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Humanizing the past: a review on the role of facial approximation in museums and its public perception

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Facial approximation in archaeological contexts represents a complex intersection of science, art, and ethics. While these reconstructions offer a unique opportunity to engage the public with the past, they also raise critical concerns regarding accuracy, representation, and the dignity of the deceased. This literature review examines the ethical discourse surrounding facial approximations in museums, emphasizing the need for transparency in their creation and presentation. By integrating anthropology, ethics, and museum studies, we highlight both the potential and the limitations of these estimations. A balanced approach—one that acknowledges interpretative subjectivity while fostering public engagement—can enhance the ethical and scientific integrity of facial approximation practices in archaeological field.

KEYWORDS

facial approximation, bioarchaeology, bioethics, museum, anthropology

1 Introduction

> "*With face comes voice. With voice comes story*" (Sanders, 2009, p. 200).

Facial reconstruction, often more accurately referred to as "facial approximation," is a scientific and artistic process used to hypothesize the likely appearance of an individual based on the skeletal remains of the skull. This can be achieved through physical reconstruction, which involves the manual modeling of facial features using materials such as clay applied directly onto a replica of the skull, or through digital reconstruction, which employs specialized software to build a three-dimensional virtual model of the face using anatomical data and imaging techniques. This technique is employed in multiple fields, including forensic science and archaeological-museum contexts, which represent its primary areas of application (Wilkinson, 2010). Additionally, facial approximation is used in a variety of educational and public outreach contexts, such as teaching physiognomy and human anatomy. It is also widely employed in museums and exhibitions. Moreover, purely artistic reconstructions inspired by facial approximation techniques are often created for use in media, including film, television, and re-enactment settings.

The terminology itself carries significant implications. The term "reconstruction" suggests a precise and scientifically verifiable process, whereas "approximation" openly acknowledges the inherent uncertainties of the technique when working with skeletal

remains (İşcan and Steyn, 2013; Stephan, 2015; Abdullah et al., 2022). This distinction underscores the need for a clear and well-articulated understanding of facial approximation as an approach. Facial approximation is an interpretative process that combines scientific methods, such as the analysis of skeletal features, with artistic interpretation to create a visual representation of an individual from the past (İşcan and Steyn, 2013; Abdullah et al., 2022). However, this approach is not without its limitations. It relies on a series of assumptions, such as the application of soft tissue depth markers and the estimation of facial features based on modern analogies or skeletal comparisons (Miranda et al., 2018; Campbell et al., 2021; Guleria et al., 2023). These assumptions introduce a degree of uncertainty, as the actual appearance of an individual could differ from the estimated image due to factors such as environmental influences, genetic variation, or the degradation of the remains over time. Additionally, the technique's context of use is essential in understanding its limitations. In the cultural heritage and museum sectors, facial approximation is often employed for educational or interpretative purposes, aiming to engage the public and foster a connection with the past, as illustrated by the reconstruction of Ta-Kush displayed at the Maidstone Museum (Kent, United Kingdom) and the facial approximations of individuals from the ancient city of Juliopolis exhibited at the Museum of Anatolian Civilizations (Ankara, Turkey; Smith et al., 2020; Sertalp et al., 2023). However, without clear communication about the nature of the process and its uncertainties, these approximations can be misinterpreted as definitive representations; a point that will be returned to later in this paper. Misleading visual impressions can arise, particularly when conclusions are drawn from incomplete or controversial data, such as skin pigmentation predictions based on modern data, or the use of datasets that may not accurately reflect the diversity and the ancestry of ancient populations (Sointula, 2020).

Scientific advancements, particularly in imaging technologies and ancient DNA analysis, have improved the accuracy of facial approximations. High-resolution 3D imaging, CT scans and digital modeling techniques now allow for more precise visualization of skeletal features, offering a better understanding of an individual's facial structure. Similarly, the analysis of ancient DNA is starting to enable researchers to gain insights into genetic traits such as hair type and even potential facial characteristics (i.e., eye color), providing a more detailed foundation for estimations (for examples see Hoole et al., 2018; Du et al., 2024). However, despite these advancements, the process remains, to some extent, an interpretative endeavor, blending scientific methodology with artistic expression. The limitations of working with incomplete or degraded skeletal remains, alongside the subjective decisions made in the modeling process, still affect the overall accuracy (Buti et al., 2017; Miranda et al., 2018; Smith et al., 2020).

Facial approximation today lies at the center of ongoing ethical debates, particularly due to its potential to mislead or misrepresent individuals from the past. While these reconstructions can offer valuable insights into historical identities, they also raise important questions about how the past is visually represented. A key concern stems from the tension between scientific interpretation and artistic freedom, especially when approximations are based on incomplete or decontextualized skeletal remains. As such, resemblance alone can significantly shape public understanding, and without clear contextualization, these images may be mistakenly perceived as factual depictions rather than informed speculations (Gazi, 2014; Campbell et al., 2021). This issue is particularly evident in controversial cases such as the first facial approximation of the Kennewick Man, which underscored the risk of producing biased or culturally insensitive portrayals (Johnson, 2016; M'charek, 2024). In the cultural heritage and museum sectors, such approximations raise important questions about accuracy, transparency, and public communication, as they generate powerful visual impressions that may be mistaken for definitive reconstructions if not properly contextualized (Wilkinson, 2010; Gazi, 2014; Johnson, 2016). Technological advancements—such as high-resolution imaging, 3D modeling, and forensic anatomical databases—have enhanced the level of detail in modern approximations, but they also introduce new ethical challenges, particularly concerning the handling and dissemination of sensitive data (Smith et al., 2020; Buti et al., 2017). Ethical responsibility thus extends beyond scientific accuracy to include the avoidance of cultural appropriation and the respectful treatment of ancestral identities, challenges clearly illustrated not only by the Kennewick Man case but also by the public presentation of Myrtis (these cases will be explored in greater depth later in this article). Thus, ethical issues will be pivotal in shaping the future of facial approximation in both academic research and public exhibitions (Buti et al., 2017; Smith et al., 2020). Given the breadth of this topic, only a few key aspects of the ethical debates surrounding facial approximations are touched upon here. Even within the more limited scope of their use in museum settings, the ethical implications remain significant, requiring extensive exploration to identify and address as many of these issues (e.g., questions of consent and post-mortem rights, potential misrepresentation or stereotyping, cultural sensitivity, and the impact on descendant communities) as possible (Tarlow, 2006; Alberti et al., 2009; Gibbon et al., 2023; de la Cova et al., 2024).

This review article follows a research-based approach, drawing on scientific literature retrieved from various academic databases to examine discussions on this topic. Specifically, literature was accessed through Scopus, PubMed, ResearchGate, and Google Scholar, selected for their wide coverage and ability to provide comprehensive results relevant to the field of study. The search was conducted primarily in English, using combinations of keywords such as "facial reconstruction," "facial approximation," "human remains," "archaeology," "museum," and "craniofacial reconstruction." No specific time range was applied, in order to encompass both foundational studies and more recent contributions. The search included peer-reviewed journal articles, book chapters, and academic monographs. For Scopus and PubMed, all retrieved records were individually screened through titles and abstracts. For ResearchGate and Google Scholar the first 10 pages of results (10 entries per page), sorted by relevance, were reviewed. In addition to English-language sources, several Italian-language references were also included, such as the ethical reflections by Belcastro et al. (2021), the article published in National Geographic Italia by Larmer (2025) "*In search of other humans*" and the consultation of the Italian legislative decree relevant to the treatment of human remains (D.Lgs. 42/2004).

Once the initial search results were gathered, titles and abstracts/introduction to chapters were reviewed to screen for relevant articles and book chapters. The literature retrieved that appeared pertinent to the subject matter was selected for full-text reading, and the full texts of these articles were subsequently examined in detail. Specifically, it aims to explore two key questions that guided the authors throughout the development of this work: (1) Why do we reconstruct faces? and (2) Is it ethically justifiable to approximate a face if accuracy cannot be guaranteed? While the article does not claim to offer definitive answers, it concludes by outlining a series of key points that emerged from the analysis, intended as reflections to support future research and practice.

Since this is not a conventionally structured review, but rather one that presents two key questions as a framework for the results and discussion, no formal results section was created, nor were the number of relevant articles explicitly reported. To avoid excessive grammatical and lexical repetition throughout the text, the process of facial approximation will occasionally be referred to using alternative terms such as "estimation" or "guesswork." However, whenever the term "reconstruction" is used, it refers to broader representational practices and not specifically to the technical process of facial approximation.

1.1 Historical background

The reconstruction or approximation of the human face has deep historical and cultural roots, as evidenced by funerary masks and facial representations documented across various societies in Africa, Asia, and Europe, practices often filled with symbolic or apotropaic functions (Krien-Kummrow, 1961; Verzé, 2009; Buti et al., 2017). In many traditions, funerary masks were believed to protect the deceased from malevolent spirits or to shield the living from the supernatural power the dead were thought to acquire in death (Krien-Kummrow, 1961). The head, often considered the seat of identity and spiritual essence, was thus preserved or isolated through masks that functioned as barriers between the living and the dead (Krien-Kummrow, 1961; Wingert, 2024). Over time, as societies developed a stronger emphasis on individual identity, funerary masks evolved from primarily ritual objects to more realistic likenesses, particularly in cultures with a well-developed cult of individuality (Krien-Kummrow, 1961). Some of the earliest evidence of this practice dates back to the Stone Age, where the first forms of masks with ochre and shells are documented in southern Europe, suggesting an early form of ritual masking (Krien-Kummrow, 1961). In the Neolithic period, skulls covered in plaster, such as those from Jericho (circa 7000 BCE), indicate a tradition of modifying human remains to preserve memory and identity (Krien-Kummrow, 1961; Verzé, 2009; Buti et al., 2017; Ashmolean Museum—Oxford, 2025). While some scholars interpret these as part of ancestor veneration, others suggest they may have served as ritual objects linked to magical or protective beliefs (Verzé, 2009; Buti et al., 2017). The modifications applied to these skulls—including the addition of pigment, incised markings to suggest hair, and shell inlays for eyes—indicate an intention to recreate a lifelike appearance, albeit not necessarily an individualized portrait.

In ancient Egypt, masks played a crucial role in funerary rites, from painted linen masks of the Old Kingdom (2686–2181 BCE) to the elaborate gold masks of the New Kingdom (1550–1069 BCE). During the Middle Kingdom (2025–1700 BCE), anthropoid coffins emerged, often containing a mummified body enclosed in up to three nested cases made of cartonnage, painted or gilded wood, or even precious metal. Each of these coffins replicated and protected the deceased's face, as the sculpted heads on the coffins were believed to hold the same symbolic value as the mask on the mummy itself (Krien-Kummrow, 1961; Beatty, 2015; Buti et al., 2017). Funerary masks depicting "idealized likenesses" were also used by the Etruscans, often sealing funerary urns (Buti et al., 2017). In ancient Rome, wax death masks (*imagines maiorum*) were used in ancestor veneration, while later the development of metal funerary helmets and realistic face coverings, blurred the boundary between protection in life and commemoration in death (Krien-Kummrow, 1961; Verzé, 2009; Buti et al., 2017). Over time, particularly in societies with a strong emphasis on individual identity—such as Hellenistic Greece and Renaissance Europe—funerary masks evolved from primarily ritual objects to increasingly lifelike representations, reflecting the growing importance of personal legacy and remembrance (Verzé, 2009). From plastered skulls to elaborately painted or sculpted death masks, these traditions highlight a widespread human desire to preserve the physical identity of the deceased (Verzé, 2009; Beatty, 2015; Buti et al., 2017). Whether intended for magical protection, ancestral commemoration, or artistic representation, such practices laid the groundwork for modern approaches to facial approximation. The enduring presence of these customs across different cultures underscores the fundamental role of the human face in shaping our relationship with the past and the dead (Buti et al., 2017).

The Renaissance marked the emergence of early techniques that would later contribute to modern facial approximation. While Renaissance scholars did not engage in actual facial reconstruction, their anatomical studies significantly influenced later developments in the field. The Renaissance saw the first use of wax models for medical purposes, with artists in northern Italy, such as Giulio Gaetano Zumbo and Ercole Lelli, pioneering highly detailed anatomical models designed for doctors and surgeons rather than for realistic facial representation (Verzé, 2009; Wilkinson, 2010; Beatty, 2015). These models, which became widespread in medical schools, provided an essential alternative to cadaveric dissection and laid the groundwork for later scientific approaches to anatomical visualization. Here, we see the fusion of art and science, as anatomical dissections and structured observations led to a more methodical study of the human face. This shift laid the foundation for a systematic approach to facial approximation, moving beyond purely artistic representations toward models informed by anatomical knowledge, an approach that would eventually evolve into the detailed forensic approximation of today (Verzé, 2009).

The modern concept and technique of facial approximation did not emerge in its current form until the early 20th century.

While the origins of the technique remain debated, Wilhelm His is often credited with pioneering early attempts at craniofacial approximation in the 19th century, particularly in his work on estimating the face of Johann Sebastian Bach based on skull morphology (İşcan and Steyn, 2013; Guleria et al., 2023). The controversy surrounding his work stems from the fact that Bach's portraits were used as a strong reference or source of inspiration for the approximation (Stephan, 2015). Another figure often cited as a "father" of facial approximation is Hermann Welcker, whose early studies on soft tissue thickness, however, do not fully meet the criteria to confirm him as the first theorist of the scientific practice, since his studies were based on comparisons of skulls with self-portraits, and not on actual skeletal remains, making his work less aligned with the scientific principles of modern facial approximation (Verzé, 2009; İşcan and Steyn, 2013; Campbell et al., 2021).

The first documented attempt at what can truly be described as "face prediction" was reached in 1898 by Kollmann and Büchly, who approximated a face from a skull without any prior knowledge of the individual's appearance (Stephan, 2015). Even in this case the literature highlights an important distinction when considering the first documented attempt as for many the first truly systematic attempts at approximating the human face from skeletal remains—based on detailed tissue depth measurements and muscle reconstruction—are attributed to Mikhail Gerasimov (1907–1970) in the Soviet Union during the mid-20th century (Verzé, 2009; Campbell et al., 2021; Navic et al., 2023).

Despite ongoing debates over the origins of the discipline, scholars generally agree on the existence of three major schools of facial approximation, each characterized by distinct methodological approaches: the Russian, American, and Manchester methods (Wilkinson, 2004; Verzé, 2009; Wilkinson, 2010; İşcan and Steyn, 2013; Stephan, 2015; Campbell et al., 2021). The first to develop was the Russian method, pioneered by Gerasimov in the mid-20th century. Gerasimov's (1955) method marked a significant departure from previous practices, as he did not rely on prior knowledge of the individual's facial features but instead worked from the skeletal remains alone, aiming to reconstruct the face solely based on anatomical and anthropological data (Gerasimov, 1955; Verzé, 2009; Stephan, 2015; Campbell et al., 2021). Gerasimov's approach is rooted in the idea that a precise understanding of muscle structure is essential for accurately reconstructing a face (Verzé, 2009; Campbell et al., 2021).

The American method emerged, reaching its recognizable form through the collaboration of Krogman, Gatliff, and Snow in the mid-to-late 20th century. This approach is based on statistical averages of tissue thickness at various cranial points, derived from extensive studies of living populations (Verzé, 2009; İşcan and Steyn, 2013). The development of this method reflects a growing interest in biometric and statistical approaches within physical anthropology and craniometry during the 20th century. It was from this method that the tables of average tissue thickness were developed, accounting for variables such as age, sex, and ancestry. However, there is some debate among sources regarding the origins of this method. McGregor is sometimes credited with being the first to conduct facial approximation in the United States, having worked on skull casts of prehistoric humans at the American Museum of Natural History in New York from 1915 onward (Wilkinson, 2004; Verzé, 2009). Nevertheless, it was likely the work of Harris Wilder (in 1912)—who approximated the faces of Native American skulls—that played a key role in adapting/or to apply these methods in North America (Verzé, 2009).

The most recent of these schools is the Manchester method. Developed by Richard Neave in the late 20th century, this approach integrates both anatomical and anthropometric principles while incorporating artistic interpretation, making it one of the most widely used techniques in forensic and archaeological contexts today (Verzé, 2009; Wilkinson, 2010). Anatomical principles focus on the structure of the human body, including muscle placement and tissue depth and anthropometric ones rely on standardized measurements and proportions derived from population studies. These scientific foundations are then combined with artistic interpretation to refine the estimated features and create a lifelike representation.

2 Questions

2.1 Why are faces reconstructed?

From the perspective of biological anthropology, facial approximation serves as a tool in completing an individual's biography, commonly referred to as an "osteobiography." While osteobiographies provide valuable insights into the biological aspects of an individual's life—such as age, sex, health, and possible cause of death—it remains limited in its ability to fully humanize the past individual. Rather than restoring the dignity of the deceased, it often risks reducing human remains to an object of scientific inquiry, emphasizing their analytical value over their personal identity (Zhuravska, 2015; Johnson, 2016; Wilkinson et al., 2024). This scientific focus can inadvertently depersonalize the individual, stripping away the broader social, cultural, and emotional dimensions that once defined their existence (Tarlow, 2006; Jones, 2019). By privileging measurable biological data, osteobiography may neglect the complexity of lived experiences, relationships, beliefs, and the cultural context that shaped the individual's life and death (Knudson and Stojanowski, 2008). Consequently, although osteobiographical approaches can offer detailed reconstructions of physical life histories, they must be critically integrated with broader archaeological, historical, and anthropological perspectives to avoid reducing past lives to fragmented anatomical narratives (Hosek, 2019; Zuckerman et al., 2025).

Facial approximation restores a visual identity to past individuals, bridging the gap between biological data and human history by offering a representation that brings the person to life and fosters a more personal and tangible connection (Nilsson et al., 2022). A compelling example of this approach is the case of the Sutherland Nine project, which involved the facial approximation of eight individuals whose remains were taken from South Africa in the 19th century and later repatriated in the first decades of the 21st century (Gibbon et al., 2023). The process was guided by collaboration with descendant communities, ensuring that their

wishes and ancestral connections were respected. Digital facial approximations played a crucial role in this initiative, allowing families to visualize their ancestors and reinforcing the link between past and present. The descendants described the images as essential to understanding the broader historical narrative, echoing Emmanuel Levinas's idea that human connection is intrinsically tied to the face (Gibbon et al., 2023). This case illustrates how facial approximation, beyond being a scientific tool, can foster empathy and provide a means for communities to reclaim their history. Another notable example is the facial approximation developed for the Stonehenge visitor center, based on a 3D scan and print of the cranium of a prehistoric individual found near the site, also known as the Winterbourne Monkton Man (Nilsson et al., 2022). The goal of this project was to "*find the face rather than create it,*" achieving an approximation that emphasized anatomical accuracy while avoiding overly speculative elements (Nilsson et al., 2022, p. 461). While features such as hair, skin, and eye color were openly estimated in the absence of genetic data, the proportions and structure of the face were modeled upon the cranial morphology. Importantly, the estimation avoided dramatic expressions or exaggerated mimicry—such as overly pronounced smiles, exaggerated muscular contractions or wrinkles that emphasize specific emotions, or theatrical facial poses more typical of artistic representations than archaeological reconstructions -, allowing visitors to form their own emotional and interpretive connections with the individual. This highly realistic yet restrained approach enabled a powerful encounter with the past, where emotional engagement stemmed not from theatrical representation, but from the subtle recognition of individuality and human presence.

The human face, as a primary locus of identity and social interaction (Zhuravska, 2015), provides a powerful medium through which the individuality of past subjects can be conveyed. As already noted, beyond its forensic applications, facial approximation is increasingly used as a tool to estimate/represent the faces of historical figures or even our earliest ancestors, bringing the past to life in a tangible and engaging way. By transforming abstract or distant historical narratives into humanized, recognizable faces, this technique fosters a deeper emotional connection and engagement with individuals from the past, allowing viewers to perceive them not merely as data or skeletal remains, but as once-living people with identities and stories (Smith et al., 2020; Sertalp et al., 2023). By complementing material culture and documentary evidence, facial reconstructions offer an additional interpretative dimension, fostering a more nuanced and empathetic understanding of the people behind the archaeological record (Buti et al., 2017; Smith et al., 2020; Gibbon et al., 2023). Increasingly present in museum exhibitions, these reconstructions serve as refined and accessible tools for public engagement, shaped by ongoing technological advancements. Digital and physical approximations alike offer new ways to visualize/represent past individuals, fostering an emotional connection with history and transforming skeletal remains from anonymous artifacts into relatable human figures (Smith et al., 2020). Museums increasingly employ these approximation not only as static displays but also as interactive educational tools, incorporating digital and virtual technologies to create immersive experiences (Smith et al., 2020; Sertalp et al., 2023). As Gregory and Witcomb (2007) note, affective responses play a key role in audience participation, enhancing the visitor experience and enriching the process of meaning-making. These reconstructions, whether 2D or 3D, can therefore encourage a deeper reflection on the lives of past individuals, reinforcing a sense of shared humanity (Kelly, 2007). Furthermore, facial approximations often serve as a tool for remembrance, linking historical individuals to cultural heritage and national narratives (Wilkinson et al., 2024). More broadly, they align with the cultural practice of preserving the memory of the deceased. This concept can be traced back to ancient traditions that sought to immortalize the faces of the dead for the afterlife (Krien-Kummrow, 1961; Verzé, 2009; Beatty, 2015; Buti et al., 2017).

These practices were not solely about visual representation but were deeply tied to beliefs regarding identity preservation and connections to the divine or ancestral spirits. In many ancient cultures, protecting the physical body was believed to safeguard the strength and wellbeing of the spirit. Ensuring the integrity of the remains was seen as a way to maintain a connection between the living and the dead, reinforcing spiritual continuity and protection (for an in-depth analysis, see Metcalf and Huntington, 1991; Insoll, 2012; Nilsson Stutz and Tarlow, 2013). While these ancient customs cannot be directly equated with modern practices, the human desire to remember and honor the deceased persists today in some culture. Today, this is reflected in the widespread tradition of placing photographs and names on gravestones, serving as a contemporary parallel to ancient practices of facial representation (Brooks, 2010). Just as death masks once captured and memorialized an individual's features, modern gravestone photographs serve as a way to maintain a visual and emotional connection with those who have passed, highlighting the enduring need for physical representations in commemoration and offering the living a tangible link to the memory of the deceased (Ruby, 1995; Hallam and Hockey, 2001).

Within the controlled environment of museums, the portrayal of historical figures through estimations can also serve as a corrective to historical misconceptions. This is evident in the case of Richard III, whose face was approximated from skeletal remains by Wilkinson and Aitken. For centuries, his image had been shaped by Tudor propaganda and literary portrayals, most notably in Shakespeare's Richard III, which depicted him as a deformed and villainous ruler (Buckley et al., 2013; Wilkinson et al., 2024). However, the facial estimation, combined with osteological analysis, challenged these long-standing perceptions by presenting a more neutral and humanized depiction of the king. This approximation aligned more closely with historical descriptions of his physical appearance, including details such as the shape of his chin and the severity of his scoliosis, which was often exaggerated in negative portrayals in literature, art, and popular culture, as evident in many of his portraits from the Tudor period, and further reinforced by Shakespeare's depiction of Richard III, where the king's physical deformities were emphasized (as seen, for example, in Antony Sher's performance for the Royal Shakespeare Company in 1984).

Similarly, increasing transparency in the estimation of early human fossils has contributed to a more nuanced understanding of our evolutionary past, moving away from outdated and often biased

interpretations. For example, early depictions of Neanderthals frequently portrayed them with excessively coarse features and very light skin, reflecting outdated assumptions rather than scientific evidence (Smith et al., 2020; Campbell et al., 2021). More recent research, including genetic analyses, has revealed a broader range of skin tones and facial diversity, leading to a reduction in stereotypical features and greater accuracy of facial estimates (e.g., Claes et al., 2014; Jablonski, 2021; Ju and Mathieson, 2021). However, a critical concern remains the potential bias and perceptual influence in the reconstruction process. While craniofacial research can provide valuable insights into general facial features based on skull morphology, the addition of surface details—such as skin tone, hair color, and facial expression—introduces an element of speculation that can significantly alter the perceived identity of the reconstructed individual (Bruce et al., 1991; Wilkinson et al., 2024).

Beyond the estimation of specific individuals, this process is integral to a broader understanding of human history and evolution. By reconstructing faces, anthropologists do not merely re-create individual life histories, they contribute to the collective narrative of our shared past. Two such examples are the facial approximations of Lucy (*Australopithecus afarensis*) and the Taung child (*Australopithecus africanus*), both of which offer valuable insights into the diversity and complexity of early hominins (for detailed images and further discussion, please refer to Campbell et al., 2021). These approximations allow viewers to visualize the diversity and complexity of humanity, fostering a deeper, more empathetic understanding of our evolutionary journey and cultural heritage. Additionally, this process helps counter centuries of racial prejudice and erroneous theories, which have often been shaped by outdated and biased perspectives (Johnson, 2016; Gibbon et al., 2023).

One well-documented example is the controversy surrounding The Ancient One, commonly known as "Kennewick Man," a 9,400-year-old skeleton discovered in 1996 in eastern Washington state. Several Native American tribes claimed The Ancient One's remains under the Native American Graves Protection and Repatriation Act (NAGPRA—Pub. L. 101-601, 25 U.S.C. 3,001 et seq., 104 Stat. 3,048), seeking repatriation based on cultural affiliation. However, this led to a lengthy legal battle with anthropologists, who argued that the remains did not belong to any Native American group (Schneider and Barran, 2014). The case raised important questions about the definition of "Native American" and the criteria for establishing cultural affiliation, highlighting the tension between scientific inquiry and cultural heritage (Schneider and Barran, 2014).

The controversy was further fuelled by facial approximation of the remains, which were widely publicized. One of the most contentious estimations, created by Dr. James Chatters in 1998, resembled actor Patrick Stewart, leading to public speculation that the remains could be of early European ancestry (Thomas, 2000; Chatters, 2001). This sparked confusion, as the media conflated the term "Caucasoid" with "European," despite scientific efforts to avoid such simplifications (Johnson, 2016). A subsequent approximation by the Smithsonian, conducted with more anthropological oversight, depicted The Ancient One with features resembling Polynesians or Japan's Ainu ethnic group (Schneider and Barran, 2014). While this version corrected some earlier misconceptions, it still underscored how preconceived notions can influence the interpretation of ancient remains. By re-creating faces with scientifically informed methods, it becomes possible to challenge these misconceptions and present a more accurate, inclusive representation of human history.

2.2 Is it ethically justifiable to approximate a face if accuracy cannot be guaranteed?

The study and display of human remains raise complex ethical questions, encompassing respect for the deceased, cultural heritage considerations and the responsibilities of researchers in representing the past. Ethical debates in bioarchaeology and anthropology often revolve around issues such as the appropriate treatment and curation of skeletal material, the rights of descendant communities, and the balance between scientific inquiry and cultural sensitivity. Within this broader ethical framework, facial approximation introduces an additional layer of complexity.

As a practice that aims to provide a visual representation of past individuals, facial approximation carries the inherent challenge of uncertainty. Unlike forensic estimations used in legal contexts, which aim to aid the identification of specific individuals, approximations in archaeological and museum settings are not meant to achieve exact likenesses. This raises an important ethical dilemma: to what extent is it justifiable to approximate a face when accuracy cannot be guaranteed? In this section, we will explore this issue, addressing concerns about scientific responsibility, the potential for misrepresentation, and the broader implications of presenting speculative approximations as part of the historical record. This discussion will be followed by two subsections outlining the criticisms and supporting evidence related to the issues surrounding facial approximation, drawing on key literature.

The ethical justification of facial approximation hinges on the delicate balance between scientific integrity and artistic interpretation. While in some instances, historical documents or portraits may support these choices, when dealing with ancient remains, the absence of reliable reference materials makes such details highly speculative, increasing the risk of inaccurate representations (Smith et al., 2020). Some argue that the process is inherently subjective, as it relies heavily on the artistic skill of the practitioner rather than purely scientific data (Wilkinson, 2010). This subjectivity can lead to speculative imagery being erroneously—and sometimes intentionally—presented as factual (Beatty, 2015). In the case of archaeological approximations, the resulting face is a mixture of known anatomical facts and artistic license, meaning that estimations cannot intrinsically guarantee full accuracy, especially when key features such as skin color, hair texture, or body fat are not directly discernible from skeletal remains (İşcan and Steyn, 2013).

Several well-known cases illustrate errors in interpretation and approximation, with reconstructions appearing not only in museum displays but also in the media (Johnson, 2016).

For example, the approximation of the "Whitehawk Woman," found in the United Kingdom and dating from the Neolithic

period, was based on aDNA analyses from other individuals of similar geographic and temporal origin, as no direct DNA was obtained from the remains themselves (Sointula, 2020). Similarly, approximations of Cro-Magnon individuals and "Myrtis," an Athenian girl from 450 BCE, relied on general assumptions drawn from the genetic makeup of other individuals from the same time period, often supplemented with artistic interpretation regarding skin and hair color (Bruce et al., 1991; Sointula, 2020).

Assigning approximated faces specific personality traits, despite the lack of historical justification, alters our understanding of the subject's identity. This dilemma underscores the challenge of balancing creative freedom with scientific responsibility and accuracy. Some critics argue that in such cases, approximations may inadvertently reinforce outdated stereotypes or misinform the public, particularly when museum displays prioritize spectacle over scientific rigor (Campbell et al., 2021).

Why does stereotyping happen? By the late 18th century, in many Western scientific and medical circles, the human body was increasingly perceived less as sacred and personal and more as an object of observation and analysis. This shift, influenced by Enlightenment thought and the rise of anatomical studies, contributed to its use in medical and racial research, particularly in ethnological investigations aimed at categorizing human diversity (Bieder, 2000; Andelković and Harker, 2011). In this context, bodies—especially those of Indigenous peoples—were systematically collected and studied to support emerging racial theories. The depersonalization of the body, which had already taken root in European medical traditions, was soon applied in American ethnology, where Native American remains became central to scientific inquiry. However, this perspective was not universal, as many Indigenous and non-Western cultures continued to regard the body with deep spiritual significance. This shift illustrates how scientific observation, while often perceived as objective, has historically been influenced by prevailing ideological frameworks. In the 18th and 19th centuries, the human body, depersonalized and reduced to data, became an object of measurement and categorization, with physical features interpreted through the lens of contemporary biases rather than empirical neutrality (Bieder, 2000).

This historical entanglement between scientific inquiry and cultural perception continues to shape contemporary practices, including facial approximations. Despite significant methodological advancements, these estimations remain susceptible to interpretative biases, as perceptions of race, gender and cultural identity inevitably influence both their creation and their reception by the public. Furthermore, the visual nature of facial approximations makes them particularly powerful tools in shaping historical narratives, often granting them an authority that may overshadow their speculative nature. This underscores the need for transparency in methodology and critical engagement with the ways in which such representations interact with cultural and historical assumptions.

Through the following subsections, the aim is to critically examine the ethical considerations involved in approximating faces from skeletal remains, exploring how these debates impact public engagement and scientific accuracy in museum exhibitions, as well as highlighting perspectives in support of this practice. The authors emphasize that the following sections present key issues discussed in the field of facial approximation, addressing both criticisms and concerns, as well as arguments in favor of its use in museum settings.

2.2.1 Criticisms of facial approximation

As previously discussed, one of the primary criticisms is the potential of such approximations to mislead the public. This criticism arises from the fact that facial approximation techniques are subject to errors that are often unquantifiable (Wilkinson, 2010; Wilkinson et al., 2024). Additionally, the extreme subjectivity of the approximation process—historically based more on the technician's experience than on scientific data—was not always explicitly acknowledged. Without clear labeling to indicate that they are approximations, reconstructions may be perceived as accurate depictions, misleading viewers about the past. The challenge of ensuring accurate and transparent communication is especially problematic in museum exhibitions, where approximations are often presented as part of the educational experience. Museums today aim to balance their academic role with engaging presentations, but as Beatty (2015) notes, the artistic interpretation inherent in approximations often competes with the goal of producing an objective reproduction.

Two publicly accessible examples illustrate different ways in which facial approximations are contextualized for audiences. In the case of The Achavanich Beaker Burial, the dedicated website offers layered access: a simplified explanation for the general public, alongside links to detailed scientific references and publications, thus accommodating different levels of engagement and intellectual curiosity (Hoole, 2018). Notably, the site also documents the evolution of the reconstruction over time, openly discussing earlier versions and how recent genetic findings—such as insights into ancestry and pigmentation—have informed updated representations of the individual. In another case, the official website of the South Tyrol Museum of Archaeology offers only a brief overview of Ötzi's facial reconstruction, with limited information about the methods used or the interpretive choices behind the final image (Vallazza, 2025). These examples are not intended as evaluations, but rather as observations that highlight the importance of open and accessible public communication, as well as transparency, contextualization, and openness to revision when presenting facial approximations. This underscores the responsibility of museums and researchers to actively shape the discourse around approximations, ensuring that they contribute to knowledge rather than distortion.

In addition, these cases underscore broader ethical concerns about how facial approximations, despite their apparent objectivity, are inevitably shaped by cultural biases. The choices made in sculpting facial features, skin tones, and expressions can unconsciously reflect modern preconceptions about race, gender, and identity. This critique ties into larger discussions on the display of human remains, particularly in institutions with colonial legacies, where the exhumation, exhibition and representation of the dead have often been conducted without regard for the wishes of descendant communities (Biers, 2019).

Another major critique concerns the potential distortion of historical understanding. Museums, as institutions of cultural mediation, play a crucial role in shaping public perceptions of history through exhibitions, narratives and material culture. While they serve multiple functions—including education, preservation, and identity formation—facial estimations, when integrated into displays, may inadvertently reinforce outdated or flawed assumptions (Moyer, 2007). The visual authority of these approximations can shape visitor interpretations in ways that do not always align with current scholarly consensus, raising questions about their responsible use in museum contexts.

Researchers have argued that approximations of ancient people, particularly those from early human history, often reflect biases rooted in prior racist ideologies, such as the assumption that hominin anatomy closely resembled that of non-human primates (Wilkinson et al., 2024), some others argue that craniofacial approximations, particularly those shaped by racial models, reinforce the controversial notion of discrete biological races (Johnson, 2016). The choice of features, such as skin tone, has been particularly problematic in the case of Cro-Magnon Man, a darker complexion was selected based on assumptions about "primitiveness" despite lacking empirical evidence (Sointula, 2020). Similarly, estimations of figures as the Athenian girl Myrtis have been critiqued for reflecting modern Western biases rather than historical accuracy (Sointula, 2020). Critics have pointed out that the facial reconstruction of Myrtis is problematic for its portrayal of light skin and red hair, characteristics that are not commonly associated with the ancient Greek population, thus reflecting modern Western beauty standards rather than a historically accurate representation of her appearance (Sointula, 2020). Additionally, the reliance on artistic conventions from ancient Greek art, such as those seen in sculptures and pottery, may have influenced the reconstruction in ways that prioritize aesthetic ideals over anthropological evidence (Sointula, 2020). In cases such as the aforementioned Kennewick Man, the media's focus on perceived physical traits and ancestry has further complicated the issue, shaping public perception in ways that risk oversimplifying the diversity and complexity of past populations (Johnson, 2016). The 1998 estimations of Kennewick Man depicted facial features that some interpreted as "Caucasoid," a term that, despite its discredited anthropological roots, fuelled speculation about pre-Columbian European contact and challenged Indigenous claims to the remains (Johnson, 2016). As noted by Pietroni and Ferdani (2021), digital reconstructions are sometimes viewed merely as visual representations rather than as integral parts of an interpretative process. When exhibitions provide limited contextualization, audiences may struggle to critically engage with the material, leading to misunderstandings or even the reinforcement of inaccurate narratives. If visitors are left to draw their own conclusions without proper guidance, the educational potential of these estimations diminishes, increasing the risk of misinterpretation.

Beyond the scientific and museological aspects, the ethical concerns extend to the descendants of the individuals depicted, particularly when it comes to the representation of their ancestors. Indigenous groups, for instance, have long fought for control over their ancestors' remains, advocating for the repatriation of human remains and for treatments that align with their cultural traditions rather than being subjected to speculative visualizations (Schneider and Barran, 2014; Gibbon et al., 2023). These groups argue that the treatment of remains should not merely serve scientific or public display purposes but must be aligned with ethical considerations that honor their ancestors' identities and legacies. In contrast, the use of facial approximation and other speculative reconstructions can be seen as both disrespectful and misleading, as over the years they have fallen into a modern, outsider's interpretation of the past, without considering the cultural significance of these individuals for their descendants. Such visualizations, while often created with good intentions, risk perpetuating inaccuracies or reinforcing stereotypes, and can perpetuate historical injustices by objectifying human remains (Schneider and Barran, 2014; Gibbon et al., 2023).

A final point of contention is the "*right to be forgotten*" (Zuckerman et al., 2025, p. 9). While typically associated with modern privacy concerns, this concept can be extended to the display of ancient individuals. Reconstructing and sharing detailed life histories based on human remains raises complex ethical issues, particularly regarding who has the right to manage and disclose the memory of the deceased (for a more in-depth discussion of this issue, see Moon, 2019; de la Cova et al., 2024; Zuckerman et al., 2025). While not formally regulated, post-mortem rights are increasingly considered in fields such as forensics and history, and similar principles could be extended to bioarchaeology. These concerns are especially relevant when descendant or culturally connected communities are involved, as they may disagree with how such information is made public (for a more in-depth discussion of this issue, see Williams and Piasere, 1990; Remotti, 2016). In this context, the role of facial approximation transcends its scientific utility, touching on deeper ethical and cultural dimensions. The necessity and appropriateness of such reconstructions are debated: while some scholars argue they add little to the scientific understanding of past societies, others point out that this perspective neglects the symbolic and emotional weight these images carry (Alberti et al., 2009). As Tarlow (2006) emphasizes, we must consider whether we owe ethical responsibilities to the ancient dead, particularly concerning how they are depicted. Since consent for excavation or display cannot be obtained by the dead (descendants may be consulted in some cases), the ethics of post-mortem representation must be carefully navigated.

Critics argue that estimating and exhibiting an ancient face imposes a modern interpretation on a past individual, potentially violating their privacy and ante-mortem interests (Johnson, 2016). Since these individuals did not consent to such representations, some view this practice as ethically questionable. Furthermore, not all living communities may wish to see their ancestors' faces reconstructed or publicly displayed. As Tarlow (2006) highlights, the research on and representation of past people can have ethical implications, not necessarily because of what we 'owe the dead', but because modern interpretations of the past can harm present communities by misrepresenting their ancestors. Tarlow (2006) suggests that ethical responsibility is not only a matter of respecting the 'living' but also how we affect the living through our portrayals of the past. Moreover, descendant communities,

scientists, and the public often hold different ethical concerns, though there is consensus that human remains should be treated with dignity and respect. Many cultures view human remains as more than just biological objects, they are seen as active links between the living and the dead, holding social, spiritual, and cultural significance (Biers, 2019). As such, representation practices such as facial reconstruction can challenge these values, particularly when they do not reflect the wishes of descendant communities. This concern is compounded when no genetic analysis has been performed, and cultural or spiritual factors influencing the reconstruction are overlooked. Gibbon et al. (2023) also warn that cognitive bias in these reconstructions can further distort historical identity, particularly when there are no written records or portraits to guide accurate depictions. In this context, the ethical responsibilities of researchers and museums should include consultation with descendant communities and careful consideration of how approximations are presented.

2.2.2 Perspectives in favor of facial approximation

Despite criticisms, facial approximation continues to be defended for its educational value, particularly in its ability to make ancient populations more relatable to the public (Smith et al., 2020; Sertalp et al., 2023). Museums and academic institutions argue that these estimations help bridge the gap between abstract archaeological findings and tangible experiences (Pietroni and Ferdani, 2021; Gibbon et al., 2023). By putting a face to the past, they can engage audiences who might otherwise find skeletal remains too impersonal or difficult to interpret (Moyer, 2007; Buti et al., 2017). This approach is especially beneficial in outreach and pedagogical contexts, where visual storytelling enhances historical understanding and fosters empathy for past individuals (Buti et al., 2017; Smith et al., 2020; Gibbon et al., 2023; Sertalp et al., 2023).

While the reconstructions still result in a form of visual representation, they can be perceived as a compromise, allowing for the communication of bioarchaeological knowledge without exposing the actual remains. Facial approximations allow for a deeper understanding of ancient lives and cultures, without the ethical and emotional challenges associated with the public display of actual human remains. Through facial approximations, institutions can present a scientifically informed, respectful representation that conveys the complexities of the past while avoiding potential discomfort or objections from both the institution and the audience. This approach enables the continuation of public education and the promotion of cultural heritage, while also mitigating the sensitive nature of displaying human remains (Johnson, 2016; Smith et al., 2020). However, it should be noted that this is a complex issue, and while this article provides an overview of facial approximation as a communicative tool, the broader ethical and cultural implications are beyond the scope of this discussion. Moreover, there is still no consensus at the regulatory or ethical code level regarding the dilemma surrounding the exhibition of human remains. The debate continues on how institutions should approach the display of human remains and whether it is more appropriate to use alternatives such as physical and digital reconstructions, or replicas in the case of skeletal remains, as a means of conveying the past.

One of the strongest arguments in favor of facial approximations, as discussed earlier, is their ability to engage the public in historical and archaeological studies. Visual representations have a profound psychological impact, influencing how individuals perceive and relate to figures from the past (Leopold and Rhodes, 2010; Zhuravska, 2015). Modern learning theories emphasize that individuals derive meaning from their experiences, both independently and socially (Kelly, 2007). Museums today are increasingly focused on fostering active learning experiences, and facial approximations can serve as effective educational tools, making abstract historical figures more tangible and relatable (Hooper-Greenhill, 2007). As Gazi (2014) asserts, exhibitions play an active role in constructing knowledge, requiring innovative approaches beyond traditional object displays (Moyer, 2007).

Another key argument is that facial approximation helps counter the objectification of human remains. Human remains are often perceived as mere artifacts, akin to pottery fragments, rather than as individuals who once lived. This perception stems from a broader tendency in archaeological and museological practices, for example in Italy, where the Codice Urbani (D.Lgs. 42/2004) provides a legal framework for the protection and regulation of cultural heritage, often categorizing human remains as "*material cultural assets*" alongside artifacts such as pottery or sculpture. According to Italian heritage law, human remains are treated as cultural property, which are subject to the same considerations as historically significant objects. This legal approach emphasizes the material value of remains, rather than recognizing their deeply human and personal significance. As Alberti et al. (2009) note, museum displays transform human remains into "*recontextualized human remains,*" detaching them from their original burial context (Alberti et al., 2009, p. 143). As we have already seen, facial approximation can restore a sense of individuality, allowing visitors to connect emotionally with past people. Research suggests that these visual representations enhance public engagement and reinforce the recognition of the subject's personhood (Leopold and Rhodes, 2010; Zhuravska, 2015).

Facial approximations are also seen as a more ethical way to present human remains. The ongoing debate over whether human remains should be displayed in museums has led to increasing restrictions, with some institutions opting to remove them entirely from public view (as the Penn Museum in Philadelphia, the Natural History Museum in Vienna or partially as the Smithsonian Institution in Washington or the British Museum in London). As Sayer (2010) notes, museums offer opportunities for both personal and collective reflection on death, and facial approximations can facilitate this engagement in a way that is both informative and respectful.

Ultimately, as highlighted by sone researchers, the effectiveness of facial approximations depends on how they are presented. Gazi (2014) emphasizes that every decision in the presentation of human remains—whether related to language, spatial arrangement, or display design—shapes how visitors interpret and engage with the subject. Ensuring transparency about the speculative nature of approximations and incorporating diverse perspectives in their creation can help mitigate biases while maximizing their educational and commemorative value.

3 Discussion

The study, access, and dissemination of human remains present multifaceted ethical concerns, shaped by diverse perspectives from researchers, museum professionals, descendant communities, and the general public. While a consensus exists on treating human remains with dignity and respect (Biers, 2019), balancing scientific research with cultural sensitivities remains a challenge. For instance, descendant communities may prioritize the cultural and spiritual significance of the remains, advocating for their respectful treatment and repatriation, while researchers and museum professionals often emphasize the value of human remains in advancing scientific knowledge and education. These tensions increase when considering access to and dissemination of data related to human remains. The public display of such remains, whether in museum exhibitions or academic studies, raises questions about consent, ownership, and the potential for exploitation (Alberti et al., 2009; Gazi, 2014; Smith et al., 2020; Zuckerman et al., 2025). In this context, facial approximation may offer an alternative approach, allowing for the representation of past individuals without the direct exposure of human remains. This method not only provides an opportunity for scientific exploration and public engagement but also addresses ethical concerns, offering a means of presenting historical identities while minimizing the ethical dilemmas associated with the display of actual human remains.

Ultimately, the ethical framework surrounding the study and display of human remains must be multi-dimensional, addressing not only the rights of contemporary communities but also the broader implications of scientific research in shaping public understanding of history and identity.

As Biers (2019) argues, the strong symbolic power of human remains continues to shape ethical debates concerning their display and study, underscoring their role in both scientific inquiry and cultural discourse. From a cultural perspective, attitudes toward death, the deceased and post-mortem treatment have varied significantly across cultures and historical periods. In European history, for instance, Christian traditions emphasized visual engagement with relics composed of skeletal and mummified remains of saints, associating their veneration and remembrance with religious and emotional experiences, thereby reinforcing their spiritual presence (Freeman, 2011; McLaren, 2014; Biers, 2019).

The tradition of using facial representations to memorialize the dead has deep historical roots across various cultures, evolving from wax and clay death masks to more advanced methods of preserving and interpreting human identity (Verzé, 2009; Buti et al., 2017). These historical precedents underscore humanity's enduring tendency to seek forms of posthumous remembrance, of which facial approximation can be considered a contemporary iteration, albeit a far more complex one, given the precision and expertise required today (Buti et al., 2017). However, this continuation of ancient practices must be carefully managed to avoid sensationalism and ensure respect for the cultural and personal significance of the deceased.

While biological anthropological methods provide insights into health, diet, and demographics, they often fail to capture individual identity, as they focus mainly on physical traits and generalized data. Tarlow (2006) highlights that such methods overlook the social and cultural factors—such as personal relationships, cultural affiliations, and subjective experiences—that shape an individual's identity, which are essential for a more complete understanding of the past. The notion that archaeological human remains should retain dignity akin to their status in life remains a key ethical concern (Buti et al., 2017). Facial approximations can enhance public engagement by transforming skeletal remains from anonymous objects into relatable individuals, fostering empathy and a deeper understanding of history (as in Gibbon et al., 2023; and Sertalp et al., 2023). Philosophically, this process resonates with Levinas' (1961) concept that the face of the Other calls for ethical recognition, emphasizing the inherent individuality and dignity of each person.

Digital imaging technologies—such as CT scans, 3D laser scanning, photogrammetry, and 3D printing—have significantly enhanced the ability of museums and researchers to document, study, and communicate human remains, while minimizing direct interaction with the physical remains (BABAO Committee, 2019; Pietroni and Ferdani, 2021). These tools support preservation, enable the creation of detailed models for scientific analysis, and foster public engagement through interactive and immersive exhibitions (BABAO Committee, 2019; Pietroni and Ferdani, 2021; Sertalp et al., 2023).

An innovative example of ethical engaged museology is the project Ancient Civilizations: A Collectively Curated Space at Maidstone Museum, which illustrates how facial approximation can be used to respectfully humanize and contextualize ancient individuals (Smith et al., 2020). The exhibit focused on Ta-Kush, a woman from the 25th Dynasty of ancient Egypt, and combined scientific methodologies—including CT scanning, bioanthropological assessment, and craniofacial analysis based on forensic anatomical databases—with 3D facial reconstruction to produce a plausible representation of her appearance (Smith et al., 2020). Rather than presenting a static image, the project employed a multi-layered interpretative strategy: a clinical-grade translucent 3D print of the skull served as a tactile object, complemented by a CGI animation that gradually reconstructed Ta-Kush's face, evolving from a neutral anatomical base to her fully adorned appearance, complete with culturally appropriate accessories, such as a wig and jewelery (Smith et al., 2020). This staged encounter allowed visitors to engage with Ta-Kush as a once-living person before viewing her mummified remains, offering a more emotionally mediated and informed experience. Observational studies and visitor feedback revealed that this multimedia approach fostered empathy, enhanced memory recall, and encouraged deeper engagement with the display (Smith et al., 2020). Moreover, the project adopted a participatory and community-driven approach, involving local youth from the museum's "Cur8" group and members of the Kent Association for the Blind (Smith et al., 2020). These collaborators contributed to enhancing the accessibility and interpretative depth of the exhibition, setting a precedent for inclusive and ethically informed curation (Smith et al., 2020). By integrating scientific accuracy with emotional engagement and inclusivity, the Ta-Kush display exemplifies how facial approximation can be employed within

museums to ethically and effectively bridge the gap between past and present individuals (Smith et al., 2020).

In the case of facial approximations of individuals from Juliopolis (Ankara, Turkey), the approximation was one of several digital methods used in the "Faces of Juliopolis" exhibition (Sertalp et al., 2023). After assessing physical characteristics, such as biological sex, age-at-death, and ethnic group, researchers generated 3D raw face approximations. These were then refined to ensure accurate cranial-facial alignment, as well as realistic skin texture and plausible hair color. The white masks from the estimations were then 3D printed and displayed alongside three-dimensional skull prints and contextual information on mortuary practices, offering a more immersive and informative experience and demonstrating the broader impact of such approximations beyond scientific inquiry through questionnaires (Sertalp et al., 2023). Visitor questionnaires indicated that ∼40% of participants felt that the facial reconstructions helped them to reimagine and empathize with the ancient individuals (Sertalp et al., 2023). Around 30% considered the use of facial reconstruction a valuable contribution to digital archaeology, while others expressed general approval and a desire to see these methods used more frequently (Sertalp et al., 2023). Overall, both the facial reconstructions and the technological display techniques were highlighted as the most fascinating aspects of the exhibition, demonstrating the broader impact of such approximations beyond scientific inquiry (Sertalp et al., 2023).

Digital and artistic estimations offer an alternative means of engaging with past individuals without physically displaying or directly interacting with their skeletal remains. These methods allow for a respectful representation of human history while reducing the ethical concerns often associated with the public exposure of human remains. However, while they mitigate certain issues—such as the need for climate-controlled display cases, and advantages in terms of conservation, allowing for the creation of durable and permanent digital records -, they also introduce new ethical challenges related to the production, use and dissemination of digital data, these include unresolved questions around data ownership, such as who holds the rights to scans and 3D models, as well as concerns over privacy, especially in cases where reconstructed individuals are linked to identifiable populations or descendant communities. Nonetheless, the generation and manipulation of digital surrogates demand careful ethical consideration. According to the principles outlined by Pietroni and Ferdani (2021), it is crucial to follow the principle of "data transparency," ensuring that interpretative choices and levels of certainty are clearly communicated. This transparency enables audiences to discern which aspect of the guesswork is based on reliable evidence and which is speculative or evocative. Furthermore, as emphasized by Santana Quintero et al. (2022), digital records should be stored in accessible and sustainable repositories that guarantee long-term preservation, traceability and clear authorship. However, the integration of digital technologies into heritage practices also raises critical ethical questions regarding representation, access, and the interpretation of the past. These concerns are particularly relevant in museum contexts, where ethical considerations increasingly shape institutional policies aimed at balancing public engagement with respect for the deceased (Alberti et al., 2009). In this regard, the British Association for Biological Anthropology and Osteoarchaeology Digital Imaging Code (BABAO Committee, 2019) outlines key issues associated with the use of digital imaging in the study and display of human remains. The code warns that digital acquisitions—along with their associated data and models—can be rapidly disseminated, often without adequate contextualization or oversight, raising the risk of misuse, misrepresentation, or loss of control once such materials enter the public domain. Best practices recommend including metadata—such as dates, contributors, and methodological notes—to support future reuse and proper contextualization. Ethical guidelines, like those promoted by the BABAO Committee (2019), also stress the importance of formal agreements for the use and reproduction of digital models, particularly when dealing with 3D printing of human remains. These agreements should respect both institutional responsibilities and the potential interests or rights of descendant communities, as in the case of "The Sutherland Nine" (see Gibbon et al., 2023). The ethical handling of digital data is not only a matter of technical preservation but also of intellectual integrity, cultural sensitivity, and community involvement. Moreover, public reactions to such representations can vary. The BABAO Committee (2019) guidelines note that while some communities appreciate digital models as an educational resource, others may find them distressing or inappropriate, particularly when they involve ancestors with ongoing cultural significance. The ethical responsibility of museums and researchers, therefore, extends beyond the creation of these images to how they are framed, shared and interpreted.

A shift toward greater transparency in the communication of these approximations is also evident. Recent popular science articles, such as one published by National Geographic Italy on *Homo longi*, explicitly acknowledge the speculative nature of facial approximations, using phrases such as "*his hypothesis about the possible appearance,*" "*proceeding by conjecture*" and finally, "*This image is probably destined to change in light of the discovery of new fossils and the results of related genetic analyses*" (Larmer, 2025. p. 39). This growing openness reflects a broader scholarly consensus on the importance of clearly communicating the provisional and interpretative nature of such reconstructions. Scholars such as Prag and Neave (1997) and Wilkinson (2010) have long emphasized the role of artistic judgment and the inherent subjectivity involved in approximating a face from skeletal remains. More recently, Campbell et al. (2021) have underlined the necessity of framing these reconstructions within appropriate scientific and cultural narratives to prevent misinterpretation by the public. This aligns with current ethical discourse advocating for transparency in order to avoid reinforcing misleading notions of objectivity or forensic certainty in museum or media contexts.

Ethical engagement in this field requires promoting inclusivity, representation and critical dialogue regarding the treatment of human remains. Transparent communication ensures that research and educational initiatives align with ethical best practices (Zuckerman et al., 2025). Museums navigate these ethical concerns, balancing scientific inquiry with responsibility and cultural sensitivity (Moyer, 2007). As Andelković and Harker (2011) emphasize, studying the past must integrate ethical responsibility and acknowledge the individuality of the deceased.

In contemporary society, increased exposure to diverse cultures and historical narratives through media and technology has heightened both personal identity awareness and interest in shared heritage (Buti et al., 2017).

The idea that individuals retain a degree of moral status and dignity after death challenges the assumption that their remains can be freely used for educational or entertainment purposes (Zuckerman et al., 2025). Just as cemetery photographs immortalize the deceased, facial approximations can offer remembrance, reinforcing shared humanity and cultural heritage. As Giacobini stated, *"Every specimen is both evidence of an individual history and a piece of human evolutionary history"* (Giacobini, 2022. p. 15), a reminder that each set of remains embodies both personal identity and broader scientific significance. These experiences, uniting scientific approximation with cultural interpretation, represent an attempt to bridge objective data and subjective experience. Scientific estimations rely on empirical analysis and advanced technologies, yet descendant communities interpret these data through cultural, historical, and symbolic lenses (Biers, 2019; Smith et al., 2020; Sertalp et al., 2023). Science seeks universal, measurable truths, but individuals engage with estimations through emotional and cultural filters. The perception of ancestral figures is influenced by historical and social contexts, meaning what appears accurate to some may seem incomplete or distorted to others.

Acknowledging that human experience cannot be reduced to biological data is essential. Human remains, though objective evidence of the past, also embody personal histories and cultural connections that no model can fully reproduce. Facial approximation thus stands at the intersection of scientific precision and human experience, restoring identity to those who might otherwise remain anonymous in archaeological records (Prag and Neave, 1997; Wilkinson, 2004, 2010). The challenge is to balance scientific integrity with respect for cultural and individual interpretations. Overemphasizing scientific objectivity risks stripping past individuals of their identities, while excessive emotional interpretation may distort data (Alberti et al., 2009). However, it is important to clarify that when discussing "*facial approximation,*" the notion of "*scientific objectivity*" becomes more nuanced. While objectivity in science typically seeks to minimize bias and ensure accuracy, facial approximations inherently involve a level of artistic interpretation (Prag and Neave, 1997; Wilkinson, 2004, 2010). The process requires making informed but subjective choices regarding missing anatomical elements, soft tissue thickness and facial expression, making it distinct from more standardized scientific techniques (Prag and Neave, 1997; Wilkinson, 2010; Beatty, 2015). The challenge, therefore, is to maintain a careful balance between the empirical basis provided by osteological data and the interpretative aspects necessary to visualize a face. Leaning too far in either direction—whether by striving for absolute objectivity or allowing too much artistic freedom—can lead to misrepresentations, either overly rigid or speculative, that distort the individual's identity (Prag and Neave, 1997; Wilkinson, 2004, 2010; Campbell et al., 2021).

This issue extends beyond facial approximation to the broader field of cultural heritage visualization. As Pietroni and Ferdani (2021) suggest, any historical artifact is both a tangible object, with its physical attributes such as form, texture, and color, and a cultural symbol shaped by historical and social interpretations. Artistic and digital reconstructions, whether depicting objects or human figures, are never entirely neutral; they are shaped by the perspectives, values, and assumptions of those who create them.

Acknowledging this interpretative aspect is especially important in museum contexts, where visual representations can be mistakenly perceived as definitive representations of the past (Alberti et al., 2009; Smith et al., 2020). Instead of presenting them as fixed realities, museums should encourage visitors to engage critically with these approximations, highlighting their provisional nature and emphasizing that they are based on current knowledge but subject to revision as new discoveries emerge. Bridging objective data and subjective experience challenges the boundaries between science, art and culture. However, this intersection has the potential to deepen our understanding of history and encourage reflection on the connections between past and present, individual and collective memory, and the role of science in preserving human heritage.

An interdisciplinary approach has become fundamental in recent years, not only for integrating established scientific methods such as osteology, anthropology and forensics but also for incorporating perspectives from fields such as ethics, history and cultural studies. This multidimensional collaboration is increasingly shaping the way facial approximations are conceived, ensuring they are not merely scientific outputs but also representations that acknowledge cultural narratives and ethical considerations. A continued emphasis on engaging with descendant communities further enriches this process, reinforcing the role of approximations as both scientific tools and culturally sensitive interpretations of the past.

Ultimately, digital and artistic approximations of past individuals must navigate a complex interplay between scientific documentation, public engagement and ethical responsibility. The challenge is not simply to create accurate representations but to ensure that they are used in ways that respect both the deceased and the living communities connected to them. While facial approximation in archaeological contexts offer potential benefits, their necessity should be critically evaluated. If such estimations do not contribute meaningful insights or scientific knowledge, they risk becoming mere exercises in technical skill or demonstrations of financial resources. Ethical considerations should prioritize whether these visualizations enhance our understanding of the past or merely serve aesthetic purposes (Sertalp et al., 2023).

4 Conclusion

Facial approximation occupies a unique space at the intersection of science, art, and ethics, particularly within archaeology and museum contexts, where its application remains both promising and contentious. As these estimations contribute to shaping public perceptions of the past, ethical considerations must guide the process. Transparency about the limitations of methodology—such as the estimation of soft tissue thickness or the general absence of genetic data—remains essential to avoid misrepresentation. Scholars such as Nilsson et al. (2022) and Gibbon et al. (2023) emphasize the

importance of clearly communicating speculative elements and contextualizing reconstructions within appropriate ethical and cultural frameworks, especially when dealing with historically marginalized remains.

Rather than striving for absolute accuracy, facial approximations should be understood as approximations that facilitate engagement with the past while maintaining scientific integrity (hence the preference for the term "approximation"). Exhibiting such images in museums introduces an additional ethical dimension: the need to balance scientific communication with public understanding, respect for the deceased, and cultural sensitivity. As Johnson (2016) notes, viewers often perceive these faces as authentic, making it imperative to frame them as informed reconstructions rather than factual representations.

This discussion highlights a broader truth: facial approximation is never neutral, it is embedded in competing perspectives and values, often positioned within exhibitions that must balance respect for the deceased, public interest, scientific accuracy, and educational objectives. Recognizing that science is shaped by the cultural context in which it is practiced does not undermine its value, but rather encourages a more critical and reflective approach—especially when it involves representing past human lives and memories.

Clear communication regarding the choices made during the estimation process can help mitigate potential misunderstandings, ensuring that these depictions are seen as informed hypotheses rather than definitive likenesses. The ethical complexities surrounding facial approximation stem not only from methodological uncertainties but also from the responsibility to represent past individuals with dignity. Ultimately, the power of facial approximations lies in their ability to evoke empathy and foster a human connection. As Gibbon et al. (2023) note, "*The images bring everything together*" and "*the faces provide the way into the bigger story,*" reflecting Emmanuel Levinas's philosophy that the human face becomes a site of ethical encounter, capable of evoking empathy and reinforcing shared humanity (Gibbon et al., 2023. p. 9).

Moving forward, interdisciplinary collaboration will be essential in refining both the technical methodologies and ethical frameworks that govern facial approximations in archaeology and heritage studies. By integrating insights from anthropology, ethics, digital technologies, and museum studies—and by actively engaging the public—we can refine both the technical methods and ethical frameworks underpinning this practice. In doing so, we not only deepen our understanding of the past but also honor the dignity of those whose faces we attempt to reconstruct.

4.1 Key takeaways

With this article, we do not aim to provide definitive answers to the critiques raised, nor to advocate unconditionally for one position over another in the debate surrounding facial approximations. Rather, we seek to emphasize the progress made in both technical and public scientific communication, to highlight the good practices now being applied, and to reflect on how much remains to be done. The examples presented here represent only a small selection of the many projects displayed in museums around the world. Likewise, while our discussion of regulatory frameworks primarily reflects the Italian context—within which the authors operate—we acknowledge the relevance of broader international ethical guidelines. Documents such as those proposed by BABAO Committee (2019) or mandated by NAGPRA (United States Congress, 1990) continue to influence the responsible display and interpretation of human remains and their facial approximations. These frameworks are essential in guiding not only the respectful treatment of ancient individuals, but also the ways in which reconstructed faces are framed, contextualized, and understood by the public.

4.1.1 Ethical transparency

Facial approximations should clearly communicate their nature as informed estimations rather than definitive likenesses. To support this, museums and institutions are encouraged to create accessible explanatory panels—both physical and digital—highlighting the methodological limitations and the degree of uncertainty involved. These should be written in clear, inclusive language that avoids technical jargon while still respecting the intelligence and curiosity of the public. Where possible, trained staff or guides should be available to answer visitors' questions and scientific references or passages from articles should be shared to foster deeper engagement, allowing those interested to explore the data and methodology behind the approximation.

Additionally these approximations sit at the crossroads of scientific data, artistic interpretation and cultural storytelling. Maintaining a thoughtful balance between these dimensions is essential to preserve both the credibility of the estimation and its communicative power. Scientific accuracy—especially in facial proportions and skeletal-based features—must guide the work, while artistic choices should serve to humanize the individual without distorting their likely appearance. Cultural context, whenever available, should inform the aesthetic decisions, ensuring that the result aligns with both evidence and meaning.

4.1.2 Cultural sensitivity and community involvement

The representation of ancient individuals must respect the cultural, emotional, and symbolic significance these remains may hold for descendant or local communities. Whenever possible, these communities should be actively included in the study and display process, creating a collaborative dialogue between scientific practice and cultural heritage. This involvement helps ensure that more interpretative elements—such as skin tone, hairstyle, or clothing—are not arbitrarily decided but instead reflect shared understandings and values. Such collaboration also supports ethical integrity and contributes to more meaningful, inclusive representations.

4.1.3 Public engagement and emotional connection

Facial approximations have a powerful potential to engage the public and stimulate emotional responses by transforming

anonymous remains into relatable human beings. As demonstrated by Nilsson et al. (2022), even a neutral and highly realistic estimation can offer visitors the sensation of "meeting" someone from the past, without imposing a specific narrative or personality. This approach allows each viewer to form their own emotional interpretation, making the experience both personal and respectful.

4.1.4 Avoiding sensationalism and fostering critical literacy

Care must be taken to present facial approximations without sensationalizing them. Institutions should refrain from portraying these guess as exact replicas of ancient individuals and instead emphasize their nature as plausible, scientifically grounded hypotheses. The language used in exhibitions, media and educational content should be carefully chosen to reinforce this idea, for example, by adopting phrasing such as "approximation," "interpretation," or "plausible reconstruction." As seen in the disclaimer strategies used by institutions like National Geographic (Larmer, 2025), this helps set appropriate expectations and encourages visitors to engage critically with what they are seeing.

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References

Abdullah, J. Y., Moraes, C., Saidin, M., Rajion, Z. A., Hadi, H., Shahidan, S., et al. (2022). Forensic facial approximation of 5000-year-old female skull from shell midden in Guar Kepah, Malaysia. *Appl. Sci.* 12:7871. doi: 10.3390/app12157871

Alberti, S., Drew, R., Bienkowski, P., Chapman, M. J., and Alberti, S. J. M. M. (2009). Should we display the dead? *Mus. Soc.* 7, 133–149. doi: 10.29311/mas.v7i3.144

Andelković, B., and Harker, J. (2011). Identity restored: nesmin's forensic facial reconstruction in context. *EAP/IEA* 6, 715–728. doi: 10.21301/eap.v6i3.10

Ashmolean Museum—Oxford (2025). *Skull*. Available online at: https://www.ashmolean.org/jericho-skull (accessed March 31, 2025).

BABAO Committee (2019). *BABAO Recommendations on the Ethical Issues Surrounding 2D and 3D Digital Imaging of Human Remains*. Available at https://babao.org.uk/wp-content/uploads/2023/08/BABAO-Digital-imagingcode-2019.pdf (accessed February 25, 2025).

Beatty, K. E. (2015). *Skin and bone: the face in the archaeological imagination*. [PhD thesis for the Department of Archaeology]. Cork (IE): University College Cork. Available online at: https://hdl.handle.net/10468/2107

Belcastro, M. G., Manzi, G., and Moggi Cecchi, J. (2021). *Quel che resta. Scheletri e altri resti umani come beni culturali*. Bologna, IT: Il Mulino.

Bieder, R. A. (2000). "The representations of Indian bodies in nineteenth-century American anthropology," in *Repatriation Reader: Who Owns American Indian Remains?*, ed. A. Devon Mihesuah (Lincoln, NE: University of Nebraska Press), 19–36.

Biers, T. (2019). "Rethinking purpose, protocol, and popularity in displaying the dead in museums," in *Ethical Approaches to Human Remains: A Global Challenge in Bioarchaeology and Forensic Anthropology*, eds. K. Squires, D. Errickson, and N. Márquez-Grant (Berlin, DE: Springer), 239–263. doi: 10.1007/978-3-030-32926-6_11

Brooks, P. J. (2010). *Dying to be seen: an interpretive study of porcelain portraits on grave markers*. [thesis for degree of Master of Arts in Professional Communication]. Colwood, CA: Royal Roads University. Available online at: https://www.viurrspace.ca/server/api/core/bitstreams/7dbeea7a-a7ea-4493-beb3-81de7d20a2b3/content

Bruce, V., Healey, P., Burton, M., Doyle, T., Coombes, A., and Linney, A. (1991). Recognising facial surfaces. *Perception* 20, 755–769. doi: 10.1068/p200755

Buckley, R., Morris, M., Appleby, J., King, T. E., O'Sullivan, D., and Foxhall, L. (2013). The king in the car park: new light on the death and burial of Richard III in the Grey Friars church, Leicester, in 1485. *Antiquity* 87, 519–538. doi: 10.1017/S0003598X00049103

Buti, L., Gruppioni, G., and Benazzi, S. (2017). "Facial Reconstruction of Famous Historical Figures: Between Science and Art," in *Studies in Forensic Biohistory: Anthropological Perspectives*, eds. C.M. Stojanowski and W.N. Duncan (Cambridge, UK: Cambridge University Press), 191–212. doi: 10.1017/9781139683531.009

Campbell, R. M., Vinas, G., Henneberg, M., and Diogo, R. (2021). Visual depictions of our evolutionary past: a broad case study concerning the need for quantitative methods of soft tissue reconstruction and art-science collaborations. *Front. Ecol. Evol.* 9:639048. doi: 10.3389/fevo.2021.639048

Chatters, J. C. (2001). *Ancient Encounters : Kennewick Man and the First Americans*. New York, NY: Simon and Schuster.

Claes, P., Liberton, D. K., Daniels, K., Rosana, K. M., Quillen, E. E., Pearson, L. N., et al. (2014). Modeling 3D facial shape from DNA. *PLoS Genetics* 10:e1004224. doi: 10.1371/journal.pgen.1004224

de la Cova, C., Hofman, C. A., Marklein, K. E., Sholts, S. B., Watkins, R., Magrogan, P., et al. (2024). Ethical futures in biological anthropology: research, teaching, community engagement, and curation involving deceased individuals. *Am. J. Biol. Anthropol.* 185:e24980. doi: 10.1002/ajpa.24980

Du, P., Zhu, K., Qiao, H., Zhang, J., Meng, H., Huang, Z., et al. (2024). Ancient genome of the Chinese Emperor Wu of Northern Zhou. *Curr. Biol.* 34, 1587–1595.e5. doi: 10.1016/j.cub.2024.02.059

Freeman, C. (2011). *Holy Bones, Holy Dust: How Relics Shaped the History of Medieval Europe*. New Haven, CT: Yale University Press.

Gazi, A. (2014). Exhibition ethics—an overview of major issues. *J. Conserv. Mus. Stud.* 12, 1–10. doi: 10.5334/jcms.1021213

Gerasimov, M. M. (1955). *Vosstanovlenie Lica po Cerepu*. Moskva: Izdat. Akademii Nauk SSSR.

Giacobini, G. (2022). "Scheletri, mummie e riproduzioni del corpo umano nei musei scientifici," in *Quel che resta. Scheletri e altri resti umani come beni culturali,* eds. M. G. Belcastro, G. Manzi, and J. Moggi Cecchi (Bologna, IT: Il Mulino), 13–38. doi: 10.1163/18253911-bja10078

Gibbon, V. E., Feris, L., Gretzinger, J., Smith, K., Hall, S., Penn, N., et al. (2023). Confronting historical legacies of biological anthropology in South Africa—Restitution, redress and community-centered science: the Sutherland nine. *PLoS ONE* 18:e0284785. doi: 10.1371/journal.pone.0284785

Gregory, K., and Witcomb, A. (2007). "Beyond nostalgia. The role of affect in generating historical understanding at heritage sites," in *Museum Revolutions. How Museums Change and are Changed*, eds. S. J. Knell, S. MacLeod, and S. Watson (London, UK: Routledge), 263–275.

Guleria, A., Krishan, K., Sharma, V., and Kanchan, T. (2023). Methods of forensic facial reconstruction and human identification: historical background, significance, and limitations. *Sci. Nat.* 110, 1–11. doi: 10.1007/s00114-023-01838-9

Hallam, E., and Hockey, J. (2001). *Death, Memory and Material Culture (1st ed.)*. London, UK: Routledge.

Hoole, M. (2018). *The Achavanich Beaker Burial. Facial reconstruction*. Available online at: https://achavanichbeakerburial.wordpress.com/facial-reconstruction/ (accessed April 29, 2025).

Hoole, M., Sheridan, A., Boyle, A., Booth, T., Brace, S., Diekmann, Y., et al. (2018). 'Ava': a beaker-associated woman from a cist at Achavanich, Highland, and the story of her (re-)discovery and subsequent study. *PSAS* 147, 73–118. doi: 10.9750/PSAS.147.1250

Hooper-Greenhill, E. (2007). "Education, postmodernity and the museum," in *Museum Revolutions. How Museums Change and are Changed*, ed. S. J. Knell, S. MacLeod, and S. Watson (London, UK: Routledge), 367–377.

Hosek, L. (2019). Osteobiography as microhistory: writing from the bones up. *Bioarchaeol Int*. 3, 44–57. doi: 10.5744/bi.2019.1007

Insoll, T. (2012). *The Oxford Handbook of the Archaeology of Ritual and Religion*. Oxford, UK: Oxford Academic. doi: 10.1093/oxfordhb/9780199232444.001.0001

İşcan, M. Y., and Steyn, M. (2013). *The Human Skeleton in Forensic Medicine*. Springfield, IL: Charles Thomas Publisher.

Jablonski, N. G. (2021). The evolution of human skin pigmentation involved the interactions of genetic, environmental, and cultural variables. *Pigment Cell Melanoma Res.* 34, 707–729. doi: 10.1111/pcmr.12976

Johnson, H. (2016). Craniofacial reconstruction and its socio-ethical implications. *Mus. Soc. Issues.* 11, 97–113. doi: 10.1080/15596893.2016.1204598

Jones, D. G. (2019). "The ethical awakening of human anatomy: reassessing the past and envisioning a more ethical future," in *Ethical Approaches to Human Remains: A Global Challenge in Bioarchaeology and Forensic Anthropology*, eds. K. Squires, D. Errickson, and N. Márquez-Grant (Berlin, DE: Springer), 73–94. doi: 10.1007/978-3-030-32926-6_5

Ju, D., and Mathieson, I. (2021). The evolution of skin pigmentation-associated variation in West Eurasia. *Proc. Natl. Acad. Sci. U.S.A.* 118:e2009227118. doi: 10.1073/pnas.2009227118

Kelly, L. (2007). "Visitors and learning. Adult museum visitors' learning identities," in *Museum Revolutions. How Museums Change and are Changed*, eds. S. J. Knell, S. MacLeod, and S. Watson (London, UK: Routledge), 276–290.

Knudson, K., and Stojanowski, C. (2008). New directions in bioarchaeology: recent contributions to the study of human social identities. *J. Archaeol. Res.* 16, 397–432. doi: 10.1007/s10814-008-9024-4

Krien-Kummrow (1961). *Maschera—Enciclopedia Treccani*. Avaialble online at: https://www.treccani.it/enciclopedia/maschera_(Enciclopedia-dell'-Arte-Antica)/ (accessed February 14, 2025).

Larmer, B. (2025). Alla ricerca di altri umani. *Natl. Geogr. Ital.* 55, 2–39.

Leopold, D. A., and Rhodes, G. (2010). A comparative view of face perception. *J. Comp. Psychol.* 124, 233–251. doi: 10.1037/a0019460

Levinas, E. (1961). *Totality and Infinity*. Pittsburgh, PA: Duquesne University Press.

M'charek, A. (2024). "Whitewashing the neanderthal: doing time with ancient DNA," in *Critical Perspectives on Ancient DNA*, eds. D. Strand, A. Källén, and C Mulcare (Cambridge, MA: MIT Press), 97–120. doi: 10.7551/mitpress/15190.003.0007

McLaren, K. T. (2014). Worthy of veneration or skepticism?: how europeans regarded relics during medieval and renaissance Europe. *Forum J. Hist.* 6, 19–27. doi: 10.15368/forum.2014v6n1.7

Metcalf, P., and Huntington, R. (1991). *Celebrations of Death: The Anthropology of Mortuary Ritual*. Cambridge, UK: Cambridge University Press. doi: 10.1017/CBO9780511803178

Miranda, G. E., Wilkinson, C., Roughley, M., Beaini, T. L., and Melani, R. F. H. (2018). Assessment of accuracy and recognition of three-dimensional computerized forensic craniofacial reconstruction. *PLoS ONE* 13:e0196770. doi: 10.1371/journal.pone.0196770

Moon, C. (2019). "What remains? Human rights after death," *in Ethical Approaches to Human Remains,* eds. K. Squires, D. Errickson, and N. Márquez-Grant (Berlin, DE: Springer), 39–58. doi: 10.1007/978-3-030-32926-6_3

Moyer, T. S. (2007). "Learning through visitors: exhibits as a tool for encouraging civic engagement through archaeology," in *Archaeology as a Tool of Civic Engagement*, eds. B. J. Little, and P. A. Shackel (Walnut Creek, CA: Altamira Press), 263–277.

Navic, P., Inthasan, C., Chaimongkhol, T., and Mahakkanukrauh, P. (2023). Facial reconstruction using 3-D computerized method: a scoping review of Methods, current Status, and future developments. *Leg. Med.* 62:102239. doi: 10.1016/j.legalmed.2023.102239

Nilsson Stutz, L., and Tarlow,. S. (2013). *The Oxford Handbook of the Archaeology of Death and Burial*. Oxford, UK: Oxford Academic.

Nilsson, O., Sparrow, T., Holland, A. D., and Wilson, A. S. (2022). "The face of Stonehenge: 3D surface scanning, 3D printing and facial reconstruction of the Winterbourne Stoke cranium," in *Visual Heritage: Digital Approaches in Heritage Science*, eds. E. Ch'ng, H. Chapman, V.L. Gaffney, and A.S. Wilson (London, UK: Springer), 449–470. doi: 10.1007/978-3-030-77028-0_22

Pietroni, E., and Ferdani, D. (2021). Virtual restoration and virtual reconstruction in cultural heritage: terminology, methodologies, visual representation techniques and cognitive models. *Information* 12:167. doi: 10.3390/info12040167

Prag, J., and Neave, R. (1997). *Making Faces: Using Forensic and Archaeological Evidence.* College Station, TX: A&M University Press.

Remotti, F. (2016). "But the forest does know it..." Persistence of omusitu in the BaNande culture and thought (Democratic Republic of Congo). Movement 3: consciousness and plants: image-tree-word, Kervan. *Int. J. Afro-Asian Stud.* 20, 237–253. doi: 10.13135/1825-263X/1883

Ruby, J. (1995). *Secure the Shadow: Death and Photography in America*. Cambridge, MA: MIT Press.

Sanders, K. (2009). *Bodies in the Bog and the Archaeological Imagination*. Chicago, IL: University of Chicago Press.

Santana Quintero, M., Duong, M., and Smith, L. (2022). "Developing an ethical framework for the digital documentation of heritage sites," in *Visual Heritage: Digital Approaches in Heritage Science*, eds. E. Ch'ng, H. Chapman, V.L. Gaffney, and A.S. Wilson (London, UK: Springer), 27–49. doi: 10.1007/978-3-030-77028-0_3

Sayer, D. (2010). Who's afraid of the dead? Archaeology, modernity and the death taboo. *World Archaeol.* 42, 481–491. doi: 10.1080/00438243.2010.498665

Schneider, A. L., and Barran, P. A. (2014). "The precedent- setting case of kennewick man," in *Kennewick Man: The Scientific Investigation of an Ancient American Skeleton*, ed. D. W. Owsley, and R. L. Jantz (College Station, TX: Texas AandM University Press), 90–107.

Sertalp, E., Emmez, Y., Bütün, E., Dogan, E., and Büyükkarakaya, A. M. (2023). Raising public awareness of at-risk cultural heritage through new methods of digital archaeology: the case of the "faces of juliopolis" exhibition. *Mediterr. Archaeol. Archaeom.* 23, 175–195. doi: 10.5281/zenodo.8179461

Smith, K., Roughley, M., Harris, S., Wilkinson, C., and Palmer, E. (2020). From ta-kesh to ta-kush: the affordances of digital, haptic visualisation for heritage accessibility. *Digit. Appl. Archaeol. Cult. Herit.* 19:e00159. doi: 10.1016/j.daach.2020.e00159

Sointula, A. (2020). *Ancient Human Reconstructions and aDNA : Is there an ethical dilemma?* [thesis for degree of Bachelor]. Uppsala (SE): Uppsala University. Available online at: https://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-417058

Stephan, C. N. (2015). Facial approximation—from facial reconstruction synonym to face prediction paradigm. *J. Forensic. Sci.* 60, 566–571. doi: 10.1111/1556-4029.12732

Tarlow, S. (2006). "Archaeological ethics and the people of the past," in *The Ethics of Archaeology: Philosophical Perspectives on Archaeological Practice*, eds. C. Scarre and G. Scarre (Cambridge, UK: Cambridge University Press), 199–216. doi: 10.1017/CBO9780511817656.012

Thomas, D. H. (2000). *Skull Wars : Kennewick Man, Archaeology, and the Battle for Native American Identity*. New York, NY: Basic Books.

United States Congress (1990). *Native American Graves Protection and Repatriation Act (NAGPRA), Public Law 101-601*. Washington, DC: U.S. Government Printing Office. Available at: https://www.nps.gov/subjects/nagpra/index.htm

Vallazza, E. (2025). *South Tyrol Museum of Archaeology. Who was Ötzi?*. Available online at: https://www.iceman.it/en/who-was-oetzi/ (accessed April 29, 2025).

Verzé, L. (2009). History of facial reconstruction. *Acta. Biomed.* 80, 5–12.

Wilkinson, C. (2004). "The history of facial reconstruction," in *Forensic Facial Reconstruction*, eds. C. Wilkinson (Cambridge, UK: Cambridge University Press), 39–68. doi: 10.1017/CBO9781107340961.004

Wilkinson, C. (2010). Facial reconstruction – anatomical art or artistic anatomy? *J. Anat*. 216, 235–250. doi: 10.1111/j.1469-7580.2009.01182.x

Wilkinson, C. M., Roughley, M. A., and Shrimpton, S. L. (2024). Digital Immortality in palaeoanthropology and archaeology: the rise of the postmortem avatar. *Heritage* 7, 7188–7209. doi: 10.3390/heritage7120332

Williams, P., and Piasere, L. (1990). "Noi non ne parliamo..." le relazioni tra i vivi e i morti in una comunità "Mānuš" della Francia. *La Ricerca Folklorica* 22, 75–87. doi: 10.2307/1479201

Wingert, P. S. (2024). *Mask. Encyclopedia Britannica*. Available online at: https://www.britannica.com/art/mask-face-covering (accessed April 28, 2025).

Zhuravska, N. (2015). Bodies in showcases objectification of the human body from a cognitive perspective. *Kleos-Amst. Bull. Anc. Stud. Archaeol.* 1, 24–32.

Zuckerman, M. K., Marklein, K. E., Austin, R. M., and Hofman, C. A. (2025). Exercises in ethically engaged work in biological anthropology. *Am. J. Biol. Anthropol.* 186:e25015. doi: 10.1002/ajpa.25015