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LAS PRIMERAS PRODUCCIONES CERÁMICAS: EL VI MILENIO CAL AC EN LA PENÍNSULA IBÉRICA

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TECHNOLOGICAL STYLE, *CHAÎNE OPÉRATOIRE*, AND LABOR INVESTMENT OF EARLY NEOLITHIC POTTERY

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Joan Bernabeu Aubán

This chapter presents technological data of Early Neolithic pottery from the Valencian Region to characterize the technological styles through the *chaîne opératoire* or production sequence and discuss degrees of labor investment in specific Early Neolithic wares. It provides a fine-grained chronological view of pottery manufacture among early agro-pastoral societies in the Western Mediterranean and discusses the relationship between the manufacturing sequence, technology, and decorative style.

Technological style is based on the observation that the manufacturing process consists of a variety of steps that can be executed in different ways. Decisions relating to production sequences —forming technique, clay preparation, etc.— are largely based on conscious and subconscious considerations formed by cultural norms. As a result, technological style is more resistant to change than decorative style. Ethnographic and ethnoarchaeological data indicate that decorated ceramics often represent permeable social boundaries (see e.g., Stark, 1998a; Stark *et al*., 2008; Sterner, 1989), since the relationship between contexts of production and distribution are unclear. In contrast, technological style is a marker of more localized social boundaries (Stark, 1998b). Therefore, comparisons of technological and decorative styles provide new insights into early pottery production and the complexities in community relationships during the Early Neolithic.

The present study focuses on technological data from pottery assemblages with clear chronological and stylistic patterns. Prior to this research, technological studies of Early Neolithic pottery from the Valencian Region was largely analyzed as en bloc (see e.g., McClure, 2007, in press; McClure and Molina, 2008), with little or no chronological subdivisions. This approach proved useful in comparing Early to Middle and Late Neolithic pottery sequences and organizations, but failed to capture the internal variability within the Early Neolithic period. The study presented here provides an opportunity to analyze production phases within the Early Neolithic and compare different decorative styles.

Technological and stylistic data from 119 vessels were analyzed from five Early Neolithic sites: Cova de l'Or, Cova de la Sarsa, Mas d'Is, Abric de la Falguera, and El Barranquet. Following Bernabeu *et al*. (Chapter 7, in this volume), the assemblages were attributed to one of 5 phases (tab. 3.1) and the results of decorative and motif analyses could be compared to the technological attributes we identified. The analysis was guided by the

Site	Type	Phase	Vessels analyzed
El Barranquet	Open air site	1 and 1.5	12
Mas d'Is	Open air site	1 and 1.5	17
Mas d'Is	Open air site	2	9
Cova de l'Or	Cave	2	5
Cova de l'Or	Cave	3/4	19
Abric de la Falguera	Rock shelter	5	25
Mas d'Is	Open air site	5	1
Cova de la Sarsa	Cave	5	30
Cova de l'Or	Cave	6	3

Table 3.1. Characteristics of the sample used in the present work.

chaîne opératoire and divided into public and private attributes. These are attributes that are equally important in the production sequence of the vessel, but differ in their implications for contemporary perceptions of pottery. Specifically, some steps of the production sequence are known only to the potter, such as the size and sorting of inclusions, whereas everyone can see others like surface finish and firing atmosphere. This distinction is important when thinking about ceramic technology in the context of this volume, since it links some technological decisions with stylistic outcomes, but not others. Furthermore, the distinction provides the opportunity to compare technological and decorative styles.

In previous research, McClure and Molina (2008) compared technological characterstics of Cardial pottery with other Early Neolithic assemblages. They found that despite some variability within the assemblages, the Early Neolithic people living in the area shared a regional potting tradition. They tempered their vessels and decorated them in a similar fashion across sites, and maintained a wide array of techniques and shapes while using different raw materials. Labor or time investment in pottery was relatively high in comparison to later in the Neolithic. However, they found that Cardial production was distinct from other Early Neolithic pottery. Based on samples from Mas d'Is, they suggested that emphasis was placed on "public" attributes in the manufacture of Cardial Ware. Differences in production techniques between two households at Mas d'Is were situated on the "invisible" side of the attribute spectrum: pottery was made differently, but the end product looked alike. In other words, distinct technological styles were represented within stylistically similar assemblages. They argued that expectations of Cardial vessels extended beyond the household and was a community-wide phenomenon. Therefore, Cardial Ware could be understood as a distinct Neolithic technological practice that was part of a larger, more varied pottery tradition.

In this paper, we explore these ideas in greater depth and detail with a larger dataset and greater chronological refinement, testing the interpretations of previous research on a broad scale. Specifically, this analysis asks what is the relationship between technological and decorative style and what are the internal dynamics of this relationship during the Early Neolithic. To address these questions, we briefly describe the methodology employed and present results of the technological analysis. This is then followed by a discussion of the Production Task Index (PTI) as a measure of time or labor investment in pottery production during the Early Neolithic and how production practices create stylistic variability.

METHODS

In order to define technological practices to compare to decorative styles, we collected macro-visual data on 119 vessels from five Early Neolithic sites in the Valencian Region. Earlier publications on Neolithic pottery technology from Valencia included petrographic analysis of thin sections to identify inclusions and elemental analyses to reconstruct raw material use (McClure, 2007, in press; McClure *et al.*, 2006; McClure and Molina 2008). Petrographic data for this study are published elsewhere in this volume (see Clop, Chapter 2). The size, relative quantity, sorting, and macro-visual angularity of inclusions as well as paste texture were documented. Traces of manufacturing procedures —such as surface treatments, firing atmosphere, and forming marks— were

identified. All variables were analyzed following the methods described in Orton *et al*. (1993), Rice (1989), and Rye (1981), and are described in greater detail elsewhere (McClure, 2007, in press; McClure *et al*., 2006). Emphasis is placed on the comparison of private and public attributes in Early Neolithic pottery production and chronological shifts. Furthermore, we compare these data for different decorative types.

The samples available for this analysis come from two open air sites, El Barranquet and Mas d'Is, and three caves or rockshelters, Cova de l'Or, Cova de la Sarsa, and Abric de la Falguera. The assemblages are well documented and details on provenance and selection for analysis, as well as the basis for attribution to chronological phase are provided elsewhere in this volume (see Bernabeu *et al*., Chapter 7). It should be noted, however, that despite the strength of the assemblages and their importance for understanding prehistoric pottery production, some phases are represented by material from a single site or site type. Therefore the analyses presented here do not encompass the totality of early Neolithic pottery manufacture. Indeed, the heavy reliance on cave sites as sources for pottery assemblages limits the interpretive potential of the variability in production, since potters did not make vessels in the cave but rather wares were selected by individuals to take to the cave with them. The criteria for this selection remain unknown. However, the vessels included in this analysis provide the largest and best documented dataset to date and as such gives greater insight into Neolithic pottery production.

Production Task	Points
Texture	
Smooth	4
Fine	3
Irregular	2
Hackly	1
Laminated	0
Inclusion Size	
Fine sand (1/8 - 1/4 mm)	4
Medium sand (1/4 - 1/2 mm)	3
Coarse sand (1/2 - 1.0 mm)	2
Very coarse sand (1.0 - 2.0 mm)	1
Sorting	
Very poor	1
Poor	2
Fair	3
Good	4
Very good	5
Inclusion Frequency	
5 percent	4
10 percent	3
20 percent	2
30 percent	1
Surface Treatment	
Smoothed	1
Well smoothed (espatulado)	2
Polished/burnished	3

Table 3.2. Production Task Index and Point Values used in the present analysis.

The *chaîne opératoire* approach emphasizes the steps of the production sequence with equal emphasis. When comparing technological practice with stylistic variability, however, a measure of relative technological complexity is useful. The Production Task Index (PTI) provides researchers with a tool to aggregate *chaîne opératoire* data into a single value. In practice, the PTI assesses efficiency and labor investment in ceramic production (Feinman *et al*., 1981; Hagstrum, 1985, 1988; McClure, 2007) by identifying the relative investment of each step in the production sequence. Stages of the sequence are assigned points based on the relative labor or time investment for that step (tab. 3.2). The resulting number is a proxy of time/labor investment in the vessel and can be compared between vessels, between sites, and through time. A combination of externally visible factors, such as decoration, and elements known only to the potter, such as density of inclusions, combine in the scoring system. Comparing the data for specific vessels to average labor input furthermore provides a measure of the impact of ceramic variability on time allocation and labor investment. PTI values were calculated for 117 vessels and are compared between sites, chronological phases, and decorative techniques.

PRIVATE ATTRIBUTES

Private attributes are elements of the production sequence that are identifiable in fresh breaks of potsherds, but not visible in a whole vessel. They consist largely of paste characteristics such as inclusion size, frequency, and sorting, as well as aggregate measures like texture, a combination of clay and inclusion properties of the paste. These elements are rough descriptors of clay preparation techniques that include many more steps than

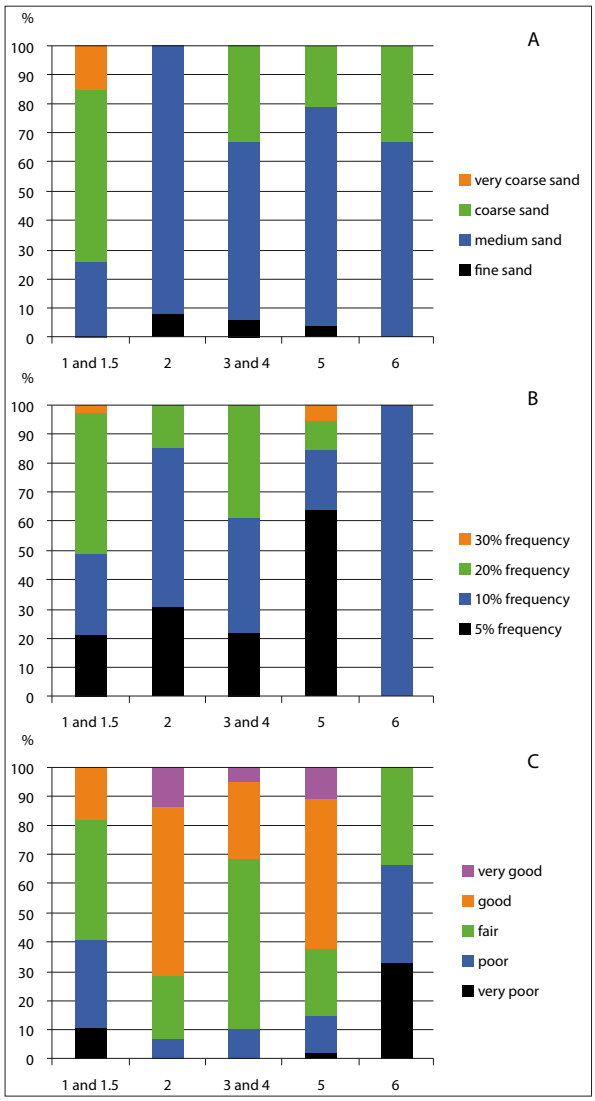


Figure 3.1. Relative proportions of: A: inclusion size (n=117); B: inclusion frequency (n=119); and C: inclusion sorting (n=119) by chronological phase on macro-visual inspection of fresh breaks.

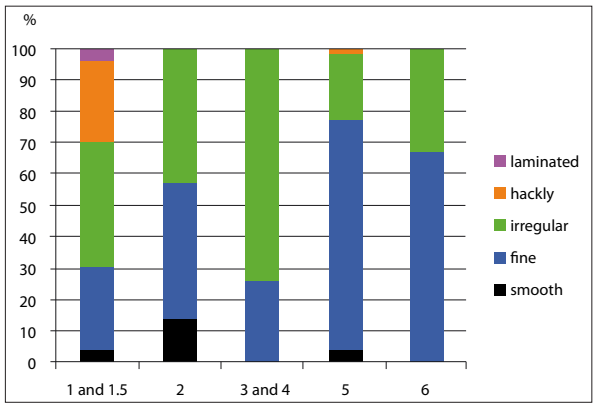


Figure 3.2. Relative proportion of texture by phase (n=119).

are visible archaeologically, such as raw material procurement, sifting, adding water, drying, and kneading. They are the result of a potter's actions during the production of a vessel and although they have consequences for a vessel's application space (e.g., thermal conductivity, porosity, strength, etc.), they are not readily visible for a consumer.

Figures 3.1 and 3.2 present the distributions of private attributes by chronological phase. Visible inclusions range in size from fine to very coarse sand and the vast majority of the vessels were made with medium to coarse sized inclusions. Of note are vessels from Phase 1 and 1.5[1] that tend towards larger inclusions and a greater frequency than pottery from other phases. The assemblage is also distinguished by poorer sorting and a more hackly texture.

While most sites and phases analyzed displayed a variety of inclusion sizes, frequencies, sorting, and texture, Barranquet and Mas d'Is in Phase 1 and 1.5 stand out in comparison to all other Early Neolithic phases analyzed.

PUBLIC ATTRIBUTES

Public attributes are elements of technology and style that are visible to the naked eye in a finished vessel, such as firing atmosphere, surface finishes, decoration, size, and shape. Some elements form part of decorative style, such as burnishing or slips, while others are not included in most definitions of decoration, such as firing atmosphere. In all cases, however, these elements are visible to wide audiences and therefore underlie different constraints than private attributes. These attributes are not exclusively within the realm of the potter. Group expectations, visual literacy, and functional qualities of size and shape influence the execution of these attributes and the degree of innovation seen through time.

Since Early Neolithic pottery assemblages from the Valencian Region are very fragmentary, data on vessel size and shape are seldom available. Rim thickness provides one measure for comparison that is a combination of size,

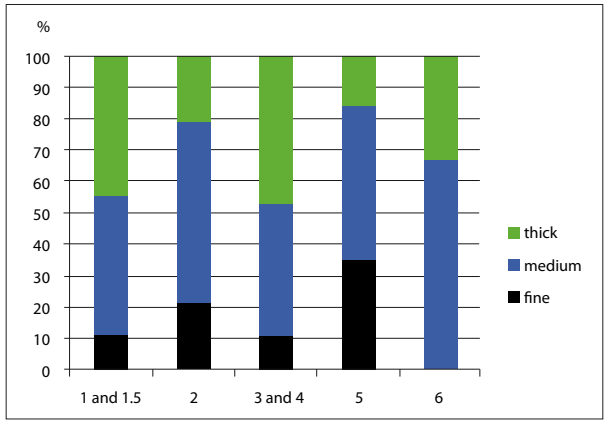
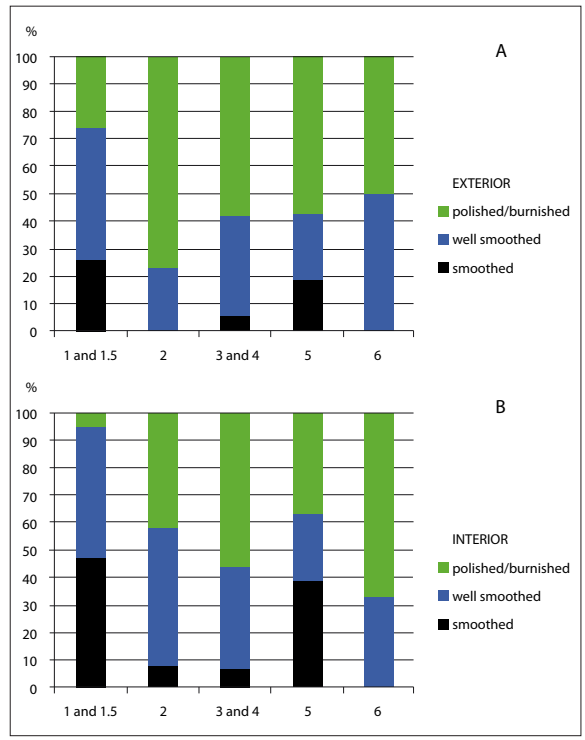


Figure 3.3. Relative proportion of vessels with fine, medium, and thick rims by chronological phase (n=118).



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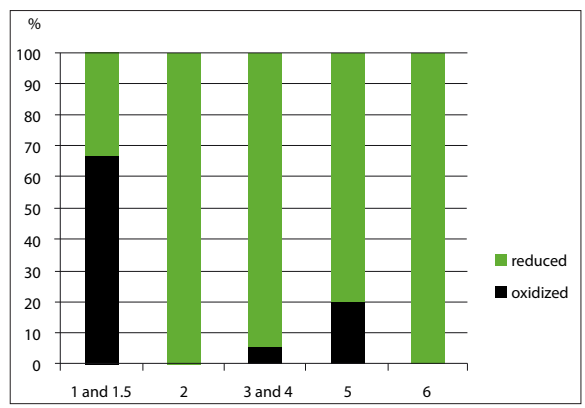

Figure 3.5. Relative proportion of oxidized and reduced firing atmospheres (n=119).

shape, function, and style: larger vessels tend to have thicker rims than smaller vessels. Although this is not an ideal measure of vessel size, it does provide a relative size category to compare through time. Figure 3.3 illustrates the relative proportion of rim thicknesses for vessels by phase. Fine, medium, and thick walled vessels are represented in all Early Neolithic assemblages analyzed; it is noteworthy that almost 50% of vessels from Phase 1 and 1.5 are thick walled. Since these are vessels from open-air sites, it may seem to correlate with the range of vessels expected in a village setting. However, Phase 3 and 4 pottery is almost identical in its distribution of rim sizes. As mentioned above, the material from this phase comes from Cova de l'Or, a cave site. It is interesting to note that the relative proportions of vessel sizes are similar between open-air and cave sites. An interesting difference, however, is visible with the material from Phase 5. The pottery from this phase is dominated by fine and medium rimmed vessels. In fact, only 15% of vessels have a thick rim, a significant decrease from earlier phases.

To a large extent, Early Neolithic potters carefully finished the exterior and interior surfaces of their vessels, polishing or burnishing the exteriors in the majority of cases and carefully smoothing and even polishing or burnishing the interiors. However, vessels from from Phase 1 and 1.5 are distinctive. Here we see greater proportions of simply smoothed and well-smoothed (*espatulado*) pottery, with relatively little polished or burnished, whereas from Phase 2 onwards, the majority of pottery is polished or burnished on the exterior and even interior surfaces are carefully finished.

Finally, Early Neolithic pottery was likely fired in open firing conditions that result in both oxidizing and reducing atmospheres. Therefore it is significant that a majority of Early Neolithic pottery is reduced, particularly Cardial Ware, suggesting that some styles may have been strategically placed within the firing

Site	Phase	9	10	11	12	13	14	15	16	17	18	19	20	Site	Phase	Av. PTI
Barranquet	1	2	1	7	1	1								Barranquet	1 and 1.5	11
Mas d'Is	1			2	1	2	1			1				Mas d'Is	1 and 1.5	13
Mas d'Is	1.5		2		2	1	3	1	1							
Total	**1 and 1.5**	**2**	**3**	**9**	**4**	**4**	**4**	**1**	**1**	**1**				**Combined**	**1 and 1.5**	**12**
Mas d'Is	2					1			2	3	2		1	Mas d'Is	2	17
C. de l'Or	2						1		2	2				Cova de l'Or	2	16
Total	**2**					**1**	**1**		**4**	**5**	**2**		**1**	**Combined**	**2**	**17**
C. de l'Or	3							1								
C. de l'Or	4			1	2	1	7		4	3				Cova de l'Or	3 and 4	15
Total	**4**			**1**	**2**	**1**	**7**	**1**	**4**	**3**						
Falguera	5		1	5	2	2	3	2	2	1	3	2	2	Falguera	5	15
Mas d'Is	5								1					Mas d'Is	5	16
C. Sarsa	5						1	3	3	8	14	1		C. Sarsa	5	17
Total	**5**		**1**	**5**	**2**	**2**	**4**	**5**	**6**	**9**	**17**	**3**	**2**	**Combined**	**5**	**16**
C. de l'Or	6					1	1	1						C. de l'Or	6	14
Total	**6**					**1**	**1**	**1**								
Total	**All phases**	**2**	**4**	**15**	**8**	**8**	**16**	**7**	**15**	**18**	**19**	**3**	**3**	**All EN Sites**		**15**

Table 3.3. Number of vessels by PTI value by phase and site; and Average PTI by site and by phase.

pit or intentionally smothered to obtain consistent results (McClure and Molina, 2008; McClure, 2007). In the current analysis, it is striking that two thirds of the vessels from Phase 1 and 1.5 are oxidized (fig. 3.5). All of the vessels from Barranquet and almost half the vessels from Mas d'Is were oxidized. This stands in contrast to pottery from all other phases of the Early Neolithic.

Based on the macro-visual analyses presented here, two key shifts are discernable. First, the pottery from Phase 1 and 1.5, the earliest phase identified in the Early Neolithic assemblages, differs from other phases in both public and private attributes. Pastes are less carefully prepared, surfaces are more expedient, and firing is distinctive from other phases. As we will demonstrate below, these differences correlate with stylistic shifts visible in vessel decorations. Furthermore, slight variations are visible in other phases of the early Neolithic, in particular in Phase 5. Here we see shifts in the private attributes, with a clear emphasis on finer pastes, smaller inclusions, and higher quality textures, while externally visible attributes remain largely within the scope of earlier periods. This is interesting in that it indicates a higher level of engagement by the potter in the preparation of pastes and forming processes. Below we explore to what extent this shift in pottery manufacture correlates with changes in decorative style.

PRODUCTION TASK INDEX

A Production Task Index (PTI) was calculated for each vessel based on the relative time or labor of technical decisions made in the production sequence (tab. 3.2). Individual characteristics were scored based on the values in Table 3.1 to facilitate comparisons between vessels, sites, and phases. This provides a rough measure of time or labor investment in a ceramic vessel, but does not include other important factors such as raw material procurement or transportation. Table 3.3 and Figure 3.6 present the relative distribution of PTI values by phases. The scores given to individual vessels range from 9 to 20, and the average score for all Early Neolithic vessels analyzed is 15 (tab. 3.3). The PTI is spread widely, mirroring the diversity of paste preparation and surface finishing techniques.

Three sites and phases are particularly interesting in light of their distributions of PTI values. Phase 1 and 1.5, and specifically Barranquet, are significantly lower in their PTI values than all other phases. This is not surprising given the macrovisual data presented above, however the degree of difference (3 points from average) underscores the fact that identified differences in various attributes characterize the assemblages as a whole and not just specific vessels. Similarly, but on the other end of the spectrum, Phase 2 assemblages have much higher PTI values, again indicating an assemblage-wide difference in time/labor investment based

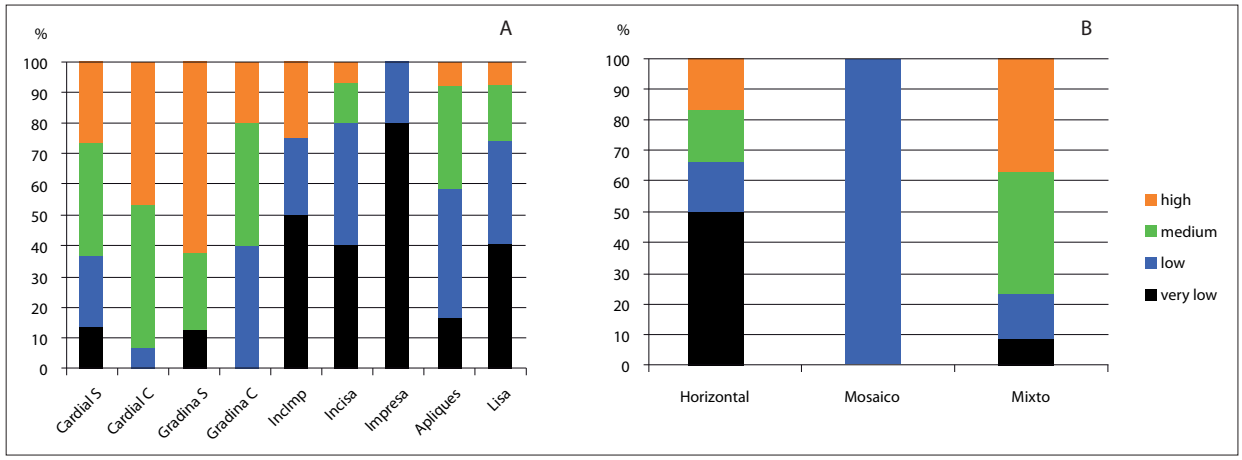

Figure 3.6. Relative proportion of very low, low, medium, and high PTI groups by: A: Decorative groups (n=138); and B: Composition type (n=59). PTI Groups: Very Low (<13), Low (13-15), Medium (16-17), High (>17).

on the individual attributes presented above. Phase 2 vessels were made in a more labor and time intensive manner than those from Phase 1 and 1.5. Finally, we want to highlight the assemblage from Abric de la Falguera, Phase 5, as the only group of vessels to span almost the entire value spectrum. Vessels from caves and rock shelters are often assumed to be highly selected, since production of pottery likely occurred in open-air contexts. The vessels found at Falguera indicate a diverse labor/time investment in pottery production during this phase (see also McClure, in press).

LABOR AND TIME INVESTMENT AND DECORATIVE STYLES

Bernabeu *et al*.'s (this volume, Chapter 7) stylistic analysis provides the opportunity to compare relative time and labor investment with specific decorative types and motifs. This is an opportunity to compare technological data with decorative outcomes on a fine scale. In this section we present the data for specific decorative styles, including various impressions, incisions, appliques, and discuss their implications. Previous studies, such as Hagstrum (1988), specifically took decorative styles and motifs into account in calculating the PTI. This was not the case here. Rather, we compare the data presented above with those presented by Bernabeu *et al*. (this volume, Chapter 7) to assess if certain decorative styles were executed on certain types of vessels. Detailed descriptions of decorative styles and motifs are found in that Chapter.

We divided the PTI values into qualitative ranges to better compare decorative categories (fig. 3.6). Decorative types consisted of complex and simple forms of Cardial and Gradina (e.g., CardialS, CardialC; Gradinas, GradinaC), as well as incised, other impressed, and applied decorations, and undecorated wares (Lisa). Furthermore, we compare the motifs —horizontal, mosaic, and mixed— as defined in Chapter 7 by Bernabeu *et al*.

Figure 3.6.A shows relative proportions of very low, low, medium, and high PTI value groups for decorative type. It clearly illustrates differences in pottery manufacture based on stylistic category. Impresa wares, largely vessels from Barranquet, consist only of very low and low PTI values, indicating that not much time or labor was put into the production of these vessels. In contrast, more typical western Mediterranean impressed wares, such as complex and simple Cardial as well as complex and simple Gradina wares have a much higher proportion of high and medium PTI values. This supports earlier claims that Cardial ware was a higher investment Early Neolithic production (McClure and Molina, 2008), but indicates that Gradina also falls into this category of high PTI wares in comparison to other Early Neolithic productions. Indeed, the majority of Gradina S pottery analyzed here falls in the "high" category. Other decorative types, such as incised, undecorated (lisa), and appliques, show a

greater diversity in PTI values. The comparison of PTI value groups based on composition type mirrors the complexities of the decorative style (fig. 3.6.B). More basic horizontal motifs are found on predominantly very low and low PTI value vessels, whereas the more complex compositions of mixed horizontal and vertical motifs are found on mostly medium and high PTI group vessels (77%).

DISCUSSION AND CONCLUSIONS

The macro-visual technological analyses of assemblages from different phases dating to the Early Neolithic in the Valencian Region have highlighted subtle shifts in pottery production techniques and investment previously not identified. The earliest phase (1 and 1.5), represented by vessels from Barranquet and Mas d'Is, consists of pastes with larger, more frequent and poorly sorted inclusions, coarser textures, and largely fired in an oxidizing environment. Furthermore, the technological changes are paralleled in the Production Task Index that indicates an assemblage-wide shift in labor and time investment in pottery production from the earliest phase to later phases. The implications of this research are twofold. First, there is a chronological shift within Early Neolithic pottery production after the earliest phase (1 and 1.5), when potters begin to invest more heavily in manufacturing procedures. Second, Cardial and Gradina wares, both simple and complex variants, are more labor/time –intensive in their production than other Early Neolithic decorative types.

This chronological shift in pottery production supports the notion that the earliest pottery on the Iberian Peninsula has a different technological style than other Early Neolithic assemblages. Ethnoarchaeological studies show that potters blur boundaries between technology, function, and style (Stark, 1998b), and some of the differences observed in these assemblages may be the result of functional properties or shifts in how pottery was used during the Early Neolithic. Technological choices are not only limited by environmental contexts; rather they are socially informed behaviors that reflect cultural norms and understandings. Chronological changes and the profusion of decorative styles, diversity of motifs, and distinctions between high and low investment pottery support the notion that pottery as a technology and a symbolic element of Neolithic life underwent interesting and intriguing changes over the course of the Early Neolithic.

Notes:

1. Excavations showed, in Sector 80 of Mas d'Is, the existence of two domestic structures overlying one to the other. Although both offered the same 14C dates, corresponding to Phase 1, in order to have a more accurate chronological framework, we have considered a second moment in this Phase (1.5) for the upper structure.

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