# When handicraft experts face novelty:
# Effects of shape and wheel familiarity on individual and community standardization of ceramic vessels

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## Introduction

Expertise in motor skill can be considered as the “ultimate” stage of learning (Biryukova and Bril, 2008), attained only after many years of extensive practice (Grossman, 1959; Ericsson and Lehmann 1996). At this stage, expert craftsmen almost flawlessly adapt their movements to the task constraints (Bernstein 1967; Bril et al. 2010). Expert stone knappers, for example, precisely control the vector of the final velocity of the hammerhead, crucial in detaching a particular flake and, consequently, for the shape of the final product (Biryukova and Bril 2008). Because it is this mastering of constraints that allows an expert craftsman to produce a high-quality artifact, expertise is surely visible at the level of the individual specimen produced but even more so in the ability to reliably reproduce the same artifact, that is, in the production of standardized assemblages of artifacts. By the same token, expertise in sport skills is undoubtedly characterized by an athlete’s outstanding performance on a given occasion, but more broadly by her/his ability to achieve such high-level performance repeatedly (Bootsma and Van Wieringen 1990; Sevrez et al. 2009, 2012). Indeed, Guthrie (1952) defined skill as consisting “in the ability to bring about some end result with maximum certainty and minimum outlay of energy, or of time and energy” (p. 136).

However, standardization of assemblages of artifacts may not only be observed at the level of the individual craftsman but also at the level of the community of practice (Lave 1991). While expertise alone can account for the former, the latter depends on additional factors such as production organization (Costin and Hagstrum 1995) and social conformism (Moscovici and Abric 1984). Within a community of practice, the proximity between expert potters would, over time, lead them to throw vessels that fit into single shapes (i.e., standardized assemblages). In this sense, these shapes represent *emblemic markers* of the community of practice (Eerkens and Bettinger 2008).

Moreover, expert craftsmen typically belong to a lineage within a handicraft tradition. Because they acquired their skill during apprenticeship(s) in the presence of mentor(s), who themselves were at some point apprentices of other mentors, their skill has been shaped by the cultural transmission that occurs over generations (Ingold 2001). Ethnoarchaeological studies have extensively described different handicraft traditions, as the Indian stone knapping tradition in Khambhat (e.g., Kenoyer et al. 1991; Roux and Bril 2005; Roux 2000) or the Kalinga pottery tradition in Philippines (e.g., Longacre et al. 1988; Longacre and Longacre 1991; Stark et al. 2000; Stark 1991). A given handicraft tradition is distinguishable by specific techniques of production (often associated with specific tools) and by specific artifact shapes. These techniques and shapes are thus familiar to the craftsmen belonging to this tradition. Importantly, over time this familiar context of production is susceptible to change. Indeed, craft traditions are not frozen cultural entities but rather sociotechnical aggregates that evolve, following the socio-economic changes of societies (Gosselain 2000). Changes in shape or technique can occur through innovation within a community or can arise from borrowing between communities. For example, in northern India the modification of the traditional Prajapati (Hindu) “jajmani” barter system has led Multani Kumhar (Muslim) potters to adopt some of the Prajapati traditional shapes (Roux 2013). Because it allowed a faster production of water storage jars, Haalpulaar’en women potters in Senegal have been reported to have borrowed the more efficient coiling technique of the Soninke women potters (Gelbert 2002).

In the present contribution we evaluate how craftsmen that are experts in the production of familiar shapes using familiar tools adapt to the production of new, unfamiliar shapes and to the use of new, unfamiliar tools. To this end, we conducted field experiments in the Uttar Pradesh region of northern India, including both the Prajapati and Multani Kumhar potting communities. We analyzed the production of adult expert potters from both communities when throwing vessels of familiar vs. unfamiliar shapes, using familiar vs.

unfamiliar wheels. This experimental approach to expertise in the face of novelty opens the road to a principled appreciation of innovation within archaeological analyses. Novelty in pottery –and how it may be detected in archaeological assemblages– has been addressed in earlier research but such studies have generally focused on novices, that is, most often children or adolescents who first learn a task (Creese 2012; Crown 2001, 2007; Wallaert-Pêtre 2001). However, learning is not restricted to novices nor to a particular age, but is a process that operates over the whole life-span. Innovation by expert craftsmen was addressed by Arnold (2012) in a study of a particular type of shell bead within a large archaeological assemblage. In this approach the characteristics of beads rejected or abandoned before completion were used to distinguish the errors of novices from the mistakes of skilled craftsmen experimenting with new bead forms. In the present contribution we assessed the consistency of the assemblages produced by expert Prajapati and Multani Kumhar potters, at the level of the individual potter and at the level of the two communities of potters. Rather than focusing on particular functional or geometrical characteristics of the vessels thrown, we evaluated the variability of the assemblages produced. In so doing, we asked whether novelty affected the standardization of the different types of vessel thrown, a product characteristic widely used and debated in the (ethno)archaeological literature for its relation with production organization (e.g., Longacre et al. 1988; Arnold 1991; Costin and Hagstrum 1995; Arnold 2000; Roux 2003; Arthur 2014).

## Materials and Methods

### *Experimental setting*

Eight Indian expert potters participated in the study: four Prajapati potters (group Pr) and four Multani Kumhar potters (group MK). The four Prajapati potters are referred to as Pr1 to Pr4; the four Multani potters are referred to as MK1 to MK4. These two groups of potters belong respectively to Hindu and Muslim communities living in the region of Uttar Pradesh, often in the same villages. The participants were all over 25 years of age and had a minimum of ten years of wheel-throwing experience (Mean ± SD, Pr: 24.3 ± 14.5 yrs and MK: 18.3 ± 7.3 yrs). In northern India the pottery handicraft is a traditional activity: the skill is learnt within endogamous castes that produce standardized traditional objects in mass production (Kramer 1997; Roux and Corbetta 1990; Saraswati and Behura 1964). Over the last few decades, the trading networks of the two communities have become undifferentiated and, as a consequence, the respective productions of the two communities tend to be the same kinds of object (Roux 2013). Although the repertories of the shapes produced are broadly shared by the two groups, the wheels used are community-specific and a non-borrowing phenomenon has been reported (Roux 2013). The Pr potters use a hand-operated, high-inertia stick-wheel (Fig. 1, top panel), while the MK potters use a foot-operated, low-inertia kick-wheel (Fig. 1, bottom panel). The same soft gray clay is used by the two communities.

***** Fig. 1 about here *****

A standardized experiment was set up in two pottery workshops –one Prajapati and one Multani– in the same village of Jahanjirabad. Potters were initially asked to produce two different assemblages. The first assemblage (denoted Experiment 1) included five familiar shapes, referred to as Money-Bank (A), Handiya (B), Kullar (C), Handi (D), and Kulfi (E), respectively (see Table 1). These familiar shapes were produced in the usual conditions of practice, using self-chosen quantities of clay. The four Prajapati potters (Pr1, Pr2, Pr3, and Pr4) produced shapes A, B, and C, while three Multani potters (MK1, MK2, and MK4) produced shapes A, D, and E. Each potter produced five specimens of the same shape. In this first experiment, potters relied on their practical experience of the shape to be produced; no visual model was presented.

***** Table 1 about here *****

The second assemblage (denoted Experiment 2) involved four unfamiliar shapes, referred to as cylinder (C1), bowl (C2), sphere (C3), and vase (C4), respectively. These unfamiliar shapes were produced using two predetermined[1] quantities of clay, 0.75 kg (A) and 2.25 kg (B), for a total of eight conditions (C1A, C1B, C2A, C2B, C3A, 3B, C4A, and C4B; see Table 2). Models of the four unfamiliar shapes were presented by 2D-drawings that were displayed on the wall in front of the potter over the full duration of the experiment. By using such 2D-drawings the models presented the four shapes but did not provide any indication of scale or the absolute dimensions to be produced: participants were simply instructed to faithfully reproduce the model shape and to throw vessels with the thinnest walls possible using the amount of clay provided (0.75 or 2.25 kg). Each potter (four Pr and four MK) produced five specimens of each of the four shapes with each mass of clay. The participants had no prior experience in the production of the unfamiliar shapes. They only briefly practiced the task the day before the experiment, producing one or two vessels under each condition.

***** Table 2 about here *****

[1] The use of predetermined quantities of clay allows comparisons with the results of our earlier study on expert French potters who demonstrated mechanical optimization when reproducing the same model shapes with the same quantities of clay (Gandon et al. 2011). Using two different quantities of clay ensured that for each model shape potters threw vessels of different size.

A week after the production of the two assemblages potters were again asked to produce the unfamiliar shape assemblage, this time using an unfamiliar wheel (denoted Experiment 3): three Pradjaptati potters (Pr1, Pr2, and Pr4) agreed to use the kick-wheel in the MK-workshop and three Multani potters (MK1, MK3, and MK4) agreed to use the stick-wheel in the Pr-workshop. In this third experiment, potters produced four specimens for each of the eight conditions (Table 2). Models were displayed as in Experiment 2. Unfortunately, because of time constraints imposed on the fieldwork, we were unable to set up an additional experiment with potters producing familiar shapes with unusual wheels.

*Data recording and analysis*

The methodology of the study was the same for the three experiments referred to as Experiment 1 (familiar shapes produced with familiar wheels), Experiment 2 (unfamiliar shapes produced with familiar wheels), and Experiment 3 (unfamiliar shapes produced with unfamiliar wheels). Using a Panasonic NV-GS320 camcorder all experimental sessions were filmed under standardized conditions: the camera was fixed on a tripod with lens orientation centered on the vertical rotation axis of the wheel. The camera was positioned at a height of 30 cm above the level of the wheel at a horizontal distance of 4 to 6 m. The lower edge of the video scene was aligned with the center of the wheel. The zoom was adapted to fully cover a 36-cm high by 42-cm wide calibration object (inverted T-shape) placed on the wheel. The image of each vessel immediately after throwing (when the vessel was still on the wheel) was extracted from the films for further analysis. These 2D images adequately captured the consistently axisymmetric shape of the vessels. From the images we extracted the 2D coordinates of the cross-sectional profiles by tracing them out on a Cintiq 21UX Wacom® tablet. After calibration (transforming image pixels to cm using the digitized coordinates of the calibration object), the profile coordinates were re-sampled to generate an equal number of (256) points at regular height intervals. After smoothing with a low-pass filter the coordinates of each vessel were normalized by the vessel's height. This method provided dimensionless profiles, allowing analysis of the shapes of the vessels independently of their size. The degree of standardization of the vessels produced in each condition was assessed (i) at the level of the individual potter and (ii) at the level of the two communities of potters (i.e., groups Pr and MK). Individual, within-potter standardization and community (within-group) standardization measures were obtained for each condition by computing the standard deviation (SD) over the different specimens (produced by an individual potter of by the group of potters) of the profile widths at each of the 256 normalized height points. The mean of these 256 SDs was taken as a global indicator of between-vessel variations in shape. The lower this global shape variability (GSV), the higher the standardization achieved.

## Results

### *Individual standardization*

Figure 2 presents –for each potter separately– the quantified level (GSV) of individual standardization of the profiles of the vessels produced in each condition of the three experiments. In order to visualize how this GSV measure relates to variations in shape, in Figure 3 we provide some representative examples of the profiles of the different specimens produced and the corresponding GSV values.

Inspection of Figure 2 revealed a consistently high level of individual standardization for the familiar shapes (Exp. 1): GSV was always smaller than 0.03, for a grand average over shapes and potters of 0.017. Throwing unfamiliar shapes on usual wheels (Exp. 2) gave rise to lower levels of individual standardization, with a grand average GSV of 0.039. This global shape variability for unfamiliar shapes was twice as large as that observed for the familiar shapes of Exp. 1. GSV varied over different shapes, reaching on average 0.021 for the cylinder (C1), 0.065 for the bowl (C2), 0.029 for the sphere (C3) and 0.041 for the vase (C4). The relatively high level of individual standardization for the unfamiliar cylinder (C1) and, to a lesser extent, sphere (C3) shapes was likely due to the fact that the straight and spherical profiles did not allow a high degree of variability in shape to emerge. The additional difficulty of throwing unfamiliar shapes on unfamiliar wheels (Exp. 3) did not give rise to a further decline in the level of individual standardization. The grand average GSV was 0.041, with averages of 0.020 for the cylinder (C1), 0.071 for the bowl (C2), 0.028 for the sphere (C3) and 0.043 for the vase (C4).

In order to confirm these observations, the GSVs observed in Exp. 2 and 3 were statistically analyzed using Analysis of Variance with factors Group (Pr, MK), Experiment (2, 3), Shape (C1, C2, C3, C4) and Mass (A, B) and repeated measures on the last three factors. This analysis confirmed that neither using different wheels nor using different clay masses affected GSV (factors Experiment and Mass: $F$s $< 1$, *ns*). Moreover, it failed to reveal an effect of Group ($F < 1$, *ns*), suggesting that Prajapati and Multani potters had comparable levels of individual standardization. As expected from visual inspection of Fig. 2, standardization differed over shapes ($F(3, 12) = 10.2$, $p < 0.001$), with the bowl (C2) demonstrating larger GSV than the other three shapes. The vase (C4) tended to be more variable than the cylinder (C1), but could not statistically be distinguished from the sphere (C3).

***** Figures 2 and 3 about here *****

*Community standardization*

Figure 4 presents the level of standardization within the Pr and MK groups of the vessels produced in each condition of the three experiments. Figures 5 and 6 provide, for the familiar (Exp. 1) and unfamiliar (Exp. 2) shapes respectively, the profiles of vessels thrown by the Pr and MK potters separately, as well as the corresponding GSV values. Inspection of Figure 4 revealed that the familiar shapes were well standardized within the communities: GSV for the Money-Bank (A) was 0.020 and 0.027 for the Pr and MK groups, respectively. The other shapes thrown also demonstrated relatively low within-group variation: Pr B: 0.026 and Pr C: 0.022; MK D: 0.024 and MK E: 0.035. Overall, for the familiar shapes the level of within-group standardization (Fig. 4) was close to the level of within-potter standardization (Fig. 2) and comparable across the two groups.

A different picture emerged for the unfamiliar shapes thrown on familiar wheels (Exp. 2). Within-group standardization was considerably lower, with average GSV reaching 0.071and 0.069 for the Pr and MK groups, respectively. While no clear effect of clay mass appeared, the cylinder (C1: Pr 0.027; MK 0.030) revealed the highest level of community standardization, followed by the sphere (C3: Pr 0.050; MK 0.045), vase (C4: Pr 0.084; MK 0.050) and bowl (C2: Pr: 0.124; MK: 0.151). In fact, except for the simple cylinder shape, the community standardization for unfamiliar shapes (Exp. 2) was systematically lower than the community standardization for familiar shapes (Exp. 1). The high within-group standardization of the familiar shapes is particularly salient when their profiles (Fig. 5) are compared to the unfamiliar shape profiles (Fig. 6). Hence, even if concrete models were displayed (Exp. 2 and 3), significant between-potter differences appeared in the assemblages of unfamiliar shapes.

As observed for the individual standardization, throwing unfamiliar shapes using unfamiliar wheels (Exp. 3) did not give rise to a further decline in community standardization, with the Pr group demonstrating an average GSV of 0.057 and the MK group an average of 0.067. The order of shapes, from highest to lowest within-group standardization was the same as in Exp. 2: C1 (Pr: 0.023; MK 0.032), C3 (Pr: 0.035; MK: 0.063), C4 (Pr: 0.066; MK: 0.052), C2 (Pr: 0.103: MK: 0.121).

***** Figures 4, 5 and 6 about here *****

## Discussion

Becoming an expert craftsman requires many years of extensive practice (Roux and Corbetta 1989; Ericsson and Lehmann 1996). In the present study we examined assemblages of vessels thrown by highly-experienced adult Prajapati and Multani potters whose workshops are characterized by the intensive production of traditional objects. As expected (Roux 2003), the remarkable level of expertise of these professional potters and their contexts of intensive production (Roux 2003 demontre le lien entre intensite de production et standardisation) gave rise to highly standardized assemblages when they threw familiar shapes using their familiar tools (high-inertia stick wheel for the Pr potters and low-inertia kick wheel for the MK potters). The first important result of our study was that the strong degree of standardization observed at the level of the individual potter (Fig. 3) was also observed at the level of the (Pr and MK) communities of potters (Fig. 5). While the mastering of the task constraints that characterizes expertise (Bernstein 1967; Bootsma and Van Wieringen 1990; Biryukova and Bril 2008; Sevrez et al. 2009, 2012; Bril et al. 2010) can explain the degree of individual (within-potter) standardization, the observed community (within-group) standardization indicates that social and socio-economical processes act as vectors of convergence at the level of the community (Moscovici and Abric 1984; Costin and Hagstrum 1995). Interestingly, although the level of within-group standardization of the familiar objects was comparable across the Pr and MK communities, this did not imply that they produced the exact same shapes. As can be seen from Figure 5 (left panels) the Money-Banks (shape A) thrown by the two communities revealed strong resemblance but no full overlap: the shapes produced by the MK potters were for instance slightly wider than those produced by the Pr potters.

The assessment of the levels of individual and community standardizations in throwing familiar shapes with familiar tools (Experiment 1) allowed us to evaluate how our expert potters dealt with novelty. We first discuss the effects of throwing unfamiliar shapes while using familiar tools (Experiment 2) before addressing the effects of using unfamiliar wheels to throw the unfamiliar shapes (Experiment 3).

Even though the unfamiliar shapes to be thrown were presented as visual models which the potters could consult as often as they wanted, the novelty of the shapes to be thrown provoked a noticeable decrease in the degree of standardization of the assemblages of the individual potters. In both communities within-potter shape consistency was particularly affected when they attempted to reproduce the bowl (C2) and vase (C4) models. The fact that this was less (although still to a certain extent) the case for the cylinder (C1) and sphere (C3) models most likely resulted from the geometrical simplicity of the latter shapes. Overall we conclude that the novelty of the shape constraints imposed in Experiment 2 affected the expert potters' performance. This result confirms that expertise is not a general ability but domain-specific (Ericsson and Lehmann 1996). Hence, rather than considering the potters who participated in the present experiments as general wheel-throwing experts, they should in fact be considered as experts in throwing their familiar shapes under their usual conditions of practice. Unfortunately, the present study does not allow us to determine the time necessary for the experienced potters to integrate new shapes into their skilled repertoire. However, the low level of within-potter standardization (Fig. 3) and *a forteriori* of within-community standardization (Fig. 6) observed for certain models indicates that such an appropriation can require a considerable amount of practice. Traces of such practice on difficult novel shapes by experienced craftsmen may therefore be expected to be detectable in archaeological assemblages, much like the traces of novice apprenticeships which have already been identified (Arnold 2012; Creese 2012; Crown 2001, 2007; Wallaert-Pêtre 2001). In the case of proficient craftsmen it would be the variability over repeated specimens of a particular shape and the consistency over repeated specimens of another shape which would characterize the expert facing novelty.

The Prajapati and Multani potting communities traditionally use different wheels: the former use a hand-driven high-inertia stick wheel while the latter use a foot-driven low-inertia kick wheel. Notwithstanding the geographical proximity of the two communities within the village of Jahanjirabad, borrowing of the other community's wheel has not been observed (Roux 2013). Nevertheless, for the purposes of the third experiment (unfamiliar shapes on unfamiliar wheels) we were able to convince three Pr potters to come to the MK workshop and throw the unfamiliar shapes (that they had thrown on their own stick wheel a week before) on the Multani kick wheel. Similarly, we were able to convince three MK potters to do the same on the kick wheel at the Pr workshop. Surprisingly, throwing with an unfamiliar wheel did not lead to a further decrease in standardization, either for the Pr potters or for the MK potters (see Fig. 2 and 4). Even though the mode of activation of the stick and kick wheels was profoundly different (and difficult for the visiting potters to adopt, notably for the MK potters adopting the stick-wheel), once the wheel was turning they were apparently able to transfer their skill to the new situation. Note that in both cases the wheels allowed the potter to freely use his hands on a lump of clay centered on a horizontal plateau rotating at speeds varying between 50 and 150 rotations/min. We therefore assume that potters transferred their usual manual gestures to the new wheels (optionnel mais aide a faire le lien avec la phrase suivante je trouve). Interestingly, Gelbert (2002) noted that the borrowing of a new coiling technique (implying new tools) did not require much training when craftswomen could transfer their usual fashioning gestures to the new technique. On the contrary, the need for unusual gestures gave rise to a substantial training period that also required a close contact between the practitioners of the two communities (Gelbert 2002).

The finding that neither in Experiment 2 (unfamiliar shapes thrown with familiar wheels) nor in Experiment 3 (unfamiliar shapes thrown with unfamiliar wheels) the mass of clay used to throw the vessels affected the degree of standardization of assemblages may appear surprising at first. As reported earlier (Gandon et al 2011, 2013), in the present study the use of larger quantities of clay resulted in larger vessels. Because larger vessels are more difficult to throw (Roux and Corbetta 1990) one might have expected a lesser degree of standardization. However, part of the difficulty of throwing larger vessels resides in the stronger mechanical constraints that they engender (see Gandon et al. 2011) which in turn limits the range of possible variations in shape. Within this framework it is also interesting to note that the shapes that were produced with the lowest degree of standardization, the bowl (C2 and vase (C4), were also those that have been demonstrated to deviate most from the model shapes provided (Gandon et al 2014), probably for reasons of mechanical optimization (Gandon et al. 2011).

Overall, our results indicate that when highly-experienced potters throw familiar shapes using their familiar tools the assemblages produced are highly (strongly? Or significantly? Pour ne pas repeter ‘highly’?...) standardized, not only at the level of the individual potter but also at the level of the potting community. While under familiar conditions expertise thus gives rise to standardized assemblages, one should be careful in inverting the relation by inferring the degree of expertise from the degree of standardization observed in archaeological assemblages. Indeed, previous studies have demonstrated that this relation depends on several socio-economic factors as the organization of production and selling (cf., Longacre et al. 1988; Arnold 1991; Costin and Hagstrum 1995; Arnold 2000; Roux 2003; Arthur 2014). Moreover, notwithstanding the "law of practice" (Newell and Rosenbloom 1981), the relation between the amount of time and effort dedicated to learning and the level of skill demonstrated is not as straightforward as might be expected (d'apres ce que je comprends, la vous dites que la quantite de pratique n'est pas en lien direct avec le niveau d'expertise atteint mais je ne vois pas trop le lien avec ce qui vient ensuite. Ne faudrait-il pas dire plutot qq chose comme; 'enfin, la conclusion principale de cette etude concerne l'interpretation de la variabilite sur les assemblages ceramiques.' Et c'est ce que vs presentez juste apres : habituellement on attribue la variabilite aux apprentis mais elle peut aussi etre la signature d'experts innovant). Apprentices, most often children and adolescents, learning a new crafting task reveal a significant degree of variability in their productions (Creese 2012; Crown 2001, 2007; Wallaert-Pêtre 2001). However, as demonstrated by the present results, a lesser degree of standardization need not indicate a lack of skill but may also result from highly-experienced craftsmen experimenting with new shapes and tools (also see Arnold 2012). Handicraft learning is thus not be limited to apprenticeships but should be expanded to the life span to include innovation.

## Conclusion

When throwing familiar shapes using familiar wheels expert Prajapati and Multani potters revealed a high degree of standardization in the assemblages produced, both at the level of the individual potter and at the level of their respective communities. Novelty, in the form of throwing unfamiliar shapes, considerably affected the degree of standardization, especially for the more difficult shapes. Hence, novelty brought about by expert innovation within a community or by borrowing from outside the community may be detected in archaeological assemblages by the coexistence of large quantities of highly standardized artifacts of one type and smaller quantities of less standardized artifacts of another type. However, throwing the unfamiliar forms on unfamiliar wheels (stick or kick wheels "borrowed" from the other community) did not give rise to additional markers of novelty in the assemblages produced. Thus, at least part of the expert potters' skill can be transferred from their usual conditions of practice to new, unfamiliar conditions without leaving observable traces in the artifacts produced.

## Acknowledgments

We are grateful to Leore Grosman for her encouragement and writing assistance; Avshalom Karasik for his help with data processing and Valentine Roux for her support in organizing the field work and for many useful discussions relating to this work. This study was funded by Aix-Marseille University and the Fyssen foundation.

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# Figure captions

**Figure 1.** The two common wheels used in northern India. Top panel: the high inertia stick-wheel used by the Prajapati potters. Bottom panel: the low-inertia kick-wheel used by the Multani potters. Drawings are adapted from Orton et al. (1993). The two wheels evoke distinct body positions: For the stick-wheel potters typically squat (sometimes they use a low stool), while for the kick-wheel potters sit.

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**Figure 2.** Individual standardization as captured by global shape variability (GSV) of the profiles of the vessels produced in the three experiments. Exp. 1 (black) A: Money-Bank, B: Handiya, C: Kullar, D: Handi, E: Kulfi. Exp. 2 (white) and Exp. 3 (gray) C1: cylinder, C2 bowl, C3: sphere, C4 vase. For Exp. 2 and 3 A and B indicate 0.75 and 2.25 kg clay masses.

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**Figure 3.** Examples of the height-normalized cross-sectional profiles of the vessels produced in the three experiments by the Prajapati (Pr) and Multani (MK) potters. Each panel represents all the specimens of a particular conditions produced by one potter. The black vertical bar represents the corresponding GSV values. The left two columns present examples of low individual standardization while the right two columns present examples of high individual standardization. Conditions are coded as in Fig. 2.

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**Figure 4.** Prajapati (top row) and Multani (bottom row) community standardization as captured by global shape variability (GSV) of the profiles of the vessels produced in the three experiments. Exp. 1 (black) A: Money-Bank, B: Handiya, C: Kullar, D: Handi, E: Kulfi. Exp. 2 (white) and Exp. 3 (gray) C1: cylinder, C2 bowl, C3: sphere, C4 vase. For Exp. 2 and 3 A and B indicate 0.75 and 2.25 kg clay masses

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**Figure 5.** Height normalized cross-sectional profiles of the familiar shapes produced by the potters of the Prajapati (top row) and Multani (bottom row) communities in Experiment 1. Individual potters are represented in different colors. Shape A = Money-Bank, shape B = Handiya, shape C = Kullar, shape D = Handi, and shape E = Kulfi.

*Web version: color*

**Figure 5.** Height normalized cross-sectional profiles of the familiar shapes produced by the potters of the Prajapati (top row) and Multani (bottom row) communities in Experiment 1. Individual potters are represented in different shades of gray. Shape A = Money-Bank, shape B = Handiya, shape C = Kullar, shape D = Handi, and shape E = Kulfi.

*Print version: black & white*

**Figure 6.** Height normalized cross-sectional profiles of the unfamiliar shapes produced by the potters of the Prajapati (top rows) and Multani (bottom rows) communities in Experiment 2. Individual potters are represented in different colors. C1: cylinder, C2: bowl, C3: sphere, C4: vase. A and B indicate 0.75 and 2.25 kg clay masses.

*Web version: color*

**Figure 6.** Height normalized cross-sectional profiles of the unfamiliar shapes produced by the potters of the Prajapati (top rows) and Multani (bottom rows) communities in Experiment 2. Individual potters are represented in different shades of gray. C1: cylinder, C2: bowl, C3: sphere, C4: vase. A and B indicate 0.75 and 2.25 kg clay masses.

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## Table captions

**Table 1.** The five familiar shapes produced with self-chosen quantities of clay. From left to right: Money-Bank (A), Handiya (B), Kullar (C), Handi (D), and Kulfi (E). Four Prajapati potters (noted in red) reproduced shapes A, B, and C; three Multani potters (noted in green) reproduced shapes A, D, and E.

*Web version: color*

**Table 1.** The five familiar shapes produced with self-chosen quantities of clay. From left to right: Money-Bank (A), Handiya (B), Kullar (C), Handi (D), and Kulfi (E). Four Prajapati potters reproduced shapes A, B, and C; three Multani potters reproduced shapes A, D, and E.

*Print version: black & white*

**Table 2.** The four unfamiliar shapes produced with 0.75 kg and 2.25 kg masses of clay by Prajapati and Multani potters. C1: cylinder, C2: bowl, C3: sphere, C4: vase.

*Web version: color and print version: black & white*