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This Week's Citation Classic®

Moss M L & Young R W. A functional approach to craniology.
Amer. J. Phys. Anthropol. **18**:281-92, 1960.
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The skull consists of a series of functional components, each of which supports or protects specific, and operationally related, soft tissues, termed functional matrices. All skeletal structural attributes reflect the morphogenetically and temporally prior demands of their matrices. [The *Science Citation Index*® (*SCI*®) and the *Social Sciences Citation Index*® (*SSCI*®) indicate that this paper has been cited in over 125 publications, making it one of the most cited published in this journal.]

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Thirty years ago, the multidisciplinary field of craniology was reinvigorated by two events. The first was significant funding by several National Institutes of Health. The second was something often observed in science: the almost simultaneous development of a new series of concepts, related hypotheses, and experimental verifications, both independently and internationally, by a number of workers.

Physical anthropology and craniology were traditional interests of the Department of Anatomy at Columbia University, where I have done all of my work including a doctoral thesis in 1954. In the thesis, I proposed an epigenetic theory of cranial growth regulation and denied any primarily active role to the sutures, explicitly contradicting one of the classical craniological theories. My work was strongly influenced by three colleagues. In 1947, Sherwood Washburn, my predecessor at Columbia, had introduced the experimental method to physical anthropology,[1] and between 1948 and 1952, C.J. van der Klaauw of Leiden suggested that there was no biological reality to the bones of classical osteology,[2] an idea strongly supported in 1955 by James Scott of Queens' University, Belfast.[3]

During 1954-1960, the further implications of my developing concepts were explored in a series of intensive experiments, work that was materially assisted by the 1959 thesis of Dick Young.[4] I believe that our 1960 paper received its frequent citations for several interrelated reasons. First, it offered a new and unitary explanation for several perennial craniological problems previously felt to be unconnected. Second, following my somewhat later textbook publication of the functional matrix hypothesis in a more fully developed form,[5] and its diffusion into, and acceptance by, a number of academic and clinical disciplines, this prior periodical reference was more readily available to more workers.

I find it of great interest that our 1960 paper is entirely conceptual in content, and in that respect it differs from the content of most of the *Citation Classics* I am aware of. It does not report directly any of our experimental data, nor does it have a quantitative content. Clearly, the concepts *per se* attracted the readers, and I feel a particular sense of pride for that. I felt then, and continue to believe, that in some very fundamental sense the "time was ripe" for our paper. It is pleasant to realize that the functional matrix hypothesis has, in one form or another, become a part of the current craniological paradigm. I prefer to believe that this is because the hypothesis has proven its explanatory power; for me, it continues to do so.[6]

1. Washburn S L. The relation of the temporalis muscle to the form of the skull. *Anat. Rec.* **99**:239-48, 1947. (Cited 115 times since 1955.)
2. van der Klaauw C J. Size and position of the functional components of the skull. *Arch. Néerl. Zool.* **9**:1-559, 1948-1952.
3. Scott J H. Craniofacial regions. *Dent. Pract.* **5**:208-14, 1955. (Cited 10 times.)
4. Young R W. The influence of cranial contents on postnatal growth of the skull in the rat. *Amer. J. Anat.* **105**:383-415, 1959. (Cited 80 times.)
5. Moss M L. The functional matrix. (Kraus B S & Riedel R A, eds.) *Vistas in orthodontics*. Philadelphia: Lea & Febiger, 1962. p. 85-98. (Cited 95 times.)
6. ———. The functional matrix hypothesis: its explanatory role in problems of craniofacial form and growth. (Graber T M, ed.) *Physiologic foundations of functional appliances*. St. Louis: C.V. Mosby, 1985. p. 3-4.

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