.

Jan. 27 Embryology

Enlow, D.H. & Hans, M.G. (1996). Prenatal facial growth and development. In *Essentials of Facial Growth*, pp. 220-232. Saunders, Phila.

Sperber, G.H. (1989). Chaps. 7-9 ("Introduction," "The calvaria," "The cranial base," and "The facial skeleton"). In *Craniofacial Embryology*, pp. 88-127. Wright, London.

Jan. 29 Competing concepts of craniofacial growth

Moss, M.L. (1968). The primacy of functional matrices in orofacial growth. *Dent. Practit.* **19**, 65-73.

Ranly, D.M. (1988). Theories of craniofacial growth. In *A Synopsis of Craniofacial Growth*, 2nd ed., pp. 142-158. Appleton & Lange, Conn.

Enlow, D.H. & Hans, M.G. (1996). Control processes in facial growth. In *Essentials of Facial Growth*, pp. 200-211. Saunders, Phila.

Feb. 3 Neurocranial growth

Young, R.W. (1959). The influence of cranial contents on postnatal growth of the skull in the rat. *Am. J. Anat.* **105**, 383-415

Moss, M.L. & Young, R.W. (1960). A functional approach to craniology. *Am. J. Phys. Anthropol.* **18**, 281-292.

Feb. 5 Facial and basicranial growth

Enlow, D.H. (1990). The facial growth process. In *Handbook of Facial Growth*, 3rd ed., pp. 58-76. Saunders, Phila.

Nanda, R., Baume, R.M., Tanne, K. & Sugawara, J. (1987). Longitudinal study of craniofacial growth in *Macaca fascicularis*. *Am. J. Phys. Anthropol.* **73**, 215-225.

Lieberman, D.E., Ross, C.F. & Ravosa, M.J. (2000). Patterns and processes of basicranial growth. In *The primate cranial base: Ontogeny, function, and integration*, pp. 122-131 only. *Yrbk. Phys. Anthropol.* **43**, 117-169.

Feb. 10 Hominid craniofacial growth

Bromage, T.G. (1989). Ontogeny of the early hominid face. *J. Hum. Evol.* **18**, 751-773.

Ackerman, R.R. & Krovitz, G.E. (2002). Common patterns of facial ontogeny in the hominid lineage. *The New Anatomist* **269**, 142-147.

Ponce de Leon, M.S. & Zollikofer, C.P.E. (2001). Neanderthal cranial ontogeny and its implications for late hominid diversity. *Nature* **412**, 534-538.

Feb. 12 Dental morphology, wear, attrition

Strait, S.G. (1997). Tooth use and the physical properties of food. *Evol. Anthropol.* **5**, 199-211.

Luke, D.A. & Lucas, P.W. (1983). The significance of cusps. *J. Oral Rehab.*

Teaford, M.F. (1994). Dental microwear and dental function. *Evol. Anthropol.* **3**, 17-30.

Feb. 17 Dental development

Aiello, L. & Dean, C. (1990). The microanatomy and development of teeth. In *Human Evolutionary Anatomy*, pp. 106-132. Academic Press, London.

Feb. 19 Life history inferences from dental eruption patterns

Smith, B.H. (1989). Dental development as a measure of life history in primates. *Evol.* **43**, 683-688.

Smith, B.H. (1991). Dental development and the evolution of life history in Hominidae. *Am. J. Phys. Anthropol.* **86**, 157-174.

Feb. 24 Life history inferences from dental histology

Schwartz, G.T. & Dean, C. (2000). Interpreting the hominid dentition: Ontogenetic and phylogenetic aspects. In (P. O'Higgins & M.J. Cohn, eds.). *Development, Growth, and Evolution*, pp. 207-233. Academic Press, London.

Schwartz, G.T., Samonds, K.E., Godfrey, L.R., Jungers, W.L. & Simons, E.L. (2002). Dental microstructure and life history in subfossil Malagasy lemurs. *Proc. Natl. Acad. Sci.* **99**, 6124-6129.

PART II FUNCTION

Feb. 26 Occlusion, mastication

Ash, M.M. & Ramfjord, S. (1995). Clinical occlusion. In *Occlusion, 4th ed.*, pp. 50-83. Saunders.

Hiiemae, K.M. (2000). Feeding in mammals. In (K. Schwenk, ed.). *Feeding: Form, function, and evolution in tetrapod vertebrates*, pp. 411-448. Academic Press, San Diego.

Mar. 2 Introduction to biomechanics

Skerry, T. (2000). Biomechanical influences on skeletal growth and development. In (P. O'Higgins & M.J. Cohn, eds.). *Development, Growth, and Evolution*, pp. 29-40. Academic Press, London.

Lieberman, D.E. (1997). Making behavioral and phylogenetic inferences from fossils: Considering the developmental influence of mechanical forces. *Ann. Rev. Anthropol.* **26**, 185-210.

Mar. 4 Craniofacial biomechanics I

Hylander, W.L. (1992). Strain gradients in the craniofacial region of primates. In (Z. Davidovitch, ed.). *The Biological Mechanisms of Tooth Movement and Craniofacial Adaptation*, pp. 559-569. The Ohio State University College of Dentistry, Columbus, OH.

Daegling, D.J. (1993). The relationship of *in vivo* bone strain to mandibular corpus morphology in *Macaca fascicularis*. *J. Hum. Evol.* **25**, 247-269.

Mar. 16 Craniofacial biomechanics II

Spencer, M.A. (1998). Force production in the primate masticatory system: Electromyographic tests of biomechanical hypotheses. *J. Hum. Evol.* **34**, 25-54.

Mar. 18 Hominid craniofacial biomechanics

Demes, B. & Creel, N. (1988). Bite force, diet, and cranial morphology of fossil hominids. *J. Hum. Evol.* **17**, 657-670.

Spencer, M.A. & Demes, B. (1993). Biomechanical analysis of masticatory system configuration in Neandertals and Inuits. *Am. J. Phys. Anthropol.* **91**, 1-20.

Mar. 23 Chewing, vocalization, speech

Lieberman, D.E., McCarthy, R.C., Hiiemae, K.M. & Palmer, J.B. (2001). Ontogeny of postnatal hyoid and larynx descent in humans. *Arch. Oral Biol.* **46**, 117-128.

Hiiemae, K.M., Palmer, J.B., Medicis, S.W., Hegener, J., Jackson, B.S. & Lieberman, D.E. (2002). Hyoid and tongue surface movements in speaking and eating. *Arch. Oral Biol.* **47**, 11-27.

Mar. 25 Hominid speech

Laitman, J.T., Heimbuch, R.C. & Crelin, E.S. (1979). The basicranium of fossil hominids as an indicator of their upper respiratory systems. *Am. J. Phys. Anthropol.* **51**, 15-34.

Arensburg, B., Schepartz, L.A., Tillier, A.M., Vandermeersch, B. & Rak, Y. (1990). A reappraisal of the anatomical basis for speech in Middle Paleolithic hominids. *Am. J. Phys. Anthropol.* **83**, 137-146.

Kay, R.F., Cartmill, M. & Balow, M. (1998). The hypoglossal canal and the origin of human vocal behavior. *Proc. Natl. Acad. Sci.* **95**, 5417-5419.

For the graduate students (skim):

Lieberman, D.E. & McCarthy, R.C. (1999). The ontogeny of cranial base angulation in humans and chimpanzees and its implications for reconstructing pharyngeal dimensions. *J. Hum. Evol.* **36**, 487-517.

PART III PHYLOGENY AND EVOLUTION

Mar. 30 Craniofacial genetics

Hunter, W.S. (1990). Heredity in the craniofacial complex. In *Handbook of Facial Growth*, 3rd ed., pp. 249-266. Saunders, Phila.

Stoltenberg, S.F. (1997). Coming to terms with heritability. *Genetica* **99**, 89-96.

Bailey, R.C. (1997). Hereditarian scientific fallacies. *Genetica* **99**, 125-133.

Apr. 1 Integration

Cheverud, J.M. (1982). Phenotypic, genetic, and environmental morphological integration in the cranium. *Evol.* **36**, 499-516.

Chernoff, B. & Magwene, P.M. (1999). Morphological integration: Forty years later. In Olson, E.C. & Miller, R.L. *Morphological Integration*, pp. 319-353. Univ. Chicago Press, Chicago.

Apr. 6 Constraint

Gould, S.J. & Lewontin, R.C. (1979). The spandrels of San Marco and the Panglossian paradigm: A critique of the adaptationist programme. *Proc. R. Soc. Lond. B* **205**, 581-598.

Pigliucci, M. & Kaplan, J. (2000). The fall and rise of Dr Pangloss: Adaptationism and the Spandrels paper 20 years later. *Trends Ecol. Evol.* **15**, 66-70

Antonovics, J. & van Tienderen, P.H. (1991). Ontoecogenophyloconstraints? The chaos of constraint terminology. *Trends Ecol. Evol.* **6**, 166-168.

For the graduate students:

Maynard Smith, J. Burian, R., Kauffman, S., Alberch, P., Campbell, J., Goodwin, B., Lande, R., Raup, D. & Wolpert, L. (1985). Developmental constraints and evolution. *Quart. Rev. Biol.* **60**, 265-287.

Apr. 8 Constraints on primate craniofacial architecture

Enlow, D.H. (1990). The plan of the human face. In *Handbook of Facial Growth*, 3rd ed., pp. 164-192. Saunders, Phila.

Ravosa, M.J. & Shea, B.T. (1994). Pattern in craniofacial biology: Evidence from the Old World monkeys (Cercopithecidae). *Int. J. Primatol.* **15**, 801-822.

For the graduate students (skim and consider whether Enlow's hypotheses are well-founded):

Enlow, D.H. & Azuma, M. (1975). Functional growth boundaries in the human and mammalian face. In (D. Bergsma, ed.). *Morphogenesis and Malformation of the Face and Brain*, pp. 217-230. Alan R. Liss, NY.

Smith, R.J. & Josell, S.D. (1984). The plan of the human face: A test of three general concepts. *Am. J. Orthodont.* **85**, 103-108.

Bromage, T.G. (1992). The ontogeny of *Pan troglodytes* craniofacial architectural relationships and implications for early hominids. *J. Hum. Evol.* **23**, 235-251.

Apr. 20 Scaling, heterochrony

Schmidt-Nielsen, K. (1984). The size of living things. In *Scaling: Why is animal size so important*, pp. 1-32. Cambridge University Press, Cambridge.

McKinney, M.L. & McNamara, K.J. (1991). Classifying and analyzing heterochrony. In *Heterochrony: The evolution of ontogeny*, pp. 13-46. Plenum, NY.

Shea, B.T. (1989). Heterochrony in human evolution: The case for neoteny reconsidered. *Yrbk. Phys. Anthropol.* **32**, 69-101.

Apr. 22 Brain evolution

Martin, R.D. (1981). Relative brain size and basal metabolic rate in terrestrial vertebrates. *Nature* **293**, 57-60.

Finlay, B.L. & Darlington, R.B. (1995). Linked regularities in the development and evolution of mammalian brains. *Science* **268**, 1578-1584.

De Winter, W. & Oxnard, C.E. (2001). Evolutionary radiations and convergences in the structural organization of mammalian brains. *Nature* **409**, 710-714.

For the graduate students:

Clark, D.A., Mitra, P.P. & Wang, S.S.-H. (2001). Scalable architecture in mammalian brains. *Nature* **411**, 189-193.

Apr. 27 Cranial base architecture

Lieberman, D.E., Ross, C.F. & Ravosa, M.J. (2000). “Angulation” and “Associations between cranial base and brain.” In *The primate cranial base: Ontogeny, function, and integration*, pp. 126-138 only. *Yrbk. Phys. Anthropol.* **43**, 117-169.

Apr. 29 Evolution of modern human skull form

Lieberman, D.E. (1998). Sphenoid shortening and the evolution of modern human cranial shape. *Nature* **393**, 158-162.

Lieberman, D.E., McBratney, B.M. & Krovitz, G. (2002). The evolution and development of cranial form in *Homo sapiens*. *Proc. Natl. Acad. Sci.* **99**, 1134-1139.