

## Right–left and the scrotum in Greek sculpture

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The scrotum in humans is asymmetric, the right testicle being visibly higher than the left in most men. Paradoxically, it is also the case that the right testicle is somewhat larger, rather than smaller, as might be expected. Greek classical and pre-classical art, which took great care in its attention to anatomical detail, correctly portrayed the right testicle as the higher, but then incorrectly portrayed the left testicle as visibly larger. The implication is that the Greeks used a simple mechanical theory, the left testicle being thought to be lower because it was larger and hence more subject to the pull of gravity. The present study examines data on scrotal asymmetry in more detail, and puts them in the context of Greek theories of functional differences between the right side and the left side.

Zoe: How's the nuts?

Bloom: Off side. Curiously they are on the right. Heavier I suppose. One in a million my tailor, Mesias, says.

James Joyce, *Ulysses*.

In man the scrotum is clearly asymmetrical, the right testicle usually being placed higher than its opposite number.<sup>1</sup> The cause of this asymmetry is not clear. We may however reject a simple mechanical explanation which would

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<sup>1</sup> Chang, Hsu, Chan, and Chan (1960) found that the right testis was the higher in 62.1% of 486 men, and the left testis higher in 27.4%, the two being equal in height in the remaining 10.5%. Antliff and Shampo (1959) found an essentially similar result in 386 men, the right testis being higher in 65.1% and the left higher in 21.9%. The two sets of authors differ in their findings as to the effect of handedness, Chang et al. claiming that the relationship is reversed in left-handers, whilst Antliff and Shampo found no such reversal. There is also evidence that in the bull the right testis tends to be the higher of the two.

Astley Cooper (1830) was well aware of the differences in height of the testes, although he did not comment on differences in size. Elsewhere, in his book on the breast, Cooper (1840) criticised the errors of sculptors. "I have, in my work on the testes, pointed out the errors of those who paint or chisel from imagination, and not from observation of nature, in placing [the testes] of equal height, although the left is usually much lower than the right; and the same remark may apply to the breasts. . .". I am unable to find any reference to sculptural representations of the scrotum in Cooper (1830), or in the second or third editions of that work.

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say that the heavier of the two organs is pulled to the lower position by the action of gravity, for in both adults and foetuses it is clear that the right testicle is both the heavier and also the greater in volume;<sup>2</sup> that is the *larger* and *heavier* is also the *higher*. Such a relationship is counter-intuitive, and we may expect that it would present difficulties to artists, and to sculptors in particular.

Table 1 shows the observed relationships in 187 sculptures, the majority of which are from ancient Greece, the data being pooled from two separate studies (McManus, 1976; Stewart, 1976). In the single largest group the right testicle is placed higher (and thus correctly), but simultaneously the left testicle is made larger, the reverse of the correct anatomical situation. Winckelmann was partly correct when he observed of Greek sculpture that, "Even the private parts have their appropriate beauty. The left testicle is always the larger, as it is in nature; so likewise it has been observed that the sight of the left eye is keener than the right."<sup>3</sup> His observations of nature were less accurate than those of sculpture. A further examination of Table 1 shows that the second most frequent asymmetric group consists of those cases in which the left testicle is higher and the right testicle is larger, that is, the mirror image of the most common type. This would imply, as I have suggested elsewhere (McManus, 1976), that the Greeks were, in

TABLE 1  
Distribution of asymmetry in 187 sculptures

<i>Side of larger testicle</i>	<i>Side of higher testicle</i>			<i>Totals</i>
	<i>Left</i>	<i>Equal</i>	<i>Right</i>	
Left	5 (2.6%)	7 (3.7%)	60 (32.1%)	72 (38.5%)
Equal	10 (5.3%)	43 (23.0%)	23 (13.4%)	78 (41.7%)
Right	26 (13.9%)	1 (0.5%)	10 (5.3%)	37 (19.8%)
Totals	41 (21.9%)	51 (27.3%)	95 (50.8%)	187 (100%)

<sup>2</sup> Chang et al. (1960) found that the average weights of the right and left testes were 9.95 and 9.36 grams respectively, and the volumes 9.69 and 9.10 ccs, the differences being highly significant statistically. The densities are thus 1.0268 and 1.0286, a difference that is unlikely to be significant. Mittwoch and Kirk (1975) found a similar relationship in human foetuses, and showed that the right ovary also tends to be the larger. This difference is also found in other animal species (Jost, Vigier, & Prepin, 1972).

<sup>3</sup> Winckelmann (1968, Book V; VI, p. 11). There is no evidence of any systematic acuity difference between the two eyes (McGuinness, 1976); there is however a trend for the right eye to be the dominant eye (Porac & Coren, 1976), a feature possibly noted in Hippocrates (Littré, 1840, Book V, p. 137, para 15).

part, using a simple mechanical theory to account for the relation of scrotal size and position. But this hypothesis alone cannot account for the predominance of cases in which it is the right testicle that is the higher. There is also a further asymmetry in Table 1 which requires explanation, namely that there are far more entries in the cells below the main bottom-left/top-right diagonal than in those above it. This results in an excess of sculptures in which the right testicle is higher but the two testicles are equal in size. The implication is that the asymmetry in height is prior to the asymmetry in size. A further examination of the data will give more information on this point, but first it is necessary to examine the difficult question of left-right symbolism in Greece, and its relation to theories of reproduction.

Right and left are of fundamental symbolic significance in many cultures, and have been much studied by anthropologists.<sup>4</sup> As G. E. R. Lloyd has emphasised (Lloyd, 1973; see also Lloyd, 1966, and Braunlich, 1936), this is no less true in Classical Greece (and as others have suggested, perhaps also in our own culture<sup>5</sup>). Most interestingly for our present purposes, this dichotomy was of fundamental importance to Greek theories of the determination of the sexes. Anaxogoras proposed that the male was the active principle in determining sex (as modern science holds). He suggested (unlike modern science) that the male seed comes from the right testis and the female from the left.<sup>6</sup> Furthermore he suggested that the male foetus grew on the right side of the uterus and the female on the left.<sup>7</sup> This theory was extended by Leophanes (or possibly Cleophanes)

<sup>4</sup> See Needham (1973) for a survey. For Biblical and Quranic examples see Walsh and Pool (1942, 1943), and for Chinese thought see Granet (1973).

<sup>5</sup> See for instance Domhoff (1968). Thus for instance in James Joyce's *Ulysses* of 1922 (Joyce, 1969) there are references to the left breast being more sensitive (p. 377), the left hand being nearer to the heart (p. 345) and to the asymmetry of the scrotum (p. 454). He also repeats the Empedoclean theory of conception (p. 415). There is some evidence that the left breast is indeed more sensitive for pressure discrimination, although the right breast is more sensitive to two-point discrimination (Weinstein, 1962).

<sup>6</sup> Aristotle, *De Gen. An.*, 763, b.31. All references to Aristotle are taken from the translations of Farquharson (1912), Ogle (1912), Platt (1910), and Warrington (1956). See also Freeman (1949, p. 272).

<sup>7</sup> It was commonly assumed that the human uterus was bicornuate, as it is in many animal species (*De Gen. An.*, 716, b.33). Also attributed to Parmenides (Tarán, 1965, p. 263), and as such quoted by Galen (*Epid.*, VI, 48); see also *De Gen. An.*, 763, b.21, and Kember (1971) and Lloyd (1972) for difficulties in the interpretation of Parmenides. Galen also claimed that "everything in the reproductive organs on each of the two sides, I mean the right and the left, [is] quite alike" (Duckworth, 1962, p. 130), although elsewhere he points out that the left side is more varicose than the right (see footnote 10) and that the scrotum around it is looser (*De Usu Partium*, II, p. 308). He also noted the asymmetry of the testicular vein insertions, but erroneously described them as arteries, and therefore suggested that the left testis received inferior blood (Lloyd, 1972) and was therefore cooler than the right (p. 306).

who proposed that a man may determine the sex of his offspring by copulating with either the right or the left testis tied off.<sup>8</sup>

Empedocles suggested that the sex of the child was determined entirely by the female, the principal feature being the heat of the womb, which was controlled by the degree of flow of the menses. Later theories stressed the importance of the female but suggested that not only the side of implantation of the foetus, but also the side of origin of the ovum were of importance, once again the right side producing the male and the left the female.<sup>9</sup>

The Hippocratic authors attributed great significance to the difference between left and right. They proposed that diseases of the right side were more severe<sup>10</sup>

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<sup>8</sup> *De Gen. An.*, 765, a.22. Also proposed by the Hippocratic authors (Littré, 1840, VIII, p. 501, para. 31), who also suggested that if the right testicle developed first the child would be male, and if the left, the first child would be female (Littré, 1840, V, p. 313, para. 21). The possibility of controlling sex by a ligature was also espoused by Giles of Rome in the late Middle Ages (Hewson, 1975), who also claimed, following the Hippocratic corpus (Littré, 1840, VI, p. 291) that the male foetus tended to be on the right side of the uterus. As late as 1891, Mrs Ida Ellis in her *Essentials of Conception* (see Pearsall, 1971, p. 303) stated, "It is the male who can progenerate a male or a female child at will, by putting an elastic band round the testicle not required. The semen from the right testicle progenerates male, whilst that from the left female children; men who have only one testicle can only beget one gender, but sometimes they do not descend, remaining in the body, in which case a child of either gender may appear." In 1914 Prof. A. Fischer-Dückelmann was still repeating the Aristotelian story of the bull who could sire either sex at will, according to the side of entry on copulation (Fischer-Dückelmann, 1914), probably deriving the story from Pliny's *Natural History* (VIII, LXX), where the use of ligatures is also described (VIII, LXXII). That the side of origin of the sperm had any bearing upon the sex of the child was rejected by Sir Thomas Browne, although on the basis of a somewhat dubious physiology (*Pseudodoxia Epidemica*, Book IV, v; Wilkin, 1852); (in another context however he also repeats the story of the significance of the side of entry of a bull during copulation; Book V, XX). Likewise de Graaf in 1668 also rejected the possibility of any differences between the testicles in their ability to produce males (*Tract. de Vir. Org. Gen. Ins.*; see Jocelyn & Setchell, 1972). The theory was rejected on experimental grounds by King (1911) and Copeman (1919), although neither experiment would be regarded as acceptable by modern criteria of statistical proof (see also Crew, 1952).

<sup>9</sup> *De Gen. An.*, 763, b.31. In its strong form the suggestion that sex is dependent upon the side of the uterus at implantation may be rejected by Aristotle's own observation that a female foetus has been observed in the right part of the uterus and a male in the left (*De Gen. An.*, 765, a.18). The modern version of the theory suggesting that the side of origin of the ovum is important was put forward by Dawson (1909). Experimental disproof of the hypothesis may be found in King (1909; 1911), Doncaster and Marshall (1910), and Copeman (1919). As with the experiments mentioned in the previous footnote, they are probably not acceptable by modern standards in rejecting a weak version of the theory, although they indubitably reject a strong version, that is that males come only from the right side. In passing, it is perhaps worth noting that there is indeed asymmetry of the foetus *in utero* but this does not seem to be sex-related: the foetus at term far more often occupies the position known as Left Occiput Transverse, than it does Right Occiput Transverse (Steele & Javert, 1942).

<sup>10</sup> Littré, 1840, VII, p. 155. Whilst there is no definite evidence that diseases on one side of the body are more severe than those on the other side (with the possible exception of carcinoma of the breast; see McManus, 1977), there are excellent statistical data showing that some diseases are more common on one side than the other; in this context, of some relevance are that carcinoma of the breast, varicocele, and tumours of the testicle occur more commonly on the right side (Beccia, Krane, & Olsson, 1976; Busk & Clemmeson, 1947; Campbell, 1928; Ferguson, 1962).

(particularly in the case of pleurisy), that the milk from the right breast was stronger and more suitable for male infants,<sup>11</sup> and perhaps most interestingly, that if the *right* testicle was cold and retracted then this was a sign of death (Littré, 1840, VIII, p. 669).

The most elaborate form of left–right symbolism found its origins in the Pythagoreans, who associated right with male and left with female, as well as with many other paired opposites (see Aristotle, *Metaphysics*, A, 5 986, a.22). This was extended by Aristotle into a general theory of right and left in biological systems, and he proposed that it was the right side that initiated movement (*De Inc. An.*, 705, b.14; 705, b.30; 706, b.5), was warmer and less watery than the left (*De Part. An.*, 493, b.19), and also stronger (*Hist. An.*, 493, b.19). Aristotle rejected all of the previous theories of sex determination and instead concluded that the critical variable was the amount of innate heat produced by the foetal heart, before any of the other organs were differentiated.<sup>12</sup> Most interestingly he proposed that the testes themselves were not directly concerned with reproduction *per se*. Their functions were twofold: first to act as weights whose action was to keep open the ducts whereby the seed is discharged,<sup>13</sup> and second to act to tension the entire body, thereby causing the deepening of the voice and the changing of the form that occurs in the male at puberty (*De Gen. An.*, 788, a.10). A further consequence of Aristotle’s theory of right and left, although not stated explicitly, is that the right testicle ought to be higher than the left, for “in as much as motion commences on the right, and the organs on this side are in consequence stronger than those on the left, they must all push upwards in advance of their opposite fellows.”<sup>14</sup> He also claims that the parts on the right are “naturally more

<sup>11</sup> Littré, 1840, V, p. 137, para. 15. This theory transmuted in the Middle Ages so that it was proposed by Trotula of Salerno in his 11th-century *Diseases of Women* that “women bearing male children have the right breast larger, those female children the left” (Mason-Hohl, 1940).

<sup>12</sup> *De Gen. An.*, 766, a.25. He argues that more female children are produced by the young and by those verging on old age since in these groups the amount of vital heat is important (*De Gen. An.*, 766, b.29). Modern research suggests that the proportion of male children does decrease with the age of the father (but *not* with the age of the mother) although the effect is small, the change in the secondary sex-ratio (at birth) being from 51.65% male children to fathers aged 16 to 51.10% male children to fathers of age 45 (Novitski & Kimball, 1958). A further consequence of Aristotle’s theory of increased vital heat in male children is that they ought to tend (but by no means completely as Aristotle himself admits) to start moving earlier in the womb (*Hist. An.*, 583, b.3).

<sup>13</sup> *De Gen. An.*, 717, a.34; and thus castration is effective because it closes the internal ducts. That a castrated bull may fertilise a female for a few days after castration was attributed to a delay in the ducts closing off (instead of to the inevitable storage of semen in the seminal vesicles for a few days or weeks). An identical theory was also held by Giles of Rome (Hewson, 1975, p. 91). The role of the seminal vesicles was correctly appreciated by Sir Thomas Browne (Wilkin, 1852, IV, v).

<sup>14</sup> *De Part. An.*, 671, b.28. Aristotle bases his theory on his (erroneous) observation that the right kidney is placed higher than that on the left, which is true in some animals but not in man.

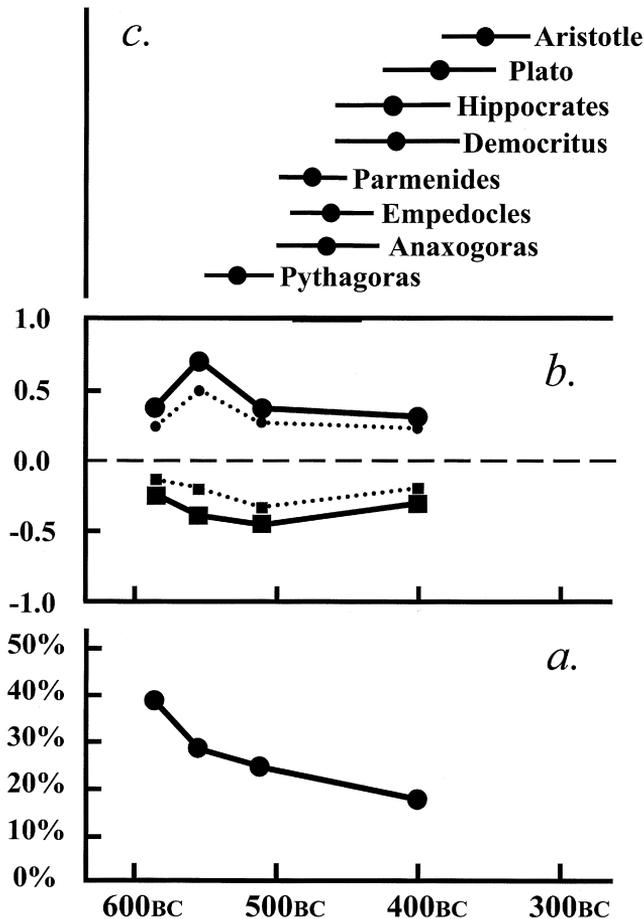
solid and more suited to motion than those on the left”:<sup>15</sup> and we thus expect that the right testis ought to be smaller (or at least denser, that is, “more solid”) than its counterpart.

Whilst this Aristotelian viewpoint suggests several good reasons why the sculptor ought to portray the right testicle as higher and smaller, there are also several contradictory implications of the theory. Perhaps the heavier and lower testis would be tensioning the left side of the body more than the right, but the left side is the female side. Similarly perhaps the stronger testis ought to be the larger, not the smaller. Pre-Aristotelian theory may be linked with Aristotelian in that the hotter (right) testis ought to produce male seed (or greater innate heat); indeed in terms of modern physiology we may expect it to be hotter since it is nearer to the abdomen.

The question now arises as to the relationship between Greek right–left theory and the portrayal of the scrotum. Stewart (1976) divided his data into three historical periods between 600 and 480 BC; my own data may be broadly regarded as “classical” (480–320 BC). In Figure 1 we can see the historical development of the left–right asymmetry of the scrotum. The percentage of works in which the testes are equal in both size and height (that is the middle cell of Table 1) decreases significantly with time ( $\chi^2 = 8.52$ , 3 df,  $p < .05$ ), possibly as a result of sculptors becoming more concerned about the details of anatomy. To assess the development of asymmetry, an asymmetry score was calculated for each of the four periods. To do this a score of +1 was given for a right testicle that was larger, –1 for a left testicle that was larger, and 0 for a case in which the two organs were equal in size. The final total was divided by the number of cases to give an average asymmetry score which could lie between +1 and –1. A similar process was used for the asymmetry scores of height, +1 being given for a higher right testicle, and –1 for a higher left testicle. These scores may be seen in Figure 1 (calculated in two ways according to the inclusion of the “equal” group). The precise method of calculation produces little substantial effect upon the conclusions. Although Stewart (1976) has suggested that there appears to be a trend whereby the right testis becomes higher somewhat before the left testis becomes larger, this is not clear in the present analysis, differences between groups being within the limits of chance variation ( $\chi^2 = 4.11$ , 3 df, NS; after exclusion of the equal groups and merging where necessary to produce expected values greater than 5). We may thus conclude that there was little change in the nature of the asymmetry over the period 600–320 BC, although its usage became more frequent.

In Figure 1 are also shown the approximate dates of the principal left–right theorists and it seems fairly clear that the asymmetry was represented in

<sup>15</sup> *De Part. An.*, 672, a.22. Based upon the differences in the amount of fat around the right and left kidneys; see also footnote 2 above about the density of the testicles.



**Figure 1.** Abscissa is calibrated in years BC. Data points are plotted at the mid-point of their relevant period. The first three points represent Stewart's data for the periods 600–570, 570–540, and 540–480 BC. The fourth point represents my own data which may be described as “classical”, and is represented by the period 480–320 BC.

*a (bottom).* The percentage of figures in each period in which the testicles were both of the same height and the same size. The decline is statistically significant (see text).

*b (middle).* The “asymmetry scores” calculated as described in the text, +1 indicating right dominance, and –1 indicating left dominance. These scores may be calculated in three ways according to the treatment of the “equal” groups. The large circles and squares joined by solid lines show the scores when all of the “equal” groups are excluded (i.e., just the corners of Table 1 remain). The small circles and squares and the dotted lines show the result when all of the data are included. If only the middle cell of Table 1 is excluded then results are obtained mid-way between the other two points, and have been excluded in the interests of clarity. The changes in the score are not statistically significant. The circles indicate the side of the higher testicle (and hence are positive, since the right testicle is usually higher) and the squares indicate the side of the larger testicle (and hence are negative, since the left testicle is usually larger).

*c (top).* The lives of some relevant philosophers for comparison with the data in *a* and *b*.

sculpture even before the theorising. The actions of the sculptors probably represent the utilisation of either a formal theory, or possibly a set of folk-beliefs, which had been extant in the centuries before it was codified by the later philosophers. The actions of the philosophers may well have encouraged the portrayal of detailed left–right asymmetry, but they were unlikely to have been the origin of it. Certainly the Greek mind would appear to be no less vulnerable to left–right speculation than any other culture, either at the anthropological or philosophical level. Evidence from the time of Homer suggests the existence of a pre-Classical right–left symbolism.

### POSTSCRIPT

This paper was originally a chapter in my unpublished PhD thesis (McManus, 1979), and was a more extensive follow-up of the very brief paper on scrotal asymmetry that I had previously published in *Nature* (McManus, 1976). It has languished unread since 1979, and it has been resurrected here because of a recent interest in the topic after my 1976 paper was awarded the 2002 Ig Nobel Prize for Medicine (Kaswell, 2003) (see also [www.improbable.com](http://www.improbable.com)). The chapter as presented here is essentially unchanged from the version in the thesis, except for minor alterations of footnote numbering, the silent correction of typographic errors, the incorporation of some very brief footnotes into the text proper, and the redrawing of the figure to modern standards. There have been developments in many of the research areas since that time, in the study of Greek sculpture (e.g., Métraux, 1995; Stewart, 1997), in thought about the use of right and left in classical civilisations (Peters, 1997), in the study of lateralisation in general (e.g., McManus, 2002), in associated pelvic asymmetries (e.g., Meanock, Ward, & Williams, 1988), in the analysis of asymmetry of the gonads in humans (Bogaert, 1997) and in other species (Dang & Guraya, 1978, Hocking, 1992), and in the embryological (Itoh et al., 2001) and molecular origins of gonadal asymmetry (e.g., Mittwoch, 1992, 2000), in the asymmetric response of the rat to hemi-castration (Frankel, Chapman, & Cook, 1989), in the association of asymmetry of the primary and secondary sexual organs with cognition (Kimura, 1999), and in detailed aspects of human lateralisation, such as eye-dominance (e.g., Bourassa, McManus, & Bryden, 1996; Khan & Crawford, 2001; McManus, Porac, Bryden, & Boucher, 1999, with particular reference to footnote 3). However none of this work has specifically looked at the topic of scrotal asymmetry in relationship to Greek thought and the representation of the scrotum in Greek sculpture, and none alters in any substantive way the conclusions reached in the original chapter. The present review, although dated, therefore still has some merit as an account of the topic.

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