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Original article

Framing the past: How virtual experience affects bodily description of artefacts

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ABSTRACT

This study uses a novel, interdisciplinary approach to investigate how people describe ancient artefacts. Here, we focus on gestures. Researchers have shown that gestures are important in communication, and those researchers often make a distinction between beat and iconic gestures. Iconic gestures convey meaning, specifically, visual-spatial information. Beat gestures do not convey meaning; they facilitate lexical access. In our study, we videotaped participants while they described artefacts presented through varied media: visual examination, physical interaction, and three-dimensional virtual and material replica (i.e., 3D prints) interaction. Video analysis revealed that media type affected gesture production. Participants who viewed actual objects displayed in a museum-style case produced few gestures in their descriptions. This finding suggests that traditional museum displays may diminish or limit museum users degree of engagement with ancient artefacts. This interdisciplinary work advances our knowledge of material culture by providing new insights into how people use and experience ancient artefacts in varied presentations. Implications for virtual reproduction in research, education, and communication in archaeology are discussed.

1. Research aims

This study is part of a larger work aimed at understanding how people perceive artefacts through different media. For this study, we videotaped people while they interacted with ancient artefacts through different media (e.g., touching an original object, looking at a picture, interacting with a 3D digital replica on a computer screen, etc.) and then examined both how they described the objects and how they gestured while describing the objects, to investigate how people perceive and understand artefacts. Analysing the gestures and speech of people talking about objects, including the shape and function of objects, can provide useful insights into how people experience and make sense of artefacts in varied forms, including virtual copies. This study also aims to clarify how people negotiate inauthentic artefacts through the body in absence of original artefacts.

In a broader theoretical perspective, this research will clarify how people think with things, specifically how they think with *objects-from-the-past*.

2. Introduction

More and more, 3D technologies are being used to digitally preserve heritage with the goal of avoiding loss or destruction [1–5]. In the context of reduced funding, today, heritage specialists are challenged with the task of preserving and disseminating archaeological artefacts. Using 3D digital artefact reproduction to aid research and preservation results in fidelity of the reconstruction of the original materials and the ability to integrate 3D copies into comparative research. Today, advanced technologies, such as 3D laser scanning techniques allow for the creation of digital models that are both accurate to within a millimetre and able to capture an object's full colour surface appearance (*a texture map*) [2,6]. The use of 3D digital representations of artefacts, within the context of heritage studies, is an economically effective way to introduce various aspects of material culture studies to large numbers of people [7–11]. A representative example of 3D digital archive is provided by the Smithsonian foundation through the *Smithsonian X3D* initiative (http://3d.si.edu/), a web-based collection of artefacts, ecofacts,

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bones, etc., which is available for students and scientists to view at no charge. As these technologies are becoming more widely known, they are changing how professionals approach preservation, data sharing, and the communication of heritage [12–17].

Though the value of digital models for preserving and disseminating tangible heritage is generally recognized, some scholars believe these models lose important information, especially information obtained through real-world human-object interaction [18–22]. This concern opens up an epistemological question about the real value of digital object representations in both research and education. Studies demonstrate that, in fact, we do think *with* objects and that interaction with physical objects is critical when attempting to make sense of an object's function [23–28].

In recent times, many projects have started to incorporate 3D digital reproductions of artefacts in museum-based heritage and material culture studies. This is an exciting time to investigate how people interact with various reproductions and how they perceive artefacts in different media. Such work could advance our knowledge of how objects are perceived in museum settings and inform the design of museum display practices. In our current work, we study how people interact with physical and virtual artefacts in varied media.

According to David McNeill [29], cognitive scientist and a leading expert on gestures, manual gestures play an important role in communication [30]. Gestures are closely aligned with speech and facilitate reasoning and learning [31]. They can help people describe and understand abstract information and abstract objects [32]. Gesture scholars often distinguish between beat gestures and iconic gestures. Beat gestures are rhythmic hand movements that convey no semantic information, but are believed to facilitate lexical access [33]. When describing an artefact, for instance, a person might make three short repeated gestures to help formulate what she is trying to say (e.g., shaking one hand). Iconic gestures are manual movements that convey visual-spatial information about the topic of discourse [29]. While describing the function of a grinding stone, for instance, a person might say, "This is for grinding corn," while making a gesture that depicts the action of grinding.

3. Experiment

In the present study, we compared how people gestured while describing objects they experienced in different media:

- visual examination;
- physical interaction;
- three-dimensional virtual and material replica interaction (Fig. 1).

We analysed their descriptions of artefacts in five different forms of media (i.e., *independent variable* Fig. 2):

- touch (real-life haptic): participants were free to see, touch, smell and manipulate the real objects located on a table;
- look (real-life visual): participants viewed objects located in display cases; the cases were on a table. This condition simulates the experience participants usually have inside a museum;
- 3D screen (3D virtual visual): participants interacted with 3D copies of objects on a computer screen. Using the mouse they could move and rotate the objects and zoom it in and out;
- pictures (2D visual): participants viewed pictures of objects. The pictures were located on a table and participants were free to either just look at them or hold them while talking;
- 3D prints (3D printed haptic): participants were free to see, touch, smell and manipulate the 3D printed copies of original artefacts, which were located on a table.

We selected touch, pictures, and look because these media are commonly used by heritage and museum specialists to study and display artefacts. We also selected 3D screen and 3D prints because they have been recently introduced in the field of archaeology as an alternative data recording mean and a valuable way to share the archaeological record both within the scientific community and with the general public.

Forty people participated in our study. Twenty were undergraduate students who received extra credit in a class. The other 20 were expert archaeologists (i.e., academics or contract archaeologists) who agreed to participate in the experiment. Half of the participants were female. All participants were highly proficient English speakers with normal or corrected vision.

All student participants and some archaeologists were video recorded in a laboratory. Some archaeologists were interviewed in their offices, on various university campuses, where we reproduced the same conditions experienced by the other participants to the best of our ability.

All participants completed a short survey that asked basic demographic questions about age and area of study as well as experience with real and digital artefacts. Participants were left alone in the lab after being told to describe the objects to a video camera, which would record their speech and gesture.

Interviews were analysed in an attempt to determine which type of interaction (physical or virtual) would best serve the research and presentation needs of archaeological material to the general public. We compared students with archaeologists to compare how different media would influence their experience with ancient artefacts. Each participant was in only one condition (i.e., *between subject* design). For instance, a single participant participated only in the Look condition or only in the 3D print condition, but not both. Participants were balanced according to age, gender, and background.

Four artefacts, made from a range of different materials and from different geographic areas and chronological contexts, were selected for the experiment, with the aim of evaluating the degree to which the techniques of 3D scanning and printing are perceived differently for different materials (e.g., stone, pottery, etc.), shape, and other physical qualities such as weight, density, and so on (i.e., *dependent variables*). A characteristic like density, for instance, is more critical when studying objects like grinding stones than for the study of ceremonial objects like a support for figurines linked to ritual practice. The artefacts selected were:

- wooden Buddhist ritual object from Nepal;
- grinding stone from California;
- ceramic vessel from Ethiopia;
- projectile point from California (Figs. 1 and 3).

All participants interacted with the same set of objects.

Below, we report a few of the most interesting findings we observed in our data.

4. Results

Our analysis compared how archaeologists and university students (non-experts) gestured when talking about artefacts. Our in-depth analysis examined when and how iconic and beat gestures were used in discourse about artefacts displayed in varied media. Table 1 shows the values for the average number of gestures produced by each group of participants in each condition.

We used both Analysis of Variance (ANOVA) and *t*-tests to analyse our data. An ANOVA compares mean differences among 3 or more experimental conditions. Here, the null hypothesis states that the means of all experimental conditions are