A Meta-analysis of Dunn and Dunn Model Correlational Research with Adult Populations

by

Christine Mangino

CHRISTINE MANGINO is an assistant professor in the Early Childhood Department at Hostos Community College, Bronx, New York and an adjunct professor in the Instructional Leadership program and Childhood Education Department at St. John's University, Jamaica, New York. 1583 Chapin Avenue, Merrick, NY 11566 (516) 546-1996 cmangino@hostos.cuny.edu

Abstract

The purpose of this investigation was to conduct a quantitative synthesis of correlational research that focused on the Dunn and Dunn Learning-Style Model and was concerned with adult populations. A total of 8,661 participants from the 47 original investigations provided 386 individual effect sizes for this meta-analysis.

The mean effect size was r = .258. This suggested that the learning-style elements had a medium effect on the 30 independent variables explored. The largest effects were on Discipline (r = .363), Achievement (r = .351), Decision-Making Groups (r = .343), Age (r = .326), Ethnicity (r = .311), Right Brain/Left Brain (r = .303), and Gender (r = .288).

Six of the 15 independent variables were discovered to have moderated the results. These included the assignment to research sample, demographic region, publication type, school level, type of statistics utilized to calculate effect size, and university.

Publication bias was not revealed through correlations of sample sizes and effect sizes. Calculation of a Fail Safe N statistic determined between 1,439 and 1,644 studies supporting the null hypothesis would be necessary to reverse the conclusion that individual's preferred learning-styles were significantly related to the categorical variables examined.

Keywords: learning styles, meta-analysis, higher education, Dunn and Dunn Model, adults

A Meta-Analysis of Dunn and Dunn Model Correlational Research with Adult Populations

Most people have heard the statistic that seven babies are born every minute in the United States, but few are aware of the astonishing detail that one journal article is published every 30 seconds in the sciences (Mahoney, 1985). That fact makes it impossible for individuals to find, read, and analyze all possible publications on a single topic of interest. To further compound the problem, the research concerning the same topic is usually diverse and complex, and may appear in a variety of journals with varied foci. For instance, while a researcher at the University of Mississippi examined the characteristics of freshman students of Alcorn State University, another researcher at Boston University investigated adult learners at an Alaskan oil industry corporation, and yet another researcher at St. John's University in New York examined non-traditional college students in multiple treatments. These researchers all used the Dunn and Dunn Learning-Style Model (1972, 1992, 1993, 1999) as the cornerstone of their investigation, but each was examining different age, achievement, and geographical populations and very different variables.

A simple search of *learning style* on *Educational Resources Information Center* (ERIC) revealed the existence of 4,019 articles. Thus, there appears to be a need to quantitatively synthesize this voluminous research to integrate its findings, analyze relevant theories, resolve conflicts that appear in the literature, and identify central issues and findings for future investigations (Cooper & Hedges, 1994, p. 5).

Overview of the Dunn and Dunn Learning-Style Model

During the late 1960s, researchers began to examine the alternative ways in which individuals learn. Their discoveries evolved into what is known today as *learning style* (Tendy & Geiser, 1998-9). Learning style is comprised of biological and developmental characteristics that make the identical instructional environments, methods, and resources effective for some learners and ineffective for others (Dunn & Dunn, 1972, 1992, 1993; Thies, 1979, 1999/2000). Compared with other learning-style approaches, the Dunn and Dunn Learning-Style Model: "(a) includes greater comprehensiveness, (b) is more extensively researched, and (c) demonstrates higher levels of consistent effectiveness" (Given, 1997-8).

According to Dunn and Dunn (1993), learning style is the way students begin to concentrate on, process, internalize, and remember new and difficult academic information. Because at every age, people learn more, do so more easily, and retain it better when they use their learning style, their styles are actually their *strengths* (Dunn, Griggs, Olson, Beasley, & Gorman, 1995).

The Dunn and Dunn Learning-Style Model is based on the theory that:

1. most individuals can learn;
2. different instructional environments, resources, and approaches respond to different learning-style strengths;
3. everyone has strengths, but different people have very different strengths;
4. individual instructional preferences exist and can be measured reliably (Burke, Guastello, Dunn, Griggs, Beasley, Gemake, Sinatra, & Lewthwaite, 1999-2000);

5. given responsive environments, resources, and approaches, students attain statistically higher achievement- and attitude-test scores in congruent, rather than incongruent treatments (Dunn & Dunn, 1992, 1993; Dunn & Griggs, 2003).

According to this model, learning style is divided into five strands called *stimuli*. The first stimulus strand consists of biologically-imposed environmental elements (Thies, 1979, 1999-2000). These include preferences for Sound versus Quiet, low versus bright Light, warm versus cool Temperatures, and Formal versus Informal Seating. The combination of Light and seating Design affect approximately 70 percent of people (Dunn & Dunn, 1998, p. 8). Although room Temperature and Sound affect only a small percentage of learners, for those who have a strong preference for either cool or warmth or quiet versus sound while concentrating, these elements become critical for functioning effectively. Such people become distracted by this need and are unable to concentrate if the temperature or acoustics in the room do not match their biological preferences (Dunn, Thies, & Honigsfeld, 2001).

The model's second stimulus strand includes the emotional elements of Motivation, Persistence, Responsibility, and Structure. Whereas the element of persistence is biologically imposed, the others are developmental (Thies, 1979, 1999-2000). Persistence is the need to complete a task before taking a break versus the need to take many breathers while working on a task. Motivation is concerned with whether or not a person is internally versus externally motivated, whereas Responsibility is denoted by whether a person is conforming or nonconforming, and structure refers to individuals' needs for internal versus external direction.

The sociological elements of Learning Alone, in a Pair, with Peers, as part of a Team, or with an Adult who is either authoritative or collegial, and the need to work in a Variety of Ways versus in a routine, comprise the third stimulus. These elements are developmental (Thies, 1979, 1999-2000) meaning that they tend to change over time in predictable patterns.

The physiological strand is composed of the elements of Perceptual Preferences, Intake, Time, and Mobility. The four modalities of perceptual strengths are: auditory (remembering ¾ of what is heard): visual (remembering ¾ of what is read or seen): tactual (remembering ¾ of what is written or manipulated with the hands); and kinesthetic (remembering ¾ of what is experienced). The idea that individuals remember differently the complex information they learn by hearing, reading, seeing, tactually manipulating, or experiencing may be one of the major findings of this era (Dunn & Dunn, 1998, p. 10). Perceptual Strength and Time of Day each affect approximately 70 percent of all people. Intake is the need to snack while learning and Mobility is the need to be pacing, rocking, or changing positions at frequent intervals while learning.

The fifth stimulus strand incorporates the psychological elements. These include Global versus Analytic processing, Hemisphericity, and Impulsive versus Reflective behaviors. The elements of Hemisphericity and Global/Analytic essentially appear to parallel each other (Dunn, Beaudry, & Klavas, 1989). Both refer to a preference for simultaneous versus sequential mental processing.

No one is affected by all 21 elements. (See Figure 1.) Most people are impacted by somewhere between 5 and 14, although some individuals are affected by as many as 16 (or more); many are impacted by fewer (two to six). All elements are important and contribute differentially to how well each adult concentrates on, processes, internalizes, and retains new and difficult information (Dunn & Dunn, 1998, p. 8).

It is difficult to identify learning style accurately without a reliable instrument (Beaty, 1986; Dunn, Dunn, & Price, 1977; Marcus, 1977). Several reliable and valid assessments that identify individual learning-style preferences have been developed. These inventories are self-reporting questionnaires that identify individual preferences. The *Learning-Style Inventory* (LSI) (Dunn, Dunn, & Price, 1975, 1978, 1984, 1986, 1987, 1989, 1990, 1996) is based on the Dunn and Dunn Learning-Style Model and different age-appropriate versions analyze the conditions under which students in grades 3 through 12 prefer to learn. The LSI also is appropriate for academically underachieving college freshmen. The *Productivity Environmental Preference Survey* (PEPS) (Dunn, Dunn, & Price, 1981, 1986, 1989, 1990, 1991, 1993, 1996) is appropriate for adult students and *Building Excellence* (BE) (Rundle & Dunn, 1996-1999) is a globally formatted instrument for corporate personnel. Once learning styles have been identified, "instructors can estimate the approach(es), method(s), and sequence(s) that are likely to make learning relatively comfortable for each person" (Dunn & Griggs, 2000, p. 19).

Purpose of the Study

There have been more than 800 studies conducted at more than 120 institutions of higher education with the Dunn and Dunn Model (*Research on the Dunn & Dunn Model*, 2004). The findings from this research were too numerous and diverse to be fully understood through a narrative review of the literature. Instead, a quantitative synthesis of this body of research led to a better understanding of the overall impact of learning-style characteristics.

One way to translate results from varied studies to a common metric and to statistically explore relationships between investigated characteristics and findings is through *meta-analysis*. A meta-analysis refers to an analysis of analyses or to the statistical analysis of a large collection of results from individual investigations for the purpose of integrating the findings (Glass, 1976). This strategy provides a viable process for comparing the differences among studies in treatments, settings, measurement instruments, and research methods that make their findings difficult to compare. Even frequent replications can prove inconclusive if these variables are interchanged. Literature on a topic may be so extensive as to obscure trends with an overwhelming amount of information (Bangert-Downs & Robert, 1991).

Therefore the purpose of this research was to conduct a quantitative synthesis of correlational studies elicited from educational journals and doctoral dissertations in which the Dunn and Dunn Learning-Style Model served as the cornerstone between 1980-2003 and which used post-high school populations.

Faith, Allison, and Gorman (1997) described the three basic goals of meta-analysis. The first goal is to find the average effect size of all studies to determine the overall effectiveness of the construct under investigation. The second goal is to determine the homogeneity or heterogeneity of that average. If the individual effect sizes are close to the average effect size, "then there is little reason to suspect that other variables are related to variations in effect size" (p. 272). If there is considerable variability around the average, usually more than 25% of the population effect size, then the researcher searches for "variables that moderate effect sizes" (p.246). Thus, a third goal of meta-analysis is to identify the variables that lead to larger or smaller effects.

Method

Data Collection

A comprehensive and methodical literature search was conducted to locate both published and unpublished correlational investigations using post-high school populations between 1980-2003 and based on the Dunn and Dunn Learning-Style Model. Studies were located through several approaches.

The Learning-Style Network offers two compilations of research on this model. *Research on the Dunn and Dunn Model* (2003) itemizes books, articles, and dissertations focused on the Dunn and Dunn Model. *Annotated Bibliography of Research* (2003) contains summaries of books, articles, and dissertations on several models of learning style. Relevant research for this meta-analysis was found using these comprehensive sources.

Next, electronic databases were systematically scanned for both published and unpublished research including the terms *learning style* and *Dunn*. This computer-based search identified relevant studies contained in *Educational Resources Information Center* (ERIC), *Proquest, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Education Full Text, Government Printing Office (GPO) on SilverPlatter, Library and Information Science Abstracts, Library Literature and Information Science*, and *PsychINFO.*

After computer databases were searched, it was necessary to conduct an "ancestry analysis for older literature by checking reference lists of retrieved publications" (Faith, Allison, & Gorman, 1997, p. 248). This process also has been titled *footnote chasing* (Cooper & Hedges, 1994, p. 46-47). Reference lists of research papers were searched to locate relevant studies. The publisher of *Building Excellence* was contacted to gather research conducted with this instrument.

For a study to be included in this meta-analysis, it had to have met specific inclusion criteria. This review and subsequent investigation focused on the 47 correlational studies that met all the criteria.

Initially, to be included, the research must have been a correlational study. Experimental, quasi-experimental, theoretical, and descriptive studies were excluded.

Second, the investigation must have utilized one of three instruments based on the Dunn and Dunn Learning-Style Model. The sample also must have included college students or adults.

Finally, the study must have reported enough statistical information to estimate effect sizes. To calculate effect size, the investigation must have reported the number of participants and summary statistics, such as F ratios, means and standard deviations, t-tests, or significance levels.

Coding Study Characteristics

Two different types of variables were considered when coding studies for this meta-analysis. The dependent variables were effect size values. The independent variables were study and design characteristics that may have influenced the magnitude of these effect sizes (Lipsey & Wilson, 2001).

Once the coding forms were developed, several studies were coded to be certain all characteristics were included and the codebook was explicit enough to enhance reliability. Next, a statistician familiar with meta-analyses was consulted for his expertise on the appropriateness and details of the coding forms. Once the forms were determined effective, this researcher coded the studies following the codebook. To increase reliability, two additional coders randomly chose 10 % of the studies to code. Intercoder reliability then was calculated at 93% agreement.

Statistical Analysis

The first stage for this part of the analysis is the combination of study results. Several statistical packages were used to analyze the data.

Prior to combining studies, it is recommended to assign more weight to studies with larger sample sizes (Schmidt & Hunter, 1977; Hunter et al., 1982; Hunter & Schmidt, 1990). The weighted and unweighted average effect sizes, with corresponding confidence intervals, were calculated.

Several methods were used to interpret mean effect-size values and to evaluate the significance of the average effect-size values. The procedures included computing 95% confidence intervals and using Cohen's (1977, 1988, 1992) definitions for small, medium, and large effect sizes for *r* and *d* calculations.

Confidence intervals indicate the range within which the population mean is likely to be, given the observed data. Wolf (1986) suggested a 95% confidence interval be calculated to interpret an effect size and to examine whether it includes zero. "It would be desirable for the average effect size *not* to encompass zero, to be positive there is a significant effect across these studies," (p.27).

These procedures fulfilled the first goal of meta-analysis, which is the combining of effect sizes. The various measures of average effect sizes and their interpretations revealed the correlations among learning-style elements and the categorical variables examined. The following procedures determined the heterogeneity of the effect sizes and examined whether the selected study characteristics and design features moderated the correlations of learning-style preferences and the variables investigated. These fulfilled the second and third goals of meta-analysis, the determination of homogeneity and the search for moderating variables.

Moderating Variables

Once the various effect sizes are averaged into a mean value, it is important to determine if they all estimate the same population effect size (Hedges, 1982; Rosenthal & Rubin, 1982). The homogeneity test assesses the null hypothesis that the between-studies variance in effects is no greater than would be expected due to sampling error alone, or 25% of the population mean.

Three indicators of homogeneity were calculated and examined. All three tests rejected homogeneity. Mean effect sizes for learning-style elements and specific variables investigated were varied enough to be described as heterogeneous. Consequently, it was essential to search for variables that moderated effect sizes.

Publication Bias

According to Glass, McGaw, & Smith (1981), a major criticism of meta-analyses is that they are dependent on the findings that researchers report. A meta-analysis' "findings will be biased, if as surely true, there are systematic differences among the results of research that appear in journals versus books versus theses versus unpublished papers" (p. 226). In general, statistically significant findings are more likely to be published than not. As this was an anticipated issue, publication type was considered a moderating variable in the coding system for this meta-analysis. Primary studies were coded to differentiate among dissertations or theses, published journal articles, both dissertations and published article, and conference papers. Potential publication bias was assessed in three ways.

Light and Pillemer (1984) introduced the *funnel plot* for the graphic detection of publication bias. A funnel plot is a scatterplot of sample size versus estimated effect size for a group of studies. Since small studies typically will show more variability among the effect sizes than will larger studies, and there will be typically fewer of the latter, the plot should look like a funnel. “When publication bias is present, the funnel will look as if it has been cut off at some point or a variation in the density of points will be observed,” (Cooper & Hedges, 1994, p. 393). This procedure was conducted and did not suggest bias. Correlations between sample sizes and effect sizes were examined during the cluster analysis, but since low correlation was revealed, publication bias was not probable.

The third assessment was the calculation of the *Fail Safe N* through Schwarzer’s *Meta-analysis Program* (1986, 1996). This procedure, originally developed by Rosenthal (1979), estimates the number of unpublished studies reporting null results needed to reduce the cumulated effect across studies to the point of nonsignificance (Lipsey & Wilson, 2001. p. 166). High values for this statistic indicated strong results and a reduced probability that unpublished results could change the overall conclusion.

Results

Mean Effect Sizes

Fifty-nine studies were identified that were based on the Dunn and Dunn model, were correlational, and focused on adult populations. Twelve of those investigations did not provide appropriate statistical information to calculate reliable effect sizes. The remaining 47 explorations were accepted and included in this research. The total sample size was 8,661 and the total number of effect sizes was 386.

The POWPAL program (Gorman, Primavera, & Karras, 1995) was used to convert individual findings into effect sizes *r*. Selected investigations provided multiple effect sizes within one study. The range included five studies that produced a single effect size to one investigation that provided 38 effect sizes. The effect sizes ranged from .009 to .785. The mean effect size was .258. Following Cohen's definitions for small, medium, and large effect sizes (ES), this meta-analysis included 204 small ES, 140 medium ES, and 42 large ES. Those effect sizes that were .249 and less were categorized as small; effect sizes that were within .250 - .399 were labeled as medium; and effect sizes equal to or above .400 were considered large.

The largest value for *r* was the Fisher's Z transformation of $r = .269$ which was weighted by sample size and the smallest value for *r* was the Schmidt-Hunter weighted *r* of $r = .236$. All the confidence intervals were far from zero (Table 1).

(INSERT TABLE 1 ABOUT HERE.)

This supported the assumption that there were significant relationships between individuals' learning styles and the variables examined in this investigation, such as academic level, achievement, age, attitude, computer usage, discipline, ethnicity, gender, grade-point average (GPA), and profession. Although these were the variables from the original research questions, several other variables were revealed once the studies were gathered and examined closely (Table 2).

Achievement was measured by the researchers through the results on standardized tests, including a reading test and a nursing examine for certification. Higher-achieving students revealed preferences for learning in Several Ways (r = .312), an Authority-figure present (r = .281), the need for Structure (r = .382), no Sound (r = .400), a Formal Design (r = .470), and tended to be more Motivated (r = .249) then lower-achieving students who revealed a strong preference for Light (r = .450). Examining the perceptual strengths, high achievers had a large effect for Kinesthetic (r = .637) and medium effects for Auditory (r = .395) and Tactual (r = .339), whereas the low achievers had a small preference for Tactual (r = .228) and a non-preference for Visual (r = .419) (Table 3).

Age was the most examined variable by researchers. Subjects under 30 years of age tended to be more Kinesthetic, prefer to learn with Peers or an Authority-figure in the Afternoon, be Parent-Motivated, and in need of Structure. Participants over 30 years of age preferred to Learn Alone, were self Motivated and teacher motivated, preferred to learn in the Morning with Structure and Light, and were Responsible, Visual, and Tactual. Individuals over 55 years of age were Self-Motivated, Responsible, and Tactual, preferred learning with Peers in the Late Morning or with an Authority-Figure present, and had a large effect size for Structure (r = .785) (Table 4).

Attitude was measured separately with job/school satisfaction and with attitude toward studying. With respect to job or school satisfaction, individuals who were satisfied revealed a small mean effect for the need to Learn Alone with no Sound. Subjects who were not satisfied disclosed small effects for Persistence, Responsibility, and Motivation. With regard to study attitude, students who had a positive attitude were Responsible, Motivated, Reflective, Visual, and preferred to Learn Alone. Those with a negative attitude appeared to prefer Intake and Mobility while learning (Table 5).

Computer usage resulted in seven individual effect sizes with a mean effect of *r* = .216 for individuals with high computer usage. Most of the elements were associated with Perceptual Strengths, although the largest effect was evidenced for Morning learners, with a medium mean effect size of *r* = .291 (Table 6).

The discipline, or academic major in which students were enrolled, evidenced the largest mean effect size. Education majors revealed preferences for three of the four perceptual modalities, Kinesthetic (*r* = .310), Visual (*r* = .332), and Tactual (*r* = .313). They also tended to be Responsible and needed Mobility. Nursing majors were Kinesthetic (*r* = .388) and Visual (*r* = .420). They also preferred the presence of an Authority figure, working with Peers in the Morning and Afternoon, Intake and Light, and were Motivated and Reflective. Music majors had large effect sizes for Auditory (*r* = .524) and Kinesthetic (*r* = .612) instructional methods. They also preferred the presence of an Authority figure, working with Peers in the Morning, Intake, and Mobility while learning new and difficult information. Business majors revealed a small effect size when correlated with all the elements but none of the researchers provided appropriate statistics to calculate effect sizes for individual elements (Table 7).

Ethnicity had an overall mean effect size (*r* = .311) which was one of the larger effects from the variables examined. Each of the researchers examined different groups and subgroups accounting for six different groupings in this meta-analysis. Caucasians revealed medium size effects for Design, Morning, Auditory, and Visual. Hispanics unveiled medium effect sizes for Intake, Auditory and Kinesthetic. Non-Caucasians disclosed a small effect for Afternoon learning (Table 8).

Gender had a medium size effect when it was correlated with all the elements (*r* = .358) and revealed a correlation with most of the elements. The data suggested that males preferred Tactual and Auditory instructional activities, learning in the Afternoon with Peers, Mobility, and learning in Several Ways. Adult males also tended to be Persistent and Responsible and males disclosed a large effect size for Design. Females revealed a preference for Structure, an Authority-figure present, Kinesthetic and Visual modalities, Temperature, Design, learning in Several Ways, and Mobility. Females tended to be Persistent, Motivated, Responsible, Morning learners, and preferred Learning Alone. Females unveiled a large effect size for Intake (Table 9).

Grade-point average (GPA) evidenced an overall mean effect size of *r* = .191. When examined closer, one medium and eleven small mean effects emerged. When GPA results were combined with the data from achievement and entrance exam scores, the mean effect size was *r* = .275. The table outlines the mean effect sizes for GPA by itself and when it was combined with the other two variables. This combination, which together can be considered achievement, shared many of the same elements. This similarity, helped support the results that achievement is correlated with learning-style elements. Students with a higher GPA preferred Kinesthetic activities, Structure, Learning Alone, Intake, no Authority-figure present, and learning in Several Ways. They were Motivated and Responsible and did not prefer Tactual instructional methods. Students with lower GPAs preferred learning in the Afternoon and with Sound present while learning (*r* = .127). When GPA was combined with achievement on standardized tests and entrance exam scores, students with high achievement revealed a large effect for Kinesthetic learning (*r* = .472). They also appeared to be Responsible, Motivated, needing Structure, Intake, and to learn in Several Ways. They tend to be Auditory but not Visual. They prefer both working Alone and with Peers. Students with low achievement appear to be Visual and prefer learning in the Afternoon (Table 10).

Numerous researchers had examined the relationship between the profession subjects chose and learning styles. Educators revealed small effect sizes for Auditory and Visual learning, Design, Intake, Mobility, an Authority-figure present, learning in Several Ways, and were Responsible and Persistent. Corporate employees disclosed small effects for each of the four perceptual modalities, preferred learning in Several Ways with Sound and Intake. They also preferenced Learning Alone, with an Authority-figure present, and in the Afternoon. Nurses tended to be Kinesthetic learners who needed bright Light, and to learn with Peers. The correlation between nurses and peers was the only medium sized effect for this variable. Paralegals revealed a non-preference for Tactual learning methods (Table 11).

(INSERT TABLES 2-11 ABOUT HERE.)

Moderating Variables

Calculations involving the mean effect sizes fulfill the first part of a meta-analysis. A major criticism of this statistical procedure is of those researchers who conclude their investigation at this point. The most valuable part of a meta-analysis is the search for moderating variables. Therefore, that was the second part of this analysis. Most of the study and design characteristics indicated significance at the $p <. 000$ levels when post hoc tests were conducted for homogeneity. This first indicator rejected homogeneity and suggested heterogeneity.

Observed effect-size variances were calculated and decomposed into two components of explained sampling error variances and unexplained population or residual variances. A second indicator of homogeneity suggested that sampling error variance should comprise at least 75 % of the total variance. When Schmidt-Hunter was utilized, the percentage of observed variance accounted for by sampling error was 43.06%. Fisher's Z Transformation calculated the sampling error variance as 42.36%. Both of these calculations were less then the needed 75%; therefore, homogeneity was again rejected and heterogeneity was evidenced.

A third indicator of homogeneity was that residual or population variance should not exceed 25% of the population effect size. In all procedures, the residual standard deviation was more than one-quarter of the population effect size. The residual standard deviation values ranged from .079 to .08, whereas the suggested limit of 25% of the population effect sizes ranged from .059 to .06. This third test, yet again, rejected homogeneity and corroborated heterogeneity.

Given that all three indicators rejected homogeneity for effect sizes, the mean effect sizes were sufficiently varied to warrant description as being heterogeneous. Hence, it was necessary to search for variables that moderated these effect sizes.

The mean effect sizes for the type of data used to calculate effect size were significantly different among the four categories (F = 6.886; $p = .000$). The mean effect size was found to be greater when means and standard deviations were utilized to calculate effect size ($r = .329$). *Tukey's Multiple Comparisons* revealed significant differences between means and standard deviations and *t*-tests and F-ratios ($p < .000$); means and standard deviations and significant values ($p < .001$); and means and standard deviations and chi-squares approached significance ($p < .055$). Hence, the type of data used to calculate effect size appeared to have been a moderating variable in this investigation.

Publication Type had significantly different mean effect sizes among the four categories using the regular ANOVA (F = 18.495; $p = .000$) and Kruskal-Wallis ANOVA ($p = .000$). The effect sizes derived from research that reflected both a dissertation and a journal article ($r = .413$) had significantly different mean effect sizes from those that were strictly dissertations ($r = .258$), journal articles ($r = .224$), or conference-presentation papers ($r = .173$) at the $p < .000$ level for each category. There was no significant difference between the mean effect sizes revealed in dissertations and journal articles ($p = .072$) or between effect sizes disclosed in a conference paper and a dissertation ($p = .156$) or a journal article ($p = .622$). Research that emerged originally from a dissertation and was later published as a journal article had significantly higher correlations between learning-style elements and specific variables, compared with other forms of research.

The large variety of University Affiliations was divided into regions rather than specific universities. Significant differences among the mean effect sizes were revealed (F = 2.901; $p = .014$). Closer examination disclosed a significant difference between mean effect sizes derived from research produced at universities in the Northeast ($r = .290$) and the mean effect sizes evolving from research produced at universities in the Southeast ($r = .244$) at the $p = .011$. There were no other significant differences among the other regions.

School level revealed significant differences between the mean effect sizes (F = 3.373; = .005). Further examination unveiled significant differences between the mean effect size for freshmen (*r* = .228) and undergraduates (*r* = .280) at the *p* = .013 level, and the differences between freshmen (*r* = .228) and adults (*r* = .273) approached significance at the *p* = .058 level.

The procedures for selecting sample populations for the research included in this study also revealed significance in the ANOVA (F= .523; *p* = .000). Volunteer samples had the largest mean effect sizes (*r* = .305) compared with other categories, Random assignment (*r* = .238), using an Entire Sample Population (*r* = .239), a Stratified Sample (*r* = .249), and when the sample assignment was Not Specified (*r* = .251). Volunteer mean effect sizes were significantly different from each of these groups at the *p* = .007, .000, .018, .010, respectively.

The variables of assignment, publication type, school level, type of data utilized to calculate effect size, and university region were moderating variables in this investigation. Consequently, research that utilized means and standard deviations, began as a dissertation and later became a published journal article, was conducted in a northeastern region, and was concerned with volunteer undergraduates, revealed the highest mean effect sizes.

Three sources of evidence evaluated publication bias for mean effect sizes. First, a scatterplot compared effect size and sample size. The scatterplot provided evidence that publication bias was not likely in this meta-analysis. Second, the correlations between sample size and effect size were examined during the cluster analysis. It was shown that one of the largest mean effect sizes (*r* = .491) had a relatively small sample size (N = 46) and, conversely, one of the smallest mean effect sizes (*r* = .109) emerged from one of the largest sample sizes (N = 144). This, too, provided evidence that publication bias was unlikely. A third procedure, the calculation of Fail Safe N values estimated that between 1,439 and 1,644 studies supporting the null hypothesis would be necessary to reverse the conclusion that individuals' preferred learning styles were significantly related to specific variables.

A total of 8, 661 adult participants from 47 correlational investigations provided 386 individual effect sizes for this meta-analysis. Although five moderating variables influenced the outcome, the results of this investigation supported the hypothesis that learning styles are significantly correlated with specific attribute variables.

Discussion

Research has repeatedly demonstrated the impact of accommodating individual learning styles on achievement and attitudes (Dunn & Griggs, 2003). More recently, research also revealed their impact on behavior (Fine, 2002; Oberer, 1999, 2003). This investigation has demonstrated the impact learning style has on other aspects of an individual's life. Learning style is related to the discipline a student chooses, the profession an adult enters, the school and program an individual decides to attend, a person's satisfaction with school, teacher or work, the amount of time an individual uses a computer, the degree a student attains, and a person's study habits and attitudes. Conversely, a person's genetic composition also affects her learning style. An individual's gender, ethnicity, age, field dependence, intuition, feeling, decision-making abilities, learning disability, and whether or not she is shy or extroverted is related to an individual's learning style.

Although it would be easy to state that all students with good study habits are motivated, especially with its large effect size (r = .707), it is still a generalization. It is important to understand the 386 individual effect sizes are tendencies in learning styles and the variables examined. The tendencies remind us that each student, employee, or friend is an individual whose needs and preferences should be accommodated for optimal success. Many of the correlations between learning-style elements and specific variables had a single effect size encompassing the mean effect size, but it was still a significant correlation. Also, each variable was significantly correlated with numerous learning-style elements. It is key to have an understanding of learning styles and to have an understanding of how an individual's learning style has at least 386 different effects on a person's being. Twenty-nine variables were investigated by researchers, although it probably does not end with those twenty-nine variables. Most likely, if each of these were significant, there are more variables that have yet to be investigated.

Teachers and employers need to test adults with whom they interact for learning styles. The Learning-Styles Model is multidimensional with various stimuli and many elements; an instrument is needed to diagnose an individual's learning style. Selected learning-style instruments have proven to be valid and reliable. The results of this investigation support that fact. There was virtually no difference between the mean effect sizes by the instrument utilized. Studies that tested their populations with the *Learning Style Inventory* had a mean effect size of $r = .2574$, whereas studies that utilized the *Productivity Environmental Preference Survey* revealed a mean effect size of $r = .2580$, for a difference of $r = .0006$.

An individual's learning-style profile should be used for all aspects of college living and employment. The discipline in which a student was enrolled had the largest effect size when correlated with specific learning-style elements ($r = .363$, $p = .000$).

Overall achievement also was highly correlated with learning-style traits (*r* = .351, *p* = .000). Professors should be required to accommodate their students' learning styles to ensure academic success. Society would agree to professors' lack of professionalism if they admitted to teaching only to those students with curly hair. It seems illogical to permit professors to only teach to one type of learner. We need to find methods to help those students, with learning-style traits that were not correlated with high achievement become successful learners. For instance, low achievers were found to be tactual rather than visual learners. It does not seem fair that because they learn tactually but teachers teach by talking, that this group is prevented from becoming high achievers. Educators need to change that.

> We use different methods for growing cabbages and azaleas. And there is no problem over which is better; one isn't right and the other wrong. Anyone would call a farmer a fool who planted them in the same place and gave them the same fertilizer, (amount of) sun, and water. We value each, and knowing that they will not thrive unless (their) needs are met, we respect their different natures and accept their special requirements. When we respect the differences we know exist in people, and when we value the contributions to be gained by those differences, we shall ...provide for their nurture and cultivation.... (Reckinger, 1979).

The lack of publication bias is also a strength of this model. Although more than 800 studies support the research on the Dunn and Dunn Model, a majority of the research is in the form of dissertations. The results of Hypothesis Three strongly support the statement that there is no statistical difference in the research found in doctoral dissertations and research published in journal articles.

It was revealed that research that *began* as a dissertation and was later *published* as a journal article had a larger mean effect size when compared with research that was only in the form of a dissertation or only in the form of a journal article. It may be possible that the requirement of being screened by two separate filter systems, dissertation committees and editors of journals, produces higher quality research.

The quality of the research was also an issue in this meta-analysis. Eleven studies were excluded from the analyses for failing to supply adequate statistical information. A few studies failed to acknowledge how the sample population has been gathered. As was shown in the analyses, the type of sample was important when interpreting the results. Therefore, it is important for researchers to explain how their samples are derived. Medical research has developed a database, the Cochrane Collaborative, which is responsible for reviewing all medically related research and incorporating it into one system. It is an official means of uniformly reporting evidence-based research results. The goal is to have everyone involved able to find relevant research, to allow researchers to build on one another' work rather than continually repeat studies because they are unaware of previous work, and to have all results accessible for medical use. It may be helpful to adopt this type of system to education.

References

*Adams, C. B. (2003). An analysis of the relationship between learning styles and the growth in technology abilities among teacher education majors. (Doctoral dissertation, University of Mississippi). *Dissertation Abstracts International, 64(05),* 1509A.

Annotated Bibliography of Research (1992, 1995, 1999, 2000, 2002). Jamaica, NY: St. John's University Center for the Study of Learning and Teaching Styles.

*Bailey, G.K. (1988). Examination of the relationship between hemispheric preferences and environmental characteristics of learning style in college students. (Doctoral dissertation, The University of Southern Mississippi). *Dissertation Abstracts International, 49*(08), 2151A.

Bangert-Drowns, Robert L. & Rudner, Lawrence M. (1991). Meta-analysis in educational research. *Practical Assessment, Research & Evaluation, 2*(8).

Beaty, S.A. (1986). The effect of inservice training on the ability of teachers to observe learning styles of students. (Doctoral dissertation, Oregon State University). *Dissertation Abstracts International, 47*, 1998A.

*Bovell, C. (2000). Analysis of learning styles of older students enrolled in non-traditional college programs. (Doctoral dissertation, St. John's University). *Dissertation Abstracts International, 62(11),* 3656A.

Burke, K., Guastello, F., Dunn, R., Griggs, S. A., Beasley, T. M., Gemake, J., Sinatra, R., & Lewthwaite, B. (1999-2000). Relationship(s) between global-format and analytic-format learning style assessments based on the Dunn and Dunn model. *National Forum of Applied Educational Research Journal, 13*(1), 76-96.

*Cambiano, R. L. (1999). Learning styles of the age cohorts: Generation X, Baby Boomers, and the Silent Generation. (Doctoral dissertation, University of Arkansas). *Dissertation Abstracts International, 60*(06), 1864A.

*Campbell, N. A. (2002). Learning style preferences of women incarcerated in a midwestern, minimum security prison. (Doctoral dissertation, University of Arkansas). *Dissertation Abstracts International, 63*(05), 1804A.

*Clark-Thayer, S. (1987). The relationship of the knowledge of student perceived learning style preferences, and study habits and attitudes to achievement of college freshmen in a small, urban university. (Doctoral dissertation, Boston University). *Dissertation Abstracts International, 48*(04), 872A.

Cohen, J. (1977). *Statistical power for the behavioral sciences*. (Re. ed.). New York: Academic Press.

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

Cohen, J. (1992). A power printer. *Psychological Bulletin*. *112*, 155-159.

*Coolidge-Parker, J.A. (1989). A comparison of perceived and objectively measured perceptual learning style modality elements of court reporters and court reporting students. (Doctoral dissertation, University of South Florida). *Dissertation Abstracts International*, *50*(07), 1896A.

Cooper, H. & Hedges, L.V. (1994). *The handbook of research synthesis*. New York: Russell Sage Foundation.

Dunn, R., Beaudry, J., & Klavas, A. (1989) Survey of research on learning styles. *Educational Leadership*, *46*(6), 50-58.

Dunn, R. & Dunn, K. (1972). *Practical approaches to individualizing instruction.* West Nyack, New York: Parker Publishing Company Division of Prentice-Hall Publishers, Inc.

Dunn, R. & Dunn, K. (1992). *Teaching elementary students through their individual learning styles.* Boston: Allyn & Bacon.

Dunn, R. & Dunn, K. (1993). *Teaching secondary students through their individual learning styles.* Boston: Allyn & Bacon.

Dunn, R. & Dunn, K. (1998). *Practical approaches to individualizing staff development for adults.* Westport, CT: Praeger.

Dunn, R., & Dunn, K. (1999). *The complete guide to the learning styles inservice system.* Boston: Allyn & Bacon.

Dunn, R., Dunn, K., & Price, G. (1977). Diagnosing Learning Styles: A prescription for avoiding malpractice suits against school systems. *Kappan*, 418-420.

Dunn, R., Dunn, K., & Price, G. (1975, 1978, 1984, 1986, 1987, 1989, 1990, 1996). *Learning Style Inventory*. Lawrence, KS: Price Systems Inc.

Dunn, R., Dunn, K., & Price, G. (1981, 1986, 1989, 1990, 1991, 1993, 1996). *Productivity Environmental Preference Survey*. Lawrence, KS: Price Systems Inc.

Dunn, R. & Griggs, S. (Eds.) (2003). *Synthesis of the Dunn and Dunn Learning-Style Model Research: Who, What, When, Where, and So What?* St. John's University.

Dunn, R., Griggs, S. A., Olson, J., Gorman, B., & Beasley, M. (1995). A meta-analytic validation of the Dunn and Dunn learning styles model. *Journal of Educational Research, 88*(6), 353-362.

Dunn, R., Thies, A. P. & Honigfeld, A. (2001). *Synthesis of the Dunn and Dunn Learning Style Model Research: Analysis from a Neuropychological Perspective*. St. John's University.

*Eitington, N. J. (1989). A comparison of learning styles of freshmen with high and low reading achievement in the Community Liberal Studies Program at Georgetown University. (Doctoral dissertation, The George Washington University). *Dissertation Abstracts International, 50*(05), 1285A.

Faith, M. S. Allison, D. B. & and Gorman, B. S. (1997). Meta-analysis of Single-Case Research. In R. D. Franklin, D. B. Allison & B. S. Gorman (Eds.), *Design and Analysis of Single-Case Research* (p. 245-277). Mahwah, NJ: Erlbaum.

Fine, D. (2002). Comparison between the learning style of special education and regular education high school students and the effects of responsive teaching on the short- and long-term achievement, attitudes, and behaviors of a subset of SPED adolescents. (Doctoral dissertation, St. John's University). *Dissertation Abstracts International, 63(01),* 67A.

*Foley, N. E. (1997). Learning style preferences of undergraduate students with and without learning disabilities. (Doctoral dissertation, University of Missouri-Columbia). *Dissertation Abstracts International, 59*(7), 2443A.

*Franchi, J. (2002). Comparison of learning and performance styles of cross-cultural populations in a global corporate organization (Puerto Rico, Columbia, United States. (Doctoral dissertation, The Florida State University). *Dissertation Abstracts International, 63*(12), 4220A.

*Galvin, A. J. (1992). An analysis of learning and productivity styles across occupational groups in a corporate setting (learning styles, corporate training). (Doctoral dissertation, Boston University). *Dissertation Abstracts International, 53*(04), 1027A.

*Given, B., Knight, G. D., Patrick, S., & McGuire, N. (1999). Personality types and learning styles of college freshman. *Educational Psychology Review*.

Glass, G.V. (1976). Primary, secondary, and meta-analysis. *Educational Researcher, 5*, 3-8.

Glass, G., McGaw, B., & Smith, M. L. (1981) *Meta-analysis in social research*. Beverly Hills, CA: Sage.

*Gordon, H. R. (1996, April). *Analysis of productivity and learning-style preferences of participants in distance education.* Paper presented at the meeting of the American Education Research Association, New York.

Gorman, B. S., Primavera, L. H. & Allison, D. B. (1995). POWPAL: A program for estimating effect sizes, statistical power and sample sizes. *Educational and Psychological Measurement*. *55*, 773- 776.

*Gould, B. J. (1987). An investigation of the relationship between supervisors' and supervisee' sociological productivity styles and teacher evaluations and interpersonal attraction ratings. (Doctoral dissertation, St. John's University). *Dissertation Abstracts International, 48(01)*, 18A.

*Griggs, S. A., Price, G. E., & Suh, B. (1997/98). Freshman's level of satisfaction with roommates, residence, and college in relation to their learning-style preferences. *National Forum of Teacher Education Journal,* Los Angeles, CA: California State University, *8*(2), 29-37.

*Harrelson, G. L., Leaver-Dunn, D., & Wright, K. E. (1998). An assessment of learning styles among undergraduate athletic training students. *Journal of Athletic Training*. *33*, 50-53.

*Hawk, T. D. (1983). A comparison of teachers' preference for specific inservice activity approaches and their measured learning styles. (Doctoral dissertation, Kansas State University). *Dissertation Abstracts International*, *44*(12), 3557A.

Hedges, L. V. (1982). Estimation of effect size from a series of independent experiments. *Psychological Bulletin*, *92*, 490-499.

*Hickerson-Roberts, V. L. (1983). Reading achievement, reading attitudes, self-concept, learning styles and estimated high school grade point average as predictors of academic success for 55 adult learners at Kansas State University. (Doctoral dissertation, Kansas State University). *Dissertation Abstracts International*, *44*(05), 1295A.

Hunter, J. E. & Schmidt, F. L. (1990). *Methods of meta-analysis: Correcting error and bias in research findings.* New Park, CA: Sage.

Hunter, J. E., Schmidt, F. L., & Jackson, G. B. (1982). *Meta-analysis: Cumulating research findings across studies*. Beverly Hills, CA: Sage.

*Jenkins, C. (1991). The relationship between selected demographic variables and learning environmental preferences of freshman students of Alcorn State University. (Doctoral dissertation, The University of Mississippi). *Dissertation Abstracts International, 53*(01), 80A.

*Jones, D. E. (1994). Predicting college grade pint average: The contribution of four developmental domains. (Doctoral dissertation, University of Kansas).

Dissertation Abstracts International, 56(04), 1249A.

*Katzowitz, E. C. (2002). Predominant learning styles and multiple intelligences of postsecondary allied health students. (Doctoral dissertation, University of Georgia). *Dissertation Abstract International, 63(11),* 3852A.

Keefe, J.W. (1982). *Student learning styles and brain behavior.* Reston, Virginia: National Association of Secondary School Principals.

*Kizilay, P. E. (1991). The relationship of learning style preferences and perceptions of college climate and performance on the National Council Licensure Examination for Registered Nurses in associate degree nursing programs (nursing students). (Doctoral dissertation, University of Georgia). *Dissertation Abstracts International, 52*(06), 1985A.

*Kuznar, E. Falciglia, G. A., Wood, L., Frankel, J. (1991). Learning style preferences: a comparison of younger and older females. *Journal of Nutrition for the Elderly, 10*(3), 21-32.

*Lam-Phoon, S. (1986). A comparative study of the learning styles of Southeast Asian and American Caucasian college students of Two Seventh-day Adventist campuses. (Doctoral dissertation, Andrews University). *Dissertation Abstracts International, 48*(09), 2234A.

*Li, T. C. (1989). *The learning styles of the Filipino graduate students of the Evangelical seminaries in Metro Manila.* (Unpublished doctoral dissertation, Asia Graduate School of Theology, Manila, Philippines.)

Light, R. J. & Pillemer, D. B. (1984). *Summing up: the science of reviewing research.* Cambridge, MA: Harvard University Press.

Lipsey, M. W. & Wilson, D. B. (2001). *Practical Meta-analysis*. Thousand Oaks, CA: Sage Publications.

*Little, T. S. (1993). The relationship of right brain/left brain hemispheric dimensions of cognitive style between teachers and principals in Northeast Tennessee. (Doctoral dissertation, East Tennessee State University). *Dissertation Abstracts International*, *54*(12), 4319A.

Mahoney, M. J. (1985). Open exchange and epistemic progress. *American Psychologist*, *40*, 29-39.

Marcus, L. (1977). How teachers view student learning styles. *NASSP Bulletin*, *61*(408), 112-114.

*McFarland, M. B. (1989). An analysis of the relationship between learning style perceptual preferences and attitudes toward computer-assisted instruction. (Doctoral dissertation, Portland State University). *Dissertation Abstracts International, 50*(10), 3143A.

*Montgomery, F. L. (1993). A comparison of learning styles of traditional high school students and adult students in Missouri area vocational-technical schools. (Doctoral dissertation, University of Missouri-Columbia). *Dissertation Abstracts International, 54*(10), 3725A.

Oberer, J. (1999). Practical application of Thies' philosophical and theoretical interpretation of the biological basis of learning style and brain behavior and their effects on the academic achievement, attitude, and behavior of fourth grade students in a suburban school district. (Doctoral dissertation, St. John's University). *Dissertation Abstracts International, 48(02)*, 283A.

Oberer, J. (2003). Effects of learning-style teaching on elementary students' behaviors, achievement, and attitudes. *Academic Exchange Quarterly*, Spring 2003.

*Onwuegbuzie, A. J. & Jaio, Q. G. (1998). The relationship between library anxiety and learning styles among graduate students for library instruction. *Library and Information Science Research*, *20*(3), 235-249.

Price, G., Dunn, R., & Dunn, K. (1982). *Productivity Environmental Preference Manual*. Lawrence, KS: Price Systems, Inc.

*Ranne, T. M. (1996). Hawthorne un-capped: The relationship of adult learning styles to the academic achievement of nursing students. (Doctoral dissertation, State University of New York at Buffalo). *Dissertation Abstracts International, 57*(09), 3771A.

Reckinger, N. (1979, January). Choice as a way to quality learning. *Educational Leadership,* 36(4), 255-256.

Research Based on the Dunn and Dunn Model (2001, 2003). New York: St. John's University Center for the Study of Learning and Teaching Styles.

*Reed, B. J. (1993). Concurrent validity of a self-report instrument to a performance-based instrument of perceptual learning style in a vocational evaluation (learning styles). (Doctoral dissertation, University of Northern Colorado). *Dissertation Abstracts International, 54*(04), 1334A.

*Reynolds, J. (1988). A study of the pattern of learning style characteristics for adult dependent decision makers. (Doctoral dissertation, Virginia Polytechnic Institute and State University). *Dissertation Abstracts International, 50*(04), 854A.

*Ritchey, J. P. (1994). A study of the relationship between information processing style and productivity environmental preference. (Doctoral dissertation, Southwestern Baptist Theological Seminary). *Dissertation Abstracts International, 55*(06), 1450A.

Rosenthal, R. (1979). The file drawer problem and tolerance for null results. *Psychological Bulletin*, *86*, 638-641.

Rosenthal, R. & Rubin, D. (1982). A simple, general purpose display of magnitude of experimental effect. *Journal of Educational Psychology*, *74*, 707-712.

Rundle, S. & Dunn, R. (1996-1999). *Building Excellence* (BE). Pittsford, NY: Performance Concepts.

Schmidt, F. L., & Hunter, J. E. (1977). Development of a general solution to the problem of validity generalization. *Journal of Applied Psychology*, *62*, 529-540.

Schwarzer, R. (1989). *Meta-analysis computer program*. Berlin, West Germany.

Schwarzer, R. (1996). *Meta-analysis programs*. Unpublished manuscript, Gottingen, Hogrefe.

*Shaver, V. E. (2000). Learning styles and student success in radiology education. (Doctoral dissertation, Florida Atlantic University). *Dissertation Abstracts International, 61*(09), 4676B.

*Siebenman, J. B. (1984). An investigation into the relationship between learning style and cognitive style in nontraditional college reading students. (Doctoral dissertation, Arizona State University). *Dissertation Abstracts International, 45*(06), 1705A.

*Skinner, M. J. (1995). The use of the *Productivity Environmental Preferences Survey* and the *Minnesota Satisfaction Questionnaire* to determine if any relationships exist between learning style and job satisfaction among registered and licensed practical nurses in acute care settings. (Doctoral dissertation, The University of Mississippi). *Dissertation Abstracts International*, *56*(09), 4804B.

Tendy, S. M. & Geiser, W. F. (1998-99). The search for style: It all depends on where you look. *National Forum of Teacher Education Journal, 9*(1), 3-15.

Thies, A. P. (1979). A brain-behavior analysis of learning styles. In *Student learning styles: Diagnosing and prescribing programs* (pp. 55-61). Reston, VA: National Association of Secondary School Principals.

Thies, A. P. (1999-2000). The neuropsychology of learning styles. *National Forum of Applied Educational Research Journal, 13*(1), 50-62.

*Tiller, R. W. (1991). An investigation into the extent of congruency between general and music-specific learning style preferences. (Doctoral dissertation, Michigan State University). *Dissertation Abstracts International, 52*(05), 1677A.

*Toppins, A. D. & Dunlap, W. R. (1984). *Learning Styles: Do They Affect Faculty Evaluation?* Paper presented at the annual meeting of the Midsouth Educational Research Association (13th, New Orleans, LA, November 14-16, 1984).

*Vafa, S. G. (2002). Learning style preferences among University of Houston online students (Texas) (Doctoral dissertation, University of Houston). *Dissertation Abstracts International*, *63*(02), 500A.

*Van Wynen (1999). The relationships between selected learning-style elements and the achievement and attitudes of older adults following wellness sessions using different instructional methodologies. (Doctoral dissertation, St. John's

University). *Dissertation Abstract International, 62(05),* 1740A.

*Vazquez, A. W. (1985). Description of learning styles of high-risk adult students taking evening courses in urban community colleges in Puerto Rico. (Doctoral dissertation, The Union for Experimenting Colleges and Universities). *Dissertation Abstracts International, 47*(04), 1157A.

*Wallin, P. D. K. (1998). Teaching and learning style factors of National Board-certified teachers. (Doctoral dissertation, The University of Southern Mississippi). *Dissertation Abstracts International, 60*(01), 103A.

*Wegner, W. W. (1980). Opsimathic styles of adults. (Doctoral dissertation, The University of Southern Mississippi). *Dissertation Abstracts International, 41*(05), 1898A.

*White, R. H. (1993). A study of the relationships between teachers' learning style preferences and their use of the microcomputer at home and at school in Medfield, Massachusetts. (Doctoral dissertation, Boston College). *Dissertation Abstracts International, 54*(06), 2124A.

*Williams, E. H. Jr. (1986). The learning style characteristics of typical and developmental junior college students. (Doctoral dissertation, The University of Southern Mississippi). *Dissertation Abstracts International, 47*(11), 4036A.

*Wittenberg, S. K. (1984). A comparison of diagnosed and preferred learning styles of young adults in need of remediation. (Doctoral dissertation, The University of Toledo). *Dissertation Abstracts International, 45*(12), 3539A.

Wolf, F. (1986). *Meta-analysis: Quantitative methods for research synthesis*. Beverly Hills, CA: Sage Publications.

*Wooldridge, B. E. M. (1993). A strategy for improving management education for public administrators: Integrating the results of selected learning style research into public administration course design and delivery. (Doctoral dissertation, University of Southern California). *Dissertation Abstracts International*, *55*(12), 3988A.

* Research included in this meta-analysis

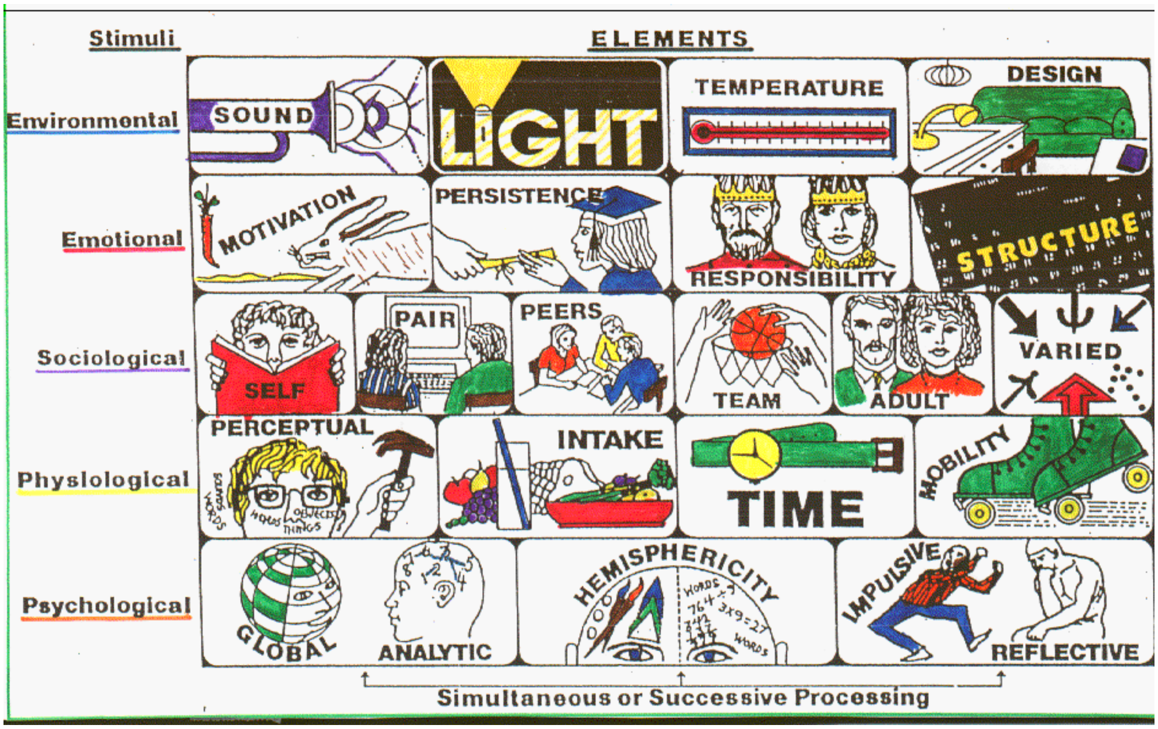

Figure 1. Dunn and Dunn Learning-Style Model

Table 1.

Meta-analysis Results for Mean Effect Sizes

	Simple Unweighted	Schmidt-Hunter	Fisher’s Z Transformation	Fisher's Z Schmidt-Hunter
Unweighted r	.258		.269	
Weighted r		.236		.241
95% Confidence Interval Low	.247	.082	.256	.234
95% Confidence Interval High	.269	.391	.270	.247

Table 2.

Mean Effect Sizes for Variables Examined

VARIABLE (N)	MEAN EFFECT SIZE	95% CONFIDENCE INTERVAL-LOW	95% CONFIDENCE INTERVAL-HIGH
Discipline (13)	.363	.290	.435
Achievement (22)	.351	.285	.418
Decision-Making Group (4)	.343	.290	.396
Age (49)	.326	.291	.360
Ethnicity (12)	.311	.243	.379
Right Brain/Left Brain (16)	.303	.256	.319
Gender (42)	.288	.256	.319
Disability (7)	.277	.259	.296
Faculty Evaluation (9)	.269	.116	.423
Study Habits (15)	.252	.117	.331
School (6)	.247	.185	.309
Employment Status (7)	.247	.230	.264

Judging/Perceiving (13)	.241	.199	.282
Educational Attainment (10)	.240	.162	.318
Type of Program (25)	.236	.187	.285
Field Dependence/Independence (11)	.236	.210	.261
Computer-Use (7)	.216	.169	.263
Job/School Satisfaction (5)	.214	.177	.251
Sensing/Intuition (8)	.212	.171	.254
Academic Level (18)	.204	.140	.268
GPA (20)	.191	.158	.224
Profession (32)	.190	.112	.443
Study Attitude (9)	.184	.124	.245
Parent-Status (5)	.182	.144	.220

Library Anxiety (6)	.170	.150	.190
Entrance Exam (1)	.166	N/A	N/A
Extrovert/Introvert (6)	.165	.109	.221
Thinking/Feeling (7)	.146	.125	.166
SES (1)	.126	N/A	N/A

Note. N = Total number of effect sizes for each variable.
N/A = 95% confidence interval cannot be calculated for one effect size.

Table 3.

Achievement Correlations

ELEMENT	HIGH ACHIEVERS	LOW ACHIEVERS
AUDITORY	.395 (1)	
KINESTHETIC	.637 (2)	
NOT VISUAL		.419 (2)
TACTUAL	.339 (2)	.228 (1)
RESPONSIBILITY	.190 (1)	
MOTIVATION	.249 (2)	
STRUCTURE	.382 (1)	
AUTHORITY	.281 (2)	
PEERS	.250 (1)	

SEVERAL WAYS	.312 (2)	
SOUND	.400 (1)	
LIGHT		.450 (1)
DESIGN	.470 (1)	
INTAKE	.150 (1)	

Note: (N) = number of individual effect sizes

Table 4.

Age Correlations

ELEMENT	UNDER 30	OVER 30	OVER 55
KINESTHETIC	.210		
TEMPERATURE		.197	.354
LEARN ALONE		.251	
PEERS	.310		.379
STRUCTURE	.209	.361	.785
INTAKE	.265	.279	
DESIGN		.337	.286
SELF-MOTIVATED		.361	.326

PARENT-MOTIVATED	.180		
TEACHER-MOTIVATED		.315	
MORNING		.343	
AFTERNOON	.362		
LATE MORNING			.267
VISUAL		.482	.270
LIGHT	.308	.343	
AUTHORITY	.289		.574
RESPONSIBILITY		.347	.491
TACTUAL		.228	.374

SOUND			.408
SEVERAL WAYS			.538
MOBILITY			.427

Note: All mean effect sizes were based on one effect size.

Table 5.

Attitude Correlations

ELEMENT	SATISFIED	NOT SATISFIED	POSITIVE	NEGATIVE
PERSISTENT		.200 (1)		
RESPONSIBILTY		.229 (1)	.194 (1)	
MOTIVATED		.260 (1)	.327 (1)	
LEARN ALONE	.194 (1)		.149 (1)	
QUIET	.189 (1)			
COMBINATION OF ELEMENTS	.197 (1) (quiet, cooler temperatures, bright light, less motivated, more responsible)			

LIGHT			.106 (1)	
DESIGN			.123 (1)	
REFLECTIVE			.178 (1)	
VISUAL			.176 (1)	
INTAKE				.109 (1)
MOBILITY				.296(1)

Note: (N) = number of individual effect sizes

Table 6.

Computer Usage Correlations for Individuals with High Computer Usage

ELEMENT	MEAN EFFECT SIZE
KINESTHETIC (2)	.238
VISUAL (2)	.222
TACTUAL (1)	.232
TEMPERATURE (1)	.186
MORNING (1)	.291
ALL PERCEPTUAL STRENGTHS (1)	.148

Table 7.

Discipline Correlations

ELEMENT	TEACHERS	NURSES	MUSIC STUDENTS	BUSINESS STUDENTS
AUDITORY			.524 (1)	
KINESTHETIC	.310 (1)	.388 (1)	.612 (1)	
VISUAL	.332 (1)	.420 (1)		
TACTUAL	.313 (1)			
AUTHORITY		.220 (1)	.334 (1)	
MOBILITY	.313 (1)		.293(1)	
RESPONSIBILITY	.336 (1)			
PEERS		.235 (2)	.277 (1)	
MORNING		.386 (1)	.315 (1)	

INTAKE		.279 (1)	.549 (1)	
LIGHT		.379 (2)		
TEMPERATURE		.197 (1)		
SOUND		.400 (1)		
AFTERNOON		.362 (1)		
MOTIVATED		.299 (2)		
REFLECTIVE		.338 (1)		
ALL ELEMENTS				.206 (1)

Note: (N) = number of individual effect sizes

Table 8.

Ethnicity Correlations

Element	Caucasian	Non-Caucasian	Caucasian Compared with Asian	Caucasian Compared with African-American	African American	Hispanic
DESIGN	.358 (1)					
MORNING	.258 (1)					
AFTERNOON		.243 (1)				
AUDITORY				.318 (1)		.303 (1)
VISUAL				.287 (1)		
KINESTHETIC						.325 (1)
SOUND					.226 (1)	
INTAKE						.251 (2)

ALL ELEMENTS			.279 (1)	.627 (1)		

Note: (N) = number of individual effect sizes

Table 9.

Gender Correlations

ELEMENT	FEMALES	MALES	NOT SPECIFIED
KINESTHETIC	.214 (2)		
VISUAL	.238 (2)		
AUDITORY		.225 (3)	
TACTUAL		.362 (2)	
PERSISITENCE	.169 (1)	.353 (2)	
RESPONSIBILITY	.275 (1)	.273 (1)	
MOTIVATION	.202 (2)		
STRUCTURE	.142 (1)		
AUTHORITY	.275 (5)		

LEARN ALONE	.198 (1)		.287 (1)
PEERS		.276 (2)	
SEVERAL WAYS	.277 (1)	.197 (1)	
TEMPERATURE	.389 (1)		
DESIGN	.343 (2)	.474 (1)	
MORNING	.249 (1)		.174 (1)
AFTERNOON		.374 (1)	.179 (1)
INTAKE	.440 (3)		
MOBILITY	.353 (2)	.297 (1)	
ALL ELEMENTS			.358 (1)

Note: (N) = number of individual effect sizes

Table 10.

GPA Correlations

ELEMENT	HIGH GPA	LOW GPA	HIGH COMBINED ACHIEVEMENT	LOW COMBINED ACHIEVEMENT
KINESTHETIC	.143 (1)		.472 (3)	
AUDITORY			.395 (1)	
VISUAL				.419 (2)
NOT VISUAL			.224 (1)	
TACTUAL			.339 (2)	.228 (1)
NOT TACTUAL	.224 (1)			
RESPONSIBILITY	.226 (3)		.217 (4)	
MOTIVATION	.220 (2)		.324 (4)	

STRUCTURE	.224 (2)		.276 (3)	
NO AUTHORITY-FIGURE PRESENT	.164 (1)		.164 (1)	
AUTHORITY			.281 (2)	
LEARN ALONE	.280 (2)		.280 (2)	
PEERS			.250 (1)	
AFTERNOON		.109 (1)		.109 (1)
SEVERAL WAYS	.164 (1)		.263 (3)	
INTAKE	.134 (1)		.143 (2)	
SOUND		.127 (1)	.400 (1)	.127 (1)
DESIGN			.166 (1)	

Note: (N) = number of individual effect sizes

Table 11.

Profession Correlations

ELEMENT	EDUCATORS	CORPORATE EMPLOYEES	NURSES	PARALEGALS
AUDITORY	.113 (1)	.191 (1)		
KINESTHETIC		.195 (1)	.235 (1)	
VISUAL	.133 (2)	.232 (1)		
TACTUAL		.163 (1)		(N0T TACTUAL) .168 (1)
SEVERAL WAYS	.187 (1)	.234 (1)		
SOUND		.198 (1)		
LIGHT			.226 (1)	
DESIGN	.116 (1)	.188 (1)		

INTAKE	.170 (1)	.246 (1)		
MOBILITY	.217 (2)			
PERSISTENCE	.154 (1)			
RESPONSIBILITY	.154 (1)			
MOTIVATED	.118 (1)			
AUTHORITY	.201 (2)	.195 (1)		
LEARN ALONE		.176 (1)		
PEERS			.279 (1)	
AFTERNOON	.146 (1)	.183 (1)		
NOT LATE MORNING	.149 (1)			

Note: (N) = number of individual effect sizes