HOW MODERN HUMANS SEE ANCIENT FIGURE FACES:
THE DIFFERENTIAL IMPRESSIONS AND PERCEIVED
EXPRESSIONS FROM CLAY FIGURE FACES FROM
PREHISTORIC AND PROTOHISTORIC JAPAN

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Anthropomorphic artifacts have unique characteristics, as they are closely related to
social and technical cognition and contain complex information. However, their
meanings can be elusive. The present study aimed to examine how modern
Japanese people perceive the faces of Japanese prehistoric (13,000–800 cal BC) and
protohistoric (AD 250–600) anthropomorphic artifacts by focusing on the facial
expressions and impressions of clay figure faces. The study included 75 Japanese
participants and 131 figure faces from three historical periods. The results showed
that participants perceived the prehistoric and protohistoric facial expressions
differently (as being happier, sadder, and less surprised), depending on the period
they were created in. We examined the relationships between impressions and
perceived expressions of the figure faces, and found that faces became more
complicated due to the introduction of facial morphometric features. The results
may be applicable to understanding the variation in Japanese figures, especially the
faces.

Key words: anthropomorphic artifacts, clay figures, impression, facial expressions,
online experiment

INTRODUCTION

Anthropomorphic artifacts are a rich source of information about the identity,
gender, technology, and social structure of the period they were created in. The
representation of the human body provides a model for conceptualizing and categorizing
the organization of natural, social, and cosmic spaces (Janik, 2014, 2020; Rice, 2019).
Anthropomorphic objects occupy the nexus between the social and material worlds and
are closely related to social and technical cognition (Mithen, 1996). Social cognition is
an essential domain that has evolved significantly in the genus Homo (Dunbar, 2003).

This work was supported by the JSPS KAKENHI, Grant Numbers JP19H05733 and JP19H05736.
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The cognition of the human face is essential in our social cognition, as it provides rich information about who the person is, and what emotions and intentions the person has (Hugenberg & Wilson, 2013). We can instantly recognize social relationships and communication signals from facial features and expressions; the same cognitive process could be initiated when we see the faces of anthropomorphic artifacts. While you recognize them as artifacts and appreciate how well, or badly, they are made, you may also be able to read the intention of the person who made them. Thus, anthropomorphic artifacts have unique potential as research subjects with multiple, complex meanings. It may be argued that differences in their representation may have affected social cognition in society.

The creation of anthropomorphic artifacts is a unique human behavior that appeared approximately 40,000 years ago, mostly attributed to the activity of Homo sapiens. An example of this is the stone “mask” which is considered to have been made by Neanderthals (Marquet & Lorblanchet, 2003; Janik, 2020). This behavior may be based on advanced cognitive abilities such as symbolic thinking and self-awareness (Morriss-Kay, 2010). While Paleolithic people used stone, bone, and ivory to make figures, clay figures became popular once the pottery-making technique appeared. In the Japanese archipelago, a particularly large number of “dogu” clay figures were produced during the Jomon and in a limited part of the Yayoi periods. Production of anthropomorphic figures became popular again in the Kofun period in the form of “haniwa.”

The Jomon period, which lasted about 14,000 years between 15,000 cal BC and 800 cal BC, was a period in which hunting, gathering, and fishing were the basis of life, and the development of material culture, such as decorated pottery, took place (Imamura, 1996; Habu, 2004; Matsumoto et al., 2017). The Jomon period is divided into six periods: Incipient (13,000–10,000 cal BC), Initial (10,000–5,000 cal BC), Early (5,000–3,500 cal BC), Middle (3,500–2,400 cal BC), Late (2,400–1,250 cal BC), and Final (1,250–800 cal BC). The production of clay figures appeared during the Incipient Jomon period and flourished from the Middle Jomon period onward. Figures from the Incipient to the Initial Jomon periods are rare and lack facial features and limbs. Many of the Jomon period clay figures are thought to represent women, based on the expression of breasts and other sexually accentuated features (Hudson & Aoyama, 2007). Some examples are difficult to distinguish by gender, and it is possible that their representation transcends human sex or gender (Ikawa-Smith, 2002). However, it should be noted that male figures are extremely rare. Facial expressions are varied, with stylization specific to each period and region. During the Early to Middle Jomon period, the population increased, many settlements were established, and figures tended to have a feminine body and face. In contrast, the Late and Final Jomon periods were marked by social changes, such as the breakup of sedentary settlements and increase in ritualistic sites, and clay figures tended to have an inhuman appearance and stern expression (Ikawa-Smith, 2002; Kosugi, 2002).

In the following Yayoi period (800 cal BC to AD 250), two-dimensional representation of humans in the form of line drawings on pottery or on bronze bells appeared, but the production of anthropomorphic clay figures died out, except for the examples from the
eastern part of Japan which descended from the Jomon dogu. Weight-shaped clay objects (Fundogata doseihin) which have been found from Okayama prefecture and surrounding areas are highly stylized human figures (Mitumoto, 2013), but most of them lack facial representation. Although the transformation of lifestyle from hunter-gatherer-fisher to farmer may be related to the change in the representation of human form, the reasons for this is a matter for future research.

The absence of clay figures continued to the early Kofun period, until the creation of human-shaped haniwa in the middle Kofun period. The Kofun period (AD 250–600) was a time of state formation in the Japanese archipelago. In this period, burial mounds were built with great energy for powerful leaders. Human-shaped and other kinds of haniwa were arranged on the burial mounds as a part of the funerary ritual, representing the life of the buried chief while he/she was alive or in the afterlife. Archeological and ethnographic research in Japan has shown that there are several types of human-shaped haniwa according to gender, social status, and professions, such as chiefs, priestesses, warriors, wrestlers, horse-keepers, and shield-bearers (Tsukada, 2007).

It is very difficult to understand how people of the past felt about the faces of the anthropomorphic artifacts, or their motivations, intentions, technological knowledge, skills, and beliefs related to the creation of figures. For more than two decades, there has been a growing interest in research on cognitive archaeology, which focuses on the cognition of ancient people (Renfrew & Zubrow, 1994). Cognitive archaeology has developed empirical methodologies to investigate the cognitive abilities possessed by ancient people that enabled them to produce artifacts such as stone tools, potteries, figures, and tombs, and to investigate how people of that time evaluated the artifacts (Mithen, 1996; Hoffecker, 2011; Henley et al., 2019; Overmann & Coolidge, 2019). This line of research has recently led to the development of various experimental procedures that examine cognitive processes in creating and evaluating artifacts (Stout et al., 2008; Key et al., 2017; Criado-Boado et al., 2019). In these experimental approaches, contemporary people participated in an experiment to examine how they evaluated, produced, or handled archeological artifacts physically, psychologically, or physiologically. Since significant social and cultural differences exist between ancient and modern humans, the results of these experiments cannot be considered as a duplicate/replica of what happened in the past. However, it is important to provide empirical evidence for discussion. We still do not know much about the cognitive foundations of human nature, or how our species-specific cognitive capacities with biological and evolutionary properties are shaped by experiences in a particular culture (Barrett, 2020). We need to investigate commonalities and differences between properties, such as culture and experience (e.g., professionals and amateurs). Experimental research using archeological material has great potential to widen the scope of cross-cultural approaches toward the past.

We are now focusing on prehistoric and protohistoric representations of faces in the Japanese archipelago, as expressed in clay figures, aiming to obtain samples from different socio-cultural contexts to consider the differences in facial representation. In the present study, we examined how modern Japanese people evaluated various
impressions and perceived facial expressions from the faces of clay figures excavated in Japan as a preliminary study, before stepping into comparative research. We used photographs of clay figures’ facial images from the Early to the Middle Jomon period, and from the Late Jomon to the Middle Yayoi period. The Yayoi examples were from eastern Japan as the tradition of figure production continued there, while it was almost terminated in western Japan during the Yayoi period. The images were selected from high-resolution depictions of the figure faces taken from the front, with the intention of covering regional variations. We selected more samples from the Late Jomon to the Yayoi figures because there were more regional variations.

In addition to the Jomon figure faces, we used facial images of human-shaped haniwa, which are clay figures produced in the Kofun period, to examine facial cognition of anthropomorphic artifacts with different social backgrounds and production purposes. Materials for this study were selected to cover regional (Kyushu, Shikoku, and Honshu), chronological (late 4th century to late 6th century), and categorical (dogu and haniwa) variations. We selected materials from burial mounds of both royal tombs and local elites, since few archeological materials have survived in good condition, priority was given to selecting materials with relatively well-preserved facial features and detailed images.

We aimed to examine how the contemporary interpretation of facial expressions on artifacts changed according to social situations. The Early and Middle Jomon societies were essentially egalitarian, and the population increased in preferable climatic conditions. The Late and Final Jomon periods and the following Yayoi period were characterized by population decline in eastern Japan with catastrophic social changes (Imamura, 1996; Habu, 2004). The Kofun period was a period of state formation, when social stratification progressed, and centralized policy was established. In addition, while Jomon figures were basically ritual objects used in daily life, haniwa were made for funerary rituals in societies with a high degree of social stratification. Therefore, we assumed that the differences in the usage and social background between the Jomon and Kofun periods could be reflected in the expressions on the faces of clay figures, perceived differently, in even modern people. It is possible that the faces might have given rise to many variations in the Jomon period because the clay figures were used personally in the Jomon period; however, for the public in the Kofun periods, and thus, may have a particular directionality in the facial morphology to be understandable to many people. It will be very surprising, if the facial impressions and expressions can be discriminative between the Early Jomon and the Later Jomon periods, or between the Later Jomon and the Kofun periods. We will also discuss the relationships between the purpose and intent of creating human-shaped artifacts and facial expressions.

**Method**

**Participants**

Eighty-seven participants were recruited, and 75 of them completed the entire experiment (53 women
and 22 men; age range: 18 to 59 years, mean age: 23.56 years [SD = 8.77]). They were all amateurs in archaeology (reported number of years expertly trained in archaeology: mean = 0.04, max = 1). Participants were all of Japanese nationality, but eight of them reported that they had lived outside Japan for over two years. All participants were informed of the design and purpose of the study. Only participants who completed the experiment were paid 1,000 yen for their participation. The study was approved by the Ethics Committee of the Faculty of Letters at Keio University.

Stimuli

We used 131 photographs of the faces of anthropomorphic artifacts from the prehistoric and protohistoric Japanese archipelago. Of the facial images used, 31 were from the Early and Middle Jomon period (hereafter referred to as “Earlier Jomon”), 49 were from the Late and Final Jomon and Yayoi period (hereafter referred to as “Later Jomon”), and 51 were from the Kofun period. Photographs of clay figures were produced from images scanned from books and digital images of the online collection of the Tokyo National Museum. The image was cut out only from the neck of each figure. The background of each image was converted to grayscale, and the images were resized to 500 × 500 pixels. However, the real size of each image presented to each participant varied depending on the PC setting.

Procedure

The experimental procedure was designed in PsychoPy 3.2 (Peirce et al., 2019) and executed using the online platform Pavlovia (https://pavlovia.org/). With informed consent, participants were asked about their age, gender, name of the country of residence other than Japan, number of years therein, and the number of years of expertise in archaeology; they answered by entering specific text for each question. Participants were instructed on the behavioral task, and a familiarization practice session was administered before...
beginning the main experiment. The experiment consisted of 131 trials, corresponding to the number of stimuli. In each trial, one of the faces was randomly presented on a screen, and some rating scales or questions were shown below the facial image (see Fig. 1). We asked participants to rate the images using a seven-point scale of five adjective impressions in Japanese, as follows: (a) “complexity” to be rated from very simple to very complicated (非常に単純な—非常に複雑な), (b) “sexual dimorphism” from very masculine to very feminine (非常に男性的—非常に女性的), (c) “humanness” from very nonhuman to very human (非常に人間らしくない—非常に人間らしい), (d) “well-made” from very badly-made to very well-made (非常に作りの悪い—非常に作りの良い), and (e) “approachability” from very unapproachable to very approachable (非常に親しみにくい—非常に親しみやすい). After rating the images on these five scales in a constant order of presentation, participants were asked to select one of five facial expressions (happy, surprised, fearful, sad, and angry). We did not ask participants to rate the degree of each facial expression to reduce the time required for each participant’s trials. These items to rate impressions and facial expressions were identical to those used by Matsumoto and Kawabata (2010). However, we changed one impression item, from “smoothness” to “complexity,” since smoothness was not a distinctive feature of the clay figure from the other items, and complexity was often used in research of impression formation (e.g., Berlyne, 1971). Moreover, we excluded a facial expression of “disgust” from the list, because “disgust” was a relatively low independent from the other expressions in Matsumoto and Kawabata (2010). Also, “neutral” was excluded from the choices to avoid the possibility of selecting “neutral” for most stimuli. Each facial image remained in the same position throughout the trial until all responses were completed. The experiment lasted approximately 30 to 40 minutes.

RESULTS

We first analyzed the variety of ratings to identify the commonalities among the 75 participants for each impression. In the first step, we calculated Cronbach’s alphas across all participants for each impression, confirming quite high commonalities, including constant and highly reliable ratings across participants for all impressions, such as complexity (α = .975), sexual dimorphism (α = .951), humanness (α = .983), well-made (α = .978), and approachability (α = .949). The mean ratings across participants were computed and used thereafter. We prepared 131 Japanese figures from three periods: Earlier Jomon, Later Jomon, and Kofun. In the following analysis, we first compared each of the five impressions that participants rated, then compared each of the five facial expressions participants selected for each figure image, and finally examined the relationships between combinations of impressions and perceived facial attractiveness.

Comparisons Among Mean Impression Ratings to Figure Faces

To examine how each impression differed among the three historical periods, we compared the three historical periods for each of the five dependent variables (i.e., impressions) by performing separate one-way analyses of variance (ANOVAs). We found no significant differences among historical periods in ratings of complexity and sexual dimorphism (Fig. 2). In contrast, we found statistically significant main effects in ratings of humanness, well-made, and approachability (see Table 1 in detail). Pairwise comparisons as post-hoc tests by Tukey for these items with significant main effects showed that clay figure faces from the Kofun period (i.e., haniwa) were evaluated as more human, well-made, and approachable than those from the Earlier Jomon (t = 10.914; p < .001 for humanness; t = 7.108; p < .001 for well-made; t = 6.581; p < .001
Differential Impressions of Figure Faces

Fig. 1. Fig. 1. 一行の時はセンター揃え

Fig. 2. Mean Ratings of Five Impressions for the Three Periods

Note. Error bars represent standard error.

Table 1. Mean Differences Among Historical Periods on Rating for Each Impression

| Historical Periods               | Earlier Jomon (N = 31) | Later Jomon (N = 49) | Kofun (N = 51) | One-way ANOVA | p     | ηp² |
|----------------------------------|------------------------|----------------------|----------------|---------------|-------|-----|
| Complexity                       | 3.186 (1.007)          | 3.691 (0.977)        | 3.581 (0.880)  | F(2, 128) = 2.821 | .063  | .042|
| Sexual dimorphism (Femininity)   | 3.643 (0.602)          | 3.437 (0.607)        | 3.558 (0.697)  | F(2, 128) = 1.039 | .357  | .016|
| Humanness                        | 2.872 (0.782)          | 3.292 (0.886)        | 4.895 (0.758)  | F(2, 128) = 75.826 | <.001 | .542|
| Well-made                        | 3.219 (0.710)          | 3.552 (0.757)        | 4.479 (0.835)  | F(2, 128) = 30.415 | <.001 | .322|
| Approachability                  | 3.384 (0.566)          | 3.427 (0.555)        | 4.254 (0.612)  | F(2, 128) = 32.966 | <.001 | .340|

Note. Numbers in brackets after each mean represent 1 SD. ANOVA = analysis of variance.

for approachability), and Later Jomon periods (t = 9.846; p < .001 for humanness; t = 5.927; p < .001 for well-made; t = 7.126; p < .001 for approachability). In addition, for humanness, figure faces from the Later Jomon period were rated as marginally significantly more human than those from the Earlier Jomon period (t = 2.248; p = .067), but there was no significant difference in ratings for well-made and approachability between Earlier and Later Jomon figure faces (well-made: t = 1.862; p = .154; approachability: t = 0.320; p = .945).

Relationships Among Mean Impression Ratings

We further examined the relationship between the ratings of each impression by conducting a principal component analysis (PCA). We entered the mean ratings of the five facial impressions for the 131 images into the PCA. We considered the first two PCs
because the number of components was extracted based on an eigenvalue above 1. The first PC (PC1) accounted for 56.169% of the explained variance, and the second PC (PC2) accounted for 20.742%, indicating the PC loadings of all the impressions. The loadings of PC1 and PC2 were .996 and .020 for well-made, .870 and .353 for humanness, .855 and .111 for approachability, .588 and .340 for complexity, and .207 and .886 for sexual dimorphism, respectively. Based on observation, emotionally positive valence ratings, such as well-made, humanness, and approachability, had high and positive loadings in PC1. In addition, the complexity rating also showed high and positive loadings in PC1. This PCA result was interpreted to mean that PC1 indicated “quality.” Whereas, only the rating for “sexual dimorphism” highly contributed to PC2. Concerning this result of the PCA, we supplementally computed Pearson’s correlation coefficients between every combination of ratings for each impression across the periods (Table 2). Regardless of the period, the correlation coefficients between sexual dimorphism and the other impressions were consistently low, whereas the correlation coefficients between the other impressions were basically high, especially between complexity and well-made ($r = .671$), humanness and well-made ($r = .796$), humanness and approachability ($r = .776$), and well-made and approachability ($r = .735$). However, the correlation coefficients by period showed some discrepancies in many combinations between items as shown the lower rows by historical periods in Table 2. In other words, the trends of correlation between ratings of each impression were not consistent among the periods.

Then, we conducted a discriminant analysis inferring the periods (response variables; the Earlier Jomon, Later Jomon, and Kofun periods) by five impressions (explanatory variables; complexity, sexual dimorphism, humanness, well-made, and approachability) to determine the impressions responsible for the discernible differences between the periods. The results indicated that a canonical function contributed to discriminating the historical periods (eigenvalue = 1.318, %variance = 94.0, canonical correlation = .754; Wilk’s lambda of .398, assessed via $\chi^2(10) = 116.110, p < .001$). Standardized canonical discriminant function coefficients showed a positive high value in humanness (0.837), and well-made (0.567), and a negative high value in complexity (−0.600), whereas it showed very low value in sexual dimorphism (0.086), and approachability (−0.149). Function at group centroids was very close between the Earlier Jomon (−1.093) and Later Jomon periods (−0.780), but the Kofun period (1.413) was distant from the other two periods. Moreover, the classification results showed high prediction performance in the Kofun period (86.3%) but low performance in the Earlier Jomon (51.6%) and Later Jomon periods (40.8%). Thus, our results suggest that figures from the Kofun period (haniwa) were clearly distinguishable from the other two periods, based on the ratings of impressions, especially humanness, well-made, and complexity. In fact, the discriminant scores of Function 1 significantly correlated with humanness ($r = .974, p < .001$), well-made ($r = .710, p < .001$), and approachability ($r = .765, p < .001$), and those of Function 2 correlated with complexity ($r = .995, p < .001$) and well-made ($r = .606, p < .001$).
Table 2. Pearson’s Correlations Among Impressions Regardless of Historical Periods (Upper in Each Cell) by Periods (Lower in Each Cell)

| Complexity      | Sexual dimorphism (Femininity) | Humanness | Well-made |
|-----------------|--------------------------------|-----------|-----------|
|                 | Earlier Jomon | Later Jomon | Kofun | Earlier Jomon | Later Jomon | Kofun | Earlier Jomon | Later Jomon | Kofun | Earlier Jomon | Later Jomon | Kofun |
| Sexual dimorphism (Femininity) |                    |            |       |               |            |       |               |            |       |               |            |       |
|                  | r = .124       |             |       |                |            |       |               |            |       |               |            |       |
|                  | p = .157       |             |       |               |            |       |               |            |       |               |            |       |
|                  | r = .028       | r = .343    | r = .039 |                |            |       |               |            |       |               |            |       |
|                  | p = .880       | p < .05     | p = .785 |               |            |       |               |            |       |               |            |       |
| Humanness        | r = .251       |             |       | r = -.031     |            |       |               |            |       |               |            |       |
|                  | p < .01        |             |       | p = .722      |            |       |               |            |       |               |            |       |
|                  | r = .300       | r = .089    | r = .549 | r = .147      | r = -.438  | r = .164 |                |            |       |               |            |       |
|                  | p = .096       | p = .547    | p < .001 | p = .422      | p < .01    | p = .251 |               |            |       |               |            |       |
| Well-made        | r = .671       |             |       | r = .152      | r = .796   |       |               |            |       |               |            |       |
|                  | p < .001       |             |       | p = .082      |            |       |               |            |       |               |            |       |
|                  | r = .817       | r = .764    | r = .217 | r = .129      | r = .199   | r = .662 | r = .491      | r = .897   |       |               |            |       |
|                  | p < .001       | p < .001    | p = .232 | p = .381      | p = .162   | p < .001 | p < .001      | p < .001   |       |               |            |       |
| Approachability  | r = .200       |             |       | r = .211      | r = .776   | r = .735 |               |            |       |               |            |       |
|                  | p < .05        |             |       | p < .05      |            |       |               |            |       |               |            |       |
|                  | r = -.203      | r = .280    | r = .414 | r = -.025     | r = .261   | r = .473 | r = .652      | r = .721   | r = .255 | r = .649      | r = .753   |       |
|                  | p = .264       | p < .01     | p < .001 | p = .866      | p = .064   | p < .01 | p < .001      | p < .001   | p < .01 | p = .159      | p < .001   | p < .001 |

Note. The first row: Pearson’s r; the second row: p-value.
Comparisons Among Mean Frequencies of Selected Facial Expression

In this experiment, participants also selected one of the five facial expressions for each clay figure. We counted the number of times each facial expression was selected for each figure face (Fig. 3), and the percentage of each selected facial expression was arcsine-transformed. For this index, we conducted a repeated-measures ANOVA with perceived facial expression (happy, surprised, fearful, sad, or angry) as a within-variable, and historical period ( Earlier Jomon, Later Jomon, and Kofun) as a between-variable, to reveal whether perceived facial expressions varied with historical periods. The results indicated a significant main effect of perceived facial expression \(F(4, 512) = 3.023, p = .018, \eta^2_p = .023\), and historical period \(F(2, 128) = 3.586, p = .031, \eta^2_p = .053\), and a significant interaction between the two variables \(F(8, 512) = 10.702, p < .001, \eta^2_p = .143\). The post-hoc tests showed that there were significant differences between surprised and sad \(t = 3.487, p < .05\) for the Earlier Jomon period, and between happy and surprised \(t = 4.496, p < .001\), happy and angry \(t = 6.178, p < .001\), surprised and sad \(t = 5.908, p < .001\), fearful and sad \(t = 4.329, p < .01\), and sad and angry \(t = 7.590, p < .001\). Moreover, there were significant differences between the Earlier Jomon and Kofun periods \(t = 4.671, p < .001\) and the Later Jomon and Kofun periods \(t = 4.444, p < .001\) for surprised, between the Earlier Jomon and Kofun periods \(t = 5.367, p < .001\) and Later Jomon and Kofun periods \(t = 4.557, p < .001\) for sad, and between the Earlier Jomon and Kofun periods \(t = 4.796, p < .001\) and the Later Jomon and Kofun periods \(t = 4.387, p < .001\) for angry. In summary, it was difficult to distinguish between the Earlier and Later Jomon periods in terms of the facial expressions of clay figures. However, it is clear that the frequency of surprised and angry facial expressions was higher than the other expressions in these periods, while the frequency of happy and sad expressions was higher than the other expressions in the Kofun period.

![Fig. 3. Sum of Selected Facial Expressions Averaged Across Figure Faces for Each Period](image_url)

*Note. Error bars represent standard error.*
Relationships Among Frequencies of Perceived Facial Expressions

As we analyzed facial impressions, we also examined the relationship between the five facial expressions by conducting a PCA. We entered the arcsine-transformed frequencies of five facial expressions across 75 participants for the 131 figure faces into the PCA. We took the first two PCs into account, in which PC1 accounted for 38.635% of the explained variance and PC2 accounted for 30.822%, indicating that PC1 might contribute negative valence and PC2 arousal. The loadings of PC1 and PC2 were −.881 and −.373 for happy, .826 and −.061 for fearful, .562 and −.744 for sad, .189 and .711 for surprised, and .063 and .567 for angry facial expressions, respectively. Moreover, as for the data of impressions, we computed Pearson’s correlation coefficients between every combination of the frequencies of each facial expression selected, using arcsine-transformed data, by historical period (Table 3). Furthermore, to determine which facial expressions were responsible for the discernible differences between the periods, we conducted a discriminant analysis including the selected five facial expressions (explanatory variables; happy, surprised, fearful, sad, and angry) to discriminate historical periods (response variables; Earlier Jomon, Later Jomon, or Kofun), as done for impression ratings. The results of perceived facial expressions also indicated that a canonical function contributed to discriminating the historical periods (eigenvalue = .881, %variance = 96.3, canonical correlation = .684; Wilk’s lambda of .514, assessed via χ²(10) = 83.818, p < .001). Standardized canonical discriminant function coefficients showed high positive values in surprise (1.312), anger (1.312), and happy (0.928; fearful = 0.076; sad = 0.261), and function at group centroids was very close between the Early Jomon (0.904) and Later Jomon periods (0.630), but the Kofun period (−1.155) was distant from the other two periods. Moreover, the classification results showed high prediction performance for the Kofun period (86.3%) but low performance for the Earlier Jomon (54.8%) and Later Jomon periods (44.9%), suggesting that, by perceived facial expressions, figures from the Kofun period were clearly distinguishable from the other two periods. Moreover, the obtained discriminant scores significantly correlated with happy (r = .312, p < .001), surprised (r = −.668, p < .001), sad (r = .778, p < .001), and angry (r = −.595, p < .001).

Relationship Between Impressions and Facial Expressions Perceived From Figure Faces

As described above, both the impressions and facial expressions of the faces of clay figures showed a variety of characteristics related to their periods. Although we tried multiple linear regression analyses to examine the influences on the impressions from the perceived facial expressions of the figure faces, we could not perform the analysis because all facial expressions had null responses. Therefore, we carried out simple linear regression analyses of all combinations between the impressions as response variables and perceived facial expressions as explanatory variables, and computed standardized coefficients (β) across periods, and for each period, as depicted in Fig. 4. This revealed a strong positive impact of the happy expression and a negative impact of the fearful expression on approachability. The relationship between the influences of impressions and perceived facial expressions became more complicated in the later periods as shown
Table 3. Pearson’s Correlations Among Perceived Facial Expressions Regardless of Historical Periods (Upper in Each Cell) by Periods (Lower in Each Cell)

|       | Happy | Surprised | Fearful | Sad   | Angry |
|-------|-------|-----------|---------|-------|-------|
|       | Earlier Jomon | Later Jomon | Kofun | Earlier Jomon | Later Jomon | Kofun | Earlier Jomon | Later Jomon | Kofun | Earlier Jomon | Later Jomon | Kofun |
| Surprised | $r = -.399$ | $r = -.423$ | $r = -.227$ | $r = -.589$ | $r = -.386$ | $r = -.882$ | $r = .294$ | $r = -.509$ | $r = -.124$ | $r = -.428$ | $r = -.139$ | $r = -.277$ | $r = -.300$ | $r = .516$ |
|       | $p < .001$ | $p < .05$ | $p < .01$ | $p < .001$ | $p < .01$ | $p < .01$ | $p < .05$ | $p < .01$ | $p < .05$ | $p < .01$ | $p < .01$ | $p < .01$ | $p < .01$ | $p < .001$ |
| Fearful | $r = -.288$ | $r = -.394$ | $r = .391$ | $r = -.457$ | $r = -.051$ | $r = -.013$ | $r = -.296$ | $r = -.427$ | $r = -.562$ | $r = -.289$ | $r = -.487$ | $r = -.237$ | $r = -.118$ | $r = -.140$ | $r = -.123$ | $r = .335$ | $r = -.165$ | $r = -.139$ | $r = -.103$ |
|       | $p < .001$ | $p < .05$ | $p < .001$ | $p < .001$ | $p < .05$ | $p < .001$ | $p < .001$ | $p < .05$ | $p < .001$ | $p < .001$ | $p < .001$ | $p < .001$ | $p < .001$ | $p < .001$ | $p < .001$ | $p < .001$ | $p < .001$ | $p < .001$ | $p < .001$ |

Note. The first row: Pearson’s $r$; the second row: $p$-value.
in panel D of Fig. 4. This is true not only for approachability, but also for other impressions such as sexual dimorphism, well-made, and humanness.
DISCUSSION

The present study aimed to examine how modern human participants perceive the faces of Japanese prehistoric and protohistoric figures to obtain impressions and perceive facial expressions. For 131 figure faces, 75 Japanese participants rated how much each figure’s face could be evaluated for each of the five impressions (complexity, sexual dimorphism, humanness, well-made, and approachability), and selected the facial expression (happy, surprised, fearful, sad, or angry) they perceived from each face. We analyzed the relationships between the five impressions, between the five perceived facial expressions, and the influence on each of the five impressions. The results showed that figure faces could be made and perceived differently across different historical periods. We need to be careful not to overgeneralize, but the present study indicates that our spontaneous tendency to evaluate impressions from facial features is relatively robust and may be applied to the faces of figures that were made thousands of years ago.

First, we found that impressions, in ratings of humanness, well-made, and approachability, differed among the three periods. The faces of human-shaped *haniwa* in the Kofun period were seen as being more human, more well-made, and more approachable than the faces from the preceding Jomon periods. However, the impressions modern humans got from the figure faces in the Earlier and Later Jomon periods did not have a significant difference. The results have implications for archeological interpretations of the differential nature of the Jomon figures and the Kofun period *haniwa*. It is not likely that specific information or knowledge have biased the subjects’ evaluations. The participants in this study were limited to those who had no or little experience with studying archaeology, therefore, it must have been difficult for them to tell a *dogu* from a *haniwa*. While some of them may know that *haniwa* are related to burial mounds, judging from the way *haniwa* are displayed in museums, and the way they are illustrated and characterized, there is little cultural context in which the general public associates *haniwa* with grief. The figure faces from the Kofun period are not more complicated, yet they generate richer and more impressive feelings and elaborated expressions in modern humans than figures from earlier periods. This may be because human-shaped *haniwa* from the Kofun period represents actual people from various social positions, while *dogu* figures from the Jomon period may represent spiritual entities. Producing figures may be codifying the person in relation to other frames of reference and to other hierarchies of significance, and the features are only readily understood within the communities in which a social identity can be shared (Tagg, 1988).

Moreover, we found that various figure faces were evaluated on two fundamental impression dimensions, namely, quality and sexual dimorphism. Previous studies have indicated that two core dimensions—valence and dominance—of human facial impressions (Oosterhof & Todorov, 2008; Sutherland et al., 2013; Nakamura et al., 2020), have shown cross-cultural universality of psychological impression space between Western and Asian countries (Sutherland et al., 2018). In the present study, we named PC1 as “quality” because the loadings were very high in rated impressions of well-made, humanness, and approachability (the PCA loadings were over .800), and relatively high
in complexity (.588). Therefore, PC1 is a positive concept and may be similar in valence as a core dimension of impression suggested in previous studies. While previous studies suggested dominance as the second component, our results did not because the items to be rated were limited. Sexual dimorphism may be correlated with the concept of dominance, suggesting that the present study showed reasonable results, corresponding to previous studies using human face images. Matsumoto and Kawabata (2010) found that the majority of Jomon figure faces depicted by traced line drawings did not look feminine to modern participants, but also suggested that the faces exhibited a relationship in which the higher the tendency for sexual dimorphism, that is, whether they appeared more masculine or more feminine, the more human it appeared. In our present study, this finding was replicated, but interestingly, we found that humanness, well-made, and approachability increased during the Kofun period.

These impressions were derived from facial morphometric features. In the present study, we asked participants to select one of five facial expressions and used the number of times each of the five expressions was selected as a measure of the strength of the expression. In the case of real human beings, the facial morphometric shape varies owing to the movement of the facial muscles depending on the facial expression. It is perhaps not surprising that forming impressions from appearance and perceiving specific facial expressions often share facial morphometric properties that give rise to similar social cognition. For example, eyebrows are a powerful cue for both forming facial impressions and perceiving facial expressions. The position of eyebrows (i.e., low eyebrows vs. high eyebrows) is a particularly salient cue differentiating male and female faces (Campbell, 1996), and yields both dominant and submissive perceptions, and anger versus fearful expressions, respectively (Keating et al., 1977; Laser & Mathie, 1982). Moreover, the corrugator supercilii muscle region moves up in the case of angry and surprised facial expressions compared to happy and sad faces, whereas the zygomatic major muscle is contracted when smiling (Ekman, 1973). Since eyebrows are rarely seen on clay figures, the movement of the corrugator supercilii muscle can only be determined by the shape of the eyes. We can only consider in our results, based on the perceived facial expressions, that we can characterize the figure faces and further analyze the morphometric features. However, this will be an issue to be addressed in the future.

It is not clear whether the figure faces were intentionally made to express certain emotions at the time of production. Our findings, however, suggest that the perceived facial expressions and evaluated impressions by modern participants for each figure face showed consistent differences between the three periods. For centuries, it has been known that many emotional states are broadcasted to others through facial expression of emotion in many ways, especially in arts, including paintings, sculptures, theaters, movies, and even in literature where there is no direct visual cue. Recently, Cowen and Keltner (2020), conducted a computational analysis of apparent facial expressions portrayed in artwork created by members of cultures isolated from Western civilization and showed that facial expressions depicted in 63 sculptures from ancient America tend to accord with Western expectations for emotions that unfold in specific social contexts. In Ancient America, sculptures not only had basic emotions that we asked participants to
rate in the current study, but also complicated and mixed emotions predicted by current Westerners, including “pain” in torture, “determination/strain” in heavy lifting, “anger” in combat, “elation” in social touch, and “sadness” in defeat, thus supporting the universality of these expressions (Ekman, 1973). In our study, it appeared to be complicated not only within perceived facial expressions and within evaluated impressions, but also between perceived facial expressions and impressions. The characteristic features of figure faces changed over time as the social situation changed, as social complexity increased in later periods.

Despite some important findings in the present study, there are several limitations to consider. Although we examined different characteristics between the three periods, Earlier Jomon, Later Jomon, and Kofun, we could not consider regions where the figures were excavated. Facial and bodily morphometric features of figures might change through inter-group interactions and cultural transmission between different geographical locations. For example, facial and bodily representations of figures are different in central Japan and in the adjacent Kanto area, even though these two areas are not far apart. Thus, further examination of the appearance of figure faces in relation to social contexts in each geographic location is necessary.

Our results, as shown Table 4 and Fig. 4, indicated that the relationship between impressions and perceived expressions became more complex over the course of history. Increasing variability in the appearance of sexual dimorphism from the Kofun period may be explained from the point of what the figures represent; human-shaped haniwa depict actual persons of different gender and social positions, while Jomon dogu do not. Identifying the gender of anthropomorphic artifacts is challenging. It should be noted that participants’ identification is often misguided by judging hairstyles and other features by modern gender stereotypes. Thus, it will be necessary to experiment with the face alone, without surrounding information. Our gender categorization should also be critically examined. Some of the figures have clear sexual bodily features, however, we need to keep in mind that the concept of gender can be culturally diverse and can be nonbinary (Walley, 2018). Examination of the relationship between sexual dimorphism of the face and sexual features on the body for figures from different periods should provide a clearer understanding of the nature of the figures and related cognitive processes.

One of the most crucial methodological problems in cognitive archaeology is that we cannot directly observe how ancient people made artifacts and felt about them. Instead, as in the present study, we can carry out experimental studies to obtain empirical data on how people perceive anthropomorphic artifacts. Indeed, we examined the perception of impressions and facial expressions of ancient figures by modern people and designated differential impressions by historical periods. In particular, one of the interesting results is that the impacts from the perceived facial expressions to impressions became more complex over the course of history. This complexity of the perceived facial expressions of clay figures over historical periods may reflect the social situation of each historical period (e.g., Habu, 2004). However, to verify the validity of such a study, we need to generalize the findings by further cross-cultural investigations, in terms of both
| Complexity | Happy | Surprised | Fearful | Sad | Angry |
|------------|-------|-----------|---------|-----|-------|
| Earlier Jomon | Later Jomon | Kofun | Earlier Jomon | Later Jomon | Kofun | Earlier Jomon | Later Jomon | Kofun | Earlier Jomon | Later Jomon | Kofun |
| β = -.033 | β = -.165 | β = .02 | β = .058 | β = .063 |
| p = .710 | p = .059 | p = .985 | p = .507 | p = .478 |
| β = -.238 | β = .256 | β = -.038 | β = -.016 | β = -.281 | β = -.099 | β = .256 | β = -.265 | β = .068 | β = -.238 | β = -.041 | β = .134 | β = .260 | β = .127 | β = -.145 |
| p = .196 | p = .075 | p = .791 | p = .931 | p = .051 | p = .488 | p = .165 | p = .066 | p = .634 | p = .198 | p = .780 | p = .350 | p = .158 | p = .385 | p = .309 |
| Sexual dimorphism (Femininity) | | | | | | | | | | | | | | |
| β = .206 | β = .017 | β = -.173 | β = -.022 | β = -.197 |
| p < .05 | p = .848 | p < .05 | p = .803 | p < .05 |
| β = .259 | β = .148 | β = .233 | β = .008 | β = -.161 | β = -.171 | β = -.317 | β = .219 | β = -.390 | β = -.097 | β = .130 | β = -.094 | β = -.114 | β = -.494 | β = .044 |
| p = .159 | p = .309 | p = .100 | p = .965 | p = .268 | p = .230 | p = .082 | p = .130 | p < .001 | p = .605 | p = .373 | p = .513 | p = .542 | p < .001 | p = .759 |
| Humanness | | | | | | | | | | | | | | |
| β = -.223 | β = -.470 | β = -.041 | β = .453 | β = -.270 |
| p < .05 | p < .001 | p = .646 | p < .001 | p < .01 |
| β = .217 | β = .173 | β = .007 | β = -.135 | β = -.228 | β = -.444 | β = -.226 | β = -.343 | β = .044 | β = -.018 | β = -.068 | β = .321 | β = -.001 | β = .211 | β = -.322 |
| p = .242 | p = .235 | p = .960 | p = .468 | p = .115 | p < .001 | p = .222 | p < .05 | p = .761 | p = .923 | p = .645 | p < .05 | p = .997 | p = .145 | p < .05 |
| Well-made | | | | | | | | | | | | | | |
| β = .200 | β = -.397 | β = -.080 | β = .319 | β = -.160 |
| p < .05 | p < .001 | p = .364 | p < .001 | p < .001 |
| β = -.085 | β = .234 | β = .097 | β = -.075 | β = -.222 | β = -.352 | β = -.067 | β = -.367 | β = -.054 | β = -.207 | β = -.119 | β = .178 | β = .261 | β = .182 | β = -.271 |
| p = .651 | p = .105 | p = .499 | p = .687 | p = .125 | p < .05 | p = .720 | p < .01 | p = .706 | p = .263 | p = .416 | p = .211 | p = .156 | p = .212 | p = .054 |
| Approachability | | | | | | | | | | | | | | |
| β = .530 | β = -.319 | β = -.332 | β = .216 | β = -.467 |
| p < .001 | p < .001 | p < .001 | p < .001 | p < .001 |
| β = .460 | β = .602 | β = .496 | β = .087 | β = -.090 | β = -.315 | β = -.528 | β = -.486 | β = -.447 | β = -.039 | β = -.213 | β = -.086 | β = -.336 | β = -.249 | β = .532 |
| p < .01 | p < .001 | p < .001 | p = .643 | p = .540 | p < .05 | p < .01 | p < .001 | p < .001 | p = .836 | p = .142 | p = .548 | p = .064 | p = .084 | p < .001 |

Note. The first row: standardized correlations (β); the second row: p-value of each regression analysis.
materials for stimuli and participants. Through this research, we hope to clarify the universal human cognition related to the production and perception of anthropomorphic artifacts and develop a methodology for inferring culturally specific meanings and functions of the figures in human history. The findings in this study were based on the participants’ perceptions of figure faces in photographs. Although the results are consistent with those of our former study using line drawings at some points (Matsumoto & Kawabata, 2010), we consider that our procedure has improved as traced drawings are very different from our natural perception. In addition to the issue of validity of cross-cultural perspectives, it would also be important to examine the influence of knowledge and familiarity with archaeological materials on the impressions of the faces of clay figures. For example, those who know that haniwa was used for the burial of the dead might perceive sadness in the expressions. Unfortunately, none of the participants in this experiment was familiar with archaeology, thus, we would like to make a comparison between experts and amateurs in a future study.

A further limitation of the present study that needs to be mentioned is the issue of the photographing settings of the facial images of the clay figures. Especially, attached shadows on faces may affect the emotion recognition. In fact, a previous study showed that the manipulation of shadows on Noh masks could alter emotional facial expressions, and that the “happy” evaluation can be changed as a function of shadow inclination of Noh masks (Kawai et al., 2013). Moreover, Noh masks can induce a variety of perceived facial expressions with changes in head orientation as well as human faces (Lyons et al., 2000). In our present study, the images of clay figures presented to participants were scanned from books and obtained from the online collection of a museum; there is no homogeneity in photographing settings including image quality, lighting, and exact facial orientation between images. Future studies should consider these photographing settings in as controlled a manner as possible. In spite of that, it is interesting to find out statistically in this study, that the impressions and perceived facial expressions of clay figures differ by historical periods.

In conclusion, our study shows that impressions of Japanese ancient figure faces were evaluated on the dimensions of valence and sexual dimorphism, and that various facial expressions derived from different periods can be quantitatively examined. This approach may lead to a deeper understanding of the facial features that drive perceived facial expressions and facial impressions.

AUTHOR’S CONTRIBUTION

All the authors conceived and designed the experiments. Data collection was performed by H.K. and R.S. The analyses were performed by H.K. The manuscript was drafted by H.K., N.M., and T.M. All authors have provided critical revisions and approved the final version of the manuscript.
CONFLICT OF INTEREST

There are no conflicts of interest to be declared.

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*(Manuscript received 27 May, 2021; Revision accepted 19 August, 2021; Released online in J-STAGE as advance publication 4 November, 2021)*