Chapter 13

UNDERSTANDING QUANTITATIVE LITERATURE AND RESEARCH

LEARNING OBJECTIVES

- Learn guidelines to interpret quantitative research articles in the professional literature.
- Apply the interpretation guidelines to a quantitative research article.

It is essential for members of a professional discipline to understand the purpose of methods and the meaning of results from quantitative research. Learning and applying guidelines for interpreting quantitative research is the focus of this chapter. We will use the information learned in the previous chapters to analyze a published research article. We will be interpreting the methods and findings of the research article but not evaluating the research as to weaknesses and strengths of the study. Research consumers need first to understand fully what happened in a study before they are in a position to coherently evaluate a study. Initially, you are asked to read a guide to interpret research developed by Gay (1976). Then you will retrieve and read a specified article. Finally, you will apply knowledge that you have learned from previous chapters and the consumer guide.

INTERPRETATION OF A QUANTITATIVE RESEARCH ARTICLE

Retrieve and read the article that will be used for interpretation: Steele, K. M., Bass, K. E., & Crook, M. D. (1999). The mystery of the Mozart effect: Failure to replicate. Psychological Science, 10, 366–369.

Then, read through the following interpretation of the article. The discussion items used to organize the interpretation of the article were drawn for the most part from the *Research Interpretation for Consumers Guide* of Professor Dennis Gay.

1. Identify the **theme** of the study. What is the basic idea, subject, topic, or argument of the study? The theme usually can be identified from the title, abstract, and purpose statement of an article.

The title provides clear thematic information with the words "the mystery of the Mozart effect" and "failure to replicate." The abstract indicates that several laboratories have been unable to replicate the existence of a Mozart effect. The purpose statement says, "to confirm the existence of the Mozart effect" by following the recommendations of the initial researchers. The theme of the research article is to determine whether the Mozart effect has a real effect on spatial reasoning, and if it does not, whether there is another explanation for the Mozart effect.

2. What is the **significance** of this study? Why is the study important? Has previous research on this topic been done? If so, what more is being contributed by this study? Will the findings of this study impact theory, knowledge, or practice? This information is usually found in the introduction and discussion sections of an article.

The original researcher of the Mozart effect reported that the hypothesis that musical experience of short duration can have a direct causal influence on spatial reasoning on both a short-term and a long-term basis is important for both practical and theoretical reasons. The expansion of teaching interventions to improve cognitive development would be astounding if an aspect of measured intelligence can be increased by listening to Mozart's music. In fact, an industry associated with the Mozart effect has been developed and can be found readily on the web.

3. How does this study relate to **previous research**? How does this research emanate from and add to key conceptual and methodological issues in the field related to the topic? This information is found in the introduction and discussion sections. A brief summary of the previous research is presented next using information from the article.

- Rauscher, Shaw, and Ky (1993) found Mozart increased spatial reasoning by eight or nine IQ points as measured by portions of the Stanford-Binet Intelligence Scale, Fourth Edition, after listening to 10 minutes of a Mozart sonata. The effect was temporary and disappeared in 10 to 15 minutes.
- Rauscher, Shaw, and Ky (1995) reported findings related to replicating the effect.
- Fifteen other research laboratories could not confirm the findings of Rauscher et al.
- Rauscher et al. reviewed some of the negative results of the researchers from other laboratories and recommended key components necessary to produce a Mozart effect.
  - Use an appropriate DV (paper folding and cutting items [PF&C]).
  - Tend to the order of presentation of the listening and task conditions.
  - Increase the time between pretest and treatment so there are no carry-over effects.

RESEARCH INTERPRETATION FOR CONSUMERS

The following guide is intended as a practice device for the interpretation of published research in education and the behavioral sciences.

I. The Initial Exposure

The initial exposure to a research study should begin by reading the entire study with a rather casual, relaxed approach with little attention to given details. The objective at this point is to gain a general overview. As one progresses through the five guidelines that follow, more and more attention to detail will become necessary; however, one should not stop and spin wheels at any point where a particularly difficult problem presents itself. Instead, continue on through until more clarification is gained and then return to the difficult problem when a more comfortable solution is available.

1. Read the entire study through rather casually to gain a general overview.
2. Ascertain the central theme of the study, the basic rationale for the research, and the relationship of the study to other research.
3. Determine the existing theory, if any, to which the research is addressed, or speculate as to the basic theoretical framework.
4. Identify the subject(s) of the study and the research setting or environment if it is localized.
5. Determine the basic nature of the research (e.g., historical, descriptive, or experimental). Studies of an inferential nature can usually be detected at this point.

II. The Research Question(s)

Every research study should have a question or questions formulated prior to its initiation. It is the nature of the question or questions and the approach toward resolution that distinguish one form of research from another. Quite often a primary question will be subdivided into subquestions. This is a matter of style and can be helpful for both the researcher and the consumer. All too often, however, the research questions (RQs) either are not stated or are stated poorly. In the event that the research questions are not stated, it is necessary for the consumer to speculate by formulating a tentative guess. One may then return later and revise the question as more information is gained.

- Ascertain the question(s) asked.
- Determine whether the criteria for good research questions are met, and if not, restate the RQs as you believe the researcher intended them to be stated, applying the criteria. This is an important step toward a clearer interpretation of the remainder of the study. A good research question must be clear, unambiguous, and in question form. It must ask about the relationship between two or more variables and must imply the possibility of empirical testing.

III. Follow a Single Question All the Way Through

The research question is the primary reference point for interpretation and evaluation of any research study. It is for this reason that all of the guidelines that are presented here should be applied to each research question individually and completely, one RQ at a time. It is quite easy for the consumer of research to become lost in the middle of the study among all

the jargon, charts, and statistics. When this happens, simply return to the specific research question and start over.

IV. The Hypotheses

Just as every research study should have at least one question, it should also have some systematic means of answering the question. This is usually, though not always, accomplished through the use of hypotheses. In that it is conceivable that more than one hypothesis is required to help answer a single research question, depending on the style of the author and how broadly the question is formulated, each hypothesis should be followed through individually and completely. All four of these guidelines should be followed by the consumer before starting on a second hypothesis.

1. For each research question identified in the study, ascertain the hypothesis (or hypotheses) intended by the researcher to help answer that research question. Formal hypotheses should be stated in two forms: the research or alternative hypothesis (H_a), which is what the researcher is actually guessing the true situation to be, and the null hypothesis (H_O), which provides a mathematical zero reference point for a formal statistical test.
2. For each research hypothesis (H_a), determine the corresponding null hypothesis (H_O) that is actually tested.
3. Determine whether the stated alternative and null hypotheses meet the criteria for good hypotheses, and if not, state or restate them applying the criteria. They should be stated as you feel the researcher meant to state them.
4. If only the null hypothesis is stated, which is unfortunately too often the case, speculate and state the research

hypothesis (H_a) in an acceptable manner. Usually when only the null hypothesis (H_O) is presented it is safe to assume that the alternative hypothesis (H_a) is a nondirectional hypothesis. This means that the researcher is not predicting a greater-than or less-than relationship, but instead is simply waiting to see what will happen. In this case a two-tailed test of statistical significance will be used in hypothesis testing.

V. The Variables

Because the very essence of research is centered on the relations between and among variables, a thorough knowledge of variables and their classifications is imperative for research interpretation. Very generally, variables are classified into three categories according to their relative purpose or existence in a study: independent variable (IV), dependent variable (DV), and extraneous variable (EV). Extraneous variables are contaminating, are unwanted, and need to be controlled in some way.

- Identify each variable important to the hypothesis and research question, and classify it as independent or dependent if appropriate within the context of the study. Some studies are more concerned with simply the association of a large number of variables, in which case this may not be appropriate. If independent, classify as either *active* or *attribute*.
- Identify all extraneous variables mentioned by the researcher for each hypothesis. These are variables that behave like independent variables and confound or contaminate the study. Determine any steps taken by the researcher to control for those extraneous variables mentioned.

VI. The Operational Definition (OD)

Every variable in a study must have an operational definition (OD). The OD is specific (though not necessarily unique) to the study. It is the precise way the variable is measured in the study, and its nature is the prerogative of the researcher.

- Identify the operational definition of each variable.
- The consumer should take time to learn about any operational definitions with which he or she is unfamiliar at this point (e.g., Q-sort technique, semantic differential, various published psychological instruments, etc.).
- Keep notes for later use.
- Determine the level of measurement (scaling) of each variable's operational definition, and distinguish between those considered continuous and those considered discrete.

VII. The Population under Study

At this point the consumer should take a closer look at exactly whom the study is concerned with.

- Determine the precise population under study. Quite often the researcher does not define the population clearly. If this is the case, one must speculate the best one can.
- Determine the actual subjects comprising the sample in the study, the number acquired, and the method of acquiring the subjects (sampling).

VIII. The Basic Research Design

The nature of the design of the research is dependent upon the research questions asked and the researcher's approach

toward answering those questions. Because of the large number of possible designs, the consumer should have some background knowledge of general research designs to assist him or her in identification. The simpler experimental or quasi-experimental attempts are usually the easiest to detect because of their emphasis on matched or random assignment and control or comparison groups. Other designs may be more difficult for the consumer to discern. At any rate, the consumer should glean what information is possible regarding the basic design from the context of the study. It may also prove helpful to diagram the design if possible.

IX. The Collection of the Data

- Determine precisely how the data were collected for each variable.
- Familiarize yourself with any procedures mentioned that are unknown to you at this point (e.g., survey techniques, mechanical devices, psychometric instruments, etc.). This is obviously related to operational definitions in many instances.
- Keep notes on new information for later use.

X. The Analysis of the Data

Most research studies are fairly clear as to how the data were analyzed. However, adequate interpretation requires some knowledge of basic statistics and the common symbols encountered. In addition, one should be familiar with the basic hypothesis-testing process. The serious consumer of published research will keep a notebook handy with acquired information that can be added to and drawn from continuously. The consumer must eventually acquire an interpretive knowledge of the

most commonly seen statistics (e.g., *Z*, *t*, *F* (the simpler models), chi-square, and *r*). These statistics, along with their use and the information they yield, may be found in any elementary statistics text. When more sophisticated techniques are encountered (e.g., multiple regression, factor analysis, discriminate analysis, or canonical correlation), use information resources related to multivariate statistics.

- Identify and define each statistical procedure employed and note the specific variables involved.
- Identify and define each symbolic expression encountered and determine the precise meaning with respect to the analysis presented.
- Take notes on information gained for future use.

XI. The Presentation of the Results

The presentation of the results is necessarily related to the analysis of the data and will usually be a combination of narrative and tables or graphs. It is important for the consumer to pay careful attention to exactly what the researcher has presented.

- Identify and define all terms and symbols presented in the results.
- Determine which null hypotheses, if any, were rejected and the level of significance for rejection.
- Stay with a table or graph until you know you understand what is presented.

XII. The Conclusions and Interpretations

The conclusions of the study should be based on the analysis of the hypotheses, if hypotheses were tested, and should be

clearly related to the original research question(s). The consumer's focus of attention should be on whether the research questions were answered, and on the final conclusions of the study regarding the questions.

- Ascertain the specific conclusion for each finding presented.
- Determine the researcher's interpretation with respect to each conclusion individually and in concert with respect to the research question(s).

Source: From Dennis A. Gay, PhD, University of Northern Colorado. By permission of Professor Gay.

The researchers of this study used the Rauscher et al. recommendations to plan a replication study to "be a faithful replication of the central conditions of the Rauscher et al. experiment." However, there were differences in this replication study that included: (1) only one posttreatment assessment was used, (2) random assignment to condition group was used to create equivalent groups, (3) the time interval was lengthened by 24 hours to 48 hours between pretest and treatment condition.

4. What conceptual, methodological, and measurement **theories** undergird this study? This information can be found in the introduction but also throughout the article.

- The overarching theory relates to cognitive learning theory.
- The more immediate theories are:
  - Musical (complexly structured) experience of short duration (long duration) improves spatial abilities.
  - Music as a mood-induction technique affects performance on cognitive tasks.

5. Who are the **participants** and what is the **research setting**?

Describe the characteristics of the sample participants.

- There were 125 introductory psychology students who comprised the study sample. There were 42 males and 83 females. The students received credit for participation.

Describe the research setting.

- The students participated in the study in a university psychology building in the early evening when the building was quiet. There were 15 persons in each session with a projector in the room.

6. What **research method(s)** are used in this study? Different general categories of research methods include survey, descriptive, causal-comparative, correlation, multivariate correlation, experimental, quasi-experimental, case study, single-case designs, qualitative, historical, evaluation, and action research.

The general method of research used in the study was experimental. The experimental design used a manipulated independent variable, random assignment to condition, and a control group.

7. Diagram the overall **research design** used in the study. There is an overall experimental design used in the study. However, it is modified for different questions. For example, there is no pretest on Profile of Mood States (POMS) scores.

The design is a randomized pretest-posttest multiple treatments control group design.

$$\begin{array}{cccc} R & O & X_{\text{Mozart}} & O \\ R & O & C_{\text{silence}} & O \\ R & O & X_{\text{Glass}} & O \end{array}$$

8. Identify the steps used to **collect data** for this study. Brief summaries of the 14 steps are presented next.

1. The researchers in this study used one posttest assessment, unlike the Rauscher study.
2. They used random assignment, not assignment by PF&C scores, to improve the design and to create equivalent groups.
3. They allowed 48 hours to elapse between sessions.

4. The study was conducted in the early evenings in a university psychology building where it was quiet.
5. The researchers used 15 students per group session to assure visibility of the projected PF&C items.
6. Acceptable deceit was used by telling participants during the first session that they were participating in a puzzle experiment.
7. The researchers used sample PF&C items to explain the task.
8. They answered student questions.
9. The 16 PF&C items were projected for 1 minute each.
10. The second session was 48 hours later, and the students were reminded of the task.
11. The participants were exposed to the stimulus condition and immediately tested on a new set of 16 PF&C items.
12. The PF&C items were counterbalanced to avoid an order effect or difficulty issues (systematic bias).
13. Exposure to music is an established mood-induction technique, so it was incorporated into the study. After the PF&C task, the participants were given a mood assessment instrument and were asked to identify their mood when the PF&C task began.
14. Performance on the PF&C task and mood were analyzed at a later time.

Identify the Research Questions in the Study

The research questions stated next were not stated in the article. They were created by reviewing the analyses and results reported. Two research questions were written to reflect the analyses and results of the study. The first research question has subquestions A, B, and C and focuses on several analyses that relate to spatial reasoning. The second question is stated with one subquestion (A).

Research Question for RQ1

RQ1: Will participants who receive the Mozart listening condition produce greater spatial reasoning performance (mean number of paper

folding and cutting items answered correctly) when compared to participants who receive the listening conditions of silence or Glass?

Research Question for RQ1 Subquestion A

RQ1 subquestion A: Will there be differences in pretest spatial reasoning performance (mean number of paper folding and cutting items answered correctly) across the three listening conditions (Mozart, silence, and Glass)?

What Are the Hypotheses for RQ1 Subquestion A?

$H_{aS\text{-}QA}$: There will there be differences in pretest spatial reasoning performance (mean number of paper folding and cutting items answered correctly) across the three listening conditions (Mozart, silence, and Glass).

$$\text{Symbolic } H_{aS-QA}\text{: } \mu_{Mozart} \neq \mu_{silence} \neq \mu_{Glass}$$

$H_{0S\text{-}QA}$: There will there be no differences in pretest spatial reasoning performance (mean number of paper folding and cutting items answered correctly) across the three listening conditions (Mozart, silence, and Glass).

$$\text{Symbolic } H_0\text{: } \mu_{Mozart} = \mu_{silence} = \mu_{Glass}$$

Variables and Operational Definitions for RQ1 Subquestion A

Independent variable (IV): Listening condition.

Condition 1 (or OD_1): Mozart

Condition 2 (or OD_2): silence

Condition 3 (or OD_3): Glass

Active IV? Yes. Attribute IV? No. Fixed IV? Yes. Random IV? No.

Scale of measurement? Discrete-nominal.

Dependent variable (DV): Pretest spatial reasoning performance.

Operational definition (OD): Mean number of paper folding and cutting items answered correctly.

Scale of measurement? Continuous-ratio.

What Was the Analysis of the Data and Presentation of the Results for RQ1 Subquestion A?

1. Identify statistical procedure employed: One-way analysis of variance.
2. Findings and values for testing the H_0(s): The following finding is reported in the left column at the top of page 368 of the article, $F(2, 122) = .05$, $p = .95$. This finding assesses the pretest means for significant differences. The pretest means are listed in Table 1 of the article.

Conclusion and the Interpretation for RQ1 Subquestion A There are no significant differences in pretest spatial reasoning across the listening condition groups of participants. The groups were equivalent at the beginning of the study on spatial reasoning, confirming that the random assignment to condition worked.

What Is the Research Question for RQ1 Subquestion B? This question reflects a factorial ANOVA statistical design, more specifically a 2×3 ANOVA. There are three analyses embedded within it. First, the differences between all groups' scores from pretest to posttest are assessed, which is also referred to as the main effect of session (pretest-posttest). Second, the differences on spatial reasoning among the three conditions groups at the posttest on spatial reasoning are assessed, called the main effect of listening condition. Third, the interaction effect between session (pretest-posttest) and listening condition (Mozart, silence, Glass) on spatial reasoning is assessed.

RQ1 subquestion B(1): Will there be session (pretest-posttest) main effect differences, treatment (listening condition) main effect differences, and an interaction effect difference (session $\times$ treatment) on the spatial reasoning performance of participants?

What are the hypotheses for RQ1 subquestion B(1)?

$H_{aB(1)}$: There will be main effect differences on the spatial reasoning performance of participants across the sessions (pretest-posttest).

$$\text{Symbolic } H_{aB(1)}: \mu_{pretest} \neq \mu_{posttest}$$

$H_{0B(1)}$: There will be no main effect differences on the spatial reasoning performance of participants across the sessions (pretest-posttest).

$$\text{Symbolic } H_{0B(1)}: \mu_{pretest} = \mu_{posttest}$$

$IV_{B(1)}$: Session.

Condition 1 (or OD_1): Pretest

Condition 2 (or OD_2): Posttest

$DV_{B(1)}$: Pretest spatial reasoning performance.
OD: Mean number of paper folding and cutting items answered correctly.

$H_{aB(2)}$: There will be main effect differences on post spatial reasoning performance of participants across the treatment listening conditions (Mozart, silence, Glass).

$$\text{Symbolic } H_{aB(2)}: \mu_{Mozart} \neq \mu_{silence} \neq \mu_{Glass}$$

$H_{0B(2)}$: There will be no main effect differences on the post spatial reasoning performance of participants across the treatment (listening conditions).

$$\text{Symbolic } H_{0B(2)}: \mu_{Mozart} = \mu_{silence} = \mu_{Glass}$$

$IV_{B(2)}$: Listening condition.

Condition 1 (or OD_1): Mozart

Condition 2 (or OD_2): silence

Condition 3 (or OD_3): Glass

$DV_{B(2)}$: Posttest spatial reasoning performance.
OD: Mean number of paper folding and cutting items answered correctly.

$H_{aB(3)}$: There will be an interaction effect (session $\times$ treatment) difference on the post spatial reasoning performance of participants.

$$\text{Symbolic } H_{aB(3)}: \mu_{session} \times \mu_{ListeningCondition} \neq 0$$

$H_{0B(3)}$: There will be no interaction effect (session $\times$ treatment) difference on the spatial reasoning performance of participants.

$$\text{Symbolic } H_{0B(3)}: \mu_{session} \times \mu_{ListeningCondition} = 0$$

$IV_{1B(3)}$: Session.

Condition 1 (or OD_1): Pretest

Condition 2 (or OD_2): Posttest

$IV_{2B(3)}$: Listening condition.

Condition 1 (or OD_1): Mozart

Condition 2 (or OD_2): silence

Condition 3 (or OD_3): Glass

$DV_{B(3)}$: Posttest spatial reasoning performance.
OD: Mean number of paper folding and cutting items answered correctly.

Analysis of the Data and Presentation of the Results for RQ1 Subquestion B Identify statistical procedure employed: 2×3 ANOVA.

Identify the findings and values for testing the H_0(s):

Main effect of session: $F(1, 122) = 76.1$, $p < .001$.

Main effect of listening condition: $F(2, 122) = 0.11$, $p = .89$.

Interaction effects of session and listening conditions: $F(2, 122) = 0.48, p = .62$

Conclusions and Interpretations for RQ1 Subquestion B The main effect of the session (pretest-postest) was a significant indication that overall the participants in the three groups showed a gain in spatial reasoning from the pretest to the posttest. The main effect of the listening condition was not significant, reflecting that the spatial reasoning means were not significantly different across the three listening condition groups at the end of the study. This is the finding that is the most important as to whether there was a Mozart effect in this study, and there was not. The interaction effect of the session and listening condition was not significant, indicating that there was no differential effect at different levels of the independent variables.

What Is the Research Question for RQ1 Subquestion C? RQ1 subquestion C: Will participants who receive the Mozart listening condition produce greater spatial reasoning performance (mean number of paper folding and cutting items

answered correctly) when compared to participants who receive the listening conditions of silence or Glass when adjusted for an individual's initial performance on the PF&C task (pretest)?

What Are the Hypotheses for RQ1 Subquestion C?

$H_{aSQ\text{-}C}$: Participants who receive the Mozart listening condition will produce greater spatial reasoning performance (mean number of paper folding and cutting items answered correctly) when compared to participants who receive the listening conditions of silence or Glass when adjusted for an individual's initial performance on the PF&C task (pretest).

$$\text{Symbolic } H_{aSQ-C}: \mu_{adj.Mozart} > \mu_{adj.silence} > \mu_{adj.Glass}$$

$H_{0SQ\text{-}C}$: There will there be no differences in spatial reasoning performance (mean number of paper folding and cutting items answered correctly) across the three listening conditions (Mozart, silence, and Glass) when adjusted for an individual's initial performance on the PF&C task (pretest).

$$\text{Symbolic } H_{0SQ-C}: \mu_{adj.Mozart} = \mu_{adj.silence} = \mu_{adj.Glass}$$

Variables and Operational Definitions for RQ1 Subquestion C

$IV_{SQ\text{-}C}$: Listening condition.

Condition 1 (or OD_1): Mozart

Condition 2 (or OD_2): silence

Condition 3 (or OD_3): Glass

$DV_{SQ\text{-}C}$: Posttest spatial reasoning performance when adjusted for an individual's initial performance on the PF&C task (pretest).

OD: Mean number of paper folding and cutting items answered correctly.

Identify the analysis of the data and presentation of the results for RQ1 subquestion C.

Identify statistical procedure employed: One-way analysis of covariance where the pretest scores on spatial reasoning were used as the covariate.

What are the findings and values for testing the H_0(s)? $F(2, 121) = 0.61, p = .55$.

Conclusion and Interpretation for RQ1 Subquestion C

Again, there was no significant difference in spatial reasoning ability across the three listening conditions (Mozart, silence, Glass) when the pretest scores on spatial reasoning were used as the covariate. This outcome is another confirmation that there was no Mozart effect in this study.

Research Question for RQ2

RQ2: Will participants who receive the Mozart listening condition produce different mood factor scores (depression, tension, anger, vigor, fatigue, and confusion) when compared to participants who receive the listening conditions of silence or Glass?

Hypotheses for RQ2

> H_{a1-6}: There will there be differences in mood factor scores (depression, tension, anger, vigor, fatigue, and confusion) across the three listening conditions (Mozart, silence, and Glass).

(There were actually six hypotheses analyzed reflecting the comparisons for differences across the listening conditions on each of the six mood factor scores. For the sake of brevity, we will write only one hypothesis, knowing, though, that six were tested.)

$$\text{Symbolic } H_{a1\text{-}6}\text{: } \mu_{1(\text{Moz})} \neq \mu_{2(\text{silence})} \neq \mu_{3(\text{Glass})}$$

(This alternative hypothesis is used for each of the six mood factor scores that are each a different dependent variable.)

> H_{01-6}: There will be no differences in mood factor scores (depression, tension, anger, vigor, fatigue, and confusion) across the three listening conditions (Mozart, silence, and Glass).

$$\text{Symbolic } H_{01\text{-}6}\text{: } \mu_{1(\text{Moz})} = \mu_{2(\text{silence})} = \mu_{3(\text{Glass})}$$

> (This null is used for each of the six mood factors.)

Variables and Operational Definitions for RQ2

IV: Listening condition.

Condition 1 (or OD_1): Mozart

Condition 2 (or OD_2): silence

Condition 3 (or OD_3): Glass

Active IV? Yes. Attribute IV? No. Fixed IV? Yes. Random IV? No.

Scale of measurement: Discrete-nominal.

DVs: The six mood factors (depression, tension, anger, vigor, fatigue, and confusion). Each mood factor is analyzed as a separate dependent variable.

OD: There were three questions drawn from each of the six mood factors of the 65 questions of the Profile of Mood States (POMS), which is a psychometric test.

Scale of measurement of the DV: Continuous-interval.

Analysis of Data and Presentation of the Results for RQ2 Identify statistical procedure employed: The researchers most likely used a series of six one-way ANOVAs.

Findings and values for testing the H_0(s): Only two of the six mood factors were significantly different across the three conditions; they were:

1. Tension $F(2, 122) = 6.32$, $p = .002$
2. Anger $F(2, 122) = 7.21$, $p = .001$

Conclusions and Interpretations for RQ2 There were significant differences in the mood factors of tension and anger across the listening conditions. A post hoc Tukey HSD was conducted to determine which paired means were different from each other. The researchers found that the Mozart condition produced the lowest tension and anger scores compared to the silence and Glass conditions. The Mozart condition produced significantly lower tension ($p = .001$) and lower anger ($p = .001$) when compared to the Glass condition.

Conclusions and Interpretations for RQ 2 Subquestion A Unlike the spatial reason findings, there was a Mozart effect on the moods of tension and anger. Mozart produced significantly lower tension and anger mood scores when compared to music by Glass.

TABLE 13.1 Comparisons of Effect Sizes of the Mozart Effect

Study	Effect Size *d*	Size of Effect
Rauscher et al. (1995)	$d = .72$	High medium
This study	$d = .06$	Very small
Average of 15 other studies	$\overline{d} = .16$	Small

Discuss the comparisons of effect sizes of previous studies and this study relative to the Mozart effect. In the discussion section of the article, the authors present and discuss the effect sizes from the original study by Rauscher et al. (1995), this study, and 15 other Mozart-versus-silence studies (see Table 13.1). Cohen's effect size convention for *d* is small (.20), medium (.50), and large (.80).

Identify the major conclusions from the study.

- No significant Mozart effect on spatial reasoning ability was found using replication procedures recommended by Rauscher. The procedures were not exactly like the ones that Rauscher et al. (1995) used. Essential experimental procedures were added by the researchers, including random assignment of participants to condition, and the PF&C items were used in a counterbalanced order across sessions and groups.

  Steele, Bass, and Crook (1999) stated, "We conclude that there is little evidence to support basing intellectual enhancement programs on the existence of the causal relationship termed the Mozart effect" (p. 368).

- There was an effect on mood (tension and anger). Tension and anger scores were significantly lower for the participants receiving the Mozart condition compared to the Glass condition. The participants were less happy listening to the Glass selection reflecting amelodic and repetitive music compared to the Mozart selection. Other studies have found that mood can affect performance in other cognitive tasks indirectly through differences in mood.

Identify recommendations for future studies.

- There need to be improved specifications of the class of music selections that are likely to produce effects. Rauscher et al. used the term "complexly structured music" to depict Mozart music. It would be valuable to conduct additional

studies focusing on other stimulus variables to see if they have an effect on spatial reasoning.

- Another issue relates to the dependent variable of spatial reasoning as measured by the PF&C items. The early research by Rauscher reported that some studies did not find a Mozart effect because they used spatial pattern-recognition tasks (Raven Progressive Matrices) rather than spatial-temporal tasks (PF&C). However, two studies used both types of tasks and found no difference. So, more research is needed using and comparing different cognitive ability tasks.

SUMMARY

The information learned in previous chapters has been applied to the analysis of a published quantitative research article. A structured format using the *Research Interpretation for Consumers* (Gay, 1976) was used to interpret the article.

PROBLEM ASSIGNMENT

The process of analyzing a quantitative research article was presented in this chapter. Now it is your turn to independently analyze a quantitative article. Retrieve the following article for review, study, and analysis.

Pace, T. M., & Dixon, D. N. (1993). Changes in depressive self-schemata and depressive symptoms following cognitive therapy. *Journal of Counseling Psychology, 40, 288–294.*

Go to the companion website and you will find an Article Analysis Worksheet to use for analyzing this new article. Use the information in this chapter to guide you as you complete the assignment. Your instructor will evaluate your completed worksheet when it is finished.

REFERENCES

American Psychological Association. (2006). Evidence-based practice in psychology: APA task force on evidence-based practice. *American Psychologist*, *61*, 271–285.

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, *84*, 822–848.

Campbell, D. T. (1957). Factors relevant to the validity of experiments in social settings. *Psychological Bulletin*, *54*, 297–312.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*. Chicago, IL: Rand McNally.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Cohen, J. (1994). The earth is round ($p < .05$). *American Psychologist*, *49*, 997–1003.

Cone, J. D., & Foster, S. L. (2006). *Dissertations and theses from start to finish* (2nd ed.). Washington, DC: American Psychological Association.

Cook, T. D., & Campbell, D. T. (1979). *Quasi-experimentation: Design and analysis issues for field settings*. Chicago, IL: Rand McNally.

Cook, T. D., & Steiner, P. M. (2010). Case matching and the reduction of selection bias in quasi-experiments: The relative importance of pretest measures of outcome, of unreliable measurement, and of mode of data analysis. *Psychological Methods*, *15*, 56–68.

Denecke, D. (2006). *The Ph.D. completion project*. Washington, DC: Council of Graduate Schools.

Dennis, M. L., Scott, C. K., Funk, R., & Foss, M. A. (2005). The duration and correlates of addiction and treatment careers. *Journal of Substance Abuse Treatment*, *28*, S51–S62.

Erdfelder, E., Faul, F., & Buchner, A. (2010, January 2). GPOWER. Retrieved from www.psycho.uni-duesseldorph.de/aap/projects/gpower/.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). A flexible power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175–191.

Fisher, R. A. (1925). *Statistical methods for research workers*. Edinburgh, Scotland: Oliver & Boyd Publishers.

Fisher, R. A. (1973). *Statistical methods for research workers* (14th ed.). New York, NY: Hafner Publishing Company.

Gay, D. (1976). *Research interpretation for consumers*. Greeley, CO: Department of Human Rehabilitation, University of Northern Colorado.

Gorin, A., Phelan, S., Tate, D., Sherwood, N., Jeffery, R., & Wing, R. (2005). Involving support partners in obesity treatment. *Journal of Consulting and Clinical Psychology*, *73*, 341–343.

Grimm, L. G. (1993). *Statistical applications for the behavioral sciences*. New York, NY: John Wiley & Sons.

Hair, J. F., Jr., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (6th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

Hays, W. L. (1963). *Statistics*. New York, NY: Holt, Rinehart, & Winston.

Horowitz, J. L., & Garber, J. (2006). The prevention of depressive symptoms in children and adolescents: A meta-analytic review. *Journal of Consulting and Clinical Psychology*, *74*, 401–415.

Horowitz, J. L., Garber, J., Ciesla, J. A., Young, J. F., & Mufson, L. (2007). Prevention of depressive symptoms in adolescents: A randomized trial of cognitive-behavioral and interpersonal prevention programs. *Journal of Consulting and Clinical Psychology*, *75*, 693–706.

Howell, D. C. (2007). *Statistical methods for psychology* (6th ed.). Belmont, CA: Thomson Wadsworth.

Howell, D. C. (2010). *Statistical methods for psychology* (7th ed.). Belmont, CA: Wadsworth, Cengage Learning.

Jones, L. V., & Tukey, J. W. (2000). A sensible formulation of the significance test. *Psychological Methods*, *5*(4), 411–414.

Kerlinger, F. N., & Lee, H. B. (2000). *Foundations of behavioral research* (4th ed.). Ft. Worth, TX/Orlando, FL: Harcourt.

Kerlinger, F. N., & Pedhazur, E. J. (1973). Multiple regression in behavioral research. New York, NY: Holt, Rinehart & Winston.

Kirk, R. E. (1995). *Experimental design: Procedures for the behavioral sciences* (3rd ed.). Pacific Grove, CA: Brooks/Cole Publishing Company.

Kluever, R. C. (1997). Students' attitudes toward the responsibilities and barriers in doctoral study. *New Directions for Higher Education*, *99*, 5–16.

Leong, F. T. L. (1991). Development and validation of the Scientist-Practitioner Inventory for psychology. *Journal of Counseling Psychology*, *38*, 331–341.

Little, R. J. A., & Rubin, D. B. (2002). *Statistical analysis with missing data* (2nd ed.). Hoboken, NJ: John Wiley & Sons.

Lowry, R. (2011). Concepts and applications of inferential statistics. Retrieved from http://faculty.vassar.edu/lowry/webtext.html.

Martin, W. E., Jr., & Bridgmon, K. D. (2009). Essential elements of experimental and quasi-experimental research. In S. D. Lapan & M. T. Quartaroli (Eds.), *Research essentials: An introduction to designs and practices* (pp. 35–58). San Francisco, CA: Jossey-Bass.

National Multiple Sclerosis Society. (2012). *What is multiple sclerosis?* Retrieved from www.nationalmssociety.org/about-multiple-sclerosis/what-we-know-about-ms/what-is-ms/index.aspx.

Neff, K. D. (2003). The development and validation of a scale to measure self-compassion. *Self and Identity*, *2*, 223–250.

Nickerson, R. S. (2000). Null hypothesis significance testing: A review of an old and continuing controversy. *Psychological Methods*, *5*, 241–301.

Norusis, M. J. (1994). *SPSS 6.1 base system user's guide, part 2*. Chicago, IL: SPSS.

Norusis, M. J. (1999). *SPSS 9.0: Guide to data analysis*. Upper Saddle River, NJ: Prentice Hall.

Norusis, M. J. (2003). *SPSS 12.0: Statistical procedures companion*. Upper Saddle River, NJ: Prentice Hall.

Norusis, M. J. (2004). *SPSS 13.0 advanced statistical procedures companion*. Upper Saddle River, NJ: Prentice Hall.

Pace, T. M., & Dixon, D. N. (1993). Changes in depressive self-schemata and depressive symptoms following cognitive therapy. *Journal of Counseling Psychology*, *40*, 288–294.

Pagano, R. R. (1998). *Understanding statistics in the behavioral sciences* (5th ed.). Pacific Grove, CA: Brooks/Cole Publishing Company.

Rash, C. J., Alessi, S. M., & Petry, N. M. (2008). Contingency management is efficacious for cocaine abusers with prior treatment attempts. *Experimental and Clinical Psychopharmacology*, *16*(6), 547–554.

Rauscher, F. H., Shaw, D. I., & Ky, K. N. (1993). Music and spatial task performance. *Nature*, *365*, 611.

Rauscher, F. H., Shaw, D. I., & Ky, K. N. (1995). Listening to Mozart enhances spatial-temporal reasoning: Towards a neurophysiological basis. *Neuroscience Letters*, *185*, 44–47.

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, *70*, 41–55.

Rossello, J., Bernal, G., & Rivera-Medina, C. (2008). Individual and group CBT and IPT for Puerto Rican adolescents with depressive symptoms. *Cultural Diversity and Ethnic Minority Psychology*, *14*, 234–245.

Salsburg, D. (2001). *The lady tasting tea: How statistics revolutionized science in the twentieth century*. New York, NY: W. H. Freeman & Company/Henry Holt & Company.

Seashore, H. D. (1955). Methods of expressing test scores. *Test Service Notebook*, 148. San Antonio, TX: The Psychological Corporation, NCS Pearson.

Shadish, W. R., & Cook, T. D. (2009). The renaissance of field experimentation in evaluating interventions. *Annual Review of Psychology*, *60*, 607–629.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston, MA: Houghton Mifflin Company.

Siegel, S. (1956). *Nonparametric statistics for the behavioral sciences*. New York, NY: McGraw-Hill Book Company.

Snedecor, G. W. (1934). *Analysis of variance and covariance*. Ames, IA: Collegiate Press.

Snedecor, G. W., & Cochran, W. G. (1967). *Statistical methods* (6th ed.). Ames: Iowa State University Press.

Steele, K. M., Bass, K. E., & Crook, M. D. (1999). The mystery of the Mozart effect: Failure to replicate. *Psychological Science*, *10*, 366–369.

Stevens, J. (1996). *Applied multivariate statistics for the social sciences*. Mahwah, NJ: Erlbaum.

Student [William Gossett]. (1908). The probable error of the mean. *Biometrika*, *VI*(1), 1–25.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston, MA: Pearson Allyn & Bacon.

Tabak, J. (2005). *Probability and statistics: The science of uncertainty*. New York, NY: Checkmark Books.

Vacha-Haase, T., & Thompson, B. (2004). How to estimate and interpret various effect sizes. *Journal of Counseling Psychology*, *4*, 473–481.

Warke, K., Al-Smadi, J., Baxter, D., Walsh, D. M., & Lowe-Strong, A. A. (2006). Efficacy of transcutaneous electric nerve stimulation (TENS) for chronic low-back pain in a multiple sclerosis population. *Clinical Journal of Pain*, *22*, 812–819.

Wegner, D. M., & Zanakos, S. (1994). Chronic thought suppression. *Journal of Personality*, *62*, 615–640.

Weisz, J. R., Southam-Gerow, M. A., Gordis, E. B., Connor-Smith, J. K., Chu, B. C., Langer, D. A., . . . Weiss, B. (2009). Cognitive-behavioral therapy versus usual clinical care for youth depression: An initial test of transportability to community clinics and clinicians. *Journal of Consulting and Clinical Psychology*, *77*, 383–396.