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Human growth data analyses and statistics – The 4th Gülpe International Student Summer School

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Abstract

Students learn by repetition. Repetition is essential, but repetition needs questioning, and questioning the repertoire belongs to the essential tasks of student education. Guiding students to questioning was and is our prime motive to offer our International Student Summer Schools. The data were critically discussed among the students, in the twilight of *Just So Stories*, common knowledge, and prompted questioning of contemporary solutions. For these schools, the students bring their own data, carry their preliminary concepts, and in group discussions, they may have to challenge these concepts. Catch-up growth is known to affect long bone growth, but different opinions exist to what extent it also affects body proportions. Skeletal age and dental development are considered appropriate measures of maturation, but it appears that both system develop independently and are regulated by different mechanisms. Body weight distributions are assumed to be skewed, yet, historic data disproved this assumption. Many discussions focused on current ideas of global growth standards as a common yardstick for all populations worldwide, with new statistical tools being developed including network reconstruction and evaluation of the reconstructs to determine the confidence of graph prediction methods.

Take home message for students Learning by repetition is essential, but question your repertoire!

Just So Stories are bedtime stories once told by Rudyard Kipling to his daughter Effie. "In the evening there were stories meant to put Effie to sleep, and you were not allowed to alter those by one single little word. They had to be told *just so*; or Effie would wake up and put back the missing sentence." (Karlin, 2015). *Just So Stories* give explanations for the origin of animals and their characteristics, we learn why "from that day to this the Camel always wears a humph", and why "from that day on, the grating in the whales' throat, which he could neither cough up nor swallow down, prevented him eating anything except very, very small fish; and that is the reason why whales nowadays never eat men or boys or little girls" ... Children take delight in order and method, and they learn by repetition. "Under ordinary circumstances, frequent repetitions are indispensable for the reproduction of a content. Vocabulary, larger poems, speeches cannot be acquired by a single demonstration, even with the greatest tension and talent. By sufficient repetition their final mastery is achieved and by further increase of repetitions the later reproductions gain in certainty and ease", wrote Hermann Ebbinghaus already in 1885 (Ebbinghaus, 1885).

When we get older we usually learn that it is not the Djinn thinking magics, with his chin in his hand, to make the camels hump; nor is it the Mariner who had cut up his raft into a little square grating all running criss-cross, and fixed it into the Whale's throat; as Kipling once told his daughter; nor the straining to reach high branches with leaves by which the giraffe eventually developed longer necks and legs, as Lamarck suggested some half century before Darwin. Evolution works differently. But what about the many myths that continue to persist in the scientific literature such as the association of thermoregulation and body size named "Bergmann's Rule" that against good evidence is still believed to also apply to the human species and is countlessly repeated in biological anthropology and in the textbooks of human physiology (Bogin, 2021); or the almost ubiquitous perception that child growth failure is the most common form of undernutrition (stunting paper). We learn that mythology repeats itself, and has "a key role in civilization and cultural movements throughout history" (Berk, 2016).

Students learn by repetition, and as Ebbinghaus stated, by "sufficient repetition their final mastery is achieved". Repetition is essential, but repetition needs questioning, and questioning the repertoire belongs to the essential tasks of student education. Guiding students to questioning was and is our prime motive to offer our International Student Summer Schools (Hermanussen et al., 2020, 2019). For these schools, the students bring their own data, they carry their preliminary concepts, and in group discussions, we sometimes have to challenge these concepts. In the first days, there often is frustration, but relief and calmness come soon when surmounting the initial incongruences and preparing for the final presentation of their tasks. In spite of the numerous restrictions due to Corona pandemics, five students were finally able to join the Summer School 2021.

Cecilie Cordua Mattsson (Mattsson, 2021) arrived at the Summer School to assess whether catch-up growth during childhood affects the long bone ratios of the arms and legs of adults. In 1998, (Boldsen, 1998) had stated that "*...in regaining size after such episodes – through catch up growth – certain body proportions were altered.*" Mattsson came to verify this statement, and failed. She used linear enamel hypoplasia (LEH) in the canines as an indicator of ill health in early childhood in archeological material, and worked on LEH in the four canines and anthropometric measurements of humerus, radius, femur, and tibia of 67 skeletons from two

Danish medieval cemeteries. She applied appropriate statistics, and concluded that linear enamel hypoplasia is not associated with altered long bone ratios.

Sonja Böker (Boeker et al., 2021) studied dental, skeletal and height data from a large sample of Guatemalan boys from different social backgrounds and according with common perception started with the hypothesis that dental age should well correlate with body height and skeletal age. Also Sonja Böker failed. The correlations between dental age and skeletal age, and dental age and height, are weak. Instead, the data strongly suggested that the dental development is an independent system that is regulated by different mechanisms than skeletal development and growth. Skeletal age is sensitive to the socioeconomic background, tooth eruption is resilient.

Liza Wilke (Wilke et al., 2021) compared historic data on height and weight of 1843 six and seven year old girls from 1914 with modern WHO references and contemporary German data and found that already a century ago, pediatricians knew about the association between social class and body height and weight. But quite in contrast to common knowledge that weight distributions are skewed, Liza Wilke discovered that this was not true in the historic samples. Weight in children of all social classes showed a symmetric Gaussian distribution.

Masiar Novine (Novine and Mattsson, 2021) scrutinized techniques for the visualizations of networks. He used synthetic data where the structure of relationships between the variables is known, and perform network reconstruction and evaluation of the reconstructs to determine the confidence of graph prediction methods. These techniques have increasingly been applied to anthropological data and found to be of great help for the understanding of the network structure of such data.

Rebekka Mumm (Mumm and Hermanussen, 2021) questioned the common idea of using global growth standards as a common yardstick for all populations worldwide. She first studied the age-group effect on weight-for-height, and thereafter compared three contemporary with three commensurable end-19th century growth charts also from Germany, England and Boston, USA, to test the consistency of national references for weight-for-height throughout recent history. Weight for height does not solely characterize the nutritional state, but is plastic, and reflects body proportion and body built, and is sensitive to secular changes in height and weight.

The manuscripts of this issue result from original data, and from selected historic data that are not readily available, provided by students and/or supervisors of the students. The data were critically discussed among the students, in the twilight of *Just So Stories*, common knowledge and prompted questioning of contemporary solutions.

We hope that this concept of our summer school will continue and result in future international scientific cooperation and friendship between participants. And it may finally be mentioned that these summer schools are not only beneficial for students. They have become an excellent training session also for the teachers who gratefully acknowledge the enthusiasm of their scholars.

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