Kentron
Revue pluridisciplinaire du monde antique

34 | 2018
Jeux et jouets

Cubic Dice: Archaeological Material for Understanding Historical Processes

Alex de Voogt and Jelmer W. Eerkens

OpenEdition Journals

Electronic version
URL: http://journals.openedition.org/kentron/2777
ISSN: 2264-1459

Publisher
Presses universitaires de Caen

Printed version
Date of publication: 18 December 2018
Number of pages: 99-108
ISBN: 978-2-84133-902-0
ISSN: 0765-0590

Electronic reference
Alex de Voogt and Jelmer W. Eerkens, « Cubic Dice: Archaeological Material for Understanding Historical Processes », *Kentron* [Online], 34 | 2018, Online since 20 December 2018, connection on 10 January 2019. URL : http://journals.openedition.org/kentron/2777

CUBIC DICE: ARCHAEOLOGICAL MATERIAL FOR UNDERSTANDING HISTORICAL PROCESSES

In research on the history and archaeology of games, dice are typically auxiliary finds that provide some, but often incomplete, information about which games were played, or how people played them. Cubic dice first appear in the archaeological record in the third millennium BCE, and even though they spread quickly to other parts of the world[1], the information that has been gleaned from their presence has, to date, been minimal.

This state of affairs may be partly explained by the abstract nature of the numeral signs and the regular shape of cubic dice that reveal little in terms of culturally or site-specific human behavior. Alternatively, it may be the lack of systematic studies on cubic dice that prohibits detection of patterns over time and/or space. Yet, a few notable studies have already demonstrated that dice can reveal important historical and culturally specific information. Below, we highlight attributes of dice to illustrate their potential in archaeological analyses.

Die Attributes Defined

The significance of dice for the understanding of gaming history, archaeological site chronology, and human behavior in general has largely been predicated on the identification of relevant die attributes. These attributes have been used in comparative studies that included historical and/or contemporary dice collections as well as in experimental studies of dice production.

In these studies, "configuration" is the arrangement of numbers on a die with respect to one another. Two configurations have shown to be historically significant[2]. For example, the dominant configuration today is where opposite sides add to seven (1 opposite 6, 2 opposite 5, and 3 opposite 4). This configuration is

1. During-Caspers 1973.
2. See, *e.g.*, Poplin 2004; Artioli *et al.* 2011, 1039.

referred to here as "Sevens". A second dominant pattern has opposites in sequential order (1 opposite 2, 3 opposite 4, and 5 opposite 6). Since the opposites add up to prime numbers, this configuration is called "Primes". A quick calculation reveals that thirty different configurations are possible, though half of these are mirror images of one another (where the same sets of numbers are opposite one another, but two have been transposed). As discussed below, all of the fifteen configurations are found in ancient dice, but only a small subset dominates the majority of known examples.

It is also possible to look at the "orientation" of particular pips patterns, which is only relevant if the pips are not symmetrical. The six, three and two need to be applied in a specific direction in relation to each other. For instance, the three may be applied from top left to bottom right or from top right to bottom left in relation to the other numbers on the die (see *fig. 1*). The orientation of dice pips has been noted in several other studies[3], but the historical relevance remains unclear. The American Museum of Natural History in New York has several dice with the same configuration, but a different orientation collected from the same venue in Hong Kong (Catalog No: 70.3/ 7668 A-G, I-L). Note that in these examples the orientation refers to a diagonal three. Three pips can also be placed orthogonally, or as the nodes of a triangle. These latter options are known as dot patterns[4]. Unlike configuration and dot pattern, variation in orientation has not been shown to carry historical or cultural significance.

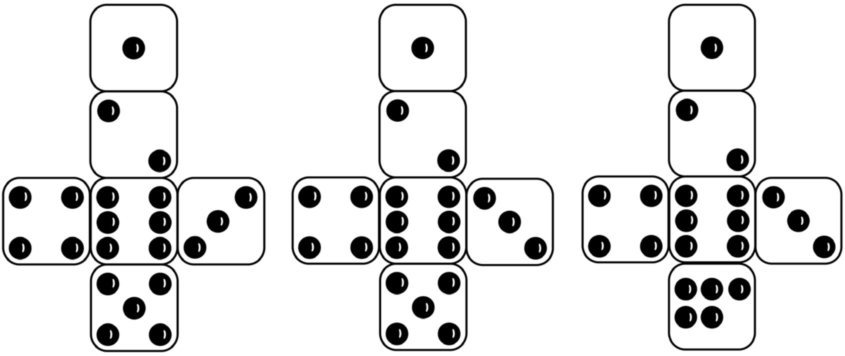

Fig. 1 – Three configurations of "Sevens" (A/B/C), with two contrasting orientations of the number 3 (A *vs* B/C) and two contrasting dot patterns for the number 5 (A/B *vs* C). Illustration by Alex de Voogt, 2018

3. Béal 1983, 47, 345-346, 349-354; Poplin 2004; Heijdt 2005.
4. Voogt *et al.* 2015, 152.

Pip style refers to the convention ancient die makers used to label sides. Today, most dice display pips that are comprised of between one and six dots on each face. Other pip styles are more common in Antiquity, such as dots with one or more rings surrounding them. As well, examples showing Roman or Arabic numerals, or even text, are also attested. As discussed below, pip style shows significant variation over time and space.

Die symmetry refers to how closely a die represents a true cube, where all sides are of the same size and shape. Most ancient dice are cuboid in shape, but not true cubes, with some dimensions up to 50% larger than others. Similarly, die size varies among ancient examples, a preference that changes markedly over time.

Dice as Chronological Markers

The main advance in archaeological analyses of dice has been their use as chronological markers. For example, a study by Paul Perdrizet[5] of Alexandrian twenty-sided dice showed Greek letters on each of its sides. Through a paleographic analysis, it was possible to date the otherwise elusive finds of these gaming implements to the second century BCE or the end of the Hellenistic period in Egypt. Later, twenty-sided dice with Roman numerals attest to the continued use of these artifacts but there are no examples that predate the Egyptian ones. Subsequently, this knowledge of twenty-sided dice was used to assist in dating the El-Hesa skeletal material in Egypt[6]. But apart from dice being subjected to paleographic analysis or other methods such as carbon-dating, systematic changes of dice-specific attributes show additional possibilities of dating dice.

In paleography, the visible elements of handwritten script are compared over time and across regions. Gradual changes in the appearance of a script help to date or locate writing samples. Dice occasionally show written numerals, but more often have pips or dots in varying styles. When comparing these styles over time or across regions, pips appear similarly informative to writing styles. The shape and size of the pips as well as the shape and size of the cube itself have been shown to vary in similar ways from Roman times onward in the Netherlands and United Kingdom, showing that dice attributes can be used as chronological markers in northwest Europe[7].

In the Dutch case, the configuration of numerals on dice also followed a specific pattern. Configurations changed from predominantly "Sevens" in Roman times, to "Primes" in the Early Medieval period, and back to Sevens after 1450 CE, while pip

5. Perdrizet 1930.
6. Voogt *et al.* 2014, 8.
7. Voogt & Eerkens 2018.

style was simplified over time from a dot-ring-ring pattern to dot-ring pattern to simple dots. The shape (symmetry and size), configuration, and pip style changed significantly for bone and antler dice from the Roman to the recent historical period. Dice pre-dating 650 CE were found to be highly variable in all attributes, while those dating between 1100 and 1450 were highly standardized, and those post-dating 1450 CE were standardized for some attributes, such as symmetry and configuration, but were variable for others, such as material type and size. It became possible to discern three distinctive time periods that each featured a different set of dice characteristics[8]: Roman times, the Medieval and the post-Medieval periods. Such a study requires well-dated dice so that the characteristics can be paired with time periods. The dice from the Netherlands follow a similar pattern to those of the United Kingdom for the same period but both here and in other parts of Europe and Asia, a larger set of dice is needed to allow for a more fine-grained analysis. This type of study may be repeated for multiple regions across Europe and Asia so that these characteristics can define dice over time and space.

Dice as Rosetta Stones

The Alexandrian dice mentioned above often use letters or even texts, as some of the bronze twenty-sided dice had full words inscribed for the pips. Such examples are particularly rare but in the case of two Etruscan dice it was possible to use dice configuration to better understand the text. Two marble cubic dice with inscribed Etruscan words are in the Bibliothèque nationale de France, Paris. Four out of these six words for numerals were known by today's epigraphists, but the words for "four" and "six" were not. Their position on the cube could assist in further decipherment of Etruscan texts.

In order to decipher the remaining text on the Etruscan dice, it was first necessary to know the dominant configuration of Etruscan dice. Artioli, Nociti and Angelini[9] analyzed ninety-one samples of Etruscan dice and found that "During the fifth century BC there was a marked shift from the typical (1–2, 3–4, 5–6) combination used in the early seventh– to fifth-century BC dice to the (1–6, 2–5, 3–4) combination used at later times". The late date of the marble dice with texts made only one configuration possible, Sevens, and hence, provided a specific translation of the words for "four" /sa/ and "six" /huth/ as a result. Although a unique example, dice with a known cultural preference for configurations provided new insight into the decipherment of the Etruscan language.

8. Voogt & Eerkens 2018, 166.
9. Artioli *et al.* 2011, 1031.

Fig. 2 – The sides for the number 4 (A) and 6 (B) on one of the Etruscan dice (BnF Luynes 816). Courtesy, Bibliothèque nationale de France, Paris

Dice as Insight into Cultural Transmission and Standardization

The configuration of numerals on dice gave inspiration for experimental and archaeological research trying to explain patterning in die attributes in the archaeological record. The appearance of different configurations on cubic dice is not well understood. As mentioned, the common configuration today (1–6, 2–5, 3–4), where opposite sides add to seven, has been attested as early as the third millennium BCE. The second most common configuration (1–2, 3–4, 5–6) in which opposite sides are sequential and which represents the only configuration where opposite sides tally to prime numbers, has been found in Etruscan times, as mentioned, but is also dominant in the Medieval period of northwest Europe. In both cases this configuration changed again to "Sevens" in that same region, though this shift happened at different points in time (500 BCE *vs* 1450 CE). Since there are fifteen configurations possible, the preference of just these two patterns for nearly 90% of examples in one survey of ancient dice[10] has remained largely unexplained. Few other configurations regularly appear in the archaeological or contemporary record, with few exceptions.

One region in the world today appears to have a preference for "Nines". Tibetan monks from Bhutan to Mongolia use cubic dice for divination[11]. A group of them prefers a configuration in which the six is opposite the three[12].

10. Voogt *et al.* 2015.
11. Dotson 2015.
12. See AMNH collections, Catalog No: 70.3/ 7709 A, B, C; 70.3/ 7711 A, B.

Fig. 3 – Three dice with a configuration of 6 opposite 3 and 5 opposite 4 as used in the Druk Choeding temple, Paro, Bhutan. Illustration by Alex de Voogt, 2015

The opposites make nine, which can be referred to as "Nines", a preferred number in their divination practice to the extent that some dice even feature nine dots on one side[13]. Mostly the six is found opposite the three and in some cases the five is also placed opposite the four, but since not all opposites can make nine, it is often just limited to the six and three[14].

Apart from the Tibetan examples, we are unaware of other regional preferences for configurations other than "Sevens" and "Primes". There is also no literature explaining why one or the other configuration was preferred by one of the many groups that adopted them. The contemporary Tibetan example suggests that configurations can be consciously chosen and that opposites seem especially relevant. If that is the case, then few configurations out of the fifteen that are possible have opposites that are easily described other than the two most often found in the archaeological record. In other words, the instruction sets that are part of the transmission process of dice production are especially simple in the case of "Sevens" (*i.e.*, opposite sides must add to seven) and "Primes" (*i.e.*, opposite sides must add to a prime number, or all numbers on opposite sides are in sequence).

13. Róna Tas 1956, 172, n. 50.
14. Mynak Rimpoche Tulku, pers. comm. 2015.

Fig. 4 – Two Mongolian dice from the region of Bayanhangor with number 6 and 3 on opposite sides. Also note the different orientation of the numbers. American Museum of Natural History, New York, Catalog No: 70.3/ 7711A, B

Pip or dot style has varied over time, as mentioned earlier, but also has some regional variation. Pips or dots are the marks on a cubic die that are repeated on each side to indicate a value. For example, Chinese dice are commonly found with red colored pips for the numbers one and four. Also, the pip for the number one is commonly enlarged. The number two, although not colored red, mostly shows its pips in an orthogonal pattern as opposed to a diagonal pattern in Western dice. The configuration, however, is identical and consistently "Sevens".

Dice as Insight into Production Bias

In an experiment on die production using novices unfamiliar with norms in configuration, in this case children between the ages of three and six, it was found that configurations are not randomly applied to unmarked dice[15]. Instead, children show a strong bias for one particular configuration that is best explained by the way they produce the dice, a process known as production bias. With each additional number, they turn the die in their hand in the same direction. As a result, almost half of all the dice that the children produced has a configuration that

15. Voogt *et al.* 2015, 155.

has the one opposite the three and the two opposite the four. This configuration is named "Turned" because the die is turned as sequential numbers are placed on the unmarked surfaces, and it appears to be typical for people unfamiliar with existing dice configurations. Adults were also found following this same production bias if they were uncertain how else to apply the pips.

Subsequent analysis of archaeological dice[16] showed that after "Sevens" and "Primes", "Turned" is the third most common configuration, and appears in higher-than-expected frequencies if configuration was randomly assigned. Both the children and the archaeological record show many, if not all of the other remaining twelve configurations but not in significant numbers. These latter examples appear to be randomly distributed and in the case of the archaeological dice they are without a preference based on region or time period. Instead, "Turned" and other irregular configurations pattern strongly with material type. They are most often found on metal and ceramic dice (versus bone and antler), in NW Europe. This may indicate that novices were the dominant producers of metal and ceramic dice.

The pattern of pips, such as the contrasting Chinese number two, has a regional significance today and experiments show that pip patterns in general are subject to production bias. The children mentioned above, preferred the pattern of the four and the six as it is found today but differed with the pattern of the three and five. These novices more commonly clustered the three pips in a triangle and presented the five dots in one row of two and one row of three. This suggests that the dot pattern on today's Western dice are not determined by production bias but at least in two instances have been deliberately chosen. An analysis of archaeological examples showed that dice with "Turned" configurations were also more likely to have dot patterns governed by production bias. In other words, novice dice producers reveal themselves in their choice of dot pattern and configuration[17].

When applying pips to each side and following the "Sevens" configuration, participants commonly applied the numbers as opposites, so first a one and then a six when opposites make seven. This may affect the way that the numbers are oriented on the dice. For instance, the six, three and two are oriented in a certain way as they are not perfectly symmetrical compared to the four, five and one. Both the study of hand movements and an inventory of orientations found on archaeological dice did not reveal a production bias or any significant preference.

While the concept of production bias emphasizes that the "Sevens" and "Primes" configurations have been deliberately chosen and applied (*i.e.*, they do not emerge from the simplest way to draw on a die), it does not explain why *only* these two

16. Voogt *et al.* 2015, 156.

17. *Ibid.*, 158.

configurations dominate the archaeological record. Contemporary examples showing the relevance of opposite numbers suggest that configurations featuring an idea about the application of numbers opposite from each other are perhaps more likely to be transmitted across regions and time periods, but this idea needs to be tested with empirical data. A quick examination of the remaining twelve configurations (after Sevens, Primes, and Turned have been removed) does not reveal any obvious or simple rule that would describe the relationship of opposite pips. Cultural transmission theory predicts that there should be a preference for transmission of the simplest instruction sets to describe a technology[18].

The archaeological relevance of configurations and dot patterns is twofold. First, it can be suggested that "Turned" configurations or biased dot patterns represent conditions where the dice maker was unfamiliar with normative styles for making dice. Such characteristics largely rule out regionally or culturally specific styles that would over-ride simpler production modes. Second, the "Primes" configuration is specific to certain regions and time periods and may help in the dating process. For the latter, a number of additional characteristics may be added as well. It is possible that biased dot patterns are combined with regionally specific configurations. Alternatively, a "Turned" configuration combined with a normative dot pattern likely indicates that the die maker was familiar with one part but not with the other. Our future research will seek to elucidate these patterns with larger sample sizes of dice from a broader range of geographic and temporal contexts.

Cubic Dice for Archaeology

The combination of configuration, pip style, and die shape has created a set of characteristics that allows cubic dice to be of increasing value to archaeology. While the finding of dice also has relevance for the interpretation of a site or grave in terms of playing practices[19], the use of dice as separate tools for the dating of sites or particular graves makes their presence of much broader relevance. The analysis of dice in specific regions and time periods may refine this tool in future studies while the study of non-cubic dice may broaden this approach for other frequently occurring randomizing devices.

Alex de Voogt
American Museum of Natural History, New York

Jelmer W. Eerkens
University of California, Davis

18. Eerkens & Lipo 2007.
19. See, *e.g.*, Hall 2016.

Bibliography

Artioli G., Nociti V., Angelini I. (2011), "Gambling with Etruscan Dice. A Tale of Numbers and Letters", *Archaeometry*, vol. 53, n. 5, p. 1031-1043.

Béal J.-C. (1983), *Catalogue des objets de tabletterie du musée de la Civilisation gallo-romaine de Lyon*, Lyon – Paris, Université Jean Moulin – De Boccard (Centre d'études romaines et gallo-romaines; 1).

Dotson B. (2015), "The Call of the Cuckoo to the Thin Sheep of Spring. Healing and Fortune in Old Tibetan Dice Divination Texts", in *Tibetan and Himalayan Healing. An Anthology for Anthony Aris*, C. Ramble, U. Roesler (ed.), Kathmandu, Vajra Publications, p. 148-160.

During-Caspers E.C.L. (1973), "Harappan Trade in the Arabian Gulf in the Third Millennium B.C.", *Proceedings of the Seminar for Arabian Studies*, vol. 3, *Proceedings of the sixth Seminar for Arabian Studies held at the Institute of Archaeology*, London, 27th and 28th September 1972, p. 3-20.

Eerkens J.W., Lipo C.P. (2007), "Cultural Transmission Theory and the Archaeological Record. Providing Context to Understanding Variation and Temporal Changes in Material Culture", *Journal of Archaeological Research*, vol. 15, n. 3, p. 239-274.

Hall M.A. (2016), "Board Games in Boat Burials. Play in the Performance of Migration and Viking Age Mortuary Practice", *European Journal of Archaeology*, vol. 19, n. 3, p. 439-455.

Heijdt L. van der (2005), *Face to Face with Dice. 5000 Years of Dice and Dicing*, Groningen, Gopher, 2006.

Perdrizet P. (1930), "Le jeu alexandrin de l'icosaèdre", *BIAO*, vol. 30, p. 1-16.

Poplin F. (2004), "Numération et orientation des dés antiques et médiévaux", *BSAF*, Séance du 17 mars 2004, 2011 (2004-2005), p. 51-65.

Róna Tas A. (1956), "Tally-Stick and Divination-Dice in the Iconography of Lha-Mo", *Acta Orientalia Academiae Scientiarum Hungaricae*, vol. 6, n. 1/3, p. 163-179.

Voogt A. de, Francigny V., Kahn J., Harcourt-Smith W. (2014), "At the Border Between Egypt and Nubia. Skeletal Material from El-Hesa Cemetery 2", *Journal of Ancient Egyptian Interconnections*, vol. 6, n. 1, p. 5-10.

Voogt A. de, Eerkens J.W., Sherman-Presser R. (2015), "Production Bias in Cultural Evolution. An Examination of Cubic Dice Variation in Experimental and Archaeological Contexts", *Journal of Anthropological Archaeology*, vol. 40, p. 151-159.

Voogt A. de, Eerkens J.W. (2018), "The Evolution of Cubic Dice from the Roman through Post-Medieval Period in the Netherlands", *Acta Archaeologica*, vol. 88, n. 1, p. 163-173.