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WRITING UP RESEARCH

*Experimental Research Report Writing
for Students of English*

Robert Weissberg and Suzanne Buker

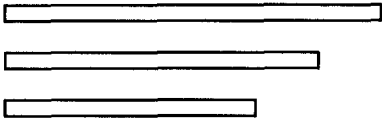


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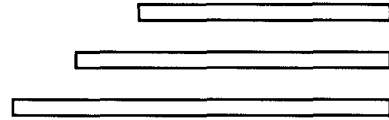
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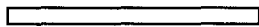
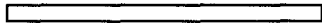
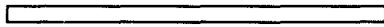
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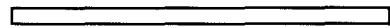
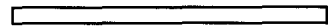
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PREFACE



Writing Up Research is designed for high-intermediate and advanced ESL/EFL university students at the upper division or graduate level who are preparing to engage in scientific research in a variety of academic disciplines. For these students, the ability to write up the results of their own research in the form of technical reports, theses, dissertations, and even journal articles for publication is a key to their success as university students and as professionals in their own disciplines. Based on almost two decades of research in written English for science and technology, this book provides instruction and practice in this special area of academic writing.

The English of an experimental research report is highly conventionalized, a fact that represents a great advantage for non-native speakers as well as for their language instructors. If one can master the conventions, one can replicate the genre in an acceptable form. Moreover, the conventions are fairly consistent across a wide variety of scientific disciplines. They involve (1) structuring arguments and (2) matching linguistic forms to rhetorical purposes. This involves the writer's having to make a series of language choices. This text helps students to see what those choices are and to select the most appropriate—that is, the most conventional—option.

Although this book deals with technical English, the instructional language is not technical. It is accessible to high-level students regardless of their fields of study. The book does, however, contain many authentic examples of technical English taken from published experimental research reports in various fields. These show students how researchers actually use the conventions presented here in reporting on their work.

The best way for students to develop skills in writing the English of experimental research reports is to acquire them in a natural setting. This involves familiarizing themselves with published literature in their fields, conducting research projects with co-workers, and finally writing up their results. A textbook

alone cannot substitute for this immersion environment; however, it can serve as a friendly and useful guide for students who are or will soon be involved in writing up their research.

ACKNOWLEDGMENTS

We wish to express our gratitude to the many workers in the field of English for science and technology whose research has provided the basis for this text. Principal among them are Louis Trimble, Mary Todd-Trimble, John Lackstrom, Robert Vly-Broman, and Larry Selinker, whose publications beginning in the 1970s first provided us with a rational approach to teaching the experimental research report. Of specific help in analyzing particular features of the report has been the work of John Swales on article introductions, Gregory West and Betty Lou Dubois on the discussion section, and Edward Cremmins on abstracts. Of course, we assume full responsibility for all rhetorical and grammatical analyses that appear here. We are especially grateful to Louisa Hellegers, our production editor at Prentice Hall, for her patience and careful attention to detail during the preparation of the book.

TO THE TEACHER

Writing Up Research may be used in academic English classes with students who are already enrolled in a university program or who are preparing for university entrance. The text can be used as part of a larger course in academic writing or it can be used throughout an entire semester. The language and content of the book are aimed at students with a TOEFL score of approximately 475 or higher. The material is appropriate for students planning to conduct research projects in the social sciences (including education), the natural and physical sciences, and engineering.

It is not the intention of this book to teach the research process itself. We assume that students will take courses in research methods and statistical analysis as part of their advanced studies or that they may already have this background. Our purpose is to show students how to translate their research activities into written reports that conform to the expectations of the English-speaking scientific/academic community.

Because most of the text models and many of the exercises used throughout *Writing Up Research* are based on excerpts from published experimental research reports, some of the terminology encountered will be new for students unfamiliar with particular fields of study. However, we have chosen these models on the basis of general interest level and accessibility to all research-oriented students. Additionally, we have attempted to represent as many

different fields of study as possible in the excerpts. Students should be advised that they need not be familiar with every word in every model or exercise in order to recognize the conventions being studied or to understand the instructional point being presented.

An Instructor's Guide is available. It includes lesson suggestions for each chapter as well as answer keys to the exercises. It also includes notes on variations found across disciplines for some of the conventions covered in the text.

Finally, we hope that this book adequately fills an important need for you and your students: a straightforward and readable guide to the conventions English-speaking researchers follow when they write up their work.

TO THE STUDENT

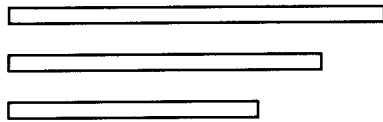
This book is designed to help you learn to use the most important features of technical and scientific English in writing about research in your field. The principal type of writing treated here is the *experimental research report*, but the information in this book is also relevant to writing research proposals, literature reviews, summaries, abstracts, and especially theses and dissertations.

Many of the expressions and grammatical structures presented in these chapters may not be new to you. What will be new are the specific uses of these items in technical writing. These uses are called "conventions" because they are commonly followed by authors in most fields of research. Technical writing in English is very conventional. That is, when you have learned the conventions presented in this book, you will be able to write an acceptable report about almost any research project that you may carry out.

Examples from published research articles in various fields are included in each chapter. These show you how scientists use the language forms you are studying when they write up their research. Sometimes these examples will include technical vocabulary that is new to you. Try not to be distracted by these terms; they should not interfere with your ability to understand the examples or to appreciate the way these writers use the language conventions you are studying. We hope, in fact, that you will find these excerpts to be interesting examples of research in many different fields.

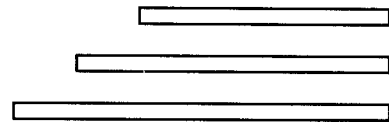
In working through this book, you will be asked to find examples of published research in your area of interest. This is done because we believe that the more you read, the better you will write. You will also be asked to carry out an original research project to put into practice the conventions you are studying. Through these activities of reading, writing, and research practice, you will soon master the language of the experimental research report.

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5

METHOD



OVERVIEW

After the introduction, the second major section of the experimental research report, often labeled **method**, describes the steps you followed in conducting your study and the materials you used at each step. The method section is useful to readers who want to know how the methodology of your study may have influenced your results, or who are interested in replicating or extending your study.

In this chapter we first look at the general kinds of information included in method; then we focus on the part of the method section that describes *procedural steps*. In the next chapter we examine *materials*.

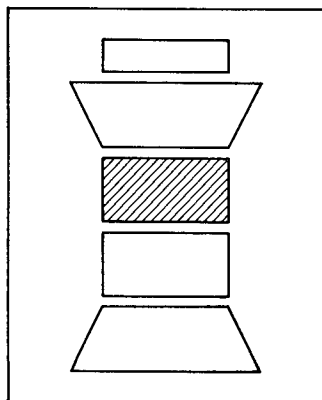


FIGURE 5.1 Method.

INFORMATION CONVENTIONS

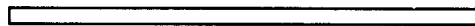
The main part of the method section is a description of the *procedural steps* used in your study and the *materials* employed at each step. However, other elements are commonly described in this section as well. In the following example from the field of bilingual education, notice the elements that have been included under method.

AUDITORY COMPREHENSION OF ENGLISH BY MONOLINGUAL AND BILINGUAL PRESCHOOL CHILDREN

Method

- overview [¹A bilingual group and a monolingual group, each comprised of 30 children, were compared. ²In each group there were six subjects at each of five different age levels. ³The subjects were
- sample [selected from seven day care centers in Houston. ⁴These centers
- restrictions [accept only children from below poverty threshold; thus, comparable socioeconomic status among the test subjects was insured.
- sampling technique [⁵The bilingual subjects were selected from the 99 Mexican-American children in a previous study (Carrow, 1971) on the basis of performance at age mean or above in both languages on a test of auditory comprehension. ⁶This criterion was employed to assure basic understanding of both languages.
- materials [⁷The test instrument employed in this study was a revised version of the Auditory Test for Language Comprehension (Carrow, 1968), which permits the assessment of oral language comprehension of English and Spanish without requiring language expression. ⁸It consists of a set of 114 plates, each of which contains three black and white line drawings representing 15 grammatical categories.
- procedure [⁹Both groups were tested by the same examiner, a Mexican-American fluent in both languages. ¹⁰The children were brought individually to a test area where they engaged in spontaneous conversation. ¹¹For the bilingual children, conversations were conducted in English and Spanish to determine the language in which each child appeared more fluent. ¹²Each bilingual subject was tested first in the language in which he demonstrated less fluency so that learning would not be a significant factor in

procedure	<p>subsequent performance when the test was administered again in the second language.</p> <p>¹³The test required the child to indicate his response by pointing to the picture which corresponded to the examiner's utterance.</p> <p>¹⁴A score of one was given for each item passed. ¹⁵Test administration required 30 to 45 minutes in each language for each child.</p>
statistical treatment	<p>¹⁶A 2 × 5 analysis of variance was used to test for age and language group differences.</p>



WHAT HAVE YOU OBSERVED?

1. What elements other than *procedures* and *materials* did the author include in this section?
2. Why do you think the author chose to order the elements in this way?
3. Did you find this procedural description clear and easy to understand?

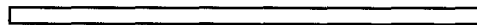
Ordering your Information

The elements included in the method section and the order in which they are presented are not fixed. However, the list in the following box is conventional and provides you with a good model.

INFORMATION ELEMENTS INCLUDED IN METHOD
Overview of the Experiment
Population/Sample
Location
Restrictions/Limiting Conditions
Sampling Technique
*Procedures
*Materials
Variables
Statistical Treatment
(*always included)

EXERCISE 5.1 Analysis

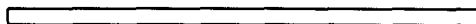
Read the following example of a method section from the field of wildlife science. The study investigated the blood chemistry of bears and its relationship to seasonal changes in bears' activity. Identify the information elements you find in each sentence of the selection. (NOTE: Some sentences may contain more than one element.)



RATIO OF SERUM UREA TO SERUM CREATININE IN WILD BLACK BEARS

Method

¹Our 3-year study of changes in the ratio of serum urea to serum creatinine in Colorado wild bears began in the winter of 1981 and ended in the fall of 1983. ²The investigation was performed in the Black Mesa-Crystal Creek area in west-central Colorado. ³The study area has three major vegetation bands: a mountain shrub community at lower elevations (2235 to 2330 m), large aspen forests at elevations between 2330 and 3330 m, and mixed forests of Engelmann spruce and fir at higher elevations. ⁴A total of 76 blood samples were obtained from 27 female and 21 male bears. ⁵Bears were captured with Aldrich spring-activated foot and lower leg snares. ⁶Snared bears were immobilized with a combination of ketamine hydrochloride and xylazine hydrochloride. ⁷A six-foot pole was used to administer the drug. ⁸In winter the bears were located with a radio signal emitted by the bears' collars. ⁹The samples were cooled, serum was separated from red blood cells, and urea and creatinine concentrations were determined. ¹⁰Statistical analysis of changes in blood parameters was done with Scheffé's comparison because seasonal values could not be considered either independent or dependent.



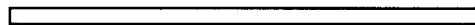
INFORMATION ELEMENT	INFORMATION ELEMENT
Sentence 1: _____	Sentence 6: _____
Sentence 2: _____	Sentence 7: _____
Sentence 3: _____	Sentence 8: _____
Sentence 4: _____	Sentence 9: _____
Sentence 5: _____	Sentence 10: _____

Writing the Procedural Description

The description of the steps you followed in conducting your study should be written clearly so that a reader in your field could accurately replicate your procedure. Of course, the best way to describe a procedure is step-by-step, or *chronologically*.

EXERCISE 5.2 Arrangement

The method section from a research report in the field of medicine is given here with the sentences in scrambled order. Rearrange and number the sentences in a more conventional order, as you think the authors originally wrote them.



MAINTENANCE ENERGY COST OF PREGNANCY AND INFLUENCE OF DIETARY STATUS IN RURAL GAMBIAN WOMEN

Method

- a. _____ In other respects the supplemented ten women were similar to the unsupplemented. All received the same clinical and prenatal care.
- b. _____ At the time of birth, the weight, head circumference, and gestational age of the babies were assessed as described previously (Lawrence et al., 1983).

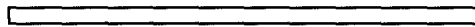
- c. _____ Twelve women from one of these villages were offered supplementary food 6 days a week. The remaining ten women from the other two villages were unsupplemented.
- d. _____ Resting metabolic rate (RMR) and body weight for each woman were measured approximately every 6 weeks during pregnancy. Subjects were asked not to eat or work beforehand. After the subject had lain quietly in an air-conditioned room for 30 min, RMR was measured by open-circuit calorimetry.
- e. _____ Twenty-two pregnant women ages 20–32 years from three villages in a remote rural area of Gambia, West Africa, were investigated.
- f. _____ The subjects breathed through a respiratory valve and expired air was collected into a Douglas bag. The volume was measured with a large capacity wet-type gas meter (Alexander Wright Co Ltd, London). Oxygen and carbon dioxide concentrations were measured with a Servomex 0A580 oxygen analyser (Taylor Instrument Analytics Ltd, Crowborough, Sussex) and a model SSI carbon dioxide analyser (Analytical Development Co Ltd, Herts).

EXERCISE 5.3 Analysis

Read each of the following sentences, or groups of sentences. They are all taken from method sections of different published studies. In each case, determine which element is represented.

1. _____ The abdomen was closed and the electrodes were connected to two Disa stimulators (Disamatic, Inc.) so that the costal and crural parts could be stimulated separately.

2. _____ The study areas were established on a watershed draining the southeast slopes of Mt. Summerford on the Dona Ana range on the University Ranch, 40 km NNE of Las Cruces, Dona Ana County, New Mexico.
3. _____ Three gibberellic acid combinations, 0, 500, and 1000 ppm, were used in a factorial combination of treatments replicated 10 times in a completely randomized design.
4. _____ The ocean depth in the area under study is 2000 m.
5. _____ The subjects were 116 students of English as a second language enrolled in the Continuing Education Program at Queens College, New York.
6. _____ A proportionate, stratified, random, cross-sectional sample was employed. The number of workers from each trade included in the study reflected the proportion of the construction population represented by that trade.
7. _____ Analyses of variance were used to detect significant differences among varieties or locations. Duncan's multiple range test was used to separate means.



EXERCISE 5.4 Library

In the library find a study in your field (either a journal article, a thesis, or a dissertation). Locate the section or chapter corresponding to method and make a photocopy of the section. Then answer the following questions.

1. Is the section (or chapter) in your report labeled "method"? If not, what is it called?
2. Which of the elements from the list on page 92 can you find in your example? In what order are they presented?
3. Read the part of your example that describes the *procedure* used in the study. Is it written clearly enough so that you can easily understand the sequence of steps that the experimenters describe?

LANGUAGE CONVENTIONS

Choosing Verb Tense and Voice in Procedural Description

Several grammatical conventions govern the method section. In this chapter we concentrate on those conventions governing the *procedural description*. These concern choosing the correct *verb tense* and *verb voice*.

SEE WHAT YOU ALREADY KNOW Pretest

The following procedural description is taken from a report in the field of civil engineering. It describes a construction project in which a special technique was used in building a dam to stabilize the ground under the structure. Fill in each blank space with any appropriate word.

STABILIZATION OF SOILS BY MEANS OF ELECTRO-OSMOSIS

Procedure

¹An earthen dam was constructed across the West Branch of the Mahoning River in northeastern Ohio. ²Three spillway conduits at the base of the dam _____ monitored for deformation during construction of the embankment. ³Just prior to completion of the embankment, large deformations _____. ⁴The top of the embankment _____ subsequently moved, and piezometers were installed. ⁵It was _____ that the piezometric levels in the clay were extremely high. ⁶Stability analyses _____ that the piezometric levels needed to be immediately lowered, and electro-osmosis was _____ as the most suitable method for this purpose.

⁷Electrodes were positioned at the bottom of the clay deposit, along the central 1000-ft long portion of the embankment. ⁸Eight rows of electrodes _____ installed along the top of the embankment, and six rows _____ placed along both the upstream and downstream sides.

⁹The power was _____ by 14 generators with capacities ranging from 90 to 300 KW. ¹⁰When fully operational, the generators _____ about 14,000 amps. ¹¹The total elapsed time from the beginning to the end of the treatment _____ about 10 months.

Choosing the Correct Verb Tense in Procedural Descriptions

The procedures you used in carrying out your study should usually be described in the *simple past tense*. Sentences included under method that are not written in the past tense usually do *not* refer to the procedures used in the study being reported. Instead, they may describe standard procedures that are commonly used by others.

<p>PROCEDURAL DESCRIPTIONS: Past Tense</p> <p>Surveys <i>were</i> sent to student health services at 180 colleges.</p> <p>The study <i>was</i> carried out on a marine laboratory research vessel.</p> <p>The generators <i>supplied</i> about 14,000 amps when fully operational.</p>
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NOTE: In a few fields of study, procedural descriptions can sometimes be written in the *simple present tense*. You should check journals in your field (see Exercise 5.11) or ask professors in your university department to determine which convention to use.

EXERCISE 5.5 Analysis

Read the following excerpt and examine Figure 5.2, both taken from another report in the field of civil engineering. This study investigated possible construction designs for the underground stations in a subway

system. The excerpt includes much information *not* directly related to the method used in the study. Identify those sentences that specifically deal with the *procedure* used in conducting this study.

SUBWAY CONSTRUCTION COSTS: THE ROLE OF THE ENGINEER

¹The determination to locate a route underground is a basic factor in the cost of the fixed facilities of the transit system. ²Once the decision is made to build underground, the general station locations are selected. ³Design and construction costs then become controlled by station configuration, site considerations, geotechnical conditions, station size, and system depth. ⁴These factors indicate the large potential range of construction costs for underground subway stations. ⁵To illustrate this range, several transit systems were visited, and seven typical station designs were developed as a representative range of acceptable solutions (see Figure 5.2).

⁶The first five types are open cut, and the last two are mined. ⁷Types 1 and 2 are very shallow or at platform level. ⁸Stations such as those are common to most systems, and particularly to Mexico City. ⁹Type 3 is a low-height train room with the mezzanine underground, separated from the main train room. ¹⁰The Toronto stations are examples of this type. ¹¹Type 4 is a station with platforms stacked one above the other. ¹²Although this station is not often used, it has advantages in narrow or constricted areas. ¹³Type 5 is a station with the mezzanine inside the train room. ¹⁴Many systems are adopting this type of station. ¹⁵Type 6 is a single-chamber system, and Type 7 is constructed with multiple chambers. ¹⁶Type 6 is not widely used, but Type 7 is used extensively, e.g., in London.

¹⁷Cost estimates were prepared for these various stations at different depths of cover, assuming that ground conditions, utilities, adjacent structures, and other controls were constant over the range of estimates. ¹⁸In order to standardize estimates and permit comparison of cost factors, station Type 5 was used as the reference station. ¹⁹The cost for this station with 20 ft of cover was calculated and established at 1.00—the basis for comparative estimates.

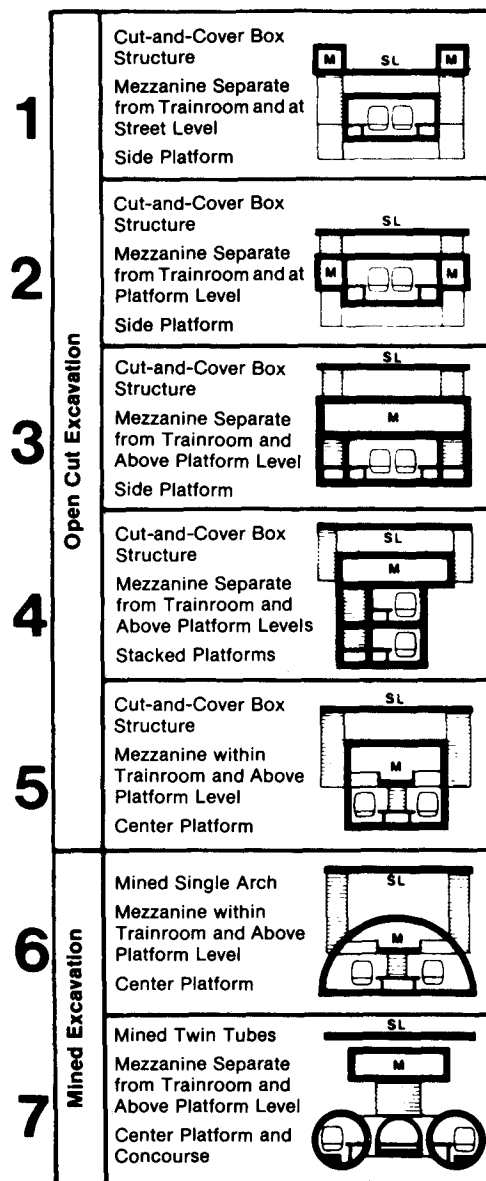
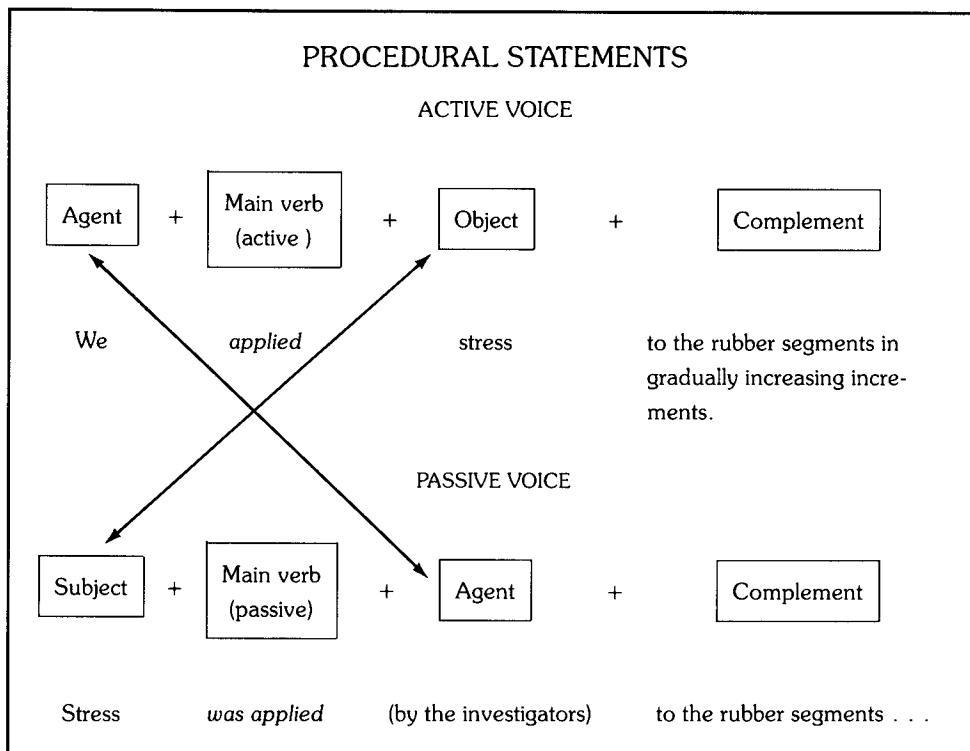


FIGURE 5.2 Subway station types.

Sentences describing *procedure*: _____, _____, _____, _____.

Choosing the Appropriate Verb Voice—Active or Passive

You can use either the *active* or the *passive voice* when you describe the procedure used in your project. Examples of both voices are given in the following box. Notice that the formation of the passive voice requires the *be* auxiliary + the past participle of a verb.



Your decision whether to use the active or passive voice in procedural statements should be made with the following considerations:

1. The passive voice is conventionally used to describe procedure in order to *depersonalize* the information. The passive construction allows you to omit the agent (usually “I” or “we”), placing the emphasis on the procedure and how it was done.

EXAMPLE A: For reasons related to personal safety, the test facility *was constructed* (by us) in a remote area 4 miles from the main road.

EXAMPLE B: Tests *were conducted* (by me) with four different types of reactors.

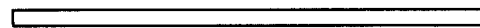
However, your professor or editor may specifically ask you *not* to use the passive voice because he or she prefers a *more personal style* with frequent use of the pronouns “I” or “we.”

2. In addition to questions of style, your choice of the active or passive voice should place *old information* near the beginning of the sentence and *new information* at the end. The old information is italicized in each sentence in example C.

EXAMPLE C: The four reactors we tested in the work reported here all contained a platinum catalyst (ACTIVE). Each *reactor-catalyst configuration* will be described separately (PASSIVE). *The quartz reactors* were manufactured by the Wm. A. Sales Company of Wheeling, Illinois (PASSIVE).

EXERCISE 5.6 Transformation

The following methodology description was taken from a report in the field of civil engineering about a highway construction project. It has been altered so that the writers of the report are mentioned as agents in each sentence. Rewrite the description in a *depersonalized* form.



CUT AND COVER CONSTRUCTION ON UNSTABLE SLOPES

Method

¹We started construction of the reinforced concrete structure in July, 1976, and completed it by May, 1977. ²We built standard sections of forms for the casting of the concrete. ³We used concrete of the B225 type, in accordance with government regulations. ⁴At the two ends of the structure we constructed wingwalls, and we installed three side openings on the downhill side to provide enough daylight to render the use of electric lights unnecessary.

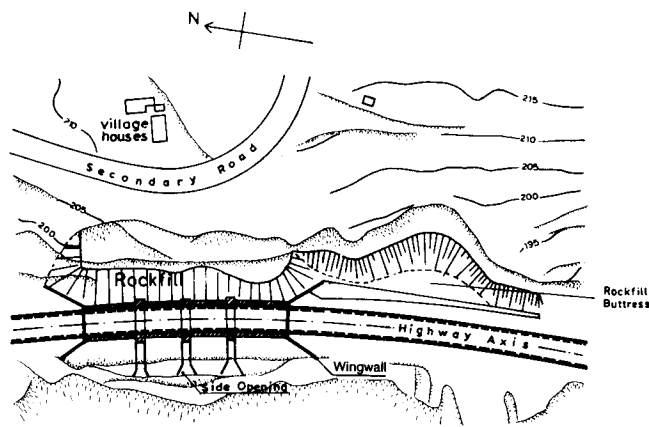
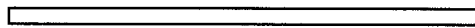
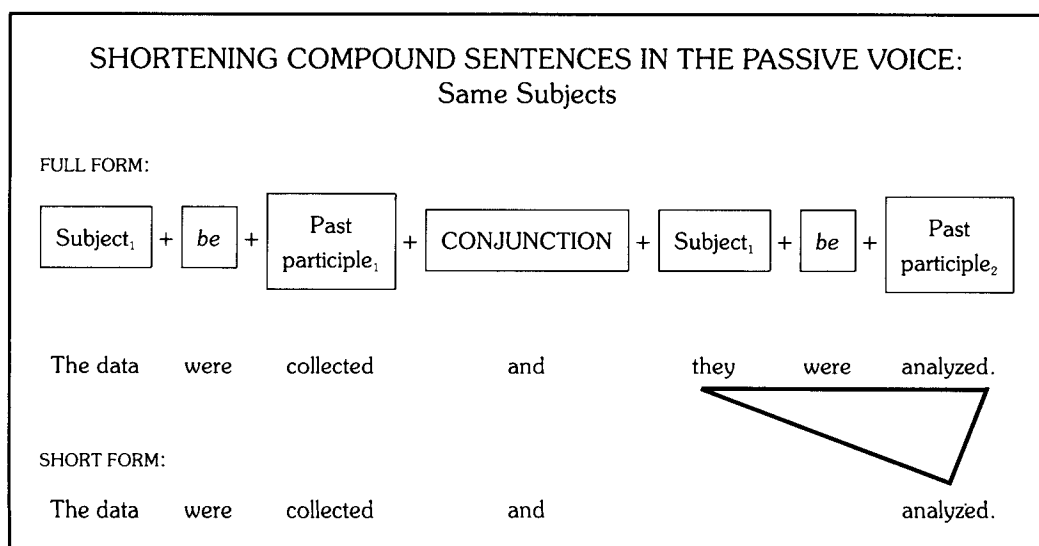


FIGURE 5.3 Reinforced concrete structure.

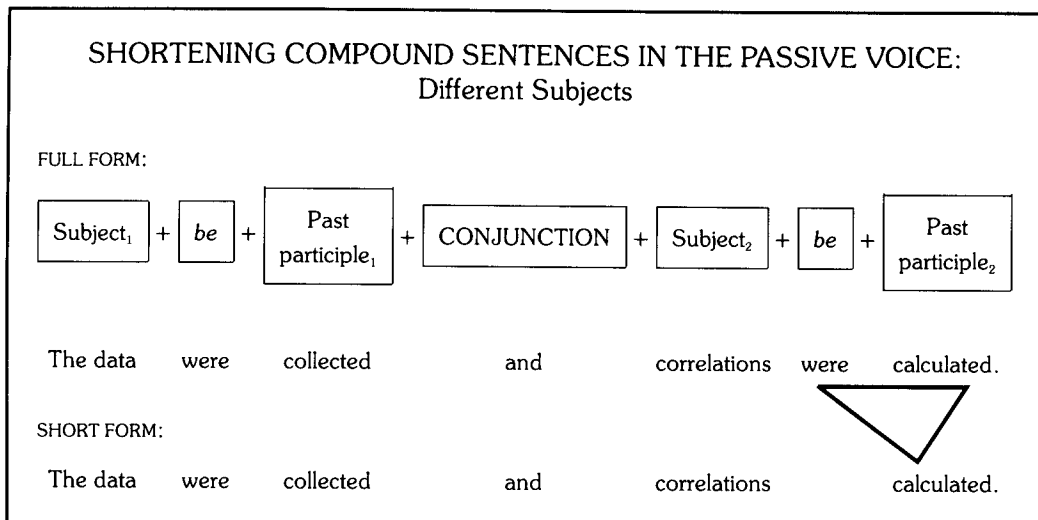


Using Short Passive Forms to Describe Procedure

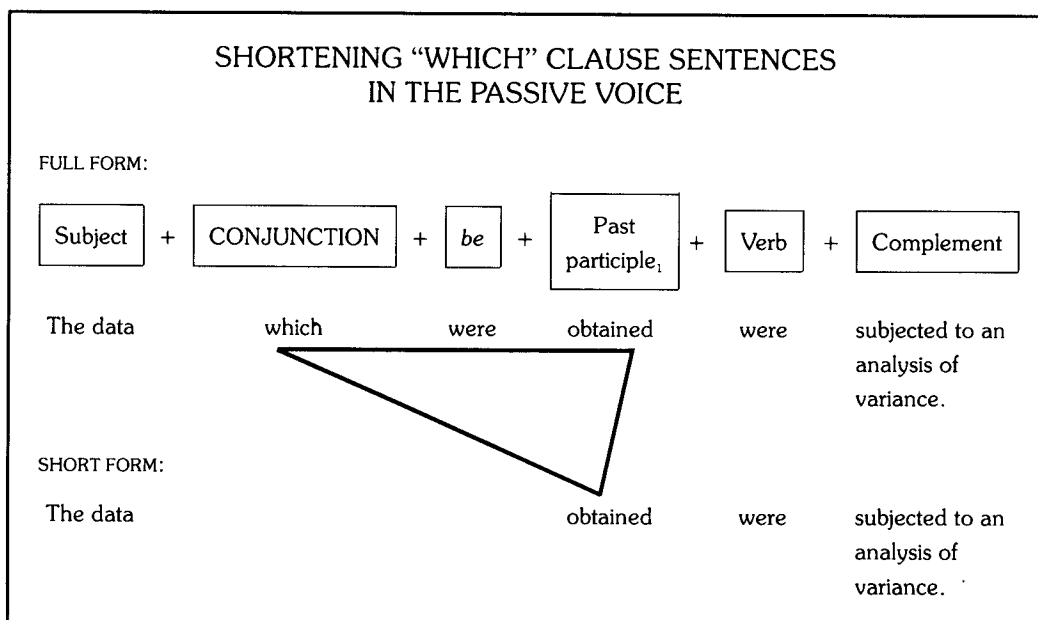
In technical and scientific English, there is a tendency to *shorten* certain kinds of passive constructions. Three such kinds of sentences are commonly used in procedural descriptions. The first type is a compound sentence with two identical subjects and two or more verbs in the passive. To shorten this kind of sentence, omit the *subject* and the *be* auxiliary in the second part of the sentence.



The second type of sentence is also compound, but in this case there are two different subjects, each with different verbs in the passive voice. To shorten this kind of sentence, omit the *be* auxiliary before the second verb.



The third type of sentence has a *which* clause containing a passive verb form. In this case, you can shorten the clause by dropping the conjunction *which* and the *be* auxiliary.



EXERCISE 5.7 Analysis/Transformation

The following sentences are taken from the method section of a report in the field of horticulture. For each example, indicate if the passive voice is used in a *compound sentence* or a *which clause* by writing CS or WC. Then rewrite each sentence in its short form. If no short form is possible, write the abbreviation NSF.

WEED CONTROL IN CHILE PEPPERS AT THE ESPAÑOLA VALLEY BRANCH STATION

1. _____ Herbicides were applied before planting at various dosage levels to plots consisting of one 30-ft row which was planted on a 36-inch bed.

2. _____ The preplant treatments were sprayed on the surface of the prepared beds and they were incorporated into the soil by double-discing.

3. _____ The plants were seeded by hand into the beds to obtain between two to five plants per hill which were spaced at 3-ft intervals.

4. _____ The variety which was seeded each year was Española No. 1.

5. _____ A randomized block design was used each year with three replications in 1966 and 1968.

6. _____ Weed counts were made and records were kept of the time which was required to remove weeds from one 30-ft row.

EXERCISE 5.8 Identification

Read the following selection describing the procedures used to carry out a study in the field of economics. Underline all examples of the passive voice. Also, underline any short forms of the passive that you recognize.

AN ECONOMIC ANALYSIS OF NATURAL GAS POLICY ALTERNATIVES

Procedures

¹A mathematical model was developed for the evaluation of alternative natural gas policies. ²The model is based upon a simplified energy-demand function which relates the quantity of energy consumed to price. ³This relationship was not estimated by a statistical procedure. ⁴Rather, parameters were specified which, on the basis of previous studies, were thought to approximate market behavior.

⁵Energy consumption was defined to include natural gas, oil, and electricity used in the residential, commercial, and industrial sectors. ⁶Fuels used for transportation and oil used for industrial feedstock were excluded because natural gas is not generally used for these purposes. ⁷It is used to produce anhydrous ammonia, but this was also excluded.

⁸The supply and price of natural gas and the prices of potential natural gas substitutes were specified for each policy option. ⁹The model was then used to calculate the price of energy, the quantity of energy, and the quantities of natural gas substitutes that would be consumed. ¹⁰From this information, policy alternatives were evaluated by comparing the consumer expenditure associated with each policy.

EXERCISE 5.9 Fill-in

The procedural description about natural gas policy is given here again. This time, without looking back at the original, fill in each blank space with any appropriate *be* auxiliary or *past participle*.

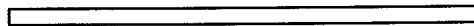
¹A mathematical model _____ developed for the evaluation of alternative natural gas policies. ²The model is based upon a simplified energy-demand function which relates the quantity of energy consumed to price. ³This relationship _____ not _____ by a statistical procedure. ⁴Rather, parameters _____ specified which, on the basis of previous studies, were _____ to approximate market behavior.

⁵Energy consumption was defined to include natural gas, oil, and electricity _____ in the residential, commercial, and industrial sectors. ⁶Fuels used for transportation and oil _____ for industrial feedstock were _____ because natural gas is not generally used for these purposes. ⁷It is used to produce anhydrous ammonia, but this use was also _____.

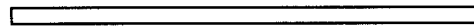
⁸The supply and price of natural gas and the prices of potential natural gas substitutes _____ specified for each policy option. ⁹The model was then _____ to calculate the price of energy, the quantity of energy, and the quantities of natural gas substitutes that would _____ consumed. ¹⁰From this information, policy alternatives _____ evaluated by comparing the consumer expenditure _____ with each policy.

EXERCISE 5.10 Reconstruction

Part of the procedural section you have been practicing with is given again, but this time the sentences are indicated only by lists of key words. Without looking back to the original, reconstruct one sentence from each list, using *passive voice verbs* or *short passive forms* wherever possible. Add all necessary words and word endings and write out each group as a complete sentence. The key words are grouped and listed in the correct order.



- | | |
|---|--|
| 1. mathematical model
develop
evaluate
alternative natural gas
policies | 3. model
then use
calculate
price of energy
and
quantities of natural gas
substitutes
would be
consume |
| 2. supply, price
natural gas
and
prices
potential natural gas
substitutes
specify
for each policy option | 4. from this information
policy alternatives
evaluate
compare the cost
associate
each |



EXERCISE 5.11 Library

Using the same example of experimental procedure that you found for Library Exercise 5.4, answer the following questions.

1. What *verb tense* is used in the description of experimental procedure? Can you find any exceptions to the tense rules we have studied here? If so, can you explain the exceptions?
2. What is the proportion of *active voice verbs* to *passive verbs* in this section? Does this proportion result in a *personalized* or *depersonalized* style of description?
3. What examples of *short passive forms* can you find in your selection?

INTEGRATION

EXERCISE 5.12 Guided Writing

Before he invented the Polaroid Camera, Edwin Land conducted many experiments on color vision and color photography. One of his experiments

involved the use of black and white film to produce a color image. This was done with camera filters and projector lamps of different colors. The procedure adapted from one of his experiments is shown here in diagram form. Notice that the procedure consisted of three main steps. Assume that you are Edwin Land and that you are writing a report on this experiment. Using the information contained in the diagram, write the *procedural description*. In order for your description to be clear, you must provide *all* of the pertinent details for each step.

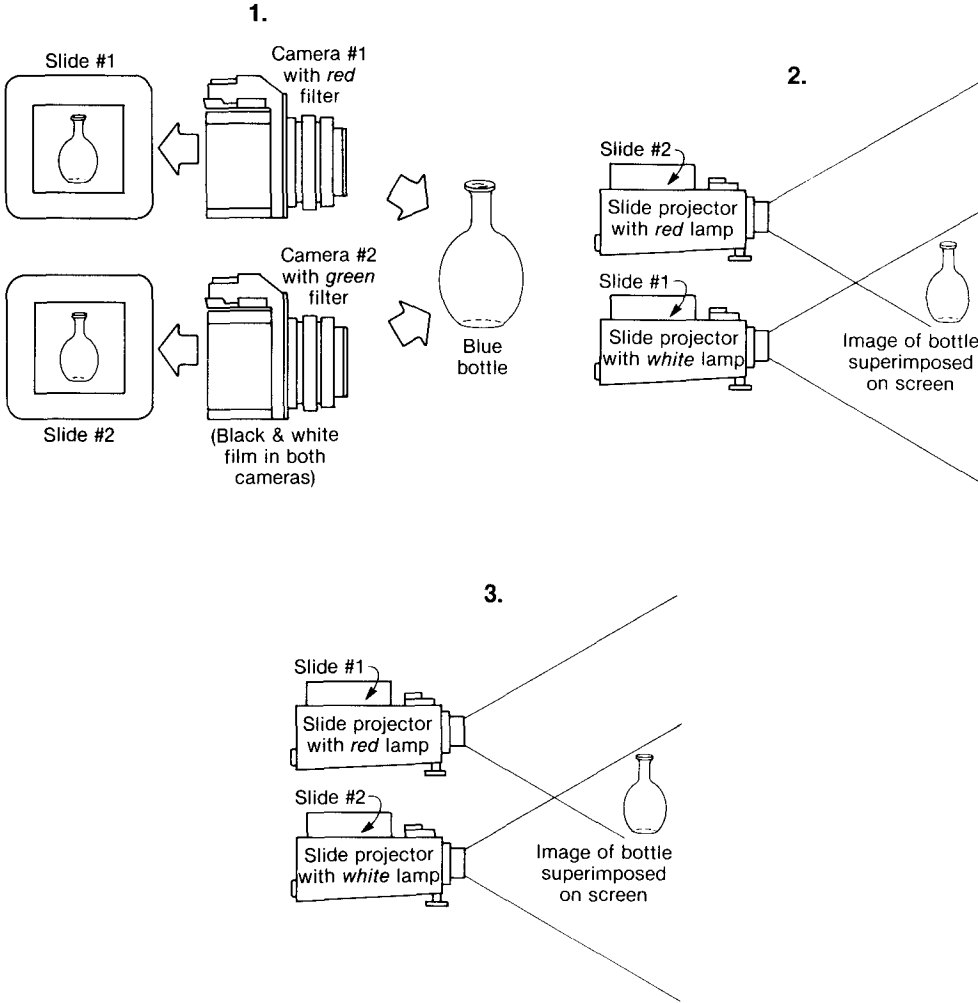


FIGURE 5.4 Color photography experiment.

EXERCISE 5.13 Guided Writing

Following are the introduction and method sections to a study in the field of engineering management. First, read the introduction to the study. Then, from the outline that follows, write a description of the procedures used to carry out the study.

VALENCE OF AND SATISFACTION WITH JOB OUTCOMES

Introduction

Job outcomes can be directly related to the experience of performing a task, or they can be allocated by others as a function of performing a task. Outcomes that are directly related to performing a task are termed *intrinsic outcomes*, while those allocated by others are called *extrinsic outcomes*. For example, performing a task that requires the worker to make full use of his/her skills and abilities provides intrinsic outcomes. Pay based upon the quality of one's work qualifies as an extrinsic outcome.

The anticipated satisfaction that one associates with specific job outcomes is a major influence on worker motivation (1). Satisfaction is a function of the job outcomes desired and expected by the worker, and those actually received (2, 3). Workers who receive the outcomes they expect or desire from their work will tend to be satisfied with their work. Satisfied workers exhibit lower absenteeism and file fewer grievances (4). If managers are able to make job satisfaction dependent upon the performance of required tasks, the results should be increased worker motivation and satisfaction.

A study of construction workers was carried out including workers from various trades in the industry to determine how job satisfaction was related to job outcomes among these workers. Results of this study may suggest ways in which construction workers can be motivated to greater productivity by ensuring that they receive the outcomes they expect from their jobs.

Method

Sample — stratified, random, cross-sectional
— 2800 construction workers, major midwestern city

- different trade unions (carpenters, electricians, plumbers)
- 30 percent of the members of each trade union

Procedure

1. Envelopes — send to local business manager of each union
 - contents: { cover letter
questionnaire
postage paid return envelope
2. Union business manager — request:
 - { select workers from his union
send envelopes to selected workers
3. Workers — fill out questionnaires
 - mail completed questionnaires to investigators (use postage paid return envelopes)

Material

- Questionnaire — modified version of Michigan Organizational Assessment Package
- 703 completed questionnaires returned

Statistical Treatment

- Multiple regression—
1. measure: overall satisfaction with job
 2. identify: most important job outcomes
 3. correlate: { job outcomes
job satisfaction



EXERCISE 5.14. Writing Up Your Own Research

In previous chapters you have begun writing up an original research project. You have already written the introduction, including a literature review

(Chapters 2, 3, and 4). Now, carry out your study. Plan and follow a series of procedural steps as determined by your purpose and your research design. Develop and use any instruments (such as surveys, questionnaires, tests, and so on) you need in order to collect data. Finally, when you have completed all the steps and collected all your data, write a *procedural description* of the methodology you used. Before you write, remember:

1. Procedural descriptions are arranged chronologically.
2. The past tense is usually used to indicate the procedures which were used in the study.
3. The passive voice and short forms of some passive constructions are commonly used in this section of the research report.

CHECKLIST FOR CHAPTER 5

Describing Experimental Procedure

INFORMATION

- _____ Include all information necessary for someone to replicate your procedure.
- _____ Describe the procedure chronologically.

LANGUAGE

- _____ Use the past tense to describe procedure.
- _____ Use the passive voice to depersonalize procedural descriptions and to keep old information at the beginning of sentences.
- _____ Use short forms of the passive voice to reduce compound sentences and *which* clauses.