[Supplementary material]

Social complexity and core-periphery relationships in an Andean Formative ceremonial centre: domestic occupation at Chavín de Huántar

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A) The Boone Index

The Boone index was first conceived for the analysis of midden deposits; however, I have adapted it here in order to use it with stratigraphic units. In Boone's original estimation, each midden constitutes the unit of analysis, while in this article the unit of analysis is each stratigraphic deposit. Boone measured the number of artefacts and the number of classes of artefacts per midden while I measured these categories for each stratigraphic deposit.

The purpose of this index (Hi) is to compare the individual provenience units (deposits) of artefacts with the cumulative distribution of all deposits combined. Larger values of Hi indicate a high measure of homogeneity (the prevalence of one class over the rest) and lower Hi values will in turn indicate a low measure (Boone 1987; Mesía-Montenegro 2007, 2014). Spatial variation in occupational density within a settlement would be an obvious reason for non-uniform distribution and size of classes within deposits in a given area. Deposit size refers to the number of artefacts present in the deposit.

Elaborating on Boone (1987), perfect heterogeneity (Hi value of 0) is reached when all defined categories or entities in a population are present in equal quantities. Perfect homogeneity (Hi value of 1) exists when the population consists almost entirely of only one category. Consequently, in analysing a series of stratigraphic deposits in the Wacheqsa sector, a measure of heterogeneity was followed in which the site-wide artefact mix, that is, the relative proportion of artefacts over the whole site, is considered heterogeneous in that it reflects the relative proportion of deposit-producing activities over a given area (in this case, the Wacheqsa sector). With this expression of a site-wide artefact mix, it is possible to measure the differences of Hi values among deposits and even among analytical units grouping all Hi values of each analytical unit to see how they behave in comparison with each other.

In calculating this index, the following procedure was followed:

- Primary data consist of frequency counts (denoted yij) from a range of artefact classes (j) retrieved from several distinct deposits (i). Site-wide totals of each artefact are denoted Yj
- An expression of site-wide relative frequencies is obtained by calculating the ratio of one class total to each remaining class. This ratio becomes the weighting factor (Wj). Wj is calculated for every class from every deposit.
- Weighed percentages (pij) of each class in each deposit are obtained by dividing each individual weighed value by the sum of all weighed values from a given deposit.
- The difference between 1 and the number of classes recorded (j) is calculated.
- Finally, the index (Hi) is calculated upon the sum of the squared deviations of pij minus Pj.

$$Wj = \frac{yij}{Yj}$$

$$pij = \frac{Wj}{\sum Wj}$$

$$Pj = \frac{1}{j}$$

$$Hi = \left[\sum (pij - Pj)^2\right]$$

yij = class artefact frequency counts per deposit (number of certain class artefact per deposit)
Yj = site wide totals of each artefact class (total number of certain class artefact in all deposits)
Wj = ratio of one class total to each class total
pij = weighed percentage of each class in each deposit.
j = number of classes

The first two steps followed Boone (1987), while the last three are suggestions recommended by Ian Robertson (*pers. comm.*). Ten classes of artefacts were considered: decorated ceramic sherds, diagnostic ceramic sherds, obsidian, burnt clay, anthracite mirrors, molluscs, lithics, projectile points, bone artefacts and chrysocolla. The null hypothesis to test while using this index is that all spatial analytical units are composed of deposits that have the same Hi value, meaning that all deposits of each analytical unit have equal proportions of classes of archaeological materials. Before trying to evaluate the richness of the deposits of the Wacheqsa sector, it is necessary to follow Cruz-Uribe, who states that "the relationship between sample size and diversity and richness should be investigated prior to any interpretation" (Cruz-Uribe 1988: 194). Sample size can seriously affect measures of diversity as large deposits may contain a greater number of classes (Boone 1987; Kintigh 1989; Orton 2000; Baxter 2003); moreover, given two populations with an equal number of classes, one of which has equal frequencies for all classes, and the other in which high frequencies are concentrated in a small subset of the classes, for small samples the former case will give rise to smaller Hi values than the latter (Shennan 2006).

Having calculated the Hi values, I generated a 90 per cent confidence interval in order to identify those deposits that are outside the confidence interval expected by the sample size. Normally this would be enough for testing sample size bias, but I went a step further. Once the expected richness (Hi) and associated confidence intervals were generated, I repeatedly sampled from the observed population using a Monte Carlo routine to determine whether Hi values calculated could reasonably be due to sample size bias. Monte Carlo routines are particularly useful for testing the significance of a test (in this case the Boone Index) as "with a Monte Carlo test the significance of an observed test statistic is assessed by comparing it with a sample of test statistics obtained by generating random samples using some assuming model" (Manly 1991: 81), which is also suggested and cited by Shennan (2006). Using a Monte Carlo routine, I was able to establish whether the Hi values observed in the Boone Index and even those observed outside the 90 per cent confidence interval, represent a real behaviour of the archaeological materials within the deposits and analytical units or if it is just a reflection of a simple size bias. Whichever method is applied, I consider it important to test this measure of diversity in order to clarify its validity and application in the archaeological assemblage of the Wacheqsa sector.

B) Kernel Density Estimations

A subset (n = 3020) of the total population of diagnostic ceramic sherds (n = 12 017) was compiled using the following parameters: stratum, analytical unit, shape, diameter and phase in order to find patterns of association and to identify possible differences in patterns among the analytical units. The following ceramic shapes were identified: neckless jars, bowls, jars, cups and plates. I used kernel density estimates (KDE) to identify modalities in diameters per type in each analytical unit. Here, the KDE used is the univariate KDE. A univariate KDE can be understood as a smoothed histogram that avoids the constraints of a histogram (Wand & Jones 1995; Baxter *et al.* 1997; Baxter 2003; Shennan 2006). Given n points X1, X2, …, Xn situated on a line, a KDE can be obtained by placing a 'bump' (essentially a unimodal density function) at each point and then summing the height of each bump at each point on the X-axis. The kernel is usually a symmetric probability density function (Baxter *et al*. 1997). The spread of the bump is determined by a window- or band-width that is analogous to the bin-width of a histogram. Here, I used KDE expressed in violin plots, which are similar to box plots but with the inclusion of a rotated kernel density plot on each side (Hintze & Nelson 1998).

Diameter is a good indicator of vessel size modality, and it has been used consistently in the literature e.g. Rice 1987; Blitz 1993; Orton *et al*. 1993; Drennan 1996; Longacre 1999; Mills 1999; Potter 2000; Rosenswig 2007).

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