Measurement: The Basic Building Block of Research

MEASUREMENT LIES AT THE HEART of statistics. Indeed, no statistic would be possible without the concept of measurement. Measurement is also an integral part of our everyday lives. We routinely classify and assign values to people and objects without giving much thought to the processes that underlie our decisions and evaluations. In statistics, such classification and ordering of values must be done in a systematic way. There are clear rules for developing different types of measures and defined criteria for deciding which are most appropriate for answering a specific research question.

Although it is natural to focus on the end products of research, it is important for the researcher to remember that measurement forms the first building block of every statistic. Even the most complex statistics, with numbers that are defined to many decimal places, are only as accurate as the measures upon which they are built. Accordingly, the relatively simple rules we discuss in this chapter are crucial for developing solid research findings. A researcher can build a very complex structure of analysis. But if the measures that form the foundation of the research are not appropriate for the analyses that are conducted, the findings cannot be relied upon.

We begin Chapter 2 by examining the basic idea of measurement in science. We then turn to a description of the main types of measures in statistics and the criteria used to distinguish among them. We are particularly concerned with how statisticians rank measurement based on the amount of information that a measure includes. This concept, known as levels of measurement, is very important in choosing which statistical procedures are appropriate in research. Finally, we discuss some basic criteria for defining a good measure.

Science and Measurement: Classification as a First Step in Research

Criminal justice research is a scientific enterprise that seeks to develop knowledge about the nature of crimes, criminals, and the criminal justice

system. The development of knowledge can, of course, be carried out in a number of different ways. Criminal justice researchers may, for example, observe the actions of criminal justice agents or speak to offenders. They may examine routine information collected by government or criminal justice agencies or develop new information through analyses of the content of records in the criminal justice system. Knowledge may be developed through historical review or even through examination of archaeological records of legal systems or sanctions of ancient civilizations.

The methods that criminal justice researchers use vary. What they have in common is an underlying philosophy about how knowledge may be gained and what scientific research can tell us. This philosophy, which is predominant in scientific study in the modern world, is usually called positivism.[1] At its core is the idea that science is based on facts and not values. Science cannot make decisions about the way the world should be (although scientific observation may inform such decisions). Rather, it allows us to examine and investigate the realities of the world as we know it. The major tool for defining this reality in science is **measurement**.

Measurement in science begins with the activity of distinguishing groups or phenomena from one another. This process, which is generally termed **classification,** implies that we can place units of scientific study—such as victims, offenders, crimes, or crime places—in clearly defined categories. The classification process leads to the creation of **variables**. A variable is a trait, characteristic, or attribute that can be measured. What differentiates measurement in science from measurement in our everyday lives is that there must be systematic criteria for determining both what each category of a variable represents and the boundaries between categories. We now turn to a discussion of these criteria as they relate to different **levels of measurement.**

Levels of Measurement

Classification forms the first step in measurement. There are a number of different ways we can classify the people, places, or phenomena we wish to study. We may be content to simply distinguish one category from another. But we may also be interested in how those categories relate to one another. Do some represent more serious crime or less serious crime? Can we rank how serious various crimes are in a clear and

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[1]See D. Black, "The Boundaries of Legal Sociology," in D. Black and M. Mileski (eds.), *The Social Organization of Law* (New York: Seminar Press, 1973), pp. 41–47.

| Figure 2.1 | *Ladder of Measurement* |
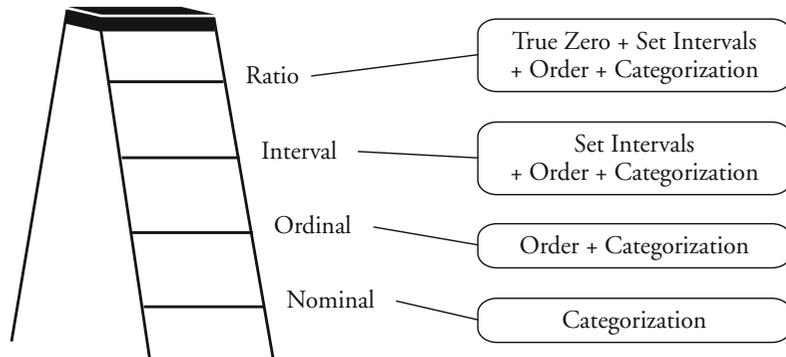
defined order? Is it possible to define exactly how serious one crime is relative to another?

As these types of questions suggest, measurement can be a lot more complex than simply distinguishing one group from another. Recognizing this complexity, statisticians have defined four basic groups of measures, or **scales of measurement,** based on the amount of information that each takes advantage of. The four are generally seen as occupying different positions, or levels, on a ladder of measurement (see Figure 2.1). Following a principle stated in Chapter 1—that statistics based on more information are generally preferred—measures that include more information rank higher on the ladder of measurement.

Nominal Scales

At the bottom of the ladder of measurement are **nominal scales**. Nominal-scale variables simply distinguish one phenomenon from another. Suppose, for example, that you want to measure crime types. In your study, you are most interested in distinguishing between violent crime and other types of crime. To fulfill the requirements of a nominal scale, and thus the minimum requirements of measurement, you need to be able to take all of the crime events in your study and place them in one of two categories: either violent crime or other crime. There can be no overlap. In practice, you might come across many individual events that seem difficult to classify. For example, what would you do with a crime event in which the offender first stole from his victim and then assaulted him? This event includes elements of both violent and property crime. What about the case where the offender did not assault the victim, but merely threatened her? Would you decide to include this in the category of violent crime or other crime?

In measurement, you must make systematic choices that can be applied across events. You cannot decide one way for one event and another way for another. In the situation described above, you might conclude that the major issue in your study was the presence of violence. Thus, all cases with any violent events would be placed in the violent category. Similarly, you might conclude that violence had to include physical victimization. Whatever your choice, to meet the requirements of measurement you must define clearly where all events in your study are to be placed.

In criminology and criminal justice, we often make use of nominal-scale variables. Many of these reflect simple dichotomies, like the distinction between violent and other crime. For example, criminologists often seek to examine differences between men and women in their involvement in criminality or treatment in the criminal justice system. It is common as well to distinguish between those who are sentenced to prison and those who are not or those who commit more than one crime ("recidivists") and those who are only one-shot offenders.

It is often necessary to distinguish among multiple categories of a nominal-level variable. For example, if you wanted to describe legal representation in court cases, you would provide a very simplistic picture if you simply distinguished between those who had some type of legal representation and those who did not. Some of the offenders would be likely to have private attorneys and others court-appointed legal representation. Still others might gain help from a legal aid organization or a public defender. In order to provide a full portrait of legal representation, you would likely want to create a nominal-scale variable with five distinct categories: No attorney, Legal aid, Court appointed, Public defender, and Private attorney. Table 2.1 presents a number of examples of nominal-level scales commonly used in criminal justice.

Nominal-scale measures can include any number of different categories. The Uniform Crime Reporting system, which keeps track of arrests in the United States, includes some 29 categories of crime. These

| Table 2.1 | Nominal-Scale Variables Commonly Found in Criminal Justice Research |

VARIABLE	COMMON CATEGORIES
Gender	Male, Female
Race-Ethnicity	Non-Hispanic Black, Non-Hispanic White, Hispanic (any race)
Marital Status	Single, Married, Separated, Divorced, Widowed
Pretrial Release Status	Detained, Released
Type of Case Disposition	Dismissed, Acquitted, Diverted, Convicted
Method of Conviction	Negotiated guilty plea, Nonnegotiated guilty plea, Bench trial, Jury trial
Type of Punishment	Incarceration, Nonincarceration

range from violent crimes, such as murder or robbery, to vagrancy and vandalism. Although there is no statistical difficulty with defining many categories, the more categories you include, the more confusing the description of the results is likely to be. If you are trying to provide a sense of the distribution of crime in your study, it is very difficult to practically describe 20 or 30 different crime categories. Keeping in mind that the purpose of statistics is to clarify and simplify, you should try to use the smallest number of categories that will accurately describe the research problem you are examining.

At the same time, do not confuse collection of **data** with presentation of your findings. You do not lose anything by collecting information in the most detailed way that you can. If you collect information with a large number of categories, you can always collapse a group of categories into one. For example, if you collect information on arrest events utilizing the very detailed categories of the criminal law, you can always combine them later into more general categories. But if you collect information in more general categories (for example, just violent crime and property crime), you cannot identify specific crimes such as robbery or car theft without returning to the original source of your information.

Though nominal-scale variables are commonly used in criminology and criminal justice, they provide us with very limited knowledge about the phenomenon we are studying. As you will see in later chapters, they also limit the types of statistical analyses that the researcher can employ. In the hierarchy of measurement, nominal-scale variables form the lowest step in the ladder. One step above are **ordinal scales**.

Ordinal Scales

What distinguishes an ordinal from a nominal scale is the fact that we assign a clear order to the categories included. Now not only can we distinguish between one category and another; we also can place these categories on a continuum. This is a very important new piece of information; it allows us to rank events and not just categorize them. In the case of crime, we might decide to rank in order of seriousness. In measuring crime in this way, we would not only distinguish among categories, such as violent, property, and victimless crimes; we might also argue that violent crimes are more serious than property crimes and that victimless crimes are less serious than both violent and property crimes. We need not make such decisions arbitrarily. We could rank crimes by the amount of damage done or the ways in which the general population rates or evaluates different types of crime.

Ordinal-scale variables are also commonly used in criminal justice and criminology. Indeed, many important criminal justice concepts are measured in this way. For example, in a well-known London survey of

Table 2.2 Ordinal Scale Variables Commonly Found in Criminal Justice Research

VARIABLE	COMMON CATEGORIES
Level of Education	Less than high school, Some high school, High school graduation, Some college or trade school, College graduate, Graduate/professional school
Severity of Injury in an Assault	None, Minor—no medical attention, Minor—medical attention required, Major—medical attention required with no hospitalization, Major—medical attention required with hospitalization
Attitude and Opinion Survey Questions	Strongly disagree, Disagree, No opinion, Agree, Strongly agree; Very high, High, Moderate, Low, Very low
Bail-Release Decision	Released on own recognizance, Released on bail, Detained—unable to post bail, Denied release
Type of Punishment	Probation/community service, Jail incarceration, Prison incarceration, Death sentence

victimization, fear of crime was measured using a simple four-level ordinal scale. Researchers asked respondents: "Are you personally concerned about crime in London as a whole? Would you say you are (1) very concerned, (2) quite concerned, (3) a little concerned, or (4) not concerned at all?"[2]

Ranking crime by seriousness and measuring people's fear of crime are only two examples of the use of ordinal scales in criminal justice research. We could also draw examples regarding severity of court sentences, damage to victims, complexity of crime, or seriousness of prior records of offenders, as illustrated in Table 2.2. What all of these variables have in common is that they classify events and order them along a continuum. What is missing is a precise statement about how various categories differ one from another.

Interval and Ratio Scales

Interval scales not only classify and order people or events; they also define the exact differences between them. An interval scale requires that the intervals measured be equal for all of the categories of the scale examined. Thus, an interval-scale measure of prior record would not simply rank prior record by seriousness; it would allow us to say how much more serious one offender's record was than another's in a standard unit of measurement—for example, number of arrests, convictions, or prison stays.

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[2]See R. Sparks, H. Genn, and D. Dodd, *Surveying Victims: A Study of the Measurement of Criminal Victimization* (New York: Wiley, 1977).

Most criminal justice variables that meet the criteria of an interval scale also meet the criteria of a **ratio scale**. A ratio scale has all of the characteristics of an interval scale but also requires that there be a non-arbitrary, or true, zero value. This means simply that zero represents the absence of the trait under study. To understand how interval scales differ from ordinal scales and from ratio scales, it is useful to examine a concrete example. We commonly measure prior offending in terms of the number of arrests on an offender's criminal history record. If we compare an offender who has 20 arrests with one who has only 5 arrests, we know that the former has 15 more arrests than the latter. We have an important piece of information that we would not have gained with an ordinal scale. Now, not only can we say that the prior record of one offender is more serious than that of another, but we can specify exactly how many more arrests the offender has. This variable thus meets the requirements of an interval scale. But it also meets the additional requirement of a ratio scale that there be a true zero value, since we can state that someone with 20 arrests has 4 times as many arrests as someone with 5 arrests. If the zero value were arbitrary, we could not make this statement.

This fact is best illustrated with an example. Suppose we alter our measure of prior record to focus on the degree to which offenders exceed a specific threshold of prior offending. Let's say that our threshold is 4 prior arrests and we are interested only in offenders who have 4 or more prior arrests. An offender with 5 arrests would gain a score of 1 on this new measure, and an offender with 20 arrests would have a score of 16. An offender with 4 arrests would have a score of 0. This variable meets the criteria of an interval scale because we can distinguish scores, rank them, and define the exact difference between them. A score of 16 represents a more serious prior criminal record than a score of 1. In turn, an offender with a score of 16 has 15 more arrests than an offender with a score of 1. However, we cannot say that the offender with a score of 16 on this measure had 16 times as many prior arrests as the offender with a score of 1. This is because the scale has an arbitrary zero point. Zero represents not the absence of a prior record, but the fact that the offender has 4 prior arrests. Thus, the scale is an interval scale but not a ratio scale.

Nearly all the statistics that we use in criminal justice (and all those that we describe in this text) are also appropriate for interval scales if they are appropriate for ratio scales. For this reason, most statistics texts do not differentiate between the scales in practice, even if they identify how they differ in theory. We follow the same approach. For the rest of the chapter and indeed the rest of this text, we will concentrate on the differences among nominal, ordinal, and *at least* interval scales.

Criminal justice researchers use interval scales to present findings about criminal justice agency resources, criminal sentences, and a whole

| Table 2.3 | Variables Commonly Found in Criminal Justice Research That Are Measured on at Least Interval Scales |

VARIABLE	COMMON CATEGORIES
Age	Years
Education	Years
Income or Salary	Dollars, etc.
Number of Crimes in a City/County State Nation	Count
Crime Rates for a City/County/State/Nation	Count of crimes, adjusted for the size of the population
Self-Reported Delinquent Acts	Count

host of other issues related to crimes and criminals. For example, we can measure the amount spent by criminal justice agencies to pay the salaries of police officers or to pay for the health care costs of prison inmates. We can measure the financial costs of different types of crime by measuring the amount stolen by offenders or the amount of time lost from work by violent crime victims. We can measure the number of years of prison served or sentenced or the age at which offenders were first arrested. Table 2.3 provides examples of criminal justice variables that meet the requirements of at least an interval level of measurement.

Now that we have defined each step in the ladder of measurement, we can summarize. As is illustrated in Table 2.4, as you move up the ladder of measurement, the amount of information that is gained increases. At the lowest level, you have only categorization. At the next level, you add knowledge about the order of the categories included. With interval scales, you not only classify and order your measure but also define how much categories differ one from another. A ratio scale requires all of these characteristics as well as a non-arbitrary, or true, zero value.

| Table 2.4 | Summary of the Information Required for Each Level of Measurement |

LEVEL OF MEASUREMENT	CATEGOR-IZATION	ORDER + CATEGOR-IZATION	SET INTERVALS + ORDER + CATEGORIZATION	TRUE ZERO + SET INTERVALS + ORDER + CATEGORIZATION
Ratio	X	X	X	X
Interval	X	X	X	
Ordinal	X	X		
Nominal	X			

Relating Interval, Ordinal, and Nominal Scales: The Importance of Collecting Data at the Highest Level Possible

One important lesson we can draw from the ladder of measurement is that you should measure variables in a study at the highest level of measurement your data allow. This is because each higher level of measurement requires additional information. And if you fail to collect that information at the outset, you may not be able to add it at the end of your study. In general, variables measured lower on the ladder of measurement cannot be transformed easily into measures higher on the ladder. Conversely, variables measured higher on the ladder of measurement can be transformed easily into measures lower on the ladder.

Take, for example, the measurement of victimization. If you decided to simply compare the types of victimization involved in a crime event, you would measure victimization using a nominal scale. You might choose the following categories: events involving loss of money or property, events including physical harm, a combination of such events, and all other events. But let us assume, for a moment, that at some time after you collected your data, a colleague suggests that it is important to distinguish not only the type of event but also the seriousness of crimes within each type. In this case, you would want to distinguish not only whether a crime included monetary loss or violence but also the seriousness of each loss. However, because your variable is measured on a nominal scale, it does not include information on the seriousness of loss. Accordingly, from the information available to you, you cannot create an ordinal-level measure of how much money was stolen or how serious the physical harm was.

Similarly, if you had begun with information only on the order of crime seriousness, you could not transform that variable into one that defined the exact differences between categories you examined. Let's say, for example, that you received data from the police that ranked monetary victimization for each crime into four ordinally scaled categories: no monetary harm, minor monetary harm (up to $500), moderate monetary harm ($501–10,000), and serious monetary harm ($10,001 and above). If you decide that it is important to know not just the general order of monetary harm but also the exact differences in harm between crimes, these data are insufficient. Such information would be available only if you had received data about harm at an interval level of measurement. In this case, the police would provide information not on which of the four categories of harm a crime belonged to, but rather on the exact amount of harm in dollars caused by each crime.

While you cannot move up the ladder of measurement, you can move down it. Thus, for example, if you have information collected at an interval level, you can easily transform that information into an ordinal-scale measure. In the case of victimization, if you have information on the exact amount of harm caused by a crime in dollars, you could at any point decide to group crimes into levels of seriousness. You would simply define the levels and then place each crime in the appropriate level. For example, if you defined crimes involving harm between $501 and $10,000 as being of moderate victimization, you would take all of the crimes that included this degree of victimization and redefine them as falling in this moderate category. Similarly, you could transform this measure into a nominal scale just by distinguishing between those crimes that included monetary harm and those that did not.

Beyond illustrating the connections among different levels of measurement, our discussion here emphasizes a very important rule of thumb for research. You should always collect information at the highest level of measurement possible. You can always decide later to collapse such measures into lower-level scales. However, if you begin by collecting information lower on the ladder of measurement, you will not be able to decide later to use scales at a higher level.

What Is a Good Measure?

In analysis and reporting of research results, measures that are of a higher scale are usually preferred over measures that are of a lower scale. Higher-level measures are considered better measures, based on the principle that they take into account more information. Nonetheless, this is not the only criterion we use in deciding what is a good variable in research. The researcher must raise two additional concerns. First, does the variable reflect the phenomenon to be described? Second, will the variable yield results that can be trusted?

The first question involves what those who study research methods call **validity**. Validity addresses the question of whether the variable used actually reflects the concept or theory you seek to examine. Thus, for example, collecting information on age in a sample is not a valid way of measuring criminal history. Age, although related to criminal history, is not a measure of criminal history. Similarly, work history may be related to criminality, but it does not make a valid measure of criminality. But even if we restrict ourselves to variables that directly reflect criminal history, there are often problems of validity to address.

Let's say that you wanted to describe the number of crimes that offenders committed over a one-year period. One option you might have

is to examine their criminal history as it is recorded on the Federal Bureau of Investigation's (FBI) criminal history record, or rap sheet. The rap sheet includes information on arrests, convictions, and incarcerations. Although each of these variables tells us something about a person's criminal history, they are not all equally valid in terms of answering the research question we have proposed.

The most valid measure of frequency of offending is the one that most directly assesses how many crimes an individual has committed. Associated with each of the three variables included on the rap sheet is some degree of threat to validity. This means that each can be criticized because it does not quite reflect the concept we wish to study. Incarceration, for example, is more a measure of seriousness of crime than frequency of offending. This is because judges may impose a number of different types of sanctions, and they are more likely to impose a prison sentence for more serious crimes. Many crimes that result in a conviction lead not to incarceration but rather to probation, fines, or community service. Thus, if we use incarceration to measure frequency of offending, we are likely to miss many crime events in an offender's criminal record. Accordingly, incarceration provides a biased picture of the number of offenses committed by an offender. It is not a highly valid measure of this concept.

Using this logic, criminologists have generally assumed that arrest is the most valid measure of frequency of offending that can be gained from official data sources, such as the FBI rap sheet. Arrests are much closer in occurrence to the actual behavior we seek to study and are not filtered by the negotiations found at later stages of the legal process. While criminologists have assumed that arrests reflect criminal behavior more accurately than convictions or incarceration, some legal scholars contend that arrests are a less valid measure of criminality precisely because they come before the court reaches a conclusion regarding the innocence or guilt of a defendant. They contend that someone has not committed a crime until the legal system defines an act as such.

Self-report surveys are generally considered to provide the most valid measure of frequency of offending. This is because an individual can be asked directly how many crimes he or she has committed. But self-report studies are often criticized in terms of another concern in measurement, which is termed reliability.

Reliability addresses the question of whether a measure gains information in a consistent manner. Will you get the same result if you repeat measurement of the same case or person? If different people have similar characteristics, will your measure reflect that similarity? Returning to the above example of criminal history, we would ask not whether the measure reflects the concept of frequency of offending, but whether measurement of the concept is reliable across different subjects.

Self-reports, which allow us to ask valid questions about the number of crimes that a person has committed, have been challenged on the basis of their reliability. One problem is that people may lie about their criminal histories. Crime is a sensitive issue, and no matter what efforts the researcher makes to assure subjects of confidentiality, people may be hesitant to talk about crimes in their past. Accordingly, depending on the degree of hesitancy of subjects, a researcher might gain different answers, irrespective of a person's actual criminal history. But even if a person is willing to provide accurate responses to such questions, he or she may not be able to. Some people have better memories than others, and the reliability of this measure depends in part on a person's ability to recall events generally. Such issues of reliability have begun to be addressed directly by criminologists, who are trying to increase the reliability of self-report methods by improving interview techniques and protocols.

Returning to the FBI rap sheets, we can also assess their reliability. In general, not only is arrest assumed to be the most valid of official measures; it is also the measure most reliably recorded on the FBI rap sheets. This is the case in good part because the rap sheets are built around fingerprint records, which police agencies have come to routinely send to the FBI. This helps the police agencies as well, because they often use this information to check the identities of arrestees and to assess their criminal histories. Other types of agencies are less consistent in their transfer of information to the FBI, and as a result convictions and incarcerations are less reliably recorded.

The issues raised in connection with the validity and reliability of criminal history information are good examples of the kinds of problems you will encounter in assessing measures in criminal justice. You should keep in mind that no variable is perfect. Some threat to validity is likely to be encountered, no matter how careful you are. Some degree of unreliability is almost always present in measurement. Your task is to develop or choose the best measure you can. The best measure is the one that most closely reflects the concept you wish to study and assesses it in a consistent and reliable way across subjects or events.

Chapter Summary

In science, we use **measurement** to make accurate observations. All measurement must begin with a **classification** process—a process that in science is carried out according to systematic criteria. This process implies that we can place units of scientific study in clearly defined categories. The end result of classification is the development of **variables.**

There are four **scales of measurement**: nominal, ordinal, interval, and ratio. With a **nominal scale,** information is organized by simple classification. The aim is merely to distinguish between different phenomena. There can be no overlap between categories nor can there be cases that do not fit any one category. There is no theoretical limit to the number of nominal categories possible. With an **ordinal scale,** not only is information categorized, but these categories are then placed in order of magnitude. An **interval scale** is one that, in addition to permitting the processes of categorization and ordering, also defines the exact difference between objects, characteristics, or events. A **ratio scale** is an interval scale for which a non-arbitrary, or true, zero value can be identified.

Data collected at a higher level of measurement may subsequently be reduced to a lower level, but data collected at a lower level may not be transformed to a higher one. For this reason, it is always advisable to collect data at the highest level of measurement possible.

There are three separate factors that affect the quality of a measure. The researcher should strive for a measure that has (1) a high scale of measurement (one that uses the most information); (2) a high level of **validity** (one that provides an accurate reflection of the concept being studied); and (3) a high level of **reliability** (one that provides consistent results across subjects or units of study).

Key Terms

classification The process whereby data are organized into categories or groups.

data Information used to answer a research question.

interval scale A scale of measurement that uses a common and standard unit and enables the researcher to calculate exact differences between scores, in addition to categorizing and ordering data.

levels of measurement Types of measurement that make use of progressively larger amounts of information.

measurement The assignment of numerical values to objects, characteristics, or events in a systematic manner.

nominal scale A scale of measurement that assigns each piece of information to an appropriate category without suggesting any order for the categories created.

ordinal scale A scale of measurement that categorizes information and assigns it an order of magnitude without using a standard scale of equal intervals.

ratio scale A scale of measurement identical to an interval scale in every respect except that, in addition, a value of zero on the scale represents the absence of the phenomenon.

reliability The extent to which a measure provides consistent results across subjects or units of study.

scale of measurement Type of categorization used to arrange or assign values to data.

validity The extent to which a variable accurately reflects the concept being measured.

variable A trait, characteristic, or attribute of a person/object/event that can be measured at least at the nominal-scale level.

Exercises

2.1   For each of the following examples of criminal justice studies, state whether the scale of measurement used is nominal, ordinal, or at least interval (i.e., interval or ratio). Explain your choice.

a. In a door-to-door survey, residents of a neighborhood are asked how many times over the past year they (or anyone in their household) have been the victims of any type of crime.

b. Parole-board members rate inmate behavior on a scale with values ranging from 1 to 10; a score of 1 represents exemplary behavior.

c. One hundred college students are asked whether they have ever been arrested.

d. A researcher checks prison records to determine the racial background of prisoners assigned to a particular cell block.

e. In a telephone survey, members of the public are asked which of the following phrases best matches how they feel about the performance of their local police force: totally dissatisfied, dissatisfied, indifferent, satisfied, or very satisfied.

f. A criminologist measures the diameters (in centimeters) of the skulls of inmates who have died in prison, in an attempt to develop a biological theory of the causes of criminality.

g. Secretaries at a top legal firm are asked the following question: "Over the past year, have you been the victim of sexual harassment—and if so, how many times?" Answers are categorized as follows: never, once, two or three times, more than three times, or refused to answer.

2.2   You have been given access to a group of 12 jurors, with a mandate from your senior researcher to "go and find out about their prior jury experience." Under each of the following three sets of restrictions, devise a question to ask the jurors about the number of experiences they have had with previous juries.

a. The information may be recorded *only* on a nominal scale of measurement.

b. The information may be recorded on an ordinal scale but not on any higher scale of measurement.

c. The information may be recorded on an interval scale.

Your senior researcher subsequently informs you that she wishes to know the answers to the following five questions:

—How many of the jurors have served on a jury before?

—Who is the juror with the most prior experience?

—What is the sum total of previous jury experience?

—Is there anyone on the jury who has served more than three times?

—What is the average amount of prior jury experience for this group?

d. If you had collected data at the nominal level, which (if any) of the above questions would you be in a position to answer?

e. If you had collected data at the ordinal level, which (if any) of the above questions would you be in a position to answer?

f. If you had collected data at the interval level, which (if any) of the above questions would you be in a position to answer?

2.3   You have been asked to measure the public's level of support for using the death penalty. Devise questions to gauge each of the following:

a. Overall support for using the death penalty.

b. Support for using the death penalty if there are other punishment options.

c. Support for using the death penalty if the chances of an innocent person being executed are

   i. 1 in 1,000.

   ii. 1 in 100.

   iii. 1 in 10.

2.4   You are investigating the effects of a defendant's prior record on various punishment decisions made by the court. One variable that you have access to in local court records is the total number of prior felony arrests for each defendant.

a. What kinds of questions would you be able to answer with prior record measured in this way?

b. Explain how you would recode this information on a nominal scale of measurement. What kinds of questions would you be able to answer with prior record measured in this way?

c. Explain how you would recode this information on an ordinal scale of measurement. What kinds of questions would you be able to answer with prior record measured in this way?

2.5   Because the Ministry of Transport (MOT) is concerned about the number of road accidents caused by motorists driving too close together, it has, on an experimental 2-km stretch of road, painted "chevrons" (lane markings) every few meters in each lane. By the roadside it has erected a sign that reads: "KEEP YOUR DISTANCE: STAY AT LEAST 3 CHEVRONS FROM THE CAR IN FRONT!" The MOT has asked you to measure the extent to which this instruction is being followed. There are a number of possible measures at your disposal. Assess the reliability and validity of each approach suggested below. Which is the best measure?

   a. Stand on a bridge over the experimental stretch of road and count how many of the cars passing below do not keep the required distance.

   b. Compare police figures on how many accidents were recorded on that stretch of road over the periods before and after it was painted.

   c. Study the film from a police camera situated 5 km farther down the same stretch of road (after the end of the experimental stretch) and count how many cars do not keep a safe distance.

2.6   The police are planning to introduce a pilot "community relations strategy" in a particular neighborhood and want you to evaluate whether it has an effect on the willingness of citizens to report crimes to the police. There are a number of possible measures at your disposal. Assess the reliability and validity of each approach suggested below. Which is the best measure?

   a. Telephone every household and ask respondents to measure, on a scale of 1 to 10, how willing they are to report particular types of crime to the police. Repeat the experiment after the scheme has been in operation six months.

   b. Compare a list of offenses reported by members of the neighborhood in the six months before introduction of the scheme with a similar list for the six months after introduction of the scheme. (It is standard procedure for the police to record the details of the complainant every time a crime is reported to them.)

2.7   You are comparing the psychological condition of three inmates serving out long terms in different high-security prisons, and you are interested in the amount of contact each one has with the outside world. You wish to determine how many letters each one has sent over the past 12 months. No official records of this exist. There are a number of possible measures at your disposal. Assess the reliability and validity of each approach suggested below. Which is the best measure?

   a. Ask each prisoner how many letters he or she sent over the past year.

     b. Check the rules in each of the prisons to see how many letters high security prisoners are allowed to send each year.

     c. Check the records of the prison postal offices to see how many times each prisoner bought a stamp over the past year.

2.8   The government is interested in the link between employment and criminal behavior for persons released from prison. In a study designed to test for an effect of employment, a group of people released from prison are randomly assigned to a job training program, where they will receive counseling, training, and assistance with job placement. The other offenders released from prison will not receive any special assistance. There are a number of possible measures at your disposal. Assess the reliability and validity of each approach suggested below. Which is the best measure?

     a. Eighteen months after their release from prison, interview all the offenders participating in the study and ask about their criminal activity to determine how many have committed criminal acts.

     b. Look at prison records to determine how many offenders were returned to prison within 18 months of release.

     c. Look at arrest records to determine how many offenders were arrested for a new crime within 18 months of release.

2.9   In a recent issue of a criminology or criminal justice journal, locate a research article on a topic of interest to you. In this article, there should be a section that describes the data. A well-written article will describe how the variables were measured.

     a. Make a list of the variables included in the article and how each was measured.

     b. What is the level of measurement for each variable—nominal, ordinal, or at least interval? Explain why.

     c. Consider the main variable of interest in the article. Assess its reliability and validity.

Computer Exercises

There are a number of statistical software packages available for data analysis. Most spreadsheet programs will also perform the basic statistical analyses of the kind described in this text through Chapter 17. The computer exercises included in this text focus on the use of two different software programs: SPSS and Stata. Most universities that we are aware of make at least one of these two statistical programs available in student computer labs. There are also student versions of each program that can be purchased separately, sometimes through a university bookstore or other offices on campus—see each company's Web site for details (www.spss.com or www.stata.com). There are many excellent reference books

on the use of either SPSS or Stata for statistical data analysis—our intent here is not to repeat what is said in those books. Rather, our goal with the computer exercises is to illustrate some of the power available to you in two widely used packages. In real-world situations where you are perform some type of statistical analysis, you rarely work through a problem by hand, especially if the number of observations is large.

Several SPSS and Stata files are available at the following Web address: http://extras.springer.com. The data file we will use first represents a subset of the data from the National Youth Survey, Wave 1. The sample of 1,725 youth is representative of persons aged 11–17 years in the USA in 1976, when the first wave of data was collected. While these data may seem old, researchers continue to publish reports based on new findings and interpretations of these data. One of the apparent strengths of this study was its design; the youth were inter- viewed annually for 5 years from 1976 to 1980 and then were interviewed again in 1983 and 1987. The data file on our Web site was constructed from the full data source available at the Inter-University Consortium of Political and Social Research, which is a national data archive. Data from studies funded by the National Institute of Justice (NIJ) are freely available to anyone with an Internet connection; go to http://www.icpsr.umich.edu/NACJD. All seven waves of data from the National Youth Survey are available, for example.

SPSS

To begin our exploration of SPSS, we will focus here on some of the data management features available to users. After starting the SPSS program on your computer, you will need to open the National Youth Survey data file from the Web site (nys_1.sav). For those readers working with the Student Version of SPSS, you are limited to data files with no more than 50 variables and 1,500 cases. We have also included a smaller version of the NYS data (nys_1_student. sav) that contains a random sample of 1,000 cases (of the original 1,725).

After you start SPSS and open the data file, the raw data should appear in a window that looks much like a spreadsheet. Each column represents a different variable, while each row represents a different observation (individual, here). If you scroll down to the end of the data file, you should see that there are 1,725 lines of data (or 1,000 if using the student version of the data file).

There are three direct ways to learn about the variables included in this data file. First, notice the buttons in the lower center of the spreadsheet. One button (which should appear as the darker shade of the two buttons) is labeled "Data View," and the other is labeled "Variable View." The data view button presents us with the spreadsheet of values for each observation and variable. If you click on the button labeled "Variable View," you should now see another spreadsheet, in which variable names are listed in the first column and the other columns contain additional information about each variable. For example, the first col- umn provides the name of the variable, another column provides a label for the

variable (allowing us to add a more informative description of our variable), and an additional column provides value labels. It is from this column that we will be able to learn more about each variable. For example, click on the cell in this column for the sex variable, and you should see a small gray box appear in the cell. Now click on this small gray box and you will be presented with a new window that lists possible values for sex and the corresponding labels. Here, we see that males have been coded as "1" and females as "2." If you click on "OK" or "Cancel," the window disappears. You can then perform this same operation for every other variable.

A second way of obtaining information about the variables in an SPSS data file involves using the "Variables" command. To execute this command, click on "Utilities" on the menu bar; then click on "Variables." What you should see is a list of variables on the left and another window on the right that presents information about the highlighted variable. If you click on the sex variable, you should see information on its coding and values in the window on the right. This command is particularly useful if you are working with an SPSS data file and simply need a reminder of how the variables are coded and what categories or values are included. This feature is useful if you are working with a data set and need to know what a particular variable refers to or how it is measured in order to continue working.

A third way of obtaining information about the variables in an SPSS data file involves the "Display Data File Information" command. To run this command, click on "File" on the menu bar; then click on "Display Data File Information," and then select the option for "Working File" (the data you have already opened up in SPSS). This command generates text for the output window in SPSS. This output contains all the information SPSS has on every variable in a data file. Executing this command is equivalent to executing the "Variables" command for every variable in the data set and saving that information in another file. Be aware that using this command on a data file with many variables will produce a very large output file. This command is most useful when you are first working with an SPSS data set that someone else has conveniently set up for you and you need to verify the contents of the data set and the nature of the variables included in the data set. Similar to what you are now doing with the NYS data file.

In subsequent chapters, the computer exercises will make use of syntax commands and files. These are the command lines that each program uses to run a particular procedure. To begin, open a syntax window in SPSS by clicking on "File," then "New" and "Syntax." A blank window opens in which you may enter command lines and save for future use. Alternatively, instead of opening a blank syntax window, you could open one that had been saved, such as Chapter_2.sps included on the text Web site.

Open the Chapter_2.sps syntax file. As a convention throughout the text, we will use CAPS to denote required or really useful components to a command, although you are free to use lowercase letters in any command that you run in SPSS. The first line of this file begins with /*—this is a comment line. Any of

the SPSS syntax files that you open and begin with this line do not run com-
mands, but are included to help explain what it is you are reading in the file.

The first two command lines of Chapter_2.sps are:

    GET FILE = '[directory_name]nys_1.sav'.

    DATASET NAME nys WINDOW = FRONT.

The GET FILE command reads the NYS data file into SPSS. Note that you
will need to provide a directory name that contains your copy of the nys_1.sav
data file. The DATASET command gives you the option of naming the data
file something else internally, while you are working in SPSS. Here, the name
given is simply "nys." The WINDOW = FRONT option is useful for those times
when you may have more than one data file opened in SPSS—this forces it to
keep this spreadsheet in the position where it is the first one you will see on your
computer screen.

It is important to note that each command line ends with a period—this
ensures that SPSS will know where the command ends and when to start execut-
ing the instruction.

To run these command lines—after you have edited the directory
information—highlight the two lines and do one of the following:

- Click on the right-pointing triangle toward the top right of the syntax window.

- Click on "Run" on the menu bar and then select the option for "Selection"—
  The keystrokes for this same procedure will appear when you click on "Run."
  They are slightly different for Mac and Windows users, but may simplify your
  work if you find keystrokes easier than point-and-click.

To obtain the file information—the complete listing of variables and their char-
acteristics, run the third line of Chapter_2.sps:
DISPLAY DICTIONARY.

This will display all of the information we highlighted above in using the
point-and-click interactive method to display the file information.

Stata

Much like our discussion of SPSS, we begin our exploration of Stata by focusing
on some of the basic data management features available to users. After starting
the Stata program on your computer, you will see a window that has several dif-
ferent boxes. On the far left, the box labeled "Review" will contain a growing
list of commands that you run during a Stata session. The largest box (top and
center) is labeled "Results" and will present all of the output from various com-
mand that you have run as well as any error messages. Just below this box is the
"Command" box, where you will enter commands, if going one command at a
time. On the right side of the Stata window is a box labeled "Variables"—the
upper half will contain a complete list of all the variables in the data file, while
the lower half provides various details about the variable that is highlighted in the
upper half.

Begin by opening the National Youth Survey data file obtained from the Web site (nys_1.dta) using "File" from the menu bar and the "Open…" option listed. Note that the "Review" box on the left now contains the Stata command that was run to open the data file, the "Variables" box on the right contains the listing of variables, and the "Results" window simply lists the Stata command that was run.

If you would like to view the data in a spreadsheet format, click on the box at the top center of the Stata window for "Data Browser" or "Data Editor"—the "Browser" view will allow you to look at the data, while the "Editor" view will allow you to make changes to the data. The window that opens will present each variable as a separate column, each observation as a separate row, and the contents of each cell will either be a numeric value or a value label that is associated with a numeric value. If you click on a cell with a value label, the corresponding numeric value appears in the white horizontal bar just above the spreadsheet.

There are several different ways of learning about the variables included in this data file. As noted already, the "Variables" box on the right contains information about each variable and is displayed as soon as the variable name is highlighted (i.e., clicked on) in the upper box.

A much more comprehensive method for obtaining information about the variables in the data file is to use the "Codebook" command, which will list all of the variables in the data file, their values, value labels, as well as other information that will become useful in subsequent chapters of this text. To run the "Codebook" command, click on "Data" on the menu bar, then the options for "Describe data" and selecting the option for "Describe data contents (codebook)." The "Results" window will generate a great deal of output that will list each variable, the variable label, the possible (numeric) values when there are fewer than 10 unique values, and any value labels. The other information presented will be discussed later.

Similar to the observation made in regard to the use of SPSS, in subsequent chapters, the computer exercises will make use of syntax commands and files, rather than the point-and-click options. Although Stata syntax is different from SPSS syntax, how it works is very much the same: the command line(s) inform Stata what procedure to run, whether it is opening a date file for use, or some other statistical procedure. To open a new syntax window in Stata, where they are called "do files," start by clicking on "File," then "New Do-file. A blank window opens in which you may enter command lines and save for future use. Alternatively, instead of opening a blank do file window, you could open one that had been saved, such as Chapter_2.do included on the text Web site.

Stata commands **must** be in lowercase letters, unless otherwise noted in the documentation for the command. As a convention throughout our text, we will place Stata **commands** and useful or required **options** in boldface font.

Open the Chapter_2.do file. The first line of this file begins with /* and ends with */—this is a comment line. In Stata, comments are bounded by these two mirror sets of characters, so without the */, Stata would interpret everything

following the initial /* as a comment—so it is important to pay attention to your use of these in any Stata do file.

The first command line of Chapter_2.do is:

use "[directory_name]nys_1.dta", clear

The **use** command reads the NYS data file into Stata. Note that you will need to provide a directory name that contains your copy of the nys_1.dta data file. Also note that after the file name and location, there is a comma followed by the **clear** option. Using this option tells Stata to clear out any existing data file currently being used without saving any changes made to that data file.

To run this command line—after you have edited the directory information—highlight the command line and do one of the following:

• Click on the box in the upper right of the do file window labeled "Run"—this will run the command quietly, meaning there is no output in the "Results" window, other than a line indicating a command was run.

• Click on the box in the upper right of the do file window labeled "Do"—this will run the command and generate output in the "Results" window.

• Keystroke options are available for both of these commands, to determine what they are for your operating system (Mac or Windows), click on "View" on the menu bar, then "Do-file Editor"—the list of options will then indicate the keystroke shortcuts that can be used to run the command quietly or not.

To obtain the file information—the complete listing of variables and their characteristics, run the second command line of Chapter_2.do:

codebook

This will display all of the information we highlighted above in using the point-and-click interactive method to display the file information.

Problems

Using one of the ways described above, work through all the variables included in the NYS data file:

1. Note the level of measurement for each variable and then briefly explain why it is what it is. (You should not rely on the level of measurement information given in the SPSS data file, especially if someone else has constructed the SPSS data file for you.)

2. Describe the likely levels of reliability and validity for each variable and explain why they are what they are.