International Statistical Review, 47 (1979) 13–24 Longman Group Limited/Printed in Great Britain

Representative Sampling, I: Non-scientific Literature

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Summary

By classifying and illustrating non-scientific uses of the term 'representative sample', its meanings can be clarified. The principal meanings seem to be: generalized if unjustified acclaim for data; absence of selective forces; miniature of the population; typical case or cases, the ideal case; and coverage of the population. Because of its ambiguities and imprecision, we recommend great caution in the use of the expression 'representative sample'. Usually a more specific expression will add clarity.

Motivation

Before beginning our exposition proper, we clarify our motivation. Some words have technical meanings as well as everyday meanings but without consequent confusion; examples from mathematics are 'group', 'field', and 'ring'. Other words, for example 'normal' (of a distribution) in statistics, might in principle cause little confusion with their everyday meanings, but in fact do create difficulties. For the normal distribution, defined by a particular family of exponential functions, confusion comes about because the word 'normal' has connotations of (1) frequently found, and (2) ideal. (See Kruskal, 1978.)

Other well-defined statistical expressions, for example, 'random sample' and 'statistically significant', are often misused in both scientific and general publications, mainly in a way suggesting false precision or pseudoscientific glamour. (For examples see Kruskal, 1978). Statisticians deplore such uses because they show fuzzy thinking and because they lead to scorn for the discipline of statistics.

This paper deals, instead, with a popular expression, 'representative sampling', that does not, at this time, have a clearcut, standard technical meaning. The expression is, nevertheless, widely used in non-scientific writing, extrastatistical scientific writing, and in some statistical writing. The phenomenon has linguistic interest, and holds statistical interest in at least four ways.

First, the term 'representative sampling', and closely related terms, appear often to be used to gain rhetorical strength by adopting an apparently reassuring technical statistical term which may be empty of content.

Second, perhaps inherent in the intuitive idea of representative sampling lies a useful concept (or concepts); an analysis of usage might bring out that concept or concepts for professional inspection and usage. The two authors of this paper do not fully agree on the potential for this concept, but we explore it together.

Third, we hope to increase linguistic self-consciousness and perhaps slightly improve clarity of discourse in statistics and statistical aspects of science generally. We have been surprised at some of the meanings of representative sampling we have encountered.

Fourth, the history within statistics of the idea of representative sampling helps us understand the development of our own discipline; this treatment will appear in 'Representative Sampling, III'.

We begin, in this paper, with a treatment of 'representative sampling' in non-scientific natural language. It seems to us a good way to start to understand possible useful concepts, and we take heart from such related works as the C.S. Lewis (1967) book, together with more recent forays into the jungle of natural language like those of Donald Davidson and Gilbert Harman (1972), K.J.J. Hintikka and others (1973) and Patrick Suppes (1974). *American Speech* contains articles along similar lines.

In our second paper we treat uses of the term in extrastatistical scientific writing; our third paper discusses uses in the statistical literature. The reason for so much effort on one term is that the idea of representativeness is closely related to basic notions of statistical inference. Because of its ambiguities and imprecision, we recommend great caution in use of the expression 'representative sample'. Usually a more specific expression will add clarity.

Introduction

Expressions like 'representative sample' and 'representative sampling' appear frequently in journalism, in other non-scientific literature, and in scientific literature of all kinds – including statistical literature. These expressions reflect vague, ambiguous ideas when we try to appreciate them in other people's writing, and in our own as well. From our haphazard collection of these expressions we infer a variety of meanings; by outlining, illustrating, and discussing these meanings, we may slightly improve the clarity of statistical writing.

In the present paper we draw examples primarily from the non-scientific literature. Our file of examples extends to the statistical and other scientific literatures, and we extend our discussion there in other essays.

First, the term 'representative sample' is sometimes used as a *seal of approval* bestowed by the writer, and perhaps by the reader on the basis of the accompanying discussion. This usage is usually vague and appears to mean that the sample is well suited for the author's purposes and conclusions. Sampling methods are not mentioned.

A second kind of use of 'representative sample' is to mean – or at least to claim – the *absence of selective forces* in the sampling or, by denying representativeness, to allude to the presence of such forces. Related to that use is a third, in which a representative sample is regarded as a *miniature or small replica of the population.*

Fourth, a sample may be regarded as representative if its members are claimed to be *typical of the population.* That, of course, replaces one ambiguity by another, but it leads us to the idea of a representative sample of size *one.* It may surprise statisticians that *Webster's Seventh New Collegiate Dictionary* is comfortable with a sample of size one, that is, with a specimen.

Typicalness may be interpreted in terms of the average, the mode, the ideal, and so on, thus diversifying meanings further. In particular, we discuss the *idealized usages* by Emerson and Arnold.

Fifth, the idea of *coverage* of a population by a sample presents another sense of representative. Coverage may mean simply heterogeneity, it may mean inclusion of extreme cases, or it may have other senses. One might define coverage more precisely by partitioning a population into disjoint classes whose union is the whole population; the members of a class are regarded as interchangeable or homogeneous for purposes of a particular discussion. Then coverage by a sample might be defined to mean inclusion in the sample of at least one member of each class.

The notion of degree of coverage by a sample then might be the percentage of the population included in the classes that have at least one item in the sample. Thus these classes are represented in the sample but not necessarily proportionately.

Our examples and discussions to follow are organized around the above five rough senses of 'representative sample'. We do not apologize for that roughness, but heed C.S. Lewis'

remark that it is '. . . better to give the reader even a dubious classification . . . than a jungle of miscellanea at the end.' [13, p. 48]

We also include a selection on negative views of representativeness, and on linguistic cousins.

Four further remarks before turning to details. First, some writers complicate ambiguity further by the use of terms like 'fairly representative sample', suggesting that there is a metric, or at least an ordering, for representativeness. We shall give one or two examples.

Second, we are well aware of the distinction between a sample (as a specified object) and a sampling *method*. We shall not, however, be much concerned at present about that distinction, important as it is, since it is overwhelmed by the ambiguities of representativeness itself.

Third, some writers adopt arbitrary definitions, for example, that 'representative sampling' is synonymous with 'random sampling'. (Then why introduce a new term?) Or that representative sampling is stratified sampling with stratum subsample sizes proportional to stratum sizes. In both cases the objection may be raised that very small samples come under those definitional rubrics, samples so small that they are most unlikely to be at all representative in any intuitive sense, but when the samples are good-sized the objection has less basis.

Fourth, a similar objection applies to another approach, that of saying that 'representative' means for a sampling method its capability of producing unbiased estimators for a particular set of important parameters. That approach founders, however, on standard examples in which no unbiased estimators exist. Of course, we might settle for some definition of 'close enough' to unbiasedness, but such a definition itself is likely to be arbitrary.

We now turn to our classified quotations, and discussion of them.

General Acclaim or Opprobrium

A common use of 'representative' is to give the sample a pat on the back, or to express qualifications about the sampling process. Consider, for example,

> '. . . private and municipal museums are, if my sampling has been representative, a little better than all but the most prestigious state museums.' [Douglas J. Stewart, 'Two cheers for the tombaroli', *The New Republic*, 28 April 1973, p. 21]
>
> 'The number [economic statistics] can be inaccurate for innocent reasons, such as unrepresentative samples of shifting seasonal patterns.' [Arthur M. Okun, guest columnist for Joseph R. Slevin, *Philadelphia Inquirer*, 27 August 1973]
>
> 'We sent several hundred questionnaires to a representative sample of *Guide* subscribers.' [*Chicago Guide*, October 1973, p. 144, in a description of an opinion poll about Chicago restaurants]
>
> 'If the sample is at all representative, most small investors have sold or are selling stocks. . . .' [Robert Metz column, *New York Times*, 5 January 1975]
>
> 'To "norm" a test, or find out what the average score should be, a test-maker gives it to what he believes to be a representative sampling of students from throughout the country.' [Gene I. Maeroff column, *New York Times*, 8 January 1975]
>
> 'Amid this multitude of poems it is difficult to make a fair or representative selection. There are, however, four which I cannot well omit.' [John Addington Symonds, *Studies of the Greek Poets*, First Series. Chapter on *The Anthology*, p. 393; London: Smith, Elder, 1873. Caution: Chapter order and pagination vary over editions]
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> '. . . dans un échantillon de 400 universités représentatives, les inscriptions aux cours de français ont baissé de 30 pour cent.' '. . . in a nationally reliable sample of 400 colleges, French enrolments went down nearly 30 percent.' [By (par) Raymond J. Cormier, in two *New York Times* columns, 15 and 16 October 1975 respectively, and titled 'Survie après

Babel: I' and 'Survival after Babel: II'. This is an especially clearcut example of the hortatory use, for 'représentative' in the French version becomes 'nationally reliable' in the English]

' "Every time you draw a sample you have a 95 percent chance that it accurately represents the total population and a five percent chance that it does not," says one pollster.' [From Ken Bode, 'The perils of polling', *The New Republic*, 17 January 1976. This one hits a new level in statistical confusion]

' ". . . by use of statistical methods we assure ourselves that the sample of transactions is representative of all the transactions being processed".' [Robert Metz, *Market Place* column in *The New York Times*, 2 May 1975. This column is subtitled 'An audit: a check, not a guarantee'. The passage above is a quotation from Fred Tepperman, a partner in the public accounting firm of Arthur Young & Co.]

In these illustrations, the concept of representativeness is used primarily as an assertive talisman, or as a means of sounding more scientific. To confirm representativeness, even if it could be or were defined for them, one would have to look at the whole population, or at least at a sizable, properly drawn sample. Generally speaking, in the quotations above there is no suggestion that such a study has been made. At best, the term 'representative sample' in these cases means 'my sample will not deceive you, gentle reader'. Yet the gentle reader can only take that on faith.

Absence of Selective Forces

One intuitive sense of representativeness is that of non-selectiveness. The idea, and it is a vague idea, is that a sample (or sampling method) is more nearly representative as it excludes special selective forces or factors. Thus the famous *Literary Digest* election misprediction of 1936 stemmed from a sample that over-represented Republican voters, who were at that time far more likely to respond to the *Digest*'s poll than Democratic voters. (See Bryson, 1976.)

Another famous such example dealt with selection of wheat shoots in a field by skilled eyes. The larger plants were more likely to be noticed and chosen, *even though* the choosers were well aware of that selective force. (See Cochran and Watson, 1936.)

At least two difficulties arise from the non-selectiveness concept of representativeness. First, selective forces are sneaky and insidious; one can never be reasonably sure that they are eliminated. Second, under some general circumstances selective forces may be introduced in a controlled way to give a sample clearly not representative in any intuitive sense, yet capable of producing excellent inferences. For example, a stratified survey of prices may draw a large fraction of its sample from the ten largest cities and a smaller fraction from towns – even smaller than proportionality would suggest. It is possible in principle, and in practice often of relatively little trouble, *given knowledge* of that sampling method, to introduce weighted procedures for untangling matters. Similarly, a stratified probability sample of the population might be made up of 75 per cent women and 25 per cent men, surely not representative in the present intuitive sense. Yet one can readily allow for the disproportion in analysis.

The following examples explicitly use 'representative sample' or 'non-representative sample' to mean, respectively, the absence or presence of selective forces in the sampling process. We reiterate the fundamental difficulty with this usage: although the presence of selective forces can be noted, their absence can never be shown except for explicit probability samples. To be especially feared are selective forces that are *unknown* in nature or magnitude.

'While both I.Q. and grade equivalency tests are purported to be based on a representative national sampling of students, they actually are not. Test makers fail to visit many different kinds of schools . . . [the] sampling . . . is very frequently biased against blacks . . .

because they . . . just don't get into those schools.' [From a *New York Times* article by William K. Stevens about educational testing, 23 March 1971]

'The small return, plus the lack of any mechanism to insure that the returns are a representative sample, virtually guarantees that the tabulations reflect biases. But which way? . . . As an indicator of how unrepresentative the tabulations are, consider that a fourth of the total response came from customers of one small Ohio firm!' [From p. 358 of *Consumer Reports*, May 1973, about an ICC study of customer reactions to household goods moving]

'The UCS . . . petition is by no means a representative sample of the entire community. Names were recruited by a mass mailing effort to some 12,000 members of the Federation of American Scientists and readers of the *Bulletin of Atomic Scientists*, who make up perhaps the most liberal and socially active segment of the research community.' [From 'Nuclear critics escalate the war of numbers', a column by R.G. [Robert Gillete] in *Science* 189 (22 August 1975), page 621. The discussion is of a petition organized by the Union of Concerned Scientists (UCS) in Cambridge]

'First of all, there is a problem with his sampling. He has interviewed exclusively Columbia University students – about 400 of them . . . – insisting that because Columbia students come from all over, they represent all young people. But that simply cannot be true. . . .' [From Christopher Lehmann-Haupt's review of Herbert Hendrin, *The Age of Sensation/ A Psychoanalytic Explanation* (Norton), *The New York Times*, 22 September 1975]

'There may also be problems with the representativeness of a sample. Interviewers have found it harder and harder to persuade frightened city residents to open their doors.' [From 'The numbers in politics don't always add up', by R.W. Apple, Jr., *New York Times*, 8 February 1976]

'In theory every person in the United States must have an equal chance of being selected in a sample if the survey is to be reasonably representative. In practice, however, certain types of people are much easier to find than others.' [From p. 44 of 'Political polling: the German Shepherd factor', by Michael Wheeler, *The Washington Monthly*, April 1976, pp. 42–50]

There are even jocular usages along the selectiveness line, 'The sample surveyed was representative. That is, one talked to the Id Biz people one happened to meet at dinner parties, in elevators and at Ronee Blakley's New York debut last week at The Other End.' [John Leonard 'About New York' column, *New York Times*, 18 August 1976]

A Miniature of the Population; Quotas

Among the more idealistic views of the representative sample is that arising from perfect mixing in a population. A classical example is a thimbleful or even a drop of a mixture of miscible fluids. If we disregard the olive, then one drop of a well-shaken martini has practically the same proportions of water, gin, and vermouth as the contents of the shaker, once the residual ice has been removed.

The practicality of this notion is the basis for much of chemical and biological analysis, both quantitative and qualitative (and its some time inapplicability for some of their mistakes). The quantitative analysis uses the perfect mixing to assist in measuring proportions, the qualitative analysis needs only good enough mixing to have in the sample detectable amounts of each constitutent. (This last is much the same as the coverage idea, to which we shall return.)

The miniature concept can work in circumstances when our population is regarded as composed of identical units. For example, if a collection of basketball players is composed of 40 per cent forwards, 40 per cent guards, and 20 per cent centers, then, if we agree to regard all people playing identical positions as alike, a team of five consisting of two forwards, two

guards, and a center is a miniature of the population. Distinctions between individuals are not made, for they are regarded for the moment as exchangeable.

As a practical matter, we might not want to demand perfection. If the league were composed of 43 per cent forwards, 38 per cent guards, and 19 per cent centers, one standard team of five would still come admirably close to a replica of the population. We tread now on awkward ground. How close is good enough? In addition, we ordinarily do not know the population values, and that is why we want the miniature replica of the population.

Once we leave the simple situation of items regarded as identical, the miniature replica idea has major shortcomings. The notion is like the long obsolete genetic idea of the homunculus (or humunculus), according to which the mammalian egg or sperm contained a tiny organism in miniature that would unfold to become the living creature. (See Fig. 1.) For a history and a thorough explanation of this idea see Gould. [9, pp. 18–29]

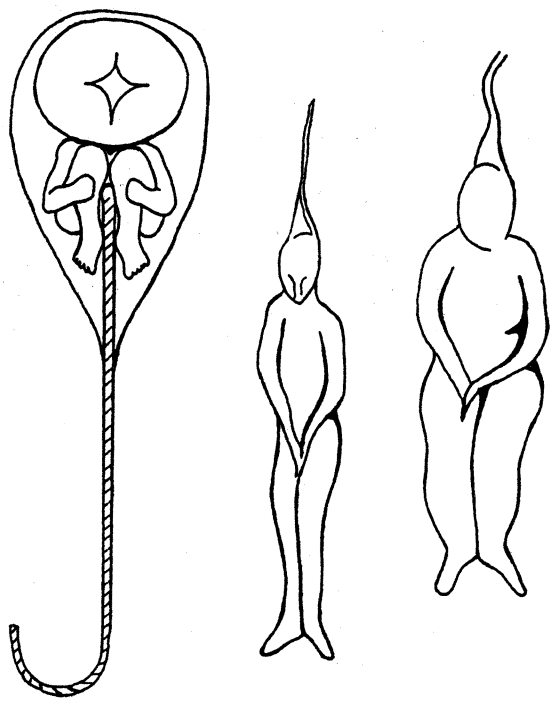

Figure 1. *'Humunculi' presumed to be seen in human sperm (after Singer: from Hartsoeker and Delenpatius). From p. 4 of Monroe W. Strickberger,* Genetics, *New York: Macmillan, 1968.*

To use another metaphor, the intuitive notion is like that of a miniature train, the table top with little snow-covered houses, enameled tunnels, complex patterns of rails, and lighted, brightly colored trains to be manipulated.

When pushed even a little beneath the surface, these attractive notions fail for several reasons, in particular because of lack of transitivity. If the miniature human inside the egg perfectly represents the adult-to-be, then inside that miniature human need be gametes that themselves are still more miniature representative humans, and so on . . . in an infinite regress of naïve determinism.

The toy train example breaks down even more quickly. The snow-covered houses do not have in them much furniture or many people, and they surely do not contain their own miniature train layouts in second order miniature. Or if some devoted train enthusiast has done that, the sequence breaks at the next step.

Our own researches have revealed that neither Queen Mary's Doll House exhibited at

Windsor Castle nor Colleen Moore's Fairy Castle in the Museum of Science and Industry in Chicago have their own still smaller doll houses. According to Susan Heller Anderson (1978), the bejewelled Titania's Palace, built by Sir Neville Wilkinson for his daughter as a doll house for fairies, does have a miniature copy of another doll house. Titania's Palace sold at Christie's in London in 1978 for $256,500. For the less affluent, fortunately, Lundby of Sweden makes an inexpensive miniature doll house for installation in doll houses. The miniature has photographs of furnishings rather than tiny furnishings.

If a sample is regarded as a miniature of some population, then a representative *sub*sample must be a miniature of a miniature and hence itself representative. Yet that sequence too must break down; it can be avoided only by some artificial definition (e.g. a sample to be representative must be at least as informative as a random sample of size 400; we might be grateful if we could know this).

Yet the primitive notion may have utility, if only as motivation. As Tennyson (1884) said in some lines not among his most memorable,

> Flower in the crannied wall,
> I pluck you out of the crannies,
> I hold you here, root and all, in my hand,
> Little flower – but *if* I could understand
> What you are, root and all, and all in all,
> I should know what God and man is.

Problems with the intuitive concept of representativeness have been analyzed recently from the viewpoint of a statistically-minded psychologist, Amos Tversky (1974). (See also Tversky and Kahneman, 1974.)

We begin our quotations with one that illustrates the political[1] sense of a representative body as a miniature, 'As a portrait should be like the person portrayed, so should a representative House be like the people whom it represents. . . . [An] authority has told us that our House of Commons should be the mirror of the people. I say, not its mirror, but its miniature.' [From p. 130 of *Phineas Finn*, Anthony Trollope, Vol. 2, Chap. 10, Dodd, Mead edition, New York, 1893. The quotation is from a fictional letter by Trollope's character Joshua Monk]

The above quotation, although it does not use the word 'sample', gives the flavor of the miniature idea. This quickly leads to demographic and related comparisons, for example, 'Robert Rice . . . said that . . . the two principal rating organizations . . . both select their . . . sample households at random from the telephone directories, [so that] they fail to study . . . families without telephone service, and these are overwhelmingly in low-income minority groups. . . . [W]hile the 1970 census for the Bay Area reported that 57.2 percent of the population was white . . . the sample had a white representation of 77.7 percent. Blacks were 13.4 percent in the census, but only 5.1 percent in the sample. Orientals made up 15.2 percent of the population, according to the census, but in the research sample, they comprised only 9.6 percent. Chicano or Spanish-surnamed residents were 14.2 percent of the Bay Area population in the census, but in the rating survey they had . . . only 1.2 percent. . . .' [From an article by Les Brown, *New York Times*, 19 February 1974]

An even more extreme case of such an approach to representativeness occurred in the selection of participants for a White House Conference on Youth in 1971. A news article said that

> '. . . the problems confronting the conference may relate . . . to demography. The youth delegates are being chosen to fit a statistical conception of the 40 million Americans

[1] There is an extensive political science and philosophical literature about representativeness in the political sense. An excellent summary is by Hanna Fenichal Pitkin (1967).

between the ages of 14 and 24. The statistics show that college students represent 16 percent of the age groups. Accordingly, they will have 160 of the 1,000 delegates.

'The conference chairman . . . said . . . that his push for near-perfect demographic representation was aimed at establishing "credibility" for the conference. . . . If [it] were weighted with liberals or with conservatives, with collegians or with working youth, [the chairman] . . . argued, it would be dismissed as unrepresentative.

'. . . The 100 youths on each panel are supposed to fit into sexual, ethnic, vocational and regional patterns. Fifty should be male, 50 female. There should be 16 college students; 39 students at vocational, trade or high schools; 39 individuals who are not in school, and 6 in the armed forces. Each panel should also contain 70 whites, 6 Mexican-Americans, 3 Puerto Ricans, 3 "other Spanish", 14 Negroes, 2 American Indians and 2 Oriental-Americans. In addition each panel should reflect the population percentages in each region of the country.

' "The biggest problem now is we have to find poor, white working females" said one staff official.' [From an article by James M. Naughton, *New York Times*, 27 March 1971]

The above quotation is a case of representation run riot. It would be hard enough to obtain the separate distributions stated, but it would be impossible to obtain in a panel the population fractions for a *cross* classification by sex, education, region and ethnicity.

Even if we could do that, it would be easy to think of still further important characteristics (e.g. age within the general youth bracket, interest in national affairs, state of health) that would complicate matters still more. There would be no end to it.

This is one of the problems for quota sampling in surveys. (See Alan Stuart, 1968.) It tends to lead to its own selective biases; for example, the harried but bright quota interviewer seeking to fill out the high education-low income cell of the sample, will go to parsonages rather than Skid Row.

Representative as Typical; the single case; the ideal case

Webster's Seventh New Collegiate Dictionary gives as its first meaning for 'sample' the idea of 'a single item presented for inspection or as shown as evidence of quality', with *specimen* as a synonym. Its second meaning is 'part of a statistical population whose properties are studied to gain information about the whole', with synonym *instance*. Its first meaning for the noun *representative* is 'a typical example'.

Two quotations without the word 'sample' first illustrate the idea: 'That opinion, too [this follows a quotation] is a representative opinion, one from a great number to the same effect. . . .' [Page 111 of Virginia Woolf, *Three Guineas*, New York: Harcourt, Brace, 1938.] 'Describe the genesis of the study, summarize the statistical bases, and select for discussion both representative and surprising conclusions.' [From a review by Robert L. Patten (*Bull. Amer. Assoc. Univ. Professors*, Spring, 1974) of Thomas W. Wilcox, *The Anatomy of College English*, San Francisco: Jossey-Bass, 1973]

In fact, the whole term 'representative sample' is sometimes used of a single case, i.e. of a sample of size one, as in the first meaning of 'sample' in *Webster's Seventh New Collegiate Dictionary:* 'To prove the point, he [Carl Bode] devotes a good deal of "The Young Mencken" to a series of articles on "The American" which appeared in *The Smart Set* in 1913–14. Here is a representative sample.' [There follows a paragraph from Mencken.] [From p. 19 of a book review by Hilton Kramer of *The Young Mencken* by Carl Bode (New York, Dial, 1973) in *The New York Times Book Review*, 19 August 1973]

Another example calls several units representative samples: 'The *Maroon* has received a large number of letters concerning Mssrs. Friedman and Harburger. . . . We . . . will endeavor to select the most representative samples [for publication].' [*The Chicago Maroon*, 11

November 1975, p. 4.] That quotation introduces the concept of *most* representative, and ordinality of degree of representativeness presents fresh questions.

In another setting we find a similar usage by George Orwell, this time of '*fairly* representative', but does he mean 'approximately' or 'fair and square' or both? 'These five passages have not been picked out because they are especially bad . . . but because they illustrate various of the mental vices from which we now suffer. They are a little below the average, but are fairly representative samples.' [From p. 78 of George Orwell, 'Politics and the English Language', pp. 77–92, *Shooting an Elephant and Other Essays*, New York, Harcourt Brace, 1950]

Superlative representativeness turns up in various ways. A non-sample example is: 'The Pentagon now estimated the fatalities as between 3.5 and 22 million, with 6.7 million as "the most representative" case.' [From 'The changing estimates of nuclear horror', by Leslie H. Gelb, *The New York Times*, 19 October 1975.] Perhaps there is here some notion like maximum likelihood.

For completeness (or coverage!) we describe next a sense of representativeness different from those of typicalness or of the miniature of a population. It is the representativeness of the ideal or perfect type. Emerson's book, *Representative Men*, exemplifies this approach; it contains a series of essays on great men . . . Plato, representing the philosopher; Goethe, representing the writer; Napoleon, representing the man of the world; etc. We understand ourselves better, says Emerson, if we understand individuals at the extreme in these activities, thus representativeness in quintessence. In his introductory essay, Emerson says that '. . . we feed on genius, and refresh ourselves from too much conversation with our mates. . . . What indemnification is one great man for populations of pigmies!' [7, p. 31]

In the same way, Miss America or Miss Universe or other winners of contests may be representatives of an ideal.

It is strange that the representativeness concept starting with the typical, should in some hands shift to the ideal extreme. Why not also shift in the opposite direction to the worst case? 'William McGonagall, the world's worst published poet, etc.' C.S. Lewis helps us understand the shift from typical to ideal in a passage from his *Studies in Words:* '. . . this demand for the typical easily merges into a demand for the perfect. The quest for the wholly normal cabbage – as we significantly say "the perfect specimen" – would involve the rejection of every cabbage which had suffered from such historical accidents as bad soil, unequal sun . . . on this side and that, too much or too little rain, and so on. In the end you would be looking for the ideal cabbage.' [13, p. 58]

A similar but more extended usage was made later by Matthew Arnold (1935), in his *Culture and Anarchy*. Arnold elaborated matters by giving representatives of the *mean*, the *excess*, and the *defect* for his classes of Englishmen: Barbarians, Philistines, and the Populace. With ironic humility, Arnold offers himself '. . . as an illustration of defect in those forces and qualities which make our middle class [the Philistines] what it is.' [3, p. 99.] There is, however, a major difference, aside from cardinality, between Emerson and Arnold. Emerson's was a monotonic scale; the representative was the best. In Arnold's ethical scale the center is best, and either excess or defect is less desirable.

We do not know to what extent Arnold was influenced specifically by Emerson's *Representative Men*,[1] but there is reason to believe that Arnold admired Emerson. One of Arnold's early poems is a sonnet titled 'Written In Emerson's Essays'. It includes the passages,

> 'A voice oracular hath peal'd to-day,
> Today a hero's banner is unfurl'd;'

[1] Emerson's writings, generally speaking, obviously influenced Arnold, as they did nearly all literary figures of the day. Arnold lectured on Emerson during a visit to America. For discussion see Trilling (1939).

'The seeds of godlike power are in us still;
Gods are we, bards, saints, heroes, if we will! –
Dumb judges, answer, truth or mockery?' [2, Vol. 1, p. 6]

Coverage of the Population: heterogeneity

A common use of 'representative sample' is to mean heterogeneity or wide coverage. Here are two examples. 'The representative sampling of products shown on the following pages graphically illustrates the diversification and appeal of our lines.' [Page 7 of the 1975 Annual Report of Western Publishing Company.] '. . . questions were tried out on 45,000 children from all socioeconomic and ethnic groups, in communities both large and small in 14 different states. . . . The six levels of the new test were administered to another representative sample. . . .' [From 'The making of tests: a very inexact science', by Virginia Adams, *New York Times*, 16 May 1976]

The coverage concept described in the introduction, that of inclusion in the sample of at least one member from each class of a relevant partition of the population, might be one way of making precise the intuitive idea illustrated above. It might also be a way to understand the following statements, which are troublesome to classify in our categories: 'The reading list is intended as a representative sample rather than an inclusive listing. . . .' [From a Barnard College course description. Quoted by Martha Peterson, President of Barnard College, in a letter to *The New Yorker*, 19 April 1971, p. 137.] 'The exhibition of the Ludwig Rosenberger Collection of Judaica will include a representative sample of the total of more than twenty thousand volumes and manuscripts.' [From an announcement by the University of Chicago Library Society, March 1976]

An interesting example of the coverage concept appears in an advertisement for Gallo Vineyards: '. . . our field men take samples of grapes from the vineyards for testing.' 'From representative rows of vines, about 200 individual grapes are collected. They are taken from both sides of the row – from the top of the vines, from the bottom, and from both the inside and the outside.' 'These individual grapes together make up one sample which our field man "juices" on the spot.' [From *The New Yorker*, 18 July 1977, p. 61]

Another example comes from a recent study of professional schools: 'To ensure a reasonably representative sample of knowledgeable scholars, each field was divided into six or more common subspecialities (for example, in law – constitutional law, criminal law, taxation, and so on). Originally the deans were asked to provide the name of a knowledgeable person in each subspeciality. . . . Where a follow-up letter did not bring a response, names of representative individuals were selected from the current catalog of the university.' [Page 44 of 'The Cartter report on the leading schools of education, law, and business', *Change*, February, 1977, pp. 44–48]

Negative Views of Representativeness: linguistic cousins

Some writers have negative views of quantification or of science and express themselves by swats at representative sampling. Here are two swats: 'Those who adhere to the scientific method and draw general conclusions from "representative" sampling are chagrined by the suggestion that there is any other way to arrive at truth, for they like their truth in tidy sentences that begin with "all".' [From 'What the Black woman thinks about Women's Lib', by Toni Morrison, *New York Times Magazine*, 22 August, 1971.] '. . . . the naïve belief in the infallibility of questionnaires, of representative surveys and of analyses of cross-sections of public opinion.' [From 'The future of religion', by Franz Cardinal König, *New York Times*, 21 December 1974.] Ms Morrison, meet Cardinal König.

Although our investigation does show that confusion reigns over the meaning of 'representative', it is a new idea to us that people using sampling 'like their truth in sentences that begin

with "all" '. Quite the reverse, we would have supposed, except perhaps for the Emersonian ideal.

The term 'representative sample' is not alone in its vagueness and multiple denotation. A sample of its linguistic cousins will help fill out the picture:

> ' ". . . the sample is a projectible sample and it's perfectly fine".' [Quotation ascribed to Daniel Yankelovich on p. 29 of 'The pitfalls of polling', by Stephen Isaacs, *Columbia Journalism Review*, 11, (May/June 1972) 28–34]
>
> '. . . his analysis was just that and not a scientific study based on a random sample.' [*New York Times*, 21 October 1973, article by Lawrence K. Altman, quoting Dr Gunnar Biörk]
>
> '. . . a cross-section survey of secondary schools. . . .' [National Bureau of Standards news release, 25 March 1974]
>
> ' ". . . they asked us to do some small sample studies . . . when we tested [the data] . . . we found the results had no statistical validity . . . the information was gathered in such a helter-skelter manner that all the samples were lopsided. You can't say the results are inaccurate . . . only [that they] . . . are worthless . . . these figures [never] would be released as verified statistics."
>
> 'Statisticians in the research bureau said the sampling was . . . so remote from scientific method that the results were a "hodgepodge" from which nothing could be inferred. . . .
>
> ' "These figures aren't worth a tinker's dam," one said.
>
> ' "If you set out to achieve a lopsided distribution you couldn't do better".' [*New York Times*, 26 May 1974 article by Will Lissner]
>
> 'Fortune News . . . in a "rough sampling" asked several former convicts about their use of guns. . . .' [*New York Times*, 15 January 1976]
>
> 'What we are given is a careless and incomplete random sampling. . . .' [From p. 751 of a review by Allan K. Wildman (pp. 750–752 of the *Journal of Modern History*, December, 1975) of Rodger Pethybridge, *The Spread of the Russian Revolution: Essays on 1917*, London: Macmillan; New York: St Martin's, 1972]
>
> 'As each boat comes in, one of its crew must make for the Fish Market with a fair sample of the night's catch (a sample should contain at least forty herring). . . .' [From p. 51 of Alastair Reid, 'A reporter at large/An appearance on the sea', *The New Yorker*, 22 December 1975, pp. 44–59]
>
> '. . . a statistically balanced sample. . . .' [From Tom Wicker, 'Ford and the art of stonewall', *The New York Times*, 8 August 1976]

Conclusions

Ordinary natural language changes with poorly understood proddings from everywhere. Understanding may have improved somewhat since Fitzedward Hall made the point clearly over 100 years ago in his *Modern English* (1873): 'The phrase "living language" . . . must import perpetual excretion and accretion . . ., involving or producing assimilation, development, and renewal. No nearer, in the nineteenth century, is English to being a finality than it has been in any previous century. . . . Countless influences have hitherto contributed to its alteration from age to age, and will always contribute to the same result.' [10, p. 18]

'As newborn words are constantly offering themselves for recognition, so not only are scattered obsolete words awaiting resurrection, but words the most current are everyday on their trial; and, to discover the grounds on which, in extending favor to the first, in renewing it on behalf of the second, and, especially in withdrawing it from the third, usage bases its arbitraments, baffles . . . our utmost ingenuity of speculation.' [10, pp. 30–31]

We address our statistical colleagues (and others) with the hope of a hearing for two themes. First, if the intuitive notion of representative sampling has content and utility beyond

that already otherwise named, let that content and utility be teased out and be given careful definition.

Second, unless and until those careful definitions arrive, let us try to avoid the term in statistical and other scientific writing, just as one tries to avoid praising the accuracy of results of unknown precision.

Abandoning for the moment our own advice just above, we wonder whether our paper gives a representative sample of non-scientific usages of 'representative sample'. We hope that at least our sample gives high coverage in the partition sense we have proposed.

Acknowledgments

We express our appreciation to those who have called our attention to additional instances and to other interpretations of some of our examples, as well as to some errors. Among these colleagues are: Felix Chayes, Miriam Gasko-Green, John P. Gilbert, Eric Hamp, David Hoaglin, Leslie Kish, Martin David Kruskal, Nan Laird, Peter McCullagh, Jack Nadler, I.R. Savage, David Seidman, David L. Sills, Stephen Stigler, Robert E. Streeter, Conrad Taeuber, Ronald Thisted, and Hans Zeisel.

The preparation of this paper was facilitated by National Science Foundation Grants Nos. NSF SOC72-05228 A04 to the University of Chicago and NSF SOC75-15702 A01 to Harvard University.

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Résumé

Les différents sens du terme 'échantillon représentatif' peuvent être clarifiés en classant et illustrant ses emplois non-scientifiques. Les principaux sens semblent être:

un enthousiasme généralisé et non justifié pour les données
l'absence de forces déformantes dans les choix
une miniaturisation de la population
un ou des exemples typiques; un exemple idéal
une situation où l'ensemble de la population est couvert.

A cause de son ambiguité et de son manque de précision, nous recommandons la plus grande précaution dans l'emploi de l'expression 'échantillon représentatif'. En général, utiliser une expression plus spécifique ajoutera de la clarté.