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1 Cultural transmission and perception of vessel shapes among Hebron potters

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30 1. Introduction

31

32 Among the processes underlying human cultural transmission, fidelity copying (action
33 imitation) has been frequently presented as particularly important (Miton and Charbonneau,
34 2018, Lewis and Laland, 2012; Tennie et al., 2009; Tomasello, 1999). Yet, this process has
35 been recently challenged by empirical evidence from wheel-throwing pottery. Gandon et al.
36 (2020a) showed that Nepalese potters used cultural, cross-cultural and individual-specific
37 hand positions (repertoires and sequences) for the fashioning of familiar pottery types. Their
38 results confirmed that the potters' skills are imprinted by the cultural context in which they
39 have been learnt although these skills are not determined by a cultural model copied during
40 learning (Bril, 2018). A complementary study with Indian Prajapati and Indian Multani
41 potters tracked the vessel morphogenesis defined as the potter-induced morphological
42 changes in the clay body, from its initial pre-formed stage following centring and opening
43 operations, up to the moment that the final form is reached (Gandon et al., 2020b). Results
44 showed that, in both Prajapati and Multani groups, potters reliably followed individual-
45 specific vessel morphogenesis towards culturally homogenous vessel types. This
46 demonstrates that, at the level of the elementary fashioning gestures, individual learning
47 rather than simple model copying of elders' gestures is required for the acquisition of a
48 complex motor skill such as throwing pottery.

49

50 This is not, of course, to say that cultural transmission plays a minor role in
51 handicrafts. As highly specialized motor behaviours, handicrafts are unlikely to be acquired
52 on the basis of individual learning alone (Boyd et al., 2011; Bril, 2002). In traditional craft
53 workshops, novices learn by deliberate practicing in socially structured environments (with
54 the presence of typical tools and materials, finished vessels, etc.) under the guidance of elders
55 (Boyer and Bril, 2001; Bril, 1986; Crown, 2014; Lave and Wenger, 1991; Minar and Crown,
56 2001; Rogoff, 1995; Roux and Corbetta, 1989). The social channeling provided by the -
57 material and human - environments educates the novices' attention towards the useful
58 sensorimotor information for achieving the task (Gibson, 1979). This social bias influencing
59 the learning process of novices' skills corresponds to the cultural transmission of handicrafts
60 and leads to culturally inherited traits (Ingold, 2001a, 2001b). As explained by Bril (2015),
61 the elders and the socially structured environment simply organize the novices' experience,
62 while the novices are alone responsible for acquiring a particular skill. The culturally

63 inherited traits are not *given* through the transmission, they *develop* through the socially
64 mediated individual learning. The skills of craftsmen are therefore likely to contain both
65 cultural traits inherited from the cultural transmission (i.e. social biased traits) and individual
66 traits resulting from the individual learning, as illustrated in the study with the Nepalese
67 potters (Gandon et al., 2020a). Accounts of handicraft apprenticeship as a process involving
68 both individual learning and cultural transmission is essential to recognize that craftsmen
69 behaviors - and their subsequent object traits - can be modified through their transmission
70 across generations (Mesoudi, 2017; Wiessner, 1983).

71

72 While craft apprenticeship can be understood as socially mediated individual learning,
73 the ensuing prediction of individual and cultural object traits within craft communities has so
74 far not been investigated in traditions such as pottery throwing. A major issue remains in that
75 we do not know to what extent the objects produced by learners vary from those of their
76 trainers. Previous experimental fieldwork with modern Indian and Nepalese potters indicated
77 subtle individual and social group signatures on ceramic shapes (Gandon et al., 2018; Harush
78 et al., 2020; Roux and Karasik, 2018). Yet, there is still a lack of systematic analysis of object
79 variations among members of crafting families where the transmission takes place. This lack
80 of knowledge limits the understanding of cultural transmission and evolution, thus depriving
81 archaeologists of a valuable framework for interpreting the variability of ancient objects and
82 their temporal evolution. The first goal of this study is to fill up this gap by measuring the
83 vessel shape variation among members of a pottery-making community including different
84 families.

85

86 A related question concerns the visual perception by the craftsmen of the variations in
87 the shape of ceramics. As acknowledged by Crown, it is evident that potters perceive the
88 shapes of the distinctive vessel types they produce: "*The potter then forms the vessel before
89 the clay dries out. These steps require knowledge of culturally appropriate vessel shapes and
90 proportions and the ability to perceive or measure these.*" (Crown, 2014: 74). But visually
91 perceiving (without using any kind of measurement tool) the barely discernible variations in
92 same-type vessel assemblages is less evident. If craftsmen do not identify the slight
93 differences between the vessels produced by distinct members of their community, then the
94 process of selection of certain shape variants would not be guided by the craftsmen choice,
95 and the evolution of ceramic shapes would be caused by other factors. Preliminary results

96 from five Nepalese potters indicated the opposite; certain participants perceived the individual
97 signatures on ceramic vessels (Gandon et al., 2018). The second goal of this study is to verify
98 this preliminary result with an experiment involving a larger sample of craftsmen.

99

100 Here we bring an experimental approach to explore these issues, with the aim of
101 providing an assessment of both (i) the vessel shape variations occurring through cultural
102 transmission and (ii) their perception by the craftsmen. We did so by setting up two field
103 experiments with 26 potters belonging to the pottery-making community of Hebron
104 (Palestinian Territories), with a clear identification of the family relationship between them.

105 In the first experiment participants were asked to throw series of customary pottery
106 types in their familiar conditions of practice. We captured the 2D profiles of their
107 axisymmetric productions. The participants' behavioral reproducibility was analysed by
108 computing the standardization of the vessel assemblages through the coefficient of variation
109 of the vessels' absolute dimensions. We used the Elliptical Fourier method to analyze vessel
110 shape variation among the productions (Gandon et al, 2013; 2018; 2020b; McLellan and
111 Endler, 1998). Following the view of handicraft learning outlined above, our first operational
112 hypothesis is that the complete assemblage of vessels produced by the 26 potters would
113 contain both individual and cultural shape traits, these latter being culturally inherited from
114 the familial transmission unit. If this hypothesis is verified, we could conclude that each
115 transmission (from a trainer to a learner) modifies the ceramic shape, the culturally
116 transmitted traits being combined with new individual traits. Beyond the question of shape
117 variation occurring during the transmission, we also want to understand how individual and
118 cultural shape traits could affect the evolutionary trend of the ceramic shapes. Do the cultural
119 traits propagate through generations of craftsmen or are they diluted in the individual traits
120 resulting from each transmission? We assume that the ceramic shapes evolved through the
121 successive transmissions with the integration of individual traits and the conservation of
122 cultural traits inherited from the familial transmission unit. Hence, our second operational
123 hypothesis is that the shape variations in the complete assemblage of vessels will reflect not
124 only the transmission units but also larger family relationships. If it is the case, it would imply
125 that cultural morphological traits in ceramics propagates through generations of craftsmen at
126 the scale of a pottery-making community including different families.

127

128 In a second experiment, we asked the participants to visually identify their own
129 productions and those of five other potters. Based on the preliminary result found with the
130 Nepalese potters, our third operational hypothesis is that participants will perceive, at least to
131 a certain extent, individual signatures in ceramic shapes. Testing this hypothesis will allow us
132 to evaluate whether potters detect the slight shape variations, and could thus select the
133 individual variant they prefer, notably disseminating it by reproduction. We could then
134 conclude for a possible influence of the potters' choice in the selection and evolution of
135 ceramic shapes.

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138 2. Materials and Methods

139

140 2.1. Experimental setting

141

142 2.1.1. Cultural context

143

144 In the southern Levant, the throwing method as practiced in Hebron dates back to the
145 early Ottoman period (16th century). In the 20st century, the city of Hebron used to be a large
146 center of pottery production. Currently only a few pottery-making families (locally called
147 'Fakhuri', meaning potters) remain. They constitute learning lineages of specialized craftsmen
148 whose craft has been transmitted over many generations. These families work in the
149 neighbourhood of Hebron, 'Al-Fahs' (Palestinian Territories). Changes in their tradition
150 mainly occurred in the type of containers as a result of market evolution. Contemporary
151 customers demand decorative vessels rather than utilitarian traditional vessels (Table 1).
152 Among the latter, the water jug called "Ebreeq" and the cooking pot called "Fokhara" are still
153 commonly used by the Palestinian population. The main part of the production is represented
154 by flowerpots (from 15 cm to 1 m high) and small tourist vessels (oil lamp, water pipes,
155 incense burners, etc.), sold both in the Palestinian territories and in Israel, very occasionally in
156 Europe or the United-States. All vessels are produced using an electrical wheel which
157 replaced the kick-wheel since the 1980s. Vessels are thrown at high production rates. Potters
158 throw for example 300 small vessels or 30 large vessels in one day. The production is
159 organized in family workshops, with members practicing the wheel-throwing in co-working
160 area (Fig. 1). These family workshops are sometimes in the same compound, this is the case

161 when they belong to a given extended family. They then house the sons and grandsons of the
162 grandfather who originally bought the compound. The different workshops included in a
163 compound can share the clay preparation and drying areas while usually, each workshop has
164 its own kiln. The craft skills are transmitted vertically from father to sons, the eldest sons can
165 also teach their young brothers. These latter are generally the assistant of their elder brothers
166 and father, they throw vessels occasionally but mostly prepare the clay, participate to simple
167 decoration tasks, carry the vessels from the drying area to the kiln, and help for the firing. The
168 family workshops constitute the transmission units, which change through the lifespan of
169 craftsmen. When the sons become adult, they leave their father's workshop and set-up their
170 own workshop with their own sons, so the roles of learner and trainer are held successively by
171 a craftsman.

172

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

174

175 **Figure 1. Co-working area with elder experts and youngers.** Left photo: P8 (Potter 8) with his son P6; right
176 top photo: P4 (left) and his elder brother P13 (right); right bottom photo: P15 (in the middle) with his two sons
177 P1 (left) and P19 (right). Becoming an expert potter requires sitting for hours at the wheel close to those of the
178 elders. While sitting next to his mentor, the apprentice can observe his mentor's fashioning gestures.

179

180

181 2.1.2. Participants

182

183 Our study involved 26 participants from the Hebron pottery-making community. The
184 participants belong to three families: HAL (16 participants), NAI (7 participants), and NAF (3
185 participants) (Table 1, Fig. 2). As shown in the Figure 2, we worked with two generations,
186 unfortunately the first generation passed away. The NAF family is not related to the two other
187 families, it is made up of four brothers working in an isolated workshop (i.e. not integrated to
188 an extended family compound). These four brothers learnt the skill in the same transmission
189 unit (with their father NAF). The HAL and NAI families have kinship ties, the grand-fathers
190 (HAL and NAI) were brothers, the sons and grand-sons are thus cousins. The compounds of
191 these two families are located a few hundred meters apart. The HAL family members who
192 participated in our experiments are currently distributed between five workshops housing five
193 transmission units made up of the father and his sons (only one father, SAL, did not wish to

194 participate). The five fathers of each workshop are brothers and learnt the skill in the same
195 transmission unit (with their father HAL). In the NAI family, the members who participated
196 are six brothers who learnt the skill in the same transmission unit (with their father NAI), and
197 one son of them (P26) which constitutes (with his father) another transmission unit. The six
198 brothers of the NAI family are currently distributed between three workshops, each of them
199 housing respectively three, two and one brother(s) and their sons (when old enough to work).
200 In total, our dataset encompassed nine transmission units which are labelled U1 to U9 (see
201 caption of Fig. 2). Among them eight transmission units are distributed between two extended
202 families (HAL and NAI's ones) (Fig. 2). The participants were all men, aged from 18 to 72
203 yrs (37.9 ± 12.4 yrs) and with different wheel-throwing experience (years of practice: $27.8 \pm$
204 12.7 yrs) as well as different pottery type specialization (Table 1). The specialization is not
205 fixed but changes over time, depending on the market. As P12 said: "*My brothers HAKA and*
206 *ISS perfectly know how to throw big flowerpots, but they did not produce them for several*
207 *years because the demand of customers is mainly for small tourist items.*" The level of
208 practice of the participants (young learner, advanced learner, and expert) was defined by the
209 vessel types they usually produce (Table 1). Among the 26 participants, one was a young
210 learner (P12), three were advanced learners (P18, P14 and P26), all the 22 others were
211 experts. The learners P12, P18, and P14 begun to learn the throwing skill early (at 8, 10, and
212 14 yrs old respectively) but, as the last sons of their family, they mainly assist their elders and
213 do not produce a lot of vessels. The learner P26 also begun early to learn how to throw pots
214 on the wheel (at 7 yrs old) but, as the eldest son of P25, he throws vessels at high production
215 rates for several years. Three participants (P3, P11, P17) were left-handed and the 23 other
216 right-handed. The participants gave their written consent to participate in the field
217 experiments after having been informed through an informative sheet.

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N°	Name	Age	Experience	Family	Most usual production
P1	HEL	31	23	HAL	Ebreeq, big flowerpots
P2	HAK	33	23	HAL	Ebreeq, Fokhara, cooking pots, small tourist items (water pipes, incense burners,...), flowerpots in all sizes
P3	HUS	57	43	HAL	Ebreeq, Fokhara, cooking pots, small tourist items (Money-Bank, water pipes, incense burners,...),
P4	ISS	31	21	HAL	Ebreeq, Fokhara, small tourist items (Money-Bank,..)
P5	EIA	34	20	HAL	Ebreeq, Fokhara, cooking pots, small tourist items (water pipes, incense burners,...)
P6	MOH	25	15	HAL	medium flowerpots
P7	SAL	51	44	HAL	Ebreeq, Fokhara, big flowerpots and big water jars
P8	HIS	49	42	HAL	Ebreeq, Fokhara, flowerpots in all sizes
P9	AHM	27	17	HAL	big flowerpots (part 1) and big water jars (part 1)
P10	MUS	35	25	HAL	small tourist items (Money-Bank,..)
P11	MUST	37	26	HAL	small tourist items (Money-Bank,..)
P12	MOH-1	23	15	HAL	small flowerpots
P13	HAKA	40	32	HAL	Ebreeq, Fokhara, small tourist items (Money-Bank,..)
P14	AMM	24	10	HAL	small tourist items
P15	WAH	72	63	HAL	Ebreeq, flowerpots in all sizes
P16	MOH-2	37	28	NAF	flowerpots in all sizes
P17	HAMA	35	23	NAF	flowerpots in all sizes
P18	ALI	18	8	NAF	small tourist items
P19	ANA	40	31	HAL	flowerpots in all sizes
P20	ALA	44	34	NAI	Ebreeq, Fokhara, flowerpots in all sizes
P21	SHU	47	39	NAI	Ebreeq, Fokhara, flowerpots in all sizes
P22	MOH-3	33	18	NAI	Ebreeq, Fokhara, Money-Bank, flowerpots medium size
P23	NUM	39	31	NAI	Ebreeq, Fokhara, flowerpots in all sizes
P24	SHAK	48	38	NAI	Ebreeq, Fokhara, Money-Bank, flowerpots in all sizes
P25	SHA	54	40	NAI	Ebreeq, Fokhara, Money-Bank
P26	HAM	21	14	NAI	Ebreeq (part 1), big flowerpots (part 1)
	mean	37,9	27,8		
	sd	12,4	12,7		

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Table 1. The 26 participants of the study. Each potter was asked about his age, experience (i.e. years of practice), family (HAL, NAI or NAF), and most usual production. The big flowerpots and the big water jars are produced with the two stages method of throwing (Fig. S1). The most usual production includes the vessel types that the participants were producing during the last months preceding our study. It does not necessarily include the different pottery types mastered by a potter, as the production changes throughout the year, depending on the market demand. For instance, P6 produces mainly medium flowerpots but he also produces Ebreeq and Fokhara

236 in series for exceptional periods. The potters over 40 years old generally master the entire repertoire of pottery
237 types.

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240

241 ***** Fig. 2 about here *****

242

243 **Figure 2. Family trees of the families HAL, NAI, and NAF participating in the experiments.** Filial relations
244 are indicated by vertical lines, and sibling relations are indicated by horizontal lines in which potters are sorted in
245 an age-descending order from left to right. HAL and NAI were brothers, so their sons and grand-sons are
246 cousins. Our dataset included nine transmission units (U1: consisting of potters P15, P19, P1; U2: P3, P5, P2;
247 U3: P13, P11, P10, P4, P12; U4: P8, P6; U5: P7, P9, P14; U6: P16, P17, P18; U7: P25, P24, P21, P20, P23, P22,
248 U8: P15, P3, P7, P8; U9: P25, P26). Among them eight transmission units are distributed between two extended
249 families (HAL and NAI's ones). SAL, NAF, and JAM did not participate, NAF and SAL are partially retired,
250 and JAM's workshop is in another area of Hebron. In the different transmission units, only the potters who
251 participated in the study are represented.

252

253

254 2.1.3. Production task

255

256 In a first experiment, participants were asked to produce three customary pottery
257 types: Ebreeq, Fokhara, and Money-Bank (Fig. 3, left). The two first types are traditional
258 vessel types known since centuries while the latter is a modern vessel type which dates to the
259 late 20st century. The Ebreeq and the Fokhara were thrown in two stages as potters usually do
260 for those types (Fig. S1). All the 22 expert participants produced the three types. They were
261 all used to them even if they produce each type in different quantities depending on their most
262 usual production (Table 1). The learner P12 did not produce the Ebreeq and Fokhara because
263 he was not advanced enough. The learners P14 and P18 produced the three pottery types with
264 a low level of practice. The learner P26 produced the Ebreeq and Fokhara with a high level of
265 practice for the part 1 of the vessels and a low level of practice for the part 2 (Fig. S1), he
266 produced the Money-Bank with a low level of practice. To assess the reproducibility of
267 behavior, five replicates were produced in each of the three pottery types, so each potter
268 produced a total of 15 pots (Fig. 3, right). There were some cases where potters produced six
269 replicates instead of five, which were included in our dataset. For each pottery type, a vessel

270 model was presented in front of the potter's working place during the whole fashioning
271 session. The instructions were to make a vessel with the same size as the model, using self-
272 chosen quantities of clay. Potters were not asked to copy the models exactly because we
273 wanted each participant to produce the pottery type following his own way. For seven expert
274 participants (P1, P2, P5, P17, P20, P21, P23) it was the first time they produced the Money-
275 Bank with the specific shape of the model (they usually produce the Money-Bank with
276 different shape variant). Potters used a basin of water to regularly wet the clay during the
277 throwing process, and a metallic scraper during the thinning and/or final fashioning steps.
278 Potters produced the experimental vessels assemblage using their usual wheel and clay,
279 working at their own pace. All finished vessels were marked on one face with numbers
280 indicating the specific potter and the replicate number in the series; then they were put to dry
281 for two days.

282

283 ***** Fig. 3 about here *****

284

285 **Figure 3. The three models of pottery types (left photo) and an example of a complete assemblage**
286 **produced by one potter (right photo).** The three models on the left photo are (from left to right): Ebreeq,
287 Fokhara, and Money-Bank. For the experiment, the Ebreeq was produced without the handle and the spout. The
288 complete assemblage on the right was produced by P8.

289

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291

292 2.1.4. Vessel identification task

293

294 In a second experiment, we asked 21 participants to visually identify their own vessels
295 and those of five other potters. Among these latter (i.e. the five other potters), one, two, three
296 or four were members of the transmission unit of the participant, and the remaining were
297 members of the extended family of the participant (living in the same compound) or members
298 of another family. Five participants were not available for this second experiment, they are the
299 three members of the NAF Family (P16, P17, and P18), P24 from the NAI family, and P12
300 from the HAL family. For this vessel identification task we selected, for each potter and each
301 pottery type, the best three replicates (among the five produced) eliminating vessels with
302 manufacturing defects (for example a fingerprint in the wall, or a little rock in the clay). This

303 was done to prevent a potter recognizing his own vessels because of the presence of a
304 noticeable defect. The vessels were then organized by groups of three vessels per pottery type
305 (x 3 types) and per potter (x 6 potters), thereby obtaining a total of 18 vessel groups including
306 3 self-vessel groups (one by pottery type) and 15 others-vessel groups (five by pottery type)
307 (Fig. 4, left). Looking at the six vessel groups for a given pottery type, each potter was
308 individually asked to visually identify his own vessels, and those of the five other potters (Fig.
309 4, right). When performing the task, the potter had the list of the six producers' names
310 (including himself) in his hands. His task was to find which vessels belong to which
311 producers. The vessels were observed from a one-meter distance without manipulation. No
312 feedback or any other type of clue was given. In total, each potter had to give 18 answers (six
313 producers to be identified, for each of the three different pottery types), which were later
314 entered into an Excel file. The participants could also refrain from answering if they were
315 unsure. To close this experimental session, the experimenter (E. Gandon) gave each potter his
316 performance and asked him which clues he used to identify the vessels' producers.

317

318 ***** Fig. 4 about here *****

319

320 **Figure 4. The vessel identification task.** Here the experimenter (E. Gandon) is working with P11. For the three
321 pottery types (front line: Money-Bank, middle line: Fokhara, and back line: Ebreeq), potters were asked to
322 identify the producer of the six vessel groups. They were invited to identify the producers starting from the
323 leftmost 3-vessels group and subsequently proceeding rightward. They could change their answers if deemed
324 necessary at the final summary given by the experimenter (photograph by W. Alqaraja).

325

326

327

328 2.2. Data recording and analysis

329

330 2.2.1. Morphology of the vessels

331

332 Once the vessels were dried, we used a Canon PowerShot-SX270 camera (resolution
333 2112 x 2816 pixels) to photograph all vessels. A size-calibration object was placed next to
334 each vessel (as in Fig. 3, left). Two vessels were removed from the dataset because they were

335 damaged (P13, one Fokhara and P8 one Money-Bank). In total, 129, 126, and 136 vessels of
336 Ebreeq, Fokhara, and Money-Bank respectively, contributed to the present analysis.

337

338 Using Matlab® software we extracted the x-y coordinates (in pixels) of the complete
339 vessel outline from each vessel photo. A low-pass filter was applied to these coordinates to
340 remove noise from pixellation. The coordinates were then converted from pixels to
341 centimeters using the calibration object present in each photo. The coordinates were
342 subsequently resampled so that the distance between neighboring points was standardized to 1
343 mm.

344

345 We computed the vessel absolute dimensions: base, aperture, height, maximal
346 diameter, and height of the maximal diameter. The base was not computed for the Fokhara
347 which have a rounded bottom. In order to assess the standardization of production we
348 computed the between-trial variation over the five replicates thrown by each participant, for
349 each of the three pottery types, using the coefficient of variation ($CV = 100 * \text{standard}$
350 $\text{deviation} / \text{mean}$) computed on the vessel absolute dimensions (Eerkens and Bettinger, 2001;
351 Kvamme et al., 1996). A smaller CV indicates a higher standardization of production. To test
352 if the pottery type (Ebreeq, Fokhara, and Money-Bank) influenced the standardization of
353 production we used an ANOVA with equal variance and t-tests for post-hoc. The effects of
354 the participants' ages and experiences were also tested with a linear regression analysis.

355

356 All complete vessel outlines were subjected to an Elliptical Fourier transformation
357 (Gandon et. al., 2013; 2018; 2020b; McLellan and Endler, 1998). The resulting series of 40
358 pairs of coefficients were normalized with respect to the first coefficients to correct for size
359 differences so that pure shape could be analyzed. For graphical representation of the shape,
360 the size-corrected Fourier coefficients were subjected to a Principal Component (PC) analysis.
361 For all vessels, over 70% of the total shape variance was captured by the first three PCs. Each
362 vessel shape could thus be represented as a point in a unique three-dimensional PC shape-
363 space, allowing a visual inspection of the variations within and among participants as well as
364 the variations within and among the transmission units. This mathematical shape description
365 also allowed to reconstruct, for each participant and each pottery type, the mean vessel shapes.
366 These mean vessel shapes were reconstructed from the mean Elliptical Fourier coefficients of
367 the five vessel replicates produced by each participant for each pottery type.

368

369 Statistical differences among vessel shapes were further examined for each of the three
370 pottery types separately. For that purpose, in a first step we ran nested permutation tests
371 (Anderson, 2001) on the 40 pairs of normalized Fourier Coefficients using the
372 `nested.npmanova` function in the R package `BiodiversityR`. This analysis was based on a two-
373 level hierarchical model, in which the individual potters were nested within transmission
374 (family) units. These permutation tests allow us to test our first operational hypothesis,
375 assessing the presence of significant shape variation among individual potters and among the
376 transmission units. Because these tests can be used only with exclusive groups, two rounds of
377 permutation tests were run. The first round tested the presence of significant variation among
378 the transmission units U1, U2, U3, U4, U5, U6, U9 and among the different individual potters
379 (20 individuals for Money-Bank, and 19 individuals for Ebreeq and Fokhara because P12 did
380 not produce these two pottery types). The second round tested the presence of significant
381 variations among the transmission units U6, U7, U8 and among the different individual
382 potters (14 individuals for all three pottery types).

383 To test our second operational hypothesis, we constructed dendrograms presenting the
384 similarities among the participant's mean vessel shapes (Figs. 8, 9, S2, and S3). The mean
385 vessel shapes were used because showing every vessel replicate would make the diagrams too
386 complex. For each pottery type (Ebreeq, Fokhara, Money-Bank) three dendrograms were
387 made. The first dendrogram provides distinct branch colours for the two families MIN and
388 RAS; the second provides this for the three families HAL, NAI, NAF; and the third provides
389 distinct colours for each of the nine transmission units. While the permutation tests assess the
390 presence of individual and cultural traits inside the global set of vessels produced by the 26
391 participants, the dendrograms illustrate the transmission of the cultural traits across the two
392 generations of participants, taking into account the combination of individual and cultural
393 traits. If cultural traits on vessel shape were conserved through successive transmissions as we
394 expected, there should be reasonably strong resemblance between the family trees (Fig. 2) and
395 these dendrograms (Figs. 8, 9, S2, and S3). The resemblance would appear in the
396 dendrograms through a distinction between the branches of two families MIN and RAS, the
397 three families HAL, NAI, NAF, and the nine transmission units. Dendrograms were produced
398 according to the unweighted pair-group mean arithmetic (UPGMA) method using the R
399 function `hclust`. For permutation tests and dendrograms, the alternative-Gower distance was

400 used as a dissimilarity measure (Anderson et al., 2006), and 10000 randomizations were used
401 to obtain *P*-values. For all statistical tests, the alpha level used was 0.05.

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407 2.2.2. Identification of the vessels

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409 To test our third operational hypothesis, the performance of the participants in the
410 identification task was measured by the number of (i) correct answers, (ii) incorrect answers,
411 and (iii) no answers (when participants refrain from answering). A correct answer was
412 recorded when the vessel's producer was correctly identified by the participant and an
413 incorrect answer was recorded when participant responded another potter instead of the
414 correct one. First, we analyzed if potters correctly identified their own vessels (i.e. self-vessel
415 groups) more than those of the other potters (i.e. others-vessel groups). Then, the Kruskal-
416 Wallis test was employed to test the effect of pottery type (Ebreeq, Fokhara, and Money-
417 Bank) on performance. Pairwise t-tests were used to compare the effect of familial distance
418 (transmission unit vs. extended family) on performance, and linear regression was used to test
419 the effects of experience and age. Results were interpreted in light of the information given by
420 the participants during the interviews closing the experimental session.

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423 3. Results and discussion

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425 3.1. Morphology of the vessels

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427 3.1.1. Standardization of production

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429 Tables S1, S2, and S3 present the mean absolute dimensions of the vessels (in
430 centimeters) produced by each participant, for the Ebreeq, Fokhara, and Money-Bank

431 respectively. The among-participant standard deviations ranged between 0.5 and 1.8 cm for
432 all pottery types (see last line of the Tables S1, S2, and S3), indicating a rather high
433 standardization of the productions at the level of the pottery-making community in line with
434 earlier results (Gandon et al., 2014a). Table 2 presents the vessel standardization (i.e. CVs) for
435 each participant and each pottery type. The values were in a range of 1.7 to 6.3 %, if one
436 excludes P11, specialized in small items. They are within the ordinary coefficients of
437 variation range reported in previous studies with potters throwing familiar pottery types at
438 high production rates (Gandon et al., 2014a; Gandon et al., 2014b; Harush et al., 2020;
439 Longacre, 1999; Roux, 2003). There was a tendency for the vessel standardization to improve
440 (CV to decrease) with the age and experience of the potter, especially for Ebreeq, and for
441 Money-Bank to a lesser degree. But there was no statistically significant relation between the
442 CVs and the participants age (Ebreeq: $r_{24} = -0.35$, $p = 0.08$, $CI = [-0.65, 0.05]$, Fokhara: $r_{24} = -$
443 0.09 , $p = 0.67$, $CI = [-0.46, 0.31]$, Money-Bank: $r_{24} = -0.33$, $p = 0.10$, $CI = [-0.64, 0.07]$), and
444 experience (Ebreeq: $r_{24} = -0.38$, $p = 0.05$, $CI = [-0.67, 0.01]$, Fokhara: $r_{24} = -0.11$, $p = 0.60$, CI
445 $= [-0.48, 0.29]$, Money-Bank: $r_{24} = -0.32$, $p = 0.11$, $CI = [-0.63, 0.08]$). Although the degree to
446 which the vessel standardization is related to the age and experience is somewhat different
447 between shapes, we conclude that, overall, the 26 participants all acquired a sufficient
448 expertise to throw standardized vessels. Finally, we found that the CVs of the Ebreeq were
449 significantly smaller than those of the Fokhara and Money-Bank; the latter two were
450 statistically equivalent ($F(2, 48) = 11.42$, $p < 0.01$) (Ebreeq: 3.5 %; Fokhara: 4.5 %; Money-
451 Bank: 4.8 %) (see Table S4 for post-hoc tests). This difference was small but could indicate
452 that the participants produce Ebreeq with a higher frequency than Fokhara and Money-Bank.

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Standardization of production (CVs %)				
Potter	Ebreeq	Fokhara	Money-Bank	Mean
P1	3.1	2.2	3.4	2.9
P2	4.4	4.9	3.4	4.2
P3	3.7	2.8	3.1	3.2
P4	2.2	3.3	5.1	3.5
P5	1.9	3.3	4.5	3.2
P6	2.3	3.7	4.9	3.6
P7	1.7	2.7	4.0	2.8
P8	2.7	2.8	3.6	3.0
P9	2.3	5.5	5.1	4.3
P10	4.6	5.3	3.4	4.5
P11	5.7	8.6	6.9	7.1
P12	-	-	4.0	4.0
P13	2.5	4.2	2.8	3.2
P14	5.2	3.5	4.7	4.4
P15	1.9	3.4	4.3	3.2
P16	3.8	4.5	4.9	4.4
P17	4.9	5.8	6.0	5.6
P18	5.7	4.4	6.4	5.5
P19	5.2	3.4	3.8	4.1
P20	4.1	4.6	5.1	4.6
P21	4.1	6.0	5.1	5.0
P22	3.8	5.1	4.5	4.5
P23	2.9	5.8	6.0	4.9
P24	3.0	6.3	6.1	5.1
P25	3.2	6.3	5.0	4.8
P26	3.8	5.3	7.2	5.4
Mean	3.5	4.6	4.8	4.3

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Table 2. Coefficients of variation of the productions. The coefficients of variation were computed over the five replicates thrown by each participant for each pottery type (Ebreeq, Fokhara, and Money-Bank). They were computed on each absolute dimension of the vessels and subsequently averaged to obtain a mean coefficient per participant and per pottery type.

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481 3.1.2. Individual and cultural traits on vessel shapes

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483 Figure 5 presents, for the Ebreeq, Ebreeq neck, Fokhara, and Money-Bank separately,
484 the morphology of the vessels in the three-dimensional PC shape-space. The shape of each
485 vessel (and Ebreeq neck) produced by each participant is represented as a point in the PC
486 shape-space, while the distinct transmission units are indicated though different colours.
487 Figure 6 presents the mean vessel shape of the five replicates produced by each participant for
488 the three pottery types. Figure 7 presents the Ebreeq necks photos of the five Ebreeq
489 replicates produced by each participant.

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491 Despite certain overall similarities of the evenly distributed graphical markers, visual
492 inspection of Figure 5-a shows that the Ebreeq vessels produced by the same potter clustered
493 in the PC shape-space, with some participants producing more standardized assemblages
494 (tighter clusters; P7, P8 for example) than others (P16, P10 for example). The specialisation
495 of the participants in certain pottery types (see Table 1) explains the individual differences
496 observed in terms of assemblage standardization: the less a potter is specialized in a pottery
497 type, the less he will produce standardized assemblages for that type. Some of the individual
498 signatures observed in Figure 5-a were detectable in the mean vessel shapes presented in the
499 Figure 6-a: the Ebreeq of P1 were particularly wide, those of P13 had a fine lower part, those
500 of P9 had an oval body, those of P20 had a square outline. Within the five-replicates
501 assemblage produced by each potter, some vessel shapes were different from the others (P3,
502 P23 for instance) (Fig. 5-a), suggesting that a given pottery type can be produced by a single
503 potter with a range of variation (see Photo dataset). A clustering of the vessel assemblages
504 also appeared at the level of the transmission units, indicating culturally inherited signatures
505 which were particularly visible for U2, U4, and U8. In the transmission unit U3, the

506 assemblages of P13 and P4 were close, while those of P11 and P10 were farther apart in the
507 PC shape-space and corresponded to atypical mean shapes (Fig. 6-a). This can be explained
508 by the fact that P11 and P10 are not specialized in the Ebreeq production, they more often
509 produce small tourist items (Table 1). The assemblage of P26 also occupied a different part of
510 the PC shape-space and corresponded to an atypical shape (Fig. 6-a); P26 being still a
511 beginner in producing this pottery type. The Ebreeq produced by the other two learners P14
512 and P18 were closer to those produced by the experts, yet they had irregular shapes and a low
513 degree of standardization (Photo dataset and Table 2).

514 As for the Ebreeq complete vessel (Fig. 5-a), individual signatures appeared in the
515 Ebreeq neck through individual clusters in the PC shape-space (Fig. 5-b). Some of these
516 individual signatures appeared clearly in Figure 7, notably two atypical neck shapes produced
517 by P3 and P24, but also the necks produced by P1 which were wider than all others, and those
518 produced by P22 which distinguished through a square-shape lip on the aperture. Some neck
519 assemblages were more standardized (for instance P7, P8, P13) than others (P10, P11, P17,
520 P5). Individual variants were exhibited in the assemblage of single potter, for example P2
521 who produced the neck with two different styles of lip on the aperture, one style being used
522 for four replicates and the other for one replicate. The same thing was observed with P20 who
523 produced three necks using one style, and two necks using another style (Figs. 5-b and 7).
524 Similarity between the necks produced by the transmission unit members was observable,
525 indicating culturally inherited signatures (Fig. 5-b). Inside each transmission unit, the higher
526 similarity of the necks did not appear between the necks produced by all members but
527 between those produced by two members, brothers (P4-P13, P20-P22, P18-P16) or father and
528 son (P7-P9).

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530 The Fokhara vessels results were similar to those of the Ebreeq. Individual signatures
531 appeared through systematic clusters of the assemblages produced by each distinct potter (Fig.
532 5-c). Some of those individual signatures were obvious in the mean vessel shapes: the
533 Fokhara produced by P1 had a wide lower part, those of P13 had an elongated body and a
534 rounded lower part, those of P19 had an elongated body (Fig. 6-b). The standardization of the
535 individual assemblages varied between the participants, for instance the assemblages of P15
536 and P3 were less variable than those of P10 and P11. The assemblage of P4 exhibited two
537 variants, three vessels were close to those of his brother P13, while the other two vessels were
538 in a different region of the PC shape-space. Two Fokhara produced by P4 were more

539 elongated than the other three vessels in the photos (see Photo dataset). A similarity between
540 the assemblages produced within each transmission unit was observed, and particularly
541 noticeable in U4, U5, and U8. As for the Ebreeq, in U3, the assemblages of P13 and P4 were
542 close while those of P10 and P11 were distant and corresponded to atypical mean shapes (Fig.
543 6-b). This result is certainly due to the specialization of P10 and P11 in small tourist items
544 (Table 1). The assemblage of P26 stood out from all others and corresponded to an atypical
545 mean shape reflecting that P26 was a learner. Although they were not skilled at producing
546 Fokhara, the vessels of the two learners P14 and P18 had a similar shape to that of the
547 experts' vessels.

548 Results of the Money-Bank vessels were qualitatively similar to those of the Ebreeq
549 and Fokhara. We observed individual signatures through distinct clusters in the PC shape-
550 space for the different potter assemblages (Fig. 5-d). In Figure 6-c we can see for instance that
551 the Money-Bank of P15 were distinguished by wide shoulders, those of P8 had a narrow neck
552 bellow their bud, and those of P19 had an elongated lower part. Some assemblages were more
553 standardized (those of P1 and P13 for instance) than others (those of P16 and P17 for
554 instance). Individual signatures did not exclude individual variants, for example we saw that
555 for P7 and P23 the five vessels were separated in two clusters (two vessels being in a distant
556 area of the three others). Similarity at the level of transmission unit appeared for U2, U4, and
557 U6. It appeared also between the four brothers of the U3 transmission unit (P4, P10, P11, and
558 P13), with the fifth brother P12 assemblage being far from the others and corresponding to an
559 atypical mean shape (Fig. 6-c) signing the learning of this young potter. The learning was also
560 observable in the vessels of P14 which were far from those of his father (P7) and brother (P9)
561 (Fig. 5-d) and corresponded to an atypical mean shape (Fig. 6-c). The Money-Bank produced
562 by the learner P18 had also an atypical mean shape (Fig. 6-c) and were in an extremity of the
563 PC shape-space (Fig. 5-d). Surprisingly, in the transmission unit U1, although the
564 assemblages of the father (P15) and the eldest son (P19) were close, the one of the youngest
565 son (P1) was in a distant area of the PC shape-space, this difference being also observable in
566 the mean shape (Fig. 6-c). In the U7 transmission unit, the assemblages of the five youngest
567 brothers were close, and that of the older brother (P25) was distant. The assemblage of P26
568 (son of P25) was distant from all others and corresponded to an atypical mean shape (Fig. 6-c)
569 signing the learning of this young potter.

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***** Fig. 5 about here *****

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573 **Figure 5. Vessels morphology represented in the three-dimensional PC shape-space.** a. Ebreeq, b. Ebreeq
574 neck, c. Fokhara, and d. Money-Bank, e. Family trees. All the vessels produced by the participants are presented.
575 The three principal components (PC1, PC2, PC3) in the x, y and z axis are derived from principal component
576 analysis on 40 sets of Elliptical Fourier coefficients of each pot shape. For all vessels, over 70% of the total
577 shape variance was captured by these first three PCs. Potters from the same transmission unit are represented in
578 the same colour, except those from the U8 who are represented by star-shaped markers. P26 is represented using
579 the same colour as the transmission unit of his father and uncles. Family relations are represented in the bottom
580 panel (e), where filial relations are indicated by vertical lines, and sibling relations are indicated by horizontal
581 lines in which potters are sorted in an age-descending order from left to right. The potters under 25 years of age
582 are represented by the markers “+”.

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***** Fig. 6 about here *****

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586 **Figure 6. Mean individual shape of the vessels.** a. Ebreeq, b. Fokhara, and c. Money-Bank. These shapes are
587 reconstructed from the mean Elliptical Fourier coefficients of the five vessel replicates produced by each
588 participant for each pottery type. Potters from the same transmission unit are represented in the same colour (U1:
589 blue, U2: yellow, U3: orange, U4: green, U5: purple, U6: light blue, U7: red) or by the same symbol (U8: *, U9:
590 +). Family relations are represented in Figure 2 and 5.

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***** Fig. 7 about here *****

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596 **Figure 7. Photos of the Ebreeq necks.** All the necks thrown by the participants are presented. The five necks
597 thrown by one potter are presented in a row, with a label on the left side indicating the potter’s number. Let’s us
598 recall that P12 did not produced the Ebreeq. Potters from the same transmission unit are represented in the same
599 colour (U1: blue, U2: yellow, U3: orange, U4: green, U5: purple, U6: light blue, U7: red) or by the same symbol
600 (U8: *, U9: +). Family relations are represented in Figure 2 and 5.

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602

603 Hierarchical permutation tests run on the normalized Elliptical Fourier coefficients
604 were used to interpret the results presented in Figures 5, 6, and 7. In line with our first
605 operational hypothesis, these tests revealed a significant vessel shape heterogeneity among

606 individuals and among the transmission units for the three pottery types (Table 3). Hence,
607 even though the standardization of the productions at the level of the pottery-making
608 community was high (Tables S1, S2, S3), there was still room for significant variation.
609 Corroborating the results of earlier work (Roux & Karasik, 2018; Gandon et al., 2018), these
610 results showed that potters left subtle but identifiable individual signatures on ceramic shapes,
611 even on typical traditional pottery types produced for a common consumer market. The
612 presence of individual signatures demonstrated that the vessels produced by the novices are
613 not perfect copies of those produced by their trainers, although the transmission unit also
614 affected the vessels. We conclude that the learning process modifies the ceramic shape, the
615 culturally inherited traits being combined with new individual traits. We should stress that the
616 individual signatures did not prevent individual shape variants within a single pottery type.
617 For the modern vessel type Money-Bank these shape variants most likely correspond to the
618 various customers preferences as explained by the participants; for the traditional vessel types
619 Ebreeq and Fokhara, it is still unclear if these shape variants result from potter personal styles
620 or from the existence of traditional shape variants transmitted by the previous generations of
621 craftsmen.

622 To our knowledge, our results demonstrate for the first time the existence of familial
623 signatures within the same community of potters made up of a few families of craftsmen.
624 These signatures likely resulted from the social channelling occurring inside the transmission
625 unit during the learning of the skill. In this respect, these signatures represent the cultural part
626 of the potters' skill, which supposedly propagates across generations. Interestingly, these
627 cultural signatures were non-significant for the Ebreeq necks which were marked only by
628 individual signatures (Table 3, Fig. 7). We can then assume that the necks are the more
629 relevant part of the vessel to be analyzed on ancient assemblages in order to detect individual
630 signatures which has also been shown by Harush et al. (2020).

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Permutation tests on U1, U2, U3, U4, U5, U6, and U9				
Pottery type	Parameters	Df	F	P
Ebreeq	Transmission unit	6	1.50	0.0429
	Individual	13	12.27	<0.0001
Fokhara	Transmission unit	6	3.28	0.0007
	Individual	13	6.83	<0.0001
Money-Bank	Transmission unit	6	2.01	0.0433
	Individual	14	10.49	<0.0001
Ebreeq Neck	Transmission unit	6	1.51	0.09049
	Individual	13	9.38	<0.0001
Permutation tests on U6, U7, and U8				
Ebreeq	Transmission unit	2	1.97	0.0496
	Individual	10	11.46	<0.0001
Fokhara	Transmission unit	2	9.25	<0.0001
	Individual	10	3.64	<0.0001
Money-Bank	Transmission unit	2	2.88	0.0405
	Individual	10	10.59	<0.0001
Ebreeq Neck	Transmission unit	2	0.95	0.5302
	Individual	10	11.57	<0.0001

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Table 3. Permutation tests results. Hierarchical permutation tests were run on the 40 size-corrected coefficients resulting from Elliptical Fourier analyses of the vessels. For each pottery type, within-potter effects are based on the five replicates thrown by each participant. The tests were run separately for each vessel type (Ebreeq, Fokhara, and Money-Bank) and the Ebreeq necks. In the first round, the analysis tested the presence of significant vessel shape variation among the transmission units U1, U2, U3, U4, U5, U6, U9 and among the different individual potters (20 individuals for Money-Bank, and 19 individuals for Ebreeq and Fokhara because P12 did not produce these two pottery types). In the second round, the analysis tested the presence of significant vessel shape variation among the transmission units U6, U7, U8 and among 14 individual potters (for all three types).

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659 3.1.3. Conservation of cultural traits through transmission

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661 Figures 8, 9, S2, and S3 present the dendrograms of the participants' mean vessel
662 shapes, for the Fokhara, Ebreeq neck, Ebreeq, and Money-Bank respectively. These graphs
663 indicate that the differences between the two families MIN and RAS, the three families HAL,
664 NAI, NAF, and the nine transmission units varied across the three pottery types. Differences
665 appeared between the two families MIN and RAS and between the three families HAL, NAI,
666 and NAF, especially for the Fokhara and to a lesser extent for the Ebreeq and Money-Bank,
667 corroborating the results of the permutation tests (Table 3). At the level of the transmission
668 unit, the differences were predominantly blurred by the individual signatures on vessel
669 shapes, for the three pottery types. Yet, several clustering units stood out, indicating that the
670 transmission units still left some traces on the vessel shapes: for the Fokhara the potters from
671 U4 and U6 produced mean vessel shapes similar to each other within each unit, while the
672 mean vessel shapes produced by potters from U1, U2, U5, U7, and U8 were similar to a less
673 extent; and the mean vessel shapes produced by potters from U3 and U9 mainly diverged
674 within each unit. For Money-Bank, contrary to Fokhara the potters from U3 produced similar
675 mean vessel shapes. This can be explained by the fact that the five brothers of this
676 transmission unit produced Money-Bank in a high rate (except the youngest one P12) (Table
677 1). For the transmission units U1, U2, U5, U6, U7, and U9 a partial clustering was noticeable,
678 while no significant clustering appeared in U4 and U8. For Ebreeq, the potters from U1, U2,
679 and U6 produced similar mean vessel shapes within each transmission unit. By contrast, the
680 mean vessel shapes produced by potters from U4, U7, and U8 were less similar, and those
681 produced by potters from U3, U5, and U9 even less. When we focus on the Ebreeq neck only,
682 although there were a few pairs close to each other from the same transmission unit (e.g., P18
683 and P16, P22 and P20, P25 and P21, P10 and P11, P4 and P13), most of the neck shapes were
684 distinct between individuals, showing the strong effects of idiosyncrasy in producing the neck
685 of Ebreeq (see also Table 3). Overall, the resemblance between the family trees (Fig. 2) and
686 the dendrograms (Figs. 8, 9, S2, and S3) was present but weak, and the strength of
687 resemblance within each family and transmission unit differ according to the vessel type. For
688 example, the family resemblance found in Fokhara was not apparent in the neck of Ebreeq.

689 And the potters from U3 produced similar Money-Bank shapes, but dissimilar Fokhara
690 shapes. These original findings do not support our second operational hypothesis and we
691 conclude that cultural traits on ceramic vessel shape do not automatically propagate within the
692 transmission chain. While we found with the permutation tests that the variability within each
693 transmission unit was significantly smaller than the variability among the different
694 transmission units, in terms of the distance between each potter's mean shape, some potters
695 from the same transmission unit were similar, while others were not (Figs. 8, 9, S2, and S3).
696 The same pattern of results was visible in the PC shape-space: while some potter's vessel
697 shapes from the same transmission unit were close to each other, others were closer to potter's
698 vessel shapes from other transmission unit (Fig. 5). Hence, even if cultural traits were
699 inherited from the family and the transmission unit, they were diluted by individual traits
700 which came to the fore. As for biological evolution, a given vessel shape is a combination of
701 culturally inherited traits (i.e. the social bias occurring through learning) and both random and
702 non-random effects. Random effects (like genetic drift in evolution) come from random
703 idiosyncrasies among potters, and non-random effects (like natural selection in evolution)
704 come from environmental effects such as the market demand. These observations predict
705 frequent evolutionary divergence of vessel shapes over time, both within and among potters
706 (Futuyma, 2005; Nielsen and Slatkin, 2013). We also observed on Figure 9 the two atypical
707 Ebreeq neck shapes produced by P3 and P24 (Fig. 7), and on Figure S2 the atypical Ebreeq
708 shape produced by the learner P26 (Figs. 5-a and 6), this latter showing the initial learning
709 difference which presumably is the source of future variation and even evolution of shapes.

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***** Fig. 8 about here *****

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713 **Figure 8. Dendrograms of the mean vessel shapes for the Fokhara.** The mean vessel shapes of Fokhara
714 produced by all participants are presented. The similarity between the mean vessel shapes of the different
715 participants is indicated by the point at which the branches diverge. The distance of the divergence between the
716 branches is indicated in the horizontal axis. The further right the diverging point is, the more similar are the
717 mean vessel shapes in the corresponding branches.

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***** Fig. 9 about here *****

Figure 9. Dendrograms of the mean vessel shapes for the Ebreeq necks. The mean vessel shapes of Ebreeq necks produced by all participants are presented. The similarity between the mean vessel shapes of the different participants is indicated by the point at which the branches diverge. The distance of the divergence between the branches is indicated in the horizontal axis. The further right the diverging point is, the more similar are the mean vessel shapes in the corresponding branches.

3.2. Identification of the vessels

Figure 10 presents the performances of the potters when they were asked to recognize their own vessels and those of their colleagues. The among-participant mean number of correct answers was 11.2 ± 4.4 , which represents more than half of the total 18 vessel-groups examined (62%). Hence, as we expected in our third hypothesis, potters do perceive to some extent the individual signatures on ceramic shapes. Differences among the participants were observed: one potter correctly identified all the 18 vessel-groups, three potters correctly identified 16 vessel-groups, 13 potters identified more than 9 vessel-groups, and four potters correctly identified less than 6 vessel-groups. These performances were not significantly related to the age of the potters ($t(19) = -0.95$, $p = 0.34$), nor their experience ($t(19) = -0.98$, $p = 0.32$) and no tendencies of relation were observed. A factor which could influence the vessels' identification is the potters' personalities, such as perfectionism or curiosity which would enhance the observation of the vessels from the different individual and workshops. For example, P7 explained: *"I like to observe, this is not the case of everyone."* The participants identified their own vessels proportionally better than those of their colleagues: 2.6 ± 0.7 (87%) correct answers in average for a total of 3 vessel groups examined (Fig. 10, bottom panel). Because the sample size of the two groups (self-vessel vs. others-vessel) was different (3 and 15 respectively), we cannot provide a statistical test of this result. Yet, we assume that the identification of self-vessels is easier for the potters because of

754 a longer exposure, as it is easier for pianists to identify their own musical performances (Repp
755 and Knoblich, 2004). Pottery Type did not influence statistically the performances ($KW(2) =$
756 $3.54, p = 0.17$) (Ebreeq: 4.1 ± 1.8 ; Fokhara: 3.9 ± 2.0 ; Money-Bank: 3.2 ± 1.7). But the lower
757 identification score for the Money-Bank is probably due to its limited frequency of production
758 (Table 1). Finally, the transmission unit vessels were not significantly better identified than
759 the extended family vessels: $4.7 (\pm 2.7)$ and $4.0 (\pm 2.7)$, for the transmission unit and extended
760 families respectively ($t(20) = 0.85, p = 0.40$). This can be explained by the tight relations
761 existing between members of extended family.

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763 The fact that participants identified to some extent the vessels' producers confirms our
764 third operational hypothesis and leads to the conclusion of a possible influence of the potters'
765 choice in the selection and evolution of ceramic shapes. The interviews done with the potters
766 just after their participation in the task revealed that they detected the vessels' producers
767 through different visual characteristics including the vessel size, the colour of clay, and the
768 shape of the whole vessel. Other characteristics allowed them to identify specifically each
769 pottery type: Ebreeq were mainly identified by their neck, Fokhara by their aperture, and
770 Money-Bank by their bud. In fact, because of curvature changes and the presence of lips,
771 these vessel parts concentrate morphological information, and thus potential morphological
772 variations constituting possible individual or family styles. Sustaining this interpretation,
773 recent accounts of social group signatures in Indian water jars showed that the distinction
774 between the Hindu and Muslim communities depended upon the jar rim curve length and
775 neck curve (Harush et al., 2020). Participants also noticed the similarity between the vessels
776 of different individuals: "*The vessels of HIS and his son MOH are highly similar*" (P13), "*My*
777 *vessels look like those of my brother HAKA*" (P4). The vessels aesthetic and the
778 standardization of vessel-groups were also underlined and attributed to a specific potter (P8).
779 In contrast, the vessels with imperfections were attributed to the less advanced potters (P14,
780 P26, and P10 for the Ebreeq). As a test, the experimenter (E. Gandon) performed the vessel
781 identification task under the instructions of her assistant (W. Alqaraja). Because she observed
782 the production of all vessels, photographed them all, and manipulated them for the setup of
783 the identification task, it was expected that she could detect the different vessels' producers.
784 Her performance was 14 correct answers for a total of 18 vessel-groups examined (78%).
785 Overall, these results suggest that an exposure to the vessels in their context of production can
786 be sufficient to recognize their producers, even by outsiders. As P2 and P5 said: "*I recognize*

787 *the vessels of my father and those of my brother because I'm used to seeing them."*
788 Importantly, this exposure to the vessels of others depends on the life history of potter who
789 can change their usual workshop for economic reasons. For instance, at the end of our field
790 work, P2 left his father (P3) workshop because he did not have enough work and joined the
791 workshop of his uncle P7. The potter P19 also explained that he could easily identify the
792 vessels of his cousin P2 because he worked with him a few years ago.

793

794

***** Fig. 10 about here *****

795

796 **Figure 10. Performances of the participants in the vessel identification task.** Top panel (All): number of
797 correct answers, incorrect answers, and non-answers given by each participant when trying to identify the
798 producers of the 18 vessel groups (3 self-vessel and 15 others-vessel groups); bottom panel (Self): number of
799 correct answers, incorrect answers, and non-answers given by each participant when trying to identify his own
800 productions (3 self-vessel groups). The participants P12, P16, P17, P18, and P24 were not available to perform
801 this task.

802

803 4. Conclusion

804

805 Many studies have addressed the selective forces operating in cultural evolution
806 (Dunnell, 1980), but the production of variation occurring through the transmission has not
807 received much experimental attention. How much are the objects produced by learners
808 different from those of their trainers? Do inherited cultural traits propagate through the
809 successive transmissions across generations? Do craftsmen perceive individual morphological
810 signatures within traditional object assemblages? We tackled these questions in examining the
811 range of variability in vessel shapes produced by 26 potters from the pottery-making
812 community of Hebron. As a long-standing crafting tradition, this community represents a
813 valuable case study. The participants – all men – belonged to three distinct families and were
814 distributed through nine familial transmission units (Fig. 2). All participants were asked to
815 produce, in controlled conditions, five vessels of three different pottery types (Ebreeq,
816 Fokhara, and Money-Bank), then 21 participants were invited to visually identify their proper
817 productions and those of five other potters.

818

819 At the scale of individuals, the coefficients of variation of the vessel absolute
820 dimensions were limited, revealing the high level of practice of the participants in the wheel-
821 throwing skill. This intra-individual variation of the vessel dimensions also revealed the
822 irreducible copying error owing to the sensori-motor limits of human performances (Eerkens
823 and Lipo, 2005), and the existence of individual shape variants inside each pottery type. At
824 the scale of the pottery-making community, the vessel shapes produced by novices differed
825 from those of their trainers, reinforcing the view of a socially mediated individual learning in
826 handicraft. Across generations, traditional vessel shapes are not reproduced as perfect copies
827 but with a combination of cultural inherited traits and individual traits. The fact that vessel
828 shapes statistically differed among the 26 participants proved that these individual variants
829 were not simply due to the human copying error but to the idiosyncratic manner with which
830 each potter fashioned each pottery type. We propose that, for potters, traditional pottery types
831 exist not as fixed templates, but as norms with certain range of variation regarding what is
832 appropriate and what is not. The pool of individual shape variants owing to the learning
833 process constitutes a set of appropriate possible variations allowing potters to adapt each
834 pottery type to the current constraints of their socio-economic environment. For example, the
835 Fokhara could have a flatter bottom for customers using gas stove, and the money-bank could
836 have a limited maximal diameter depending upon the clay's hardness.

837

838 Concerning the evolutionary trend of the ceramic shapes, the findings contradicted our
839 assumption that all cultural morphological traits propagate necessarily through artisan
840 generations. Belonging to a familial transmission unit left cultural traits on the vessel shapes
841 but the individual traits prevented the conservation of clear cultural traits across the two
842 generations of participants in the present study. One could say that, from trainers to novices, a
843 transmission of cultural traits exists but is not exclusive, which corroborates the fact that the
844 learning process corresponds more to a socially mediated individual learning than to a fidelity
845 copying. Our quantification of the vessel shape variation indicated that the individual traits
846 overtook cultural ones, which could lead to divergence of vessel shapes within the
847 transmission chain. Hence, without stabilizing mechanisms, we could predict changes of the
848 ceramic shapes over time, exhibiting evolution disconnected from the social organization of
849 their production. However, when we compared the vessel shapes of a given pottery type
850 (Money-Bank) produced by potters originated from four distinct pottery-making communities
851 (Indian Prajapati, Indian Multani, Nepalese, and Palestinian), we observed that the subsets of

852 vessels produced by each community were distinct from each other's ($F(3, 192) = 24.73, p <$
853 0.001) (Fig. S4). This indicates that ceramic shapes certainly carry inherited cultural traits
854 transmitted through learning lineages. For future research, it would be challenging to develop
855 a more qualitative analysis of the vessel shapes, isolating the various discrete morphological
856 traits interwoven in the whole vessel shape. We hypothesize that certain traits could
857 perpetuate through generations and even historical periods, although they do not constitute the
858 whole shape (Harush et al., 2020). We stress that, if it is the case, our study demonstrated that
859 such cultural continuity in ceramic shapes does not result from fidelity copying in the form of
860 a reproduction, by the novices, of all the trainers' vessel morphological traits. Instead, this
861 shape continuity could result from stabilizing mechanisms such as consumer demand, which
862 directly influences the potters' choice. The results of the identification task supported this
863 view, showing that potters do perceive the subtle same-type vessel shape variations and
864 thereby could select the individual variant they prefer, notably disseminating it by
865 reproduction. Importantly, not only expert potters perceive the morphological variations, but
866 they are also able to produce new shapes without a long training period (Gandon and Roux,
867 2019). This imply that they can easily modify the shape of a given pottery type following their
868 choice for new morphological traits.

869

870 In brief, the Hebron case offered insights into the cultural transmission and evolution
871 of craft objects. The results highlight the individual part of the learning process and of the
872 subsequent developed skills and vessels (Gandon et al., 2018; Gandon et al., 2020a, Gandon
873 et al., 2020b). This study will help archaeologists to interpret the ancient ceramic shapes
874 variation and to better understand how those shapes have evolved. Now, a new avenue of
875 research is opened in order to disentangle the individual and cultural morphological traits.
876 This is essential in order to obtain a thorough understanding of the evolution of morphological
877 types across time and space. Finally, the craftsmen's ability to perceive shape variations
878 certainly plays a key role in the selection and evolution of traditional objects' shapes. We
879 demonstrated that craftsmen practicing in shared or neighbour workshops developed,
880 probably through simple vessels exposure, the ability to perceive the slight morphological
881 differences characterizing the objects of each individual. The question remains to understand
882 how potters' personalities modulate the development of this perceptive ability.

883

884

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899 Dataset reference

900

901 The photos dataset is provided in a Zenodo repository link: <https://zenodo.org/record/4589147>

902 References

903

904

905 Anderson, M.J. (2001). A new method for non- parametric multivariate
906 analysis of variance. *Austral ecology*, 26(1), 32-46. [https://doi.org/10.1111/j.1442-](https://doi.org/10.1111/j.1442-9993.2001.01070.pp.x)
907 [9993.2001.01070.pp.x](https://doi.org/10.1111/j.1442-9993.2001.01070.pp.x)

908

909 Anderson, M.J., Ellingsen, K.E., McArdle, B.H. (2006). Multivariate dispersion as a measure
910 of beta diversity. *Ecology letters*, 9(6), 683-693. [https://doi.org/10.1111/j.1461-](https://doi.org/10.1111/j.1461-0248.2006.00926.x)
911 [0248.2006.00926.x](https://doi.org/10.1111/j.1461-0248.2006.00926.x)

912

913 Boyd, R., Richerson, P.J., Henrich, J. (2011). The cultural niche: Why social learning is
914 essential for human adaptation. *Proceedings of the National Academy of Sciences*,
915 108(Supplement 2), 10918-10925. <https://doi:10.1073/pnas.1100290108>

916

917 Boyer, I., Bril, B. (2001). Structuring a child activity: A comparative study of mother-child
918 interaction in a complex bimanual task. In: Van Der Kamp, J., Ledebt, A., Savelsbergh, G.,
919 Thelen, E. (Eds). Proceedings of the International Conference on Motor Development and
920 Learning in Infancy. Amsterdam: IFKB, pp. 55-58.

921

922 Bril, B. (1986). The Acquisition of an Everyday Technical Motor Skill: The Pounding of
923 Cereals in Mali (Africa). In: Whiting, H.T.A., Wade, M.G. (Eds), Themes in Motor
924 Development. NATO ASI Series (Series D: Behavioural and Social Sciences), vol 35.
925 Springer, Dordrecht, pp. 315-326. https://doi.org/10.1007/978-94-009-4462-6_18

926

927 Bril, B. (2002). Apprentissage et contexte. *Intellectica*, 35, 251-268.
928 <https://doi.org/10.3406/intel.2002.1669>

929

930 Bril, B. (2015). Learning to use tools: A functional approach to action. In: Filletaz, L., Billet,
931 S. (Eds.). Learning through and for practice: contributions from Francophone perspectives.
932 Springer International Publishing, pp. 95-118.

933

934 Bril, B. (2018). Action, Movement, and Culture: Does Culture Shape Movement?
935 *Kinesiology Review*, 7(1), 79-87. <https://doi.org/10.1123/kr.2017-0060>

936

937 Crown, P.L. (2014). The archaeology of crafts learning: Becoming a potter in the Puebloan
938 Southwest. *Annual Review of Anthropology*, 43, 71-88. [https://doi:10.1146/annurev-anthro-](https://doi:10.1146/annurev-anthro-102313-025910)
939 [102313-025910](https://doi:10.1146/annurev-anthro-102313-025910)

940

941 Dunnell, R.C. (1980). Evolutionary theory and Archaeology. *Advances in Archaeological*
942 *Method and Theory*, 3, 35-99. <https://doi.org/doi.org/10.1016/B978-0-12-003103-0.50007-1>

943

944 Eerkens, J.W., Bettinger, R.L. (2001). Techniques for assessing standardization in artifact
945 assemblages: Can we scale material variability? *American Antiquity*, 66(3), 493-504.
946 <https://doi.org/10.2307/2694247>

947

- 948 Eerkens, J.W., Lipo, C.P. (2005). Cultural transmission, copying errors, and the generation of
949 variation in material culture and the archaeological record. *Journal of Anthropological*
950 *Archaeology*, 24(4), 316-334. <https://doi.org/doi.org/10.1016/j.jaa.2005.08.001>
951
- 952 Futuyma, D.J. (2005). *Evolution*. Sinauer & Associates. Inc., Sunderland, Massachusetts,
953 226-243.
954
- 955 Gandon, E., Nonaka, T., Sonabend, R., Endler, J. (2020a). Assessing the influence of culture
956 on craft skills: a quantitative study with expert Nepalese potters, *PLoS ONE*.
957 <https://doi.org/10.1371/journal.pone.0239139>
958
- 959 Gandon, E., Nonaka, T., Endler, J., Coyle, T., Bootsma, R.J. (2020b). Traditional craftspeople
960 are not copycats: Potter idiosyncrasies in vessel morphogenesis, *PLoS ONE*.
961 <https://doi.org/10.1371/journal.pone.0239362>
962
- 963 Gandon, E., Roux, V. (2019). Cost of motor skill adaptation to new craft trait: Experiments
964 with expert potters facing unfamiliar vessel shapes and wheels. *Journal of Anthropological*
965 *Science*, 53, 229-239. <https://doi.org/10.1016/j.jaa.2019.01.004>
966
- 967 Gandon, E., Coyle, T., Bootsma, R.J., Roux, V., Endler, J. (2018). Individuals among the
968 pots: How do traditional ceramic shapes vary between potters? *Ecological Psychology*, 30(4),
969 299-313. <https://doi.org/10.1080/10407413.2018.1438200>
970
- 971 Gandon, E., Coyle, T., Bootsma, R.J. (2014a). When handicraft experts face novelty: Effects
972 of shape and wheel familiarity on individual and community standardization of ceramic
973 vessels. *Journal of Anthropological Archaeology*, 35, 289-296.
974 <https://doi.org/10.1016/j.jaa.2014.06.008>
975
- 976 Gandon, E., Roux, V., Coyle, T. (2014b). Copying errors of potters from three cultures:
977 Predictable directions for a so-called random phenomenon. *Journal of Anthropological*
978 *Archaeology*, 33, 99-107. <https://doi.org/10.1080/10407413.2018.1438200>

979

980 Gandon, E., Bootsma, R.J., Endler, J., Grosman, J. (2013). How can ten fingers shape a pot?
981 Evidence for equivalent function in culturally distinct motor skills. PLoS ONE 8(11): e81614.
982 <https://doi:10.1371/journal.pone.0081614>

983

984 Gibson, J.J. (1979). The theory of affordances. The ecological approach to visual perception.
985 Houghton Mifflin, Boston.

986

987 Harush, O., Roux, V., Karasik, A., Grosman, L. (2020). Social signatures in standardized
988 ceramic production – A 3-D approach to ethnographic data. *Journal of Anthropological*
989 *Archaeology*, 60, 101208. <https://doi.org/10.1016/j.jaa.2020.101208>

990

991 Ingold, T. (2001a). From the transmission of representations to the education of attention. In:
992 Whitehouse, H. (Ed.), *The Debated Mind: Evolutionary Psychology Versus Ethnography*.
993 Berg, Oxford, pp. 113-153.

994

995 Ingold, T. (2001b). Beyond art and technology: The anthropology of skill. In: Schiffer, M.B.
996 (Ed.), *Anthropological perspective on Technology*. University of New Mexico Press,
997 Albuquerque, pp. 17-31.

998

999 Kvamme, K.L., Stark, M.T., Longacre, W.A. (1996). Alternative procedures for assessing
1000 standardization in ceramic assemblages. *American Antiquity*, 61, 116-126.
1001 <https://doi.org/10.2307/282306>

1002

1003 Lave, J., Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge
1004 University Press, New York. <https://doi:10.1017/CBO9780511815355>

1005

1006 Lewis, H.M., Laland, K.N. (2012). Transmission fidelity is the key to the build-up of
1007 cumulative culture. *Philosophical Transactions of the Royal Society of London B: Biological*
1008 *Sciences*, 367(1599), 2171-2180. <https://doi:10.1098/rstb.2012.0119>

1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
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1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039

Longacre, W.A. (1999). Standardization and specialization: What's the link? In: Skibo, J.M.,
Feinman, G. (Ed), Pottery and People. Salt Lake City, University of Utah Press, pp. 44-58.

Miton, H., Charbonneau, M. (2018). Cumulative culture in the laboratory: Methodological
and theoretical challenges. *Proceedings of the Royal Society B: Biological Sciences*,
285(1879). <https://doi.org/10.1098/rspb.2018.0677> PMID:29848653

McLellan, T., Ender, J.A. (1998). The relative success of some methods for measuring and
describing the shape of complex objects. *Systematic Biology*, 47, 264-281.
<https://doi.org/10.1080/106351598260914>

Mesoudi, A. (2017). Pursuing Darwin's curious parallel: Prospects for a science of cultural
evolution. *Proceedings of the National Academy of Sciences*, 114(30), 7853-7860.
<https://doi.org/10.1073/pnas.1620741114>

Minar, C.J., Crown, P.L. (2001). Learning and craft production: An introduction. *Journal of*
Anthropological Research, 57(4), 369-380. <https://doi:10.1086/jar.57.4.3631351>

Nielsen, R., Slatkin, M. (2013). *An introduction to population genetics*. Sunderland, MA:
Sinauer Associates.

Repp, B.H., Knoblich, G. (2004). Perceiving action identity: How pianists recognize their
own performances. *Psychological Science*, 15(9), 604-609.
<https://doi.org/doi.org/10.1111/j.0956-7976.2004.00727.x>

Rogoff, B. (1995). Observing sociocultural activity on three planes: Participatory
appropriation, guided participation, and apprenticeship. In: Wertsch, J.V., Del Río, P.,
Alvarez, A. (Eds.), *Sociocultural studies of mind*. Cambridge University Press, pp. 139-164.
<https://doi.org/10.1017/CBO9781139174299.008>

1040 Roux, V. (2003). Ceramic Standardization and Intensity of Production: Quantifying Degrees
1041 of Specialization. *American Antiquity*. 68(4), 768-782. <https://doi.org/10.2307/3557072>

1042

1043 Roux, V., Corbetta, D. (1989). Wheel-throwing technique and craft specialization. In: Roux,
1044 V. (Ed.), *The Potter's Wheel. Craft specialization and technical competence*. New Delhi,
1045 Oxford and IBH Publishing, pp. 1-91.

1046

1047 Roux, V., Karasik, A. (2018). Standardized vessels and number of potters: looking for
1048 individual production. In: Vukovic, J., Miloglav, I. (Eds.), *Artisans Rule: product*
1049 *Standardization and Craft Specialization in Prehistoric Society*. Cambridge: Cambridge
1050 Scholars Publishing, pp. 20-39.

1051

1052 Tennie, C., Call, J., Tomasello, M. (2009). Ratcheting up the ratchet: On the evolution of
1053 cumulative culture. *Philosophical Transactions of the Royal Society B: Biological Sciences*,
1054 364(1528), 2405-2415. <https://doi:10.1098/rstb.2009.0052>

1055

1056 Tomasello, M. (1999). *The Cultural Origins of Human Cognition*. Harvard University Press,
1057 Cambridge.

1058

1059 Wiessner, P. (1983). Style and social information in Kalahari San projectile points. *American*
1060 *antiquity*. 48(2), 253-276.

1061

1062

1063

1064

1065

1066

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1081 Captions Supplement Figures

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1084 **Figure S1. The two stages method of throwing used for the Ebreeq and Fokhara.** In a first stage, the potter
1085 throws the roughout of the vessel keeping the lower part of the wall thick (left drawing). This roughout is then
1086 cut from the wheel and left to dry under conditions allowing the lower part to remain wet. In a second stage, the
1087 roughout is placed upside-down on the wheel (sometimes in a chuck, made up of leather-hard ring of clay) for
1088 the throwing of the final vessel (right drawing). Starting by the base or the upper part depends on the vessel type.
1089 For the Ebreeq, the potter starts throwing the base, while for the Fokhara he starts throwing the upper part.
1090 Starting by the base or by the opening depends on the location of the maximum diameter and enables the potter
1091 to overcome the risks of collapse while wheel throwing thin walls, from the bottom to the top without further
1092 post-throwing operations (drawings by X. Desormeau).

1093

1094 **Figure S2. Dendrograms of the mean vessel shapes for the Ebreeq.** The mean vessel shapes of Ebreeq
1095 produced by all participants are presented. The similarity between the mean vessel shapes of the different
1096 participants is indicated by the point at which the branches diverge. The distance of the divergence between the
1097 branches is indicated in the horizontal axis. The further right the diverging point is, the more similar are the
1098 mean vessel shapes in the corresponding branches.

1099

1100 **Figure S3. Dendrograms of the mean vessel shapes for the Money-Bank.** The mean vessel shapes of Money-
1101 Bank produced by all participants are presented. The similarity between the mean vessel shapes of the different
1102 participants is indicated by the point at which the branches diverge. The distance of the divergence between the

1103 branches is indicated in the horizontal axis. The further right the diverging point is, the more similar are the
 1104 mean vessel shapes in the corresponding branches.

1105

1106 **Figure S4. Geometrical distribution of the Money-Bank thrown by potters of four cultures.** Indian
 1107 Prajapati: yellow, Indian Multani: orange, Nepalese: blue, Hebron: purple. The points in the PC shape-space
 1108 show the variations among potters, for the four groups, and are based upon Elliptical Fourier coefficients derived
 1109 from every pot shape. The pot outlines (right of the graph) are reconstructions of the shapes resulting from the
 1110 mean coefficients of each group's production.

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1117 Supplement Tables

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Dimensions (cm)										
Ebreeq										
Potter	B		H		A		MD		HMD	
	m	sd	m	sd	m	sd	m	sd	m	sd
P1	8.8	0.5	29.4	0.4	6.7	0.2	17.9	0.3	12.2	0.4
P2	7.8	0.2	29.6	0.9	7.2	0.6	15.8	0.3	11.1	0.7
P3	8.0	0.4	30.4	0.5	5.1	0.4	17.2	0.2	11.7	0.3
P4	8.4	0.2	29.6	0.3	6.0	0.2	16.9	0.3	12.4	0.4
P5	7.5	0.2	29.2	0.8	6.5	0.1	16.7	0.2	12.1	0.3
P6	8.0	0.2	29.2	0.6	7.0	0.2	17.2	0.2	12.5	0.4
P7	8.4	0.1	29.8	0.3	7.1	0.2	17.7	0.4	12.7	0.1
P8	8.1	0.3	31.5	0.6	7.0	0.2	17.8	0.4	12.7	0.4
P9	8.1	0.2	31.2	0.4	7.2	0.2	16.5	0.4	14.1	0.4
P10	10.1	0.5	26.4	1.0	8.0	0.3	14.7	0.6	11.1	0.8
P11	8.4	0.1	25.6	0.4	7.1	0.3	13.3	0.6	10.1	1.7
P13	7.5	0.2	31.1	0.6	6.7	0.1	17.1	0.2	13.3	0.6
P14	8.0	0.6	25.8	0.9	6.3	0.3	15.0	0.3	10.1	0.8
P15	8.7	0.2	29.9	0.5	6.9	0.1	17.6	0.5	13.0	0.2
P16	10.2	0.7	30.0	0.8	6.9	0.3	18.2	0.5	12.7	0.3
P17	9.1	0.7	27.8	1.2	7.9	0.3	17.4	0.5	11.6	0.7
P18	10.4	0.8	29.2	1.4	7.3	0.3	17.0	0.8	11.3	0.9
P19	9.2	0.8	29.9	1.2	7.4	0.4	17.6	0.7	12.9	0.7
P20	8.2	0.3	27.2	1.5	6.6	0.2	16.3	0.5	12.4	0.6
P21	8.0	0.2	29.0	1.0	7.2	0.4	15.9	0.5	13.6	0.7
P22	8.6	0.3	30.3	0.8	6.9	0.2	16.5	0.7	12.6	0.7
P23	8.7	0.2	29.0	0.8	7.4	0.4	17.0	0.5	11.7	0.1

P24	7.7	0.2	29.7	0.6	6.0	0.2	16.2	0.6	13.4	0.4
P25	8.6	0.4	26.4	0.6	7.2	0.2	15.3	0.3	11.4	0.5
P26	8.7	0.2	27.8	0.6	6.8	0.3	14.7	0.4	11.6	0.8
m	8.5		29.0		6.9		16.5		12.2	
sd	0.8		1.6		0.6		1.2		1.0	

1120

1121 **Table S1. Ebreeq absolute dimensions (centimeters).** The mean and standard deviation are computed over the
 1122 five replicates thrown by each participant. B: Base, H: Height, A: Aperture, MD: Maximal Diameter, HMD:
 1123 Height of Maximal Diameter. The two last lines of the table present the among-participant mean and standard
 1124 deviation.

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Dimensions (cm)									
Fokhara									
	H		A		MD		HMD		
Potter	m	sd	m	sd	m	sd	m	sd	
P1	16.2	0.4	12.0	0.3	18.9	0.3	8.3	0.2	
P2	16.1	0.8	10.7	0.1	15.8	0.7	5.9	0.5	
P3	15.0	0.6	12.0	0.2	16.5	0.3	6.5	0.3	
P4	14.1	0.6	11.8	0.1	15.8	0.3	6.3	0.4	
P5	16.6	0.5	10.9	0.2	17.1	0.4	8.2	0.5	
P6	14.4	0.4	11.3	0.3	15.6	0.6	5.7	0.3	
P7	16.5	0.3	14.9	0.6	17.0	0.4	6.8	0.2	
P8	16.3	0.2	11.7	0.2	16.6	0.3	5.2	0.3	
P9	17.8	0.5	13.2	0.7	15.6	0.9	7.0	0.5	
P10	13.8	0.8	10.9	0.3	13.7	0.4	3.7	0.4	
P11	13.0	0.7	10.2	0.3	12.6	0.3	4.7	1.1	
P13	16.8	0.4	10.9	0.8	15.7	0.5	5.6	0.2	
P14	12.9	0.2	10.4	0.5	14.2	0.3	4.9	0.2	
P15	14.5	0.5	10.7	0.4	16.1	0.6	4.9	0.1	
P16	11.9	0.5	12.3	0.4	14.6	0.5	3.6	0.3	
P17	12.0	0.5	11.8	0.3	14.7	0.5	4.4	0.6	
P18	12.1	0.3	12.0	0.4	14.3	0.4	3.4	0.3	
P19	18.0	0.5	11.0	0.3	16.6	0.4	6.2	0.3	
P20	13.3	0.7	11.6	0.3	14.4	0.5	4.4	0.3	
P21	13.1	0.6	11.8	0.8	14.4	0.6	3.9	0.3	
P22	13.7	0.6	11.9	0.6	14.8	0.6	4.3	0.3	
P23	13.1	0.8	11.1	0.6	14.7	0.5	3.6	0.3	
P24	14.4	0.5	12.5	1.1	14.5	0.5	4.9	0.5	

P25	14.9	0.8	11.6	0.4	15.6	0.8	4.4	0.5
P26	15.2	0.9	12.8	0.5	14.2	0.7	6.7	0.5
m	14.6		11.7		15.4		5.3	
sd	1.8		1.0		1.3		1.4	

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1133 **Table S2. Fokhara absolute dimensions (centimeters).** The mean and standard deviation are computed over
 1134 the five replicates thrown by each participant. H: Height, A: Aperture, MD: Maximal Diameter, HMD: Height of
 1135 Maximal Diameter. The two last lines of the table present the among-participant mean and standard deviation.

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Dimensions (cm)									
Money-Bank									
	B		H		MD		HMD		
Potter	m	sd	m	sd	m	sd	m	sd	
P1	6.6	0.3	15.3	0.4	12.5	0.2	6.0	0.2	
P2	4.9	0.3	11.9	0.2	10.0	0.2	5.0	0.2	
P3	4.9	0.2	11.9	0.3	10.0	0.2	5.3	0.1	
P4	5.6	0.2	12.5	0.7	10.4	0.4	5.5	0.4	
P5	5.4	0.4	11.7	0.4	10.0	0.4	5.1	0.2	
P6	5.0	0.3	12.9	0.5	10.3	0.1	5.5	0.5	
P7	6.0	0.4	12.1	0.5	10.9	0.3	5.8	0.2	
P8	5.3	0.2	12.6	0.4	10.5	0.2	5.9	0.3	
P9	6.2	0.5	12.5	0.5	11.1	0.4	5.8	0.2	
P10	5.2	0.3	12.9	0.1	11.0	0.3	6.1	0.2	
P11	5.4	0.6	13.0	0.8	10.6	0.5	6.1	0.4	
P12	5.3	0.1	12.4	0.4	9.8	0.3	5.4	0.4	
P13	5.5	0.1	13.6	0.3	11.6	0.3	6.6	0.3	
P14	5.7	0.4	10.6	0.4	10.4	0.3	4.3	0.2	
P15	5.3	0.2	11.5	0.6	10.6	0.3	6.4	0.4	
P16	5.3	0.6	11.6	0.1	10.6	0.4	4.9	0.2	
P17	5.1	0.4	12.1	0.4	10.7	0.3	5.6	0.5	
P18	5.4	0.4	11.2	0.4	10.0	0.3	4.5	0.5	
P19	4.7	0.2	13.1	0.6	10.4	0.3	7.1	0.3	
P20	6.3	0.3	10.0	0.3	10.7	0.3	4.5	0.4	
P21	4.8	0.3	11.1	0.3	9.7	0.3	5.3	0.4	
P22	5.7	0.3	9.4	0.4	10.0	0.2	4.4	0.2	
P23	5.7	0.3	10.6	0.5	10.8	0.5	5.3	0.5	

P24	5.4	0.3	10.6	0.6	10.0	0.3	4.4	0.5
P25	4.9	0.3	11.6	0.6	9.8	0.3	6.1	0.3
P26	5.8	0.2	10.4	0.8	9.8	0.3	3.7	0.5
m	5.4		11.9		10.5		5.4	
sd	0.5		1.3		0.6		0.8	

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1145 **Table S3. Money-Bank absolute dimensions (centimeters).** The mean and standard deviation are computed
 1146 over the five replicates thrown by each participant. B: Base, H: Height, MD: Maximal Diameter, HMD: Height
 1147 of Maximal Diameter. The two last lines of the table present the among-participant mean and standard deviation.

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Pair	t	df	p
Ebreeq – Fokhara	-3.45	24	0.002
Ebreeq – Money-Bank	-4.21	24	0.0003
Fokhara - Money-Bank	-0.89	24	0.37

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1157 **Table S4. Post-hoc t-test for the effect of pottery type on the coefficient of variation of the production.**

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