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Research Questions and Hypotheses

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Three Types of Basic Hypotheses or Research Questions

A hypothesis is a predictive statement about the relationship between 2 or more variables. Research questions are similar to hypotheses, but they are in question format. We expand on that general definition by splitting research questions into 3 basic types: *difference questions, associational questions,* and *descriptive questions.* For difference and associational questions, *basic* means that there is one independent and one dependent variable. For descriptive questions, *basic* means that there is one variable.

Remember that both difference and associational questions have the exploration of relationships between variables as a *general purpose* (see Fig. 1 in Morgan et al., 1999, p. 1596). This commonality across types of questions is in agreement with the statement by statisticians that most common parametric inferential statistics are relational, and it is consistent with the notion that the distinction between the comparative and associational approaches is somewhat arbitrary. However, we believe that the distinction is educationally useful. Remember that difference and associational questions differ in specific purpose and the kinds of statistics they usually use to answer the question.

For the difference type of questions, we *compare groups or levels* derived from the independent variable in terms of their scores on the dependent variable. This type of question typically is used with the randomized experimental, quasi-experimental, and comparative approaches. For an associational question, we *associate or relate* the independent and dependent *variables.* Our descriptive questions are not answered with inferential statistics; they merely *describe or summarize* data.

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There are a number of acceptable ways to state research hypotheses/questions. Our preference and an example of each of these types of questions are given in Table 1. We think it is advisable to use the research question format when one does not have a clear directional prediction and for the descriptive approach.

Difference Versus Associational Statistics

We think it is educationally useful, although not commonly explicit in statistics books, to divide inferential statistics into 2 types corresponding to difference and associational hypotheses/questions. Difference inferential statistics are *usually* (but not always) used for the randomized experimental, quasi-experimental, and comparative approaches, which test for *differences between groups* (e.g., using analysis of variance, also called ANOVA). Associational inferential statistics test for *associations or relationships between variables* and use some type of correlation or multiple regression analysis. We realize that this dichotomy of using one type of data analysis procedure to test for differences (where there are a few levels of the independent variable) and another type of data analysis procedure to test for associations (where there is a continuous independent variable) is somewhat artificial. Both continuous and categorical independent variables can be used in a general linear model (regression) approach to data analysis. However, the practical implications are that most researchers adhere to the above dichotomy in data analysis. We will utilize this contrast between difference and associational inferential statistics in a later column when discussing how to select an appropriate statistic.

Six Types of Research Questions: Three Basic and Three Complex

Remember that many studies are more complex than implied by the above examples. In fact, most studies have more than one hypothesis or research question and may utilize more than one of the research approaches. It is common to find a study with one active independent variable (e.g., treatment) and one or more attribute independent variables (e.g., gender). This type of study combines the randomized experimental approach (if the participants were randomly assigned to groups) and the comparative approach and asks 2 *difference* questions. We will see below that there are actually 3 questions. This *set* of 3 questions can be considered a complex dif-

TABLE 1
Examples of Three Kinds of Basic Research Questions

1. Basic Difference (Group Comparison) Questions
   For this type of hypothesis, the level or categories of the independent variable (e.g., anxiety) are used to split the participants into groups (e.g., high and low) which are then compared to determine whether they differ with respect to the average scores on the dependent variable (e.g., test performance).
   Example: Do persons with low and high anxiety differ on average test scores? In other words, will the average performance of the high-anxiety persons be significantly different from the average performance of the low-anxiety persons?
2. Basic Associational (Relational) Questions
   For this type of hypothesis or question, the scores on the independent variable (e.g., anxiety) are associated with or related to scores on the dependent variable (e.g., performance).
   Example: Is there a negative association (correlation) between anxiety scores and test performance? In other words, will those persons who are high on anxiety tend to have low performance, those with low anxiety tend to have high performance, and those in the middle on the one variable tend to be in the middle on the other variable?
3. Basic Descriptive Questions
   For this type of question, scores on a single variable are described in terms of their central tendency, variability or percentages in each category/level.
   Example: What percent will have scores between 70 and 80?

ference question because the study has 2 independent variables that can be analyzed together. They could both be active or both attribute; it would still be a study with a complex difference question. Likewise, complex associational questions are used in studies with more than one independent variable considered together.

Table 2 expands our overview of research questions to include both basic and complex questions of each of the 3 types: *descriptive, difference,* and *associational.* We use the terms *basic* and *complex* because the more common names, *univariate* and *multivariate,* are not used consistently in the literature. The table also includes examples of the types of statistics that we include under each of the 6 types of questions.

Note that some complex descriptive statistics (e.g., a cross-tabulation table) *could* be tested for significance with inferential statistics; if they were so tested, they would no longer be considered descriptive. We think that most qualitative/constructivist researchers ask complex descriptive questions because they con-

TABLE 2
Summary of Six Types of Research Questions

Type of Research Question—No. of variables	Example Statistics
1. Basic Descriptive Questions—1 variable.	Mean, standard deviation, frequency distribution
2. Complex Descriptive Questions—2 or more variables, but no use of inferential statistics.	Box plots, cross-tabulation tables, factor analysis, measures of reliability
3. Basic/Single Factor Difference Questions—1 independent and 1 dependent variable. Independent variable usually has a few levels (ordered or not).	*t* Test, one-way ANOVA
4. Complex/Multi-Factor Difference Question—Usually 2 or a few independent variables and 1 dependent variable.	Factorial ANOVA
5. Basic Associational Questions—1 independent variable and 1 dependent variable. Usually at least 5 *ordered* levels for both variables. Often they are continuous.	Correlation tested for significance
6. Complex/Multivariate Associational Questions—2 or more independent variables and 1 dependent variable. Usually 5+ ordered levels for all variables, but some or all can be dichotomous variables.	Multiple regression

Note: Many studies have more than one dependent variable. It is common to treat each one separately (i.e., to do several *t* tests, ANOVAs, correlations, or multiple regressions). However, there are complex statistics (e.g., MANOVA and canonical correlation) used to treat several dependent variables together in one analysis. ANOVA = analysis of variance; MANOVA = multivariate analysis of variance.

sider more than one variable/concept at a time, but they seldom use inferential/hypothesis testing statistics. Furthermore, complex descriptive statistics are used to check reliability and to reduce the number of variables (e.g., with factor analysis).

Examples of Complex Difference and Associational Questions

Complex Difference (and Interaction) Questions. When you have 2 categorical independent variables considered together, you will have 3 research questions or hypotheses. As we will discuss in a later column, there are advantages of considering 2 or 3 independent variables at a time. An example of a set of 3 questions answered by *one* 2-way (factorial) ANOVA is as follows:

- Is there a difference between children having high versus low anxiety with regard to their average achievement scores?
- Is there a difference between male and female children with regard to their average achievement scores?
- Is there an interaction between anxiety and gender with regard to achievement?

Note that the first question states the *levels* or categories of the first independent variable; i.e., it states the groups that are to be compared (high- versus low-anxiety children). The second question does the same for the second independent variable; i.e., it states the *levels* (male and female) to be compared. However, in the third (interaction) question, it is asked whether the first variable itself (anxiety) interacts with the second variable (gender). The answer to this third question (whether there is a statistically significant interaction) is the key to understanding and interpreting the analysis, as we will see in a later column.

Complex Associational Questions. In the associational approach, when 2 or more *independent* variables are considered together, rather than separately, you get a new kind of question. An example is as follows:

- Is there a combination of anxiety, gender, father's education, grades, and motivation that predicts achievement better than any one predictor variable alone?

We think that phrasing your research questions/hypotheses as shown above will help match the question to the appropriate statistical analysis. However, it is also appropriate to phrase a research question as simply a relationship between the independent variable(s) and the dependent variable. What is not desirable, unless you have a well-controlled, randomized experiment, is to phrase your hypotheses/questions as "What is the effect of the independent variable on the dependent variable?" This phrasing is common in statistics books, but it may lead one to infer causation when that is inappropriate.

REFERENCE

Morgan GA, Gliner JA, Harmon RJ (1999), Quantitative research approaches. *J Am Acad Child Adolesc Psychiatry* 38:1595–1597

Ear-Piercing Techniques as a Cause of Auricular Chondritis. Daniel R. More, James S. Seidel, MD, PhD, Paul A. Bryan, MD

Objective: To investigate the different methods of ear and body piercing as possible sources of infection, and to provide a brief literature review of infections resulting from high ear piercing as well as bacterial coverage of common disinfectants used as preparation agents. *Methods:* Two cases of auricular chondritis caused by Pseudomonas are presented. A survey of 14 businesses that pierce ears was conducted using a scheduled interview. Information regarding the type of piercing instrument, composition of earring, training of employees, anatomic placement of earrings, and preparation and aftercare of ears was obtained. *Results:* One hundred percent of the interviews attempted were completed. The cosmetic shops and earring kiosks both used hand-powered earring "guns" to pierce ears, while the tattoo parlors used sterile needles and forceps. All of the businesses interviewed used earrings composed of either 14K or 24K gold, stainless steel, and other piercing-grade metals. None of the businesses used earrings made of nickel. The cosmetic shops and kiosks used a combination of videos, demonstrations, and direct supervision to train employees but did not have a specified training period. The tattoo parlors required their employees to complete an apprenticeship training program of varying time lengths. All of the businesses pierced the lobe and cartilaginous portions of the ear. The cosmetic shops and kiosks used benzalkonium chloride or isopropyl alcohol as ear preparation agents, while the tattoo parlors used only iodine-based solutions. At all of the businesses, minimal aftercare instructions were given and they typically dealt with maintaining ear-hole patency. *Conclusion:* The cosmetic shops and earring kiosks used piercing methods that predisposed to auricular chondritis, such as poor training of employees and use of benzalkonium chloride as a preparation agent. Emergency physicians need to be aware of the severity of these types of infections, which often require surgical management and intravenous antibiotics covering *Pseudomonas.* **Pediatr Emerg Care** 1999;15:189–192. Reproduced with permission from Lippincott Williams & Wilkins.