1 *Planning a research project*

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Science advances by the development of new observations and concepts. Planning experiments and observations that may lead to changes in theory is not easy because these advances often depend on critical observations and interpretations that involve imponderables. Thus relatively small studies are sometimes the ones that trigger large advances in understanding, whereas in other instances they merely fill small gaps in accepted knowledge. When conceptual paradigms change, new tests or ways of interpreting old ones may ensue. Late in a very successful career in reproductive endochrinology, Parkes (1985) concluded that research can be planned, but discovery not; it is the thinking of the investigator rather than the technique of investigation that matter the most.

At risk of oversimplification, one can group many notions about scientific advance into one or the other of two contrasting ideas: 1. methods (finer and more exact measurements) may lead to new theories; 2. moving from one hypothesis and test to a new hypothesis is the key to scientific advance. There seems always to be an element of unplanned serendipity associated with major advances, but this usually follows carefully planned tests of prior ideas and attempts to confirm or contradict them. Thus the testing of prior ideas forms the platform of knowledge on which new ideas are constructed. Various theories of science all lead to the conclusion that planning one's studies is desirable.

Biological anthropology is a subject of wide scope. The research through field studies and surveys to be discussed in this book deals primarily with one aspect of it: human biological variation. To understand the causes and consequences of the variation, it must be dealt with both within and between human groups. Studies must not only consider relationship with other biological variables, but also the relationship with climatic, geographic and other physical conditions, and with social and cultural influences. This identifies such studies as anthropology, although those engaged in the studies may not be trained as anthropologists and the skills they contribute from other disciplines are often essential. Whatever their background, those embarking on such studies who have not had formal training in anthropology should include in their prep-

aration some reading of general works on the subject such as Harrison *et al.* (1988).

Choice of topic

In reports of research, attention is usually focussed on the hypothesis to be studied but not on the rationale for the choice of the general subject matter. That is because the subject matter may be determined by someone other than the researcher such as a professor or employer. In addition to the competencies and interests of the researchers, availability of funds and other resources may influence the decision. Nevertheless, the choice of the general subject and specific topic is the first important task in any research project. The limitations of available material, accessibility of populations, facilities and the prior training of the researchers, are primary considerations, but the relevance of the work for other people, including the general public, also influence the choice.

There is a difference between a broad subject of interest and a narrower topic for specific research. The broad area is explored by appropriate reading and study. The narrower topic should relate to this knowledge in some meaningful way if research is to be more than a disconnected set of items for the questions of a quiz show host. The topic is best set out in the form of a hypothesis or question to be answered by results of the proposed procedures of the study. Thus posed in operational terms and scaled to the limitations of the circumstances, there should be an excellent prospect of tangible results that can be published as a research paper (see Chapter 8).

It is possible to embark on field work or surveys with more than one hypothesis in mind during the data collection phase of the study. Nevertheless, the strategy must be specified in the plan. What observations are to be made, and how will the results be analyzed? Hypotheses should not be intermingled in a way that will make it difficult to know where to start. Failure to plan may make it difficult to interpret results in the light of results of prior work. If subsidiary issues are of real concern, one must consider whether they are an integral part of this study or should be reserved for the next.

That the general subject is biological anthropology in its wide sense is taken for granted by the frame of reference of this book. That still leaves a vast variety of subjects. There is no generally accepted catalog of subspecialties of biological anthropology nor has the field clearly defined limits. However, the focus of this work is on field studies and surveys, hence on living peoples or the recently dead rather than on old bones and

Table 1.1. *Conditions related to human biological variation*

1. Aspect
form, anatomy function, physiology body composition biochemistry
growth genetics response to stress diseases
2. Anatomical system
bones teeth joints muscles vessels nerves organs
3. Environment
climate altitude occupation diet housing and education
social relations pollutants
4. Geographic focus
continents nationalities ethnic groups isolates
5. Sex
female male
6. Age group
embryo and fetus neonatal and infancy preschool preadolescent
adolescent reproductive post reproductive

fossils. Furthermore, the concern here is with population biology rather than with individuals as such.

Research in biological anthropology may be experimental, descriptive, or comparative. Some features, such as statistical analysis, may apply to each of these, but laboratory experiments are generally in areas of overlap with other sciences, and description, which was characteristic of earlier phases of the subject, is now largely overlaid by the comparative approach. Comparisons of the very characteristics that had been described serve as a form of experimental approach where the experiments have been performed by nature. The anthropologist may select for study a comparative situation that it would be impractical or unethical to create in a human experiment. The task of planning may be viewed as largely one of 'choice' rather than 'design'.

It may help in the choice of a subject to use a list with some of the conditions that relate to human biological variation. A topic for possible study could consist of comparison of population samples that differ with respect to items in one of the rows of Table 1.1, but are the same with respect to the items in other rows.

For instance, one could study the Variations in the *gross anatomy* (1) of *the thorax* (2) at *high and low altitude* (3) in *Chinese* (4) *male* (5) *adolescents* (6), or the Comparison of the *ages of emergence through the*

gums (1) of *the secondary teeth* (2) in *upper and lower class* (3) *school children* (6) of *each sex* (5) in *Managua* (4). Such studies are directed to more general problems: respectively the effect of altitude on growth of the lungs and the role of social environment in dental development. By specifying the conditions one can assess the probable usefulness of a proposed study relative to the state of knowledge from past studies using similar or different combinations of factors. When the design shows little or no improvement over past studies and the conditions closely duplicate those of the past, little is gained unless the results of the prior studies are contradictory, biased in some ways, or samples were too small. If the purpose of a study is to check on past work, some overlap of the conditions is desirable, but it is also well to explore further relationships by including some additional variables. Originality of a study usually lies in the exploration of more relationships of some phenomenon than had been successully demonstrated by prior work. Scientific breakthrough may need insight, but the day-to-day work of biological anthropology proceeds through expanding the comparisons to different combinations of conditions. This in turn may disclose larger questions that permit new insights; that is, even small accretions of fact may suggest different ways of studying the larger subject and may raise questions of general theory.

Since the purpose of research is to acquire new knowledge, some aspects of research activity cannot be planned. One learns as one works and what one learns should influence one's further work. Although forethought is almost always helpful, at some point getting on with the job must supplant planning. In anthropological work there are often more imponderables than in other types of research. Field work, survey work, and especially longitudinal, prospective and to-be-followed-up studies need to be planned so that some aspects are consistently pursued from the start, but other aspects are flexible and subject to repeated rethinking as the study progresses and knowledge is attained.

The setting

Although more limited objectives are legitimate, a primary purpose of human biology research is to learn something about human beings in general. In many ways any subpopulation of human beings is more or less representative of the whole species. A purpose of comparative studies is to delimit the range of variability. Such studies measure the degrees of similarities and differences. Biological variables express different fractions of their variability within and between subpopulations. The less the relative variation between subpopulations, the greater the likelihood that

other subpopulations are also similar and that one can generalize results to the whole population. Furthermore, as comparisons are made among more groups and the groups become more representative, general conclusions gain credibility.

For example, a study by Hulse (1964) has been interpreted to indicate that when inbred human groups breed out, growth in stature and some other body dimensions increases. Hulse examined Italian-speaking Swiss from the canton of Ticino (and most of them from two alpine valleys, Val Maggia and Val Verasca). The offspring of marriages of parents from the same village were assumed to be appreciably more inbred than those of parents who came from two different villages. Hulse studied individuals in two environments (Switzerland and California) and took account of differences in mean age between samples. Other studies in different settings gave different results, however. This tends to limit any conclusion about an outbreeding effect in children of village-endogamous marriages to situations where there was considerable inbreeding to start with, since studies of small or less inbred samples may demonstrate little or no signicant differences (Lasker *et al.*, 1990).

The studies of concern in this book refer to a single species that encompasses all living and recent human beings. The general similarity to each other of human beings allows for a choice of settings based on many factors: Besides appropriateness for the purpose of the study, one considers one's command of the language of the subjects, prior acquaintance with local individuals or with others who can provide useful contacts, conditions of living for the researcher at the site of the research, and probable costs of working there relative to available financial resources. In selecting a site for study one should not neglect the question of safety and comfort of the field workers. Howell (1990) provides useful information on the matter of safety based on the experiences of many field workers.

Research skills

The most rigidly set precondition of a study is the technical competence of the persons responsible for it. One should plan to do work for which one has learned the necessary competences or can do so in advance. It is essential to have practiced procedures in the laboratory before going into the field. If one has not taken appropriate laboratory courses in the university or had other training by competent mentors, it helps to visit such people to profit by their experience. Most scientists are willing to help a visitor learn a specific field procedure. Many problems are studied

BOX 1.1. Choosing field research projects

Bernard (1988) discusses different aspects of choosing a research project. Although he deals with field work in social anthropology, his five points are also applicable to biological anthropology.

1. *You must have an interest in your problem and in the people who are your subjects.* This seems self evident. It takes a lot of motivation to put up with the hardships usually encountered in the field, and the financial rewards of such a career are usually meagre.
2. *The problem must be one susceptible to scientific investigation.* Can it be couched in operational terms? That is, if I do this and find that can I infer so-and-so?
3. *The scope of the problem must be such that you can accomplish it within the time and with the available financial resources.* I have some reservation about the application of this point to human biology. A small preliminary study may set the problem, determine the best methods and even begin to show some results. Foundations that support research want to be assured that the researcher can do what he or she says and see it through to a conclusion. A pilot study may well give such assurance.
4. *The project must be ethical.* Just saying so will carry little weight. One's ethical standards come from the culture of one's own society. The researcher should be familiar with applicable laws and be aware that violation of the ethical standards of the profession can meet with severe sanctions: isolation and even ostracism.
5. *The problem should be of some theoretical interest.* That is, the results should be applicable to situations beyond the ones tested in the study itself. Different researchers vary in their opinions as to how far speculation should go, however.

Reference

Bernard, H. Russell (1988). *Research Methods in Cultural Anthropology*. Newbury Park, California: Sage Publications.

through collaboration and useful collaboration sometimes gets started through a visit to a laboratory or office of someone working on a related project.

During the training one can repeat and check results and evaluate reliability. A pilot study may be possible. Preliminary studies of reliability should be systematic enough to warrant reporting the results. It is desirable to continue to duplicate some procedures on the same individuals during a study not only to minimize technical error but also to measure the probable extent of unavoidable remaining error.

In the past a field worker often worked alone or with trained local assistants or university students. In today's circumstances, most large studies involve teams in which competencies of members complement each other. The work is distributed accordingly. The participants in a joint research project should not only fulfil their assigned tasks but should try to understand and be helpful to the other members of the team because authors of research reports are properly any of those who contributed importantly to any part of the planning, execution or interpretation of the research, but all authors are responsible for all that is said in a published report.

From the point of view of sponsors, training and retraining constitute one product of research. Doing research with others and ready communication among participants are considered good training. Such training is important because poor work cannot be redeemed later. For instance, Bolsden and Jeune (1990) concluded from the reports of women on their age at menopause that the answers were warped by digit preference (reporting age to an age ending in '0' or '5'). They adjusted for this statistically on the assumption that the reported age was the nearest round number and that the actual pattern of ages was continuous. Nevertheless, conclusions from such studies remain in some doubt until the studies are repeated with more exact evidence about ages.

An example of controversy stemming from incorrect data is seen in the 1990 US Census of Population. There were many omissions in the counts in large cities and debate is still heated over whether and to what extent subsequent statistical adjustments to the counts are justifiable. Even after more careful repetition, uncertainties about the extent of previous errors can plague the interpretation. One should strive for accuracy from the beginning.

We all have shortcomings in knowledge and skills. It is easier to acquire some knowledge than to develop most skills, so it is often better to take responsibility for aspects of research for which one has the skills to proceed, than for aspects about which one knows a great deal but for which one has not yet mastered the technical skills. However, both methods and knowledge are constantly advancing so there is need both to 'retool' to apply the techniques being developed and to keep up on the literature. Through practising and reading one always remains a student.

Computer literacy is one of the skills necessary for field and survey research. It may be feasible to use a portable computer in the field. Some instruments, including anthropometric measuring devices, can feed original data directly into a computer file. Even when that is not possible, well-planned studies use record forms that permit transfer of the data to

computer files with minimum risk of errors. Letters of the Roman alphabet and Arabic numerals are the symbols least likely to lead to later ambiguities. Accents and other double strike symbols are the most likely to lead to later problems. Of course at the analysis stage of the work it may be possible to collaborate with a person who has greater command of programming and programs, but it is wise to plan for this in advance so the data will be in ready-to-use form.

Risk of bias

The matched controls possible in experimental work on other species usually can be only roughly approximated in field work studies in human biology. The strategy therefore must be to make comparisons between groups within the population that differ from each other with respect to a critical variable. Samples for such comparisons must be selected in a way that is unbiased with respect to any covariable that may be involved, or, if there is a bias, one that does not favor the hypothesis being tested.

With respect to the comparison of stature between American-born and immigrant Chinese which was the basis for my PhD dissertation and is cited in Box 1.2, the bias does prevent the simple interpretation of the results. From the prior studies of Boas (see Chapter 3 and Chapter 4 (Box 4.1)) and a few others (cited by Kaplan, 1954), it was possible to state the hypothesis that adult stature depends to some extent on the conditions of life during childhood growth. Did the conditions during their rearing in the United States of Chinese born there lead to greater stature than that of first-generation immigrants from China? However, it was already known that adult stature gradually had been increasing in most parts of the world (presumably including China). It was also known that people shrink in stature at older ages because of compression of their cartilaginous intervertebral discs and changes in their posture. Thus older Chinese men anywhere would be expected to have shorter stature, on average, than younger ones. The finding of greater stature in the American-born than in the immigrant Chinese who were mostly older, is therefore subject to alternative explanations. Since the samples were matched in most respects (including the counties in China where their ancestor lived) the greater average stature of the American-born compared with the immigrant Chinese might be due to the different environments in which they grew up, as hypothesized, but it also might be explained by a bias that had not been excluded: on average, the American-born were considerably younger than the immigrants. It was only because of other evidence that adult stature changes little (e.g., Roche, 1992, Fig. 4.1) that it could be argued, despite shortcomings in the

design of the study, that the differences in the circumstances of growing up in China and in the United States did have a substantial influence on the stature of Chinese men. The only bias that a good study can tolerate is one that disfavors the hypothesis.

In observations about dental decay in the same thesis research project (Lasker, 1945), the bias was against the hypothesis. The etiology of dental caries was less well understood then than now, and genetic influences were exaggerated in some publications about the causes. The idea of a predominant environmental influence (diet) was sometimes underrated and the added evidence of an increase of this dental disease in Chinese born in America therefore was of interest. But could the finding have been biased by the age difference? No. Quite the contrary. There were more carious, filled and lost (i.e. extracted) teeth in the American-born than in the Chinese immigrants. Dental caries is progressive. Therefore, after the permanent dentition has emerged through the gums, the number of diseased, filled and missing teeth can only increase. The finding of more caries in the younger American-born than in the older immigrants implies that growing up in America was related to the observed difference and that the study design underestimated the difference. That is, Chinese subjects of the *same* age might be expected to show an even greater influence of the diet and other factors associated with the life in America on those born there. Subsequent studies of other populations have shown that great use of sugar and other refined carbohydrates had a profound effect on dental caries, especially before the widespread use of fluorides in the prevention of dental caries.

When these studies were being done, multivariate methods of statistical analysis such as multiple regression were known, but the burden of calculations on a calculating machine of the time were onerous. Although it was then impractical, today anthropologists deal with a problem such as a disparity in ages by using multivariate statistics to control for age or other differences.

One should bear in mind, however, that control by multiple regression does not completely solve the problem. It is best to record the exact date of birth and to calculate age as a decimal fraction of years. This is often not possible in field situations, however. Then, even if the regression on age is linear (or converted to linear by some formula) regression on stated or estimated age makes incomplete allowance for age.

Suppose one allows for age in a study of body size and achievement in school children aged 5 to 10 years old. Then one might include in the same category children who were just barely 6 and others aged 6 years and 11 months. But the latter would be likely to be larger and know more than

BOX 1.2. Learning by error

In 1939 I decided to do for my doctor's thesis a study using Franz Boas' strategy (see Chapter 3 and Chapter 4). At that time most anthropologists believed that anthropometric characteristics were racial and fixed by heredity. Boas had found that American-born sons of immigrants had statures and cephalic indices (c.i.) different on average from those of their fathers. His interpretation that this was caused by environmental factors was still being challenged, however, and I planned to compare measurements and observations of first-generation immigrant Cantonese Chinese with those born in America.

My Professor at Harvard, E. A. Hooton, was not attracted by the hypothesis of a significant environmental component in these traits, but he let his students explore for themselves and he told me: 'Go ahead – and while you are doing it measure as many Chinese as possible from every part of China so you can describe the regional types.'

I also went to see Boas at Columbia University. He spoke about his experience in studying the cephalic index and said: 'what will it take to demonstrate a statistically significant difference? Suppose the standard deviation is about 4 [c.i.] units and the difference between immigrants and American-born averages 1 unit; then, let me see, three probable errors of difference [equals about 2 standard errors] would usually require samples of more than 100 immigrants and 100 American-born to show a significant difference at $p = 0.05$. You will find it hard to measure that many.' By the logic of Boas' power analysis (see Chapter 2) it would have required larger samples than I was able to measure, and the difference I found in c.i. was not statistically significant – although some other differences were.

The final thesis was about 3 inches thick. Hooton, with his usual good nature, bellowed: 'The biggest goddam thesis I ever saw; heh, heh; really two theses; heh, heh; The one I wanted you to write and the one you wanted to write yourself; heh, heh, heh.'

Except for a piece about the dentition, only the comparison of immigrants with American-born ever appeared in print (Lasker, 1946). The experience taught me that one has to start somewhere and even if one's hypothesis is not fully sustained, some of the results may be of interest. Knowledge is cumulative so that studies that are too small to yield significant results in one respect may be large enough to answer another question or to serve as a pilot for further studies.

Reference

Lasker, G. W. (1946). Migration and physical differentiation. *American Journal of Physical Anthropology*, ns **4**, 273–300.