Teaching Anthropology

2025, Vol. 14, No 1. pp. DT1

The Brains and Bones Project: Using Embodied Teaching to Teach Embodiment

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Abstract
This article summarises the initial phase of a new project, Brains and Bones, which seeks to teach audiences of all ages about evolutionary anthropology and the embodied relationships between our brains, bones, and the world around us. Using an embodied teaching paradigm, Brains and Bones conveys information tangibly through interactive and reflexive activities with participants. By enabling participants through an enactive and hands-on approach, we hope to make the rich field of evolutionary anthropology accessible to the wider community and engage audiences with research conducted at Durham University.

Keywords: Evolution, Brains, Bones, Embodiment, Pedagogy

Introduction:

In evolutionary anthropology, we seek to understand both our biology and our lived experiences as humans (Gibson & Lawson, 2015). Collaborations between neuroscience [brains] and osteology [bones] within the context of evolutionary anthropology help to emphasise the interconnected nature of the shape and affordances of our bodies and the ways in which we interact with - and comprehend - the world around us (Gibson 1986, van Boekholt et al 2024). The evidence of these relationships can be seen in the bodies of our ancestors and in our bodies today, giving us a sense of our place in the world and in our evolutionary story. The *Brains and Bones* project, a new collaboration between researchers at Durham University specialising in human skeletal anatomy and brain evolution, demonstrates these embodied relationships through interactive exercises involving our bodies and hands-on experience with models of the human brain and bones.

The goal of this project is to engage audiences of all ages with evolutionary anthropology, with a particular emphasis on demonstrating the wealth of information about human evolution and functional anatomy available in our own bodies today. It encourages participants to reflect on their physical experience, especially as they move through the world, and consider how their uniquely human shape influences their lives. As this project is an interdisciplinary venture, it uses methods and data from archaeology, neuroscience, evolutionary anthropology, and palaeoanthropology. As such, it covers a wide range of material from different academic perspectives to illuminate the primary question: how does the structure of the human brain and human bones impact lived human experience, and how may such understanding be leveraged to transform learning in evolutionary anthropology?

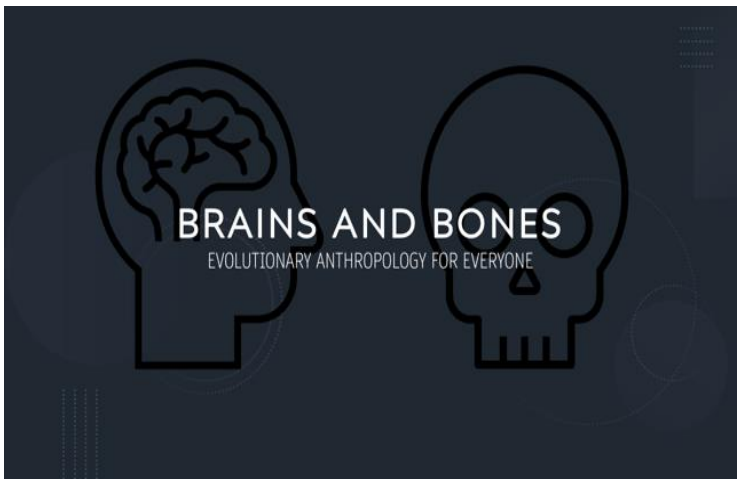


Figure 1 Introductory Slide

Method and Theory

The project uses theoretical frameworks from evolutionary anthropology, which seek to explain the enormous range of human variation across the world (Gibson & Lawson, 2015). It also draws upon research from palaeoanthropological and bioarchaeological research, particularly on the development of bipedalism before the phenomenon of encephalisation (McHenry, 1982), the use of entheseal changes to analyse human activity (Villotte & Knüsel, 2013), and the environmental impact on skeletal morphology e.g. rickets in low UV contexts (Mays et al., 2006). As primarily an impact and engagement project, it also reflects Barton's ongoing research on embodied neuro-cognitive evolution (Barton, 2012; Barrett et al., 2022; Venditti et al 2024), and Rosen's research on the importance of the human skeleton in the experiences of the living (Rosen, 2023). These programmes have in common an integrative perspective on aspects of human adaptation that are often considered in isolation from one another but which are better interpreted in terms of their interrelationships, namely living skeletons, bodies, brains, cognitive processes and patterns of behaviour.

By bringing together data from multiple disciplines, we hope to integrate insights from evolutionary biology, functional anatomy, and cognitive neuroscience. Early hominins began walking bipedally, which was reflected in the shape of their skeletons and initial changes in neuroanatomy. This was followed by the elaboration of material culture and significant brain expansion (McHenry, 1982), which continued and accelerated towards the present in several hominin lineages up to and including the advent of our own species (Miller et al., 2019; Venditti et al 2024). The structure of our expanded brains was intimately associated with how we interacted with our physical and social environments (Barton 2012, Barrett et al., 2022). The body-brain connection is mutual and bidirectional and involves plasticity: our environment shapes our skeleton, and we shape our own skeleton through our behaviour (Villotte & Knüsel, 2013; Mays et al., 2006). Similarly, brains both shape and are shaped by our physical interactions with the world. Thus, an embodied paradigm emerges as a promising framework for understanding the multifaceted relationships between our bodies, our behaviour, and our world.

Embodiment is central not only to how our brains evolved but also to how we now think and learn. Conceptions of embodied cognition vary (Wilson 2002). Here, we align with Clark's (1997) general formulation that "the biological mind is, first and foremost, an organ for controlling the biological body…Minds are not disembodied logical reasoning devices". Although "off-line" cognition can occur without simultaneous action - when we just sit and think - there are compelling arguments and evidence that even off-line cognition is body-based (Wilson 2002). That is, what may often feel like disembodied abstract, symbolic thought itself involves simulation of our physical interactions with the world and, on a neural level, activation of the same sensory-motor systems. In the prescient words of neuroscientist Rodolfo Llinás (1987) "…a reconstruction of possible movements and their possible consequences becomes, in fact, the substrate of 'thinking'". The learning paradigm employed in western-style education for the past few hundred years, however, does treat the mind as a disembodied reasoning - and learning - device. Typically, learning predominantly involves sitting still. Despite this, we have known for a long time that infants and young children naturally learn by actively experimenting through physical interactions with the world (Piaget 1972), that this enactive experimentation moulds the developing brain, and that these processes potentially extend into adulthood (Gopnik 2009; Köster et al 2020). Somewhat belatedly, there is a growing realisation that learning practices exploiting physical movement can be particularly effective and enriching, and there is now great interest in the implications of this perspective for learning and education. (Skulmowski and Rey 2018; Macedonia 2019; Hegna & Ørbæk, 2021;) We suggest that this is particularly obvious when it comes to learning about the body, functional anatomy and movement: in essence, we propose that embodied learning can be effectively harnessed to enrich understanding of how bodies and brains evolved and how they mediate our interactions with the world. Thus, embodied learning is a central tenet of *Brains and Bones*, acknowledging the body as both a source of knowledge and a source of knowledge production.

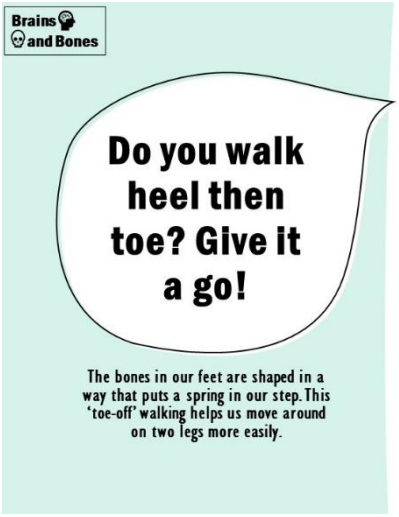
Implementation

The *Brains and Bone*s project is currently in its initial phase of development. We developed a pilot event aimed at younger age-groups, funded by the UKs Economic and Social Research Council as part of their Festival of Social Science. The funding allowed purchase of high-quality teaching models of the human brain and the human skeleton that could be handled and examined by any attendee of the event, regardless of age or experience. The event was a collaboration with Ustinov College of Durham University, as the college accommodates students with families and the *Brains and Bones* pilot event was designed to be family-friendly. Information regarding the event was circulated within the College community to encourage attendance. The event itself was held in a meeting room within the family accommodation block after school hours in order to facilitate access for families

and reduce travel times. On the day, word of mouth appeared to increase the numbers of attendees and there were a several walk-ins. This indicates that events of this nature could benefit from taking place onsite (i.e. schools, community centres) where children and/or their families are already present. We did not in this pilot phase attempt to measure learning outcomes, but this would be important in the future.

Attendees were given a 45-minute presentation, alternating between the two presenters (SR and RB), with embodied activities to reinforce relevant information; examples of these activities can be found in figures 2 and 3. The presentation began with definitions of basic terms followed by a summary of the development of bipedalism, brain expansion, and subsistence strategies, ending with the roles of brains and bones in contemporary human life—including the importance of exploration and play for brain development. The brain model was used to draw attention to the interconnectedness of brain regions such as the cerebellum and neocortex and their role in behaviour (Barton 2012). The presentation was followed by an allotted 15 minutes of hands-on experience with the teaching models. During this 15-minute period, attendees were encouraged to explore the models, try to relate them to their own bodies and behaviours, and ask questions in order to reinforce the information. The audience, including both adults and children, was consistently engaged throughout the presentation and dedicated hands-on experience period. One unexpected phenomenon we observed was the inclination of parents to apologise when children handled the teaching materials enthusiastically, which we interpret as a cultural constraint on embodied learning. This constraint was easily ameliorated by reassurances that the models were purchased for this very purpose and that anyone was welcome to interact with the models in any way that helped their learning. In the future, we see potential for adapting and experimenting with this general approach to assess its efficacy for teaching functional anatomy and human evolution to older age-groups, including university students.

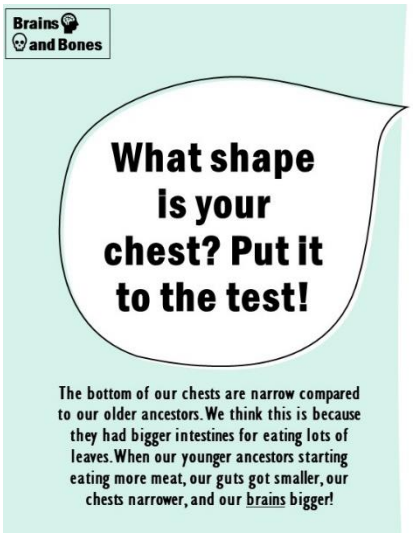
Figure 2: Bipedalism Teaching Activity – Toe-Off Walking



For this activity, attendees were encouraged to walk normally across the room while paying particular attention to the movements of their feet. They were then asked to walk across the room toe-first, heel-second in order to determine which movement was more difficult. Simultaneously, we drew attention to the participants' underlying skeletal anatomy, using the models. This activity demonstrates the value of toe-off walking for bipedal locomotion.

Figure 3: Ecology Teaching Activity - Thorax Morphology

For this activity, participants were asked to feel the shape of their thoraxes and determine if they were narrow or flared at the bottom. This activity demonstrates that our omnivorous diets were different than our smaller-brained ancestors, who had flared thoraxes to compensate for their larger intestines.



Conclusion

The *Brains and Bones* project uses embodied teaching techniques to teach audiences about embodied relationships between our brains, bones, and the world around us. By using this approach, it rejects the assumed dichotomy between the mind and body while acknowledging the body as a source of both knowledge and knowledge production, and seeks to exploit the affordances established by physical interaction with the world. We believe from the success of our pilot phase and the strength of its theoretical foundation that this project has the potential to grow and engage participants across schools, museums, and other educational contexts. We look forward to bringing *Brains and Bones* to a wider audience and developing web pages and other teaching resources for wider use, and are optimistic that this approach will prove to be both effective and enjoyable for audiences of all ages. Further collaborations are under way to present *Brains and Bones* to the broader community of the North East of England.

Acknowledgements
Sarah Rosen was supported by an Economic and Social Research Council (ESRC) Postdoctoral Fellowship (ES/X006190/1). Support from Durham University's ESRC Impact Acceleration Account (https://www.durham.ac.uk/research/helping-business/grow-your-business/esrc-iaa/) provided us with essential teaching materials, including full replicas of the human shoulder and arm, the human leg and hip, and a 14-piece teaching model of the human brain. This support was crucial as it allowed members of the public to interact with teaching materials that would otherwise be inaccessible to them. With this support, we were also able to build relationships with partners across the university and include the local community. Ustinov College kindly provided space and logistical support for our pilot teaching session. The authors would like to thank HT, who inspired - and indeed embodied - their collaboration.

Disclosure statement
No potential conflict of interest was reported by the authors.

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