INVENTING
SOCIAL
MEASUREMENT

L YCURGUS, the legendary lawgiver of Sparta, is credited by Plutarch with instituting the senate, or Council of Elders, members of which he at first appointed. Subsequently he provided that each vacancy caused by death would be filled by electing the "most deserving" man over sixty years of age.

The election was made in the following manner. An assembly of the people having been convened, chosen men were shut up in a room near by so that they could neither see nor be seen, but only hear the shouts of the assembly. For as in other matters, so here, the cries of the assembly decided between the competitors. These did not appear in a body, but each one was introduced separately, as the lot fell, and passed silently through the assembly. Then the secluded judges, who had writing-tablets with them, recorded in each case the loudness of the shouting, not knowing for whom it was given, but only that he was introduced first, second, or third, and so on. Whoever was greeted with the most and loudest shouting, him they declared elected (Plutarch, *Lycurgus* xxvi [Perrin 1967, p. 285]).

References to which citations are made in each chapter are located at the end of that chapter.

The use of judges to record the volume of applause must represent one of the earliest examples of psychophysical method in the service of social measurement, one of the themes that will concern us later. For the moment, let me call attention to some other features of the example. First, what is at stake here is indeed social measurement, albeit of a crude variety. Interestingly enough, the quantity directly measured (volume of applause or perceived volume of applause) is not the one of interest. Presumably the latter is the collective preference, however vague that concept may have been. (Compare the ordinary thermometer, where we read length of the column of mercury or alcohol to ascertain degree of warmth, another vague concept rendered more precise by the very instrument devised to measure it.) Moreover the reading, while it apparently pertains to a continuous variable, volume of applause, is used only to make a categorical decision—to elect just one of the candidates. (Compare the household thermostat, which reads the continuous variable temperature to make the binary decision, on versus off.)

Unfortunately, we do not know how the judges recorded loudness on their writing tablets or how their records were aggregated, for these procedures too were inventions (albeit ones now lost). Indeed, the passage quoted from Plutarch mentions a number of social inventions that were either brought together from antecedent practice or devised anew by "Lycurgus": the senate, the assembly, the election, the procedure of acclamation, and randomization by lot. Another such invention, mentioned by Herodotus (Book 6) is proxy voting. When Sparta came to have two kings both sat with the Council of Elders and, if they were absent, their nearest kin among the council members cast the two proxy votes as well as their own. Several of these inventions have direct bearing on our topic of social measurement. What I am trying to suggest is that many—and perhaps the most basic—of the procedures natural and social scientists use in measuring were actually invented to solve practical problems. In the beginning, measurement served social purposes only. The scientist may come into the picture when there is a recognized need to improve the measuring instrument. Or, taking the current practice of measurement as his point of departure, he may let his imagination work freely on ideas of amount, extent, magnitude, intensity, duration, numerousness, dimension, scale, and proportion to create abstract conceptual structures and systems of relationships.

The Spartan system evidently persisted in its essentials for some centuries. In his day, Aristotle scorned it as "childish," presumably by contrast with the highly developed procedures of voting and sortition (selection by lot) which he described in *Constitution of Athens*. The somewhat conjectural early history of voting has been nicely summarized by Larsen, who observes (p. 164),

The practice of taking formal votes in political assemblies and of counting the votes is one of those inventions which, when once made, seem so obvious that they are taken for granted. Consequently, the average observer does not realize that any invention has been necessary; yet it would be hard to point to any single innovation which has influenced more profoundly the development of political institutions. The neglect of the subject by students of Greek history has been particularly unfortunate, for they seem to have before them the key to the invention as far as Western civilization is concerned. . . . there seems to be no trace of the usage in the political institutions of the ancient Near East.

As to timing, Larsen points out that no votes were taken in any of the several meetings of councils and assemblies described in Homer's *Iliad* and *Odyssey*. But voting was apparently in use by the time of the historically attested reforms of Solon (early sixth century B.C.), who transferred the election of magistrates from the *Areopagus* (council) to the popular assembly where, it is supposed, voting was accomplished by show of hands.

Herodotus regularly depicts councils of state or military command reaching their decisions by voting. He does not seem to regard the procedure as novel and, with one exception to be mentioned later, gives few details on the method of voting. According to his Book 6, at the Battle of Marathon (490 B.C.) the Athenian commanders were evenly divided, five in favor of risking a fight and five against. Miltiades then persuaded the commander-in-chief, Callimachus, to cast the deciding vote in favor of engaging the Persians. Book 4 records a unanimous vote of eleven Ionian kings not to destroy a bridge over the Danube, the removal of which would have left the Persians under Darius (died 486 B.C.) at the mercy of the Scythians. In Book 1, the Persian king Cyrus (died 530 B.C.) sought the opinions of his chief officers, but, on hearing from Croesus the Lydian, decided for the course opposite to their unanimous vote. When Darius, who was king

of Persia from 522 to 486, and six other conspirators massacred the Magi then ruling Persia, according to Herodotus's story in Book 3, they held a remarkable formal debate on the form the new government should take. Otanes spoke for democratic government arguing, among other things, that equality under the law was promoted when magistrates were appointed by lot. Megabyzus recommended oligarchy and Darius spoke for monarchy. The remaining four voted with him, and he was subsequently selected king when Otanes proposed that the selection be made by drawing lots.

Voting of a sort was practiced in Scythia, according to Herodotus in Book 4. When their king fell sick, three soothsayers named an offender whose false oath was the cause of the malady. When the accused denied it, six more soothsayers deliberated. If they were for conviction the defendant was executed. If not, still more soothsayers were brought in, as many as needed. If in the end the majority found the accused innocent, the original three soothsayers were executed.

Of course all of these accounts may be fiction, as the details of the speeches on democracy, oligarchy, and monarchy would have to be. But it matters little for our present purpose which Persian, Scythian, or Greek, if not Herodotus of Halicarnassus himself, came up with these variations on the idea of voting. His audience in fifth-century Greece could be expected to understand and accept them. His subsequent readers may well have picked up ideas about the exercise of suffrage from the father of history.

There is reason to believe that the secret ballot was used from the times of the earliest formal votes. The "Greek words for voting, for putting a question to vote, and for a decree adopted as the result of a vote" are derived from "*psephos*, the name for a voting token" (Larsen, p. 173). The root, literally "pebble," is preserved in "psephology," a word coined in our time to denote the scientific study of elections. In the fifth century, Pindar in his Eighth Nemean Ode deplored the use of "secret votes" by the Greek chieftains in making the Judgment of Arms that awarded the armor of the slain Achilles to Odysseus (Ulysses) in preference to Aias (Ajax). The incident is dramatically depicted in a painting (c. 490 B.C.) on a cup by Douris that is exhibited in several histories of Greek art (see especially Stanford and Luce, pp. 28–29). On one side of the cup the Greeks are shown dropping their pebbles while the procedure is supervised by a not disinterested

Athena, who anticipates the outcome that will select her favorite. Although the Judgment of Arms was mentioned in the *Odyssey* (11: 544–546), Homer said nothing about how the decision for Odysseus was made. By the time of Douris and Pindar it was assumed that a vote was taken. Not all accounts of the incident agree, however, on this point (Graves, p. 321), so we are probably safe in surmising that the versions of Pindar and Douris are anachronistic.

Another of our words that echoes some of the history of Greek voting is "ostracism." The *ostraka* were bits of broken pottery on which the Athenian citizen wrote the name of the person he wished to have expelled from the city. If 6,000 or more votes were cast, the man with the highest vote had to stay away for a decade. Ostracism was first used in 487 B.C. and the device was abolished c. 415 B.C.

A mythological justification for the extensive use of voting in legal proceedings is recapitulated in the *Eumenides* of Aeschylus, a contemporary of Pindar and Douris. Orestes is tried for the murder of his mother, Clytemnestra (in revenge for her killing of Agamemnon, her husband and the father of Orestes and Electra). The goddess Athena as judge goes out to

> . . . choose the noblest of the breed
> Of Athens, and here bring them to decide
> This bloody judgement even as truth is tried.

Athena announces that these proceedings will be the prototype for future tribunals. Then she charges "these men/ To cast true stones." Anticipating the divided outcome, she says:

> One judgement still remains. I, at the last,
> To set Orestes free this stone will cast:
> . . . .
>
> Wherefore I judge that here, if equal be
> The votes ye cast, Orestes shall go free.
> Ye judges, haste . . .
> And cast the gathered sea-stones from the urns.

Athena announces the verdict:

> This prisoner, since the stones for ill and good
> Are equal, has escaped the doom of blood.

And to the Chorus of Furies who will, therefore, not be allowed to punish Orestes, she states, "Equal, stone for stone,/ The judgement fell." (Quotations from the Murray translation, lines 485–795)

In chapters 68–69 of *Constitution of Athens* Aristotle describes how in his day (fourth century B.C.) jurors voted in making their decision. Each of them had two brass ballot balls with a stem through the center; the stem of one ball was pierced, the other solid. The pierced stem ballot was used to vote for the plaintiff and the solid one to vote for the defendant. The juror dropped the ball signifying his vote in a brass urn and discarded the other ball in an urn of wood. The brass urn was emptied upon a "reckoning board" for the official counting.

Both Larsen and Staveley find that the system of voting in the assemblies of the Greek city-states was more democratic than the Roman system. In Greece votes were counted by heads, whereas in Rome the vote was taken by curias, centuries, or tribes. The earliest form of the Roman assembly we know about comprised 193 centuries; 80 of these were under the control of the first property class and 18 more were held by the knights, likewise in the first class. If these two groups agreed their position prevailed; they voted first, and it was seldom necessary to call for votes from the remaining four classes. Later developments somewhat broadened electoral participation, but Rome never devised a system that threatened the dominance of a small oligarchy. Group voting per se need not have this effect if the voting strength of the groups is about proportional to their size. In the U.S. presidential elections, for example, the electoral college, although it requires each state to vote as a unit, is based on a sophisticated theory of representation intended to be fair to the whole electorate. In the Roman system however, "although the units might differ as much in their number of voters as our states do, there was no difference in the value of the unit votes" (Taylor, p. 1).

The Roman procedure may have had a persisting influence on ideas about voting. The article on "Electoral Processes" in the 1979 *Encyclopaedia Britannica* describes as "holistic" the conception of representation that prevailed in the Middle Ages and considers that the practice of counting individual votes, which became increasingly prevalent in the seventeenth century, resulted from a conception that was more individualistic. The election of the Catholic bishops and the pope provides a case history of evolutionary change in procedures.

Marc Bloch (p. 351), who tells part of the story, notes that in the twelfth century there was a continuing "reluctance merely to count votes. The decision was considered to belong, not to the majority pure and simple, but, according to the traditional formula, to the fraction which was at once 'the most numerous and the most sound.' . . . Hence the frequency of disputed elections." To the present the conclave, in theory, has an option in regard to the procedure for electing a pope in that the cardinals may choose to elect by inspiration, by compromise, or by ballot. In the latter event, the candidate needs two-thirds of the votes to be elected (Swift, p. 573).

Having located the invention of voting in classical Greece, we would also like to determine the beginnings of the theory of voting. Staveley has many remarks that amount to imputation of implicit theories to those who designed or reformed the Greek and Roman systems. With respect to the group vote, for example, he states (p. 133): "It is tempting to suppose that the principle was deliberately embraced by the governing class . . . to delay the advance of popular sovereignty." The earliest explicit formulation on properties of voting systems I have seen is a letter of Pliny the Younger (A.D. 62?–c. 113) given by Farquharson (1969, *Theory of Voting*, Annexure, pp. 57–60), where the question is raised as to how the outcome may be affected by following different procedures when the Roman senate is confronted with a choice among the alternatives of acquittal, banishment, or death for persons accused of a capital crime. Farquharson's own monograph provides an elegant analysis of the problem which shows, among other things (as Pliny suspected), that what happens under a specified procedure depends on whether the voters vote "sincerely" or are "sophisticated," that is, whether they vote strategically.

This monograph is illustrative of a line of work by contemporary theorists (see also, for example, Arrow 1951; Black 1958; Straffin 1980) that traces back more or less directly to an eruption of mathematical social science in France during the last decades of the eighteenth century. It is not clear whether priority belongs to Borda (see de Grazia 1953, which includes a translation of Borda's paper read in 1770, published in 1781) or Condorcet (1785; excerpts in translation in Baker 1976; commentary in Black 1958) for the observation that in a three-way race where the plurality of votes defines the winner, it is quite possible that either of the other two candidates may actually be pre-

ferred to the winner by a majority of voters. This leads to the "first proposal for preferential voting" (Lakeman, p. 298), which is for each voter to rank the candidates. The ranking procedure was also considered further by Laplace (see Todhunter, pp. 546–548), who noted its vulnerability to strategic voting, leading, as he thought, to a bias in favor of mediocre candidates. Laplace indicated that "experience" had led to its abandonment where it had been tried, but gave no details. His analysis of this issue may be one of the precursors of the modern theory of games of strategy, although I have not attempted to establish a historical linkage.

We should note that, although Borda and Condorcet both proposed the use of ranking, they had different ideas about how to pick the winner. Borda is credited with the "method of marks," which amounts to declaring as winner the candidate with the highest mean rank. Condorcet suggested that the candidate, if any, who gets the majority in all pairwise comparisons with each of the others should be elected. But there is no assurance that the electorate's set of rankings will produce a Condorcet winner. Where Condorcet's criterion does select a winner, moreover, it need not be the one chosen on Borda's rule. For example, if six of ten voters rank three candidates A B C and four voters rank them B C A, the Borda winner is B whereas A is the Condorcet winner. Clearly, we cannot insist that both criteria be satisfied without risking an indeterminate election, even though both criteria are attractive. Arrow's monograph, demonstrating a more general impossibility theorem of this kind, has stimulated much work on the compatibility of various rules or criteria for a voting system (or "social welfare function," as Arrow called it).

I wish I knew whether Borda and Condorcet had read Herodotus. In Book 8 of the *History* he records that after the final defeat of the Persian king Xerxes in the battle of Salamis (480 B.C.), and following the distribution of the plunder, the Greek commanders met at the Isthmus to award a prize of valor to the one of their number judged best in terms of his conduct in the whole campaign. They cast votes for first and second place. Each commander felt that he had fought the most bravely, but a majority put Themistocles second. Although no formal award was made, Themistocles had gained the reputation of being the most able. We may, of course, wonder if the account is anachronistic or fictional. But some Greek—Herodotus himself, if not

the commanders or an earlier genius—had invented the preferential
ballot over two millennia before the French mathematicians.

Gillispie attempts to put the French work into a historical context
and indicates that it was Turgot who stimulated Condorcet's and,
indirectly, Laplace's interest in "mathematics with civic relevance."
Gillispie argues that Turgot and Condorcet were not interested in
improving the representativeness of electoral processes. Rather they
thought of voting as "a collective device for determining the truth."
That Condorcet's paradox has been reinterpreted in accordance with
Anglo-Saxon ideas about popular government is one of many nice
ironies in the history of measurement. The thrust of Turgot's thinking
is made clear in Sewell's summary (pp. 127–128) of the 1774 *Mémoire*
which Turgot had intended for Louis XVI. It contemplated "a hierar-
chy of parish, regional, provincial, and national assemblies" in which
votes were restricted to property owners and "allocated in strict propor-
tion to the value of their land." The intention, in Turgot's own words,
was to place "the plurality of voices, most often, on the side of those
who have received the most education" so as to "render the assemblies
much more reasonable than if badly instructed and uneducated people
predominated." Fifteen years later, the revolution was under way, with
a conflict over voting systems a precipitating factor. The Estates Gen-
eral, called to assemble on 1 May 1789, was to be constituted—as at
the last meeting in 1614—in the three separate orders, Clergy, Nobil-
ity, and Third Estate, each having the same number of deputies and
each voting as a unit. Earlier, however, some provincial assemblies
had introduced a modified system in which the Third Estate had
double representation and voting was by head. Petitions tendered in
late 1788 called for a similar "doubling of the Third." From the
beginning of its meetings, the Third tacitly refused to assent to the
principle of vote by order; it simply neglected to organize itself to
render a unit vote. A month of failure to reconcile the orders produced
growing agitation and, after considering various proposals, the Third
Estate, on 17 June, voted 491 to 89 to constitute itself the "National
Assembly," in which nobles and priests would be seated, but with
voting by head without regard to order. On 22 June, Louis XVI de-
clared this and other actions null and void but accepted the idea of vote
by head and double representation for the Third in provincial Estates,
which were to be elected by order. But this and other concessions were

too late. In any event, many nobles continued to insist that they were forbidden by their mandates to vote by head. Mobilization of troops in late June was followed by the reaction of the Parisian masses. The fall of the Bastille on 14 July 1789 later came to symbolize the revolution that already had occurred. (See Lefebvre, especially pp. 29–30, 44–56, 67–79, concerning the issue of voting; also Sewell, pp. 78–85; Stewart, pp. 25–88.) Thus was a controversy over social measurement implicated in a sequence of events with major consequences for physical measurement, as I shall note subsequently.

It remains only to mention that the nineteenth and twentieth centuries have seen a variety of voting schemes suggested. The British mathematician and author of *Alice in Wonderland*, C. L. Dodgson ("Lewis Carroll"), was one of the numerous inventors. He became embroiled in a controversy with the dean of Christ Church (Oxford University), H. G. Liddell (the father of "Alice" in real life), concerning college architecture, and in this context of academic politics issued a series of pamphlets on methods of voting. (The fascinating details are given by Black, Ch. XX.) A more influential literature in political science produced innovations in the electoral systems of many countries during the nineteenth century. For reasons that will become evident, I took special interest in the account of experience with rational election systems by Lakeman, which I quote (p. 9):

Systems of voting and of counting votes are the mechanism by means of which the country records and measures its reactions to the political issues of the day. As with all recording and measuring devices, therefore, it is important that these systems should be as accurate, as reliable, and as impartial as we can make them. To tamper with them—or to tolerate the continuance of their known defects . . . is on a par with using false weights and measures.

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