

Comparative analysis of the learning styles of Brazilian and German adolescents by age, gender, and academic achievement levels

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Introduction

Despite educational reforms in Brazil in the 1990's, retention and dropout rates still were high in 1999, with only 32.6 percent of the population between 15 and 17 years of age attending secondary school (*Instituto Nacional de Estudos e Pesquisas Educacionais [INEP]*, 2000). It also was reported that Brazilian adolescents had diverse learning styles but that complex socioeconomic problems, combined with traditional instructional methods, led to school environments not conducive to learning (Weschler, 1993). Based on the alarming statistics, it became apparent that educators should investigate this problem and suggest solutions for increasing the number of Brazilian adolescents in full-time attendance.

German education, with its emphasis on high scholastic performance, has been a source of interest for educators for many years (Third International Mathematics and Science Study [TIMSS], 1995). Scholastic aptitude is the most important factor of the German education system, with students grouped by academic achievement, a system quite different from that of other nations (Noack, 1999), including Brazil's.

Learning styles has allowed several teachers to meet the needs of the individual child in the classroom. Students in every nation of the world learn new and difficult material in ways that are often similar and, at the same time, different from the way other students of the same age, gender, race, religion, culture and nationality prefer to learn (Dunn & Griggs, 1995; *Research on the Dunn & Dunn Model of Learning Styles*, 2002).

The purpose of this study was to identify and compare the preferred learning-style characteristics of adolescents from the countries of Brazil and Germany, and to analyze the similarities and differences by age, gender, and academic achievement within and among these groups of students.

For the purpose of this research, the following hypotheses were of primary interest:

H1 There will be significant differences among the learning-style preferences of Brazilian and German 13-, 15-, and 17-year-old students (De Paula, 2002; Dunn & Griggs, 1995; Hlawaty, 2002; Milgram, Dunn, & Price, 1993; Price, 1980).

H2 There will be significant differences between the learning-style preferences of Brazilian and German male and female students (De Paula, 2002; Hlawaty, 2002; Honigsfeld, 2002; Jenkins, 1991; Lam-Phoon, 1986; Marcus, 1979; Pengiran-Jadid, 1998; Pizzo, Dunn, & Dunn, 1990; Ponder, 1990; Zikmund, 1988).

H3 There will be significant differences among the learning-style preferences of academically different Brazilian and German students, as defined by their academic placement (Calvano, 1985; De Paula, 2002; Hlawaty, 2002; Honigsfeld, 2001; McCabe, 1992; Pengiran-Jadid, 1998; Yong & McIntyre, 1992; Young, 1985).

Population and Sample

Participants for this investigation consisted of 13-, 15-, and 17-year-old Brazilians and Germans attending 18 urban, suburban, and rural schools, with a total sample of 1774 adolescents from a population of over 25,000 students. Males and females were represented in a 7:10 ratio, respectively.

The *Learning Style Inventory* (LSI) (Dunn, Dunn, & Price, 1996, 2000) was utilized to measure the students' learning-style preferences. Means and standard deviations were calculated for the descriptive statistics. Inferential statistics were established by univariate analyses of variance (ANOVAs), *t*-tests, and multivariate analyses of variance (MANOVAs).

Materials

The Brazilian-Portuguese and German versions of the *Learning Style Inventory* (LSI) (Dunn, Dunn, & Price, 1996, 2000) for Grades 5-12 were used to identify the learning-style preferences of the participants in the following 22 areas: Noise, Light, Temperature, Design, Motivation, Persistent, Responsibility, Structure, Alone/Peers, Authority Figure, Several Ways, Auditory, Visual, Tactual, Kinesthetic, Intake, Time of Day, Late Morning, Afternoon, Mobility, Parent Motivated, and Teacher Motivated. The LSI had high reliability and face/construct validity (Kirby, 1979), and was rated as having good or better validity and reliability than nine other instruments that measured learning styles (Curry, 1987; DeBello, 1990; Tendy & Geiser, 1998-1999). It also evidenced predictive validity (Dunn & DeBello, 1999; Dunn, Thies, & Honigsfeld, 2001; Roberts et al., 2001; Schiering & Dunn, 2001; Searson & Dunn, 2001; Sullivan, Dunn, Denig, Lynch, & Cantelmo, 2001) and, therefore, was suitable for use in this study.

Procedures

Data for this investigation were collected in Brazil and Germany during winter and spring 2001. To maintain the integrity of the LSI, each researcher was the sole collector of data in her respective country. These measures were undertaken to ensure as much control of external variables as possible.

Statistical Procedures

The transformed scores and matching demographic information for each of those students were entered into a database. The *Statistical Package for the Social Sciences (SPSS) for Windows* 10.0 (2000) was used for statistical analyses. Means and standard deviations were calculated for the descriptive statistics. Inferential statistics were established by univariate analyses of variance (ANOVAs), *t*-tests, multivariate analyses of variance (MANOVAs) and Tamahane's T2 post-hoc tests. The level of statistical significance was set at an $\alpha < 0.05$.

Bonferroni adjustments for inflation of the Type I error rate were made due to the large number of statistical tests conducted.

In the case of the three-level independent variables (age and academic achievement level), Type I error was controlled through the utilization of the extended-Fisher procedure for multiple comparisons (Levin, Serlin, & Seaman, 1994). Significant omnibus one-way multivariate analyses of variance (MANOVAs) ($\alpha = .05$) were further followed by level-specific pairwise multivariate analyses of variance (MANOVAs) at $\alpha = .05$. Subsequent post-hoc tests were conducted with a Bonferroni adjustment of $\alpha = .02$. Tamahane's T2 tests of unequal variance were performed for learning-style variables that revealed significant differences in variances through Levene's test for homogeneity of variance. In the case of homogeneous variances, the Tamahane's T2 procedure is approximately equal to Fisher's LSD.

Eta-squares (η^2) were reported as effect sizes to determine the magnitude of the results regardless of sample size. As suggested by Huberty and Lowman (2000), effect sizes should be reported for group mean comparisons involving multilevel grouping variables, such as the three-level age variable, two-level gender variable and three-level achievement variable. An $.25 < \eta^2$ was reported as a large effect size, $.01 < \eta^2 < .24$ as a medium effect size, and $\eta^2 < .01$ as a small effect size (Cohen, 1988). The strength of association measured how much association existed between the dependent learning-style variables and the independent variable. Therefore, placement within each independent-variable group was indicative of how much adolescents' learning-style preferences were associated with that variable. Thus, *full* strength-of-association generalizations of those learning-style characteristics with large effect sizes could be concluded according to a specific grouping classification. Generalizations regarding medium effect sizes were *modest* and they were *minimal* for small effect sizes.

Results

Age. Utilizing the extended-Fisher application for multiple comparisons, as described by Levin, Serlin, & Seaman (1994), MANOVAs were conducted to determine the effect of the 3 levels of age on the 22 dependent learning-style elements, regardless of gender or academic achievement level. The results of this procedure illustrated significant differences among the three age groups of both the Brazilian and German samples.

The Brazilian results of this procedure illustrated significant differences among the three age groups, Wilks' $\lambda = .74$, $F(44, 1762) = 6.68$, $p < .001$.

Follow-up Level-Specific MANOVAs revealed significant differences among all three pairwise comparisons of age groups:

- (1) 13- vs. 15-year-olds, Wilks' $\lambda = .85$, $F(22, 632) = 5.17$, $p < .001$;
- (2) 13- vs. 17-year-olds, Wilks' $\lambda = .72$, $F(22, 656) = 11.36$, $p < .001$; and
- (3) 15- vs. 17-year-olds, Wilks' $\lambda = .87$, $F(22, 453) = 3.11$, $p < .001$.

Further, a Levene's test of homogeneity was conducted because assumptions of equal population variance were not made. Results revealed significant differences in variances, $\alpha = .05$, for eight elements (responsibility, alone vs. peers, with an authority-figure, tactual perceptual preference, afternoon, mobility, parent-

motivated, and teacher-motivated). Adjusted by means of a Bonferroni correction, Tamahane's T2 post-hoc comparisons were performed to evaluate differences among the dependent learning-style variables on the three age groups. Results revealed significant F values for 9 of the 22 elements (light, motivation, structure, alone, tactual perceptual strength, intake, evening versus morning, parent-motivated, and teacher-motivated); each pairwise comparison was tested at the .002 level (.05 divided by 22). In addition, 99.8% confidence intervals were calculated, with significance indicated by non-overlapping intervals. The strength of association between age and the nine learning-style variables, as assessed by η^2 , ranged within the medium scope (.01 < η^2 < .24).

The German results of this procedure illustrated significant differences among the three age groups, Wilks' $\lambda = .71$, $F(44, 1690) = 7.16$, $p < .001$.

Follow-up level-specific MANOVA revealed significant differences among all three pairwise comparisons of age groups:

- (1) 13- vs. 15-year-olds, Wilks' $\lambda = .86$, $F(22, 675) = 4.83$, $p < .001$;
- (2) 13- vs. 17-year-olds, Wilks' $\lambda = .62$, $F(22, 493) = 13.56$, $p < .001$; and
- (3) 15- vs. 17-year-olds, Wilks' $\lambda = .80$, $F(22, 501) = 5.53$, $p < .001$.

A Levene's test of homogeneity was conducted, which revealed significant differences in variances, $\alpha = .05$, for 6 elements (light, design, authority-figure, tactual and kinesthetic perceptual preferences, and mobility). Tamahane's T2 post-hoc comparisons were conducted to evaluate differences among the dependent learning-style variables on the three age levels, revealing significant F values for 9 of the 22 elements (light, temperature, persistence, authority-figure present, tactual perceptual strength, intake, afternoon, parent-motivated, and teacher-motivated).

The strength of association between age and the learning-style variables, as assessed by η^2 ranged from small to medium effect sizes. The learning-style elements of temperature, persistence, tactual perceptual preference, and afternoon had small effect sizes ($\eta^2 < .01$), whereas the elements of light, authority-figure, parent-motivated, and teacher-motivated had medium effect sizes (.01 < η^2 < .09). Because of the large amount of statistical analysis, only significant means, standard deviations, 99.8% confidence intervals, F -values, and effect sizes were reported in Table 1.

Overall, both Brazilian and German 13-year-olds:

- (1) were more tactual and parent-motivated than 17-year-olds.

Overall, both Brazilian and German 17-year-olds:

- (1) needed more light than 13- and 15-year-olds;

In general, Brazilian 13-year-olds:

- (1) were more self- and teacher-motivated than the two older groups;
- (2) preferred learning in the morning more than 15- and 17-year-olds;
- (3) preferred learning with structure more than 17-year-olds; and
- (4) were more peer-oriented than 17-year-olds.

In general, Brazilian 15-year-olds:

- (1) preferred learning with peers more than 17-year-olds; and
- (2) required more intake while learning than 13-year-olds.

In general, German 13-year-olds:

- (1) were more persistent than 17-year-olds;
- (2) were more authority-oriented than 15- and 17-year-olds;
- (3) preferred to learn more in the afternoon than 17-year-olds; and
- (4) were more teacher-motivated than 17-year-olds.

In general, German 15-year-olds:

- (1) required more warmth than 13-year-olds; and
- (2) were more teacher-motivated than 17-year-olds.

A multivariate effect was revealed for six elements when analyzed by age and country-of-origin. The six elements of temperature, structure, alone vs. peers, authority, time of day, and preference for learning in the afternoon were found to have significant interaction effects when Brazilian participants were compared to the German sample at $p < .0001$. All variables had low to the lower end of moderate effect sizes (η^2 ranged from .007 to .014).

Gender. A series of independent-samples t -tests were conducted to assess any gender significant differences of learning-style preferences students would have regardless of age and academic achievement. The t -tests for equality of means revealed significant differences for both the Brazilian and German samples. Utilizing a Bonferroni adjustment to amend the level of significance ($\alpha = .002$) in this same sample, the t -tests for equality of means revealed significant differences for one learning-style element (persistence) at a $p < .0001$ level. In the Brazilian sample, a Levene's test detected unequal variance for seven learning-style elements—light, design, motivation, persistence, learning in several ways, tactual perceptual modality, and teacher motivation—as having significant values ($\alpha = .05$). Utilizing a Bonferroni adjustment to amend the level of significance ($\alpha = .002$), the t -tests for equality of means revealed significant differences for 2 of the 22 learning-style elements—responsibility and learning in several ways—at the $p < .001$ level. In this and other similar cases, t -tests with Satterwaithe adjusted degrees of freedom were performed. The German sample revealed significant differences for four learning style elements (motivation, persistence, intake, and afternoon) having significant values. With the same Bonferroni adjustment, the t -tests for equality of means revealed significant differences for 5 of the 22 learning-style elements (light, motivation, responsibility, learning in several ways, and intake) at the $p < .002$, $p < .001$, and $p < .0001$ levels. Refer to Table 2 for means, standard deviations, degrees of freedom, significant t -ratios, and effect sizes.

The overall findings for gender differences among learning-style preferences revealed that both Brazilian and German *female* students tended to exhibit more characteristics of responsibility/conformity and a stronger preference for learning in various sociological environments than *males*. Specific to the German sample, *female* students tended to be more (a) in need of light, (b) self-motivated, and (c) apt to need intake while learning than *male* students. The effect size of the relationship between gender and the learning-style elements, as measured by η^2 , was small ($\eta^2 > .01$) for light and intake, and medium in scope ($.01 < \eta^2 < .09$) for motivation, responsibility, and learning in several ways.

Table 1
Brazilian and German Adolescents' Learning-Style Preferences by Age: Means, Standard Deviations, Confidence Intervals, Significant F-values, and Effect Sizes

Age in years	13	15	17	99.8% Confidence Interval for Mean			F	Effect Size
	(n=429 ^a) (n=344 ^b)	(n=226 ^a) (n=354 ^b)	(n=250 ^a) (n=171 ^b)	Lower	Upper			
Element	M (SD)	M (SD)	M (SD)	Bounds		(df=1773)	? ²	
Light ^a	52.79 (9.53)	54.59 (9.34)	56.57 (9.33)	51.38 52.65	54.20 56.54	(13) (15)	12.87	.028
	Light ^b	48.35 (10.61)	50.60 (10.00)	53.79 (9.23)	54.72 46.65	58.42 50.02		
Temperature ^b		50.12 (10.37)	52.68 (10.56)	53.67 (10.64)	48.97 51.40	52.30 56.18	(15) (17)	9.10
	Persistence ^b	50.17 (10.87)	49.21 (9.89)	45.83 (10.77)	48.28 48.42	51.78 51.93	(13) (13)	
Motivation ^a		57.84 (7.32)	54.94 (7.14)	54.96 (7.81)	47.45 43.32	50.91 48.30	(15) (17)	17.10
	Structure ^a	53.55 (12.17)	51.20 (12.22)	48.20 (12.27)	56.73 53.51	58.95 56.42	(13) (17)	
Alone vs. Peers ^a		48.33 (11.06)	48.92 (10.35)	44.56 (8.83)	51.72 48.69	55.37 53.72	(13) (15)	15.23
	Authority Figure ^b	47.03 (11.08)	42.65 (9.92)	41.46 (9.00)	45.80 46.79	50.59 49.87	(17) (13)	
Tactual ^a		53.03 (9.83)	51.35 (9.93)	48.60 (11.41)	46.80 42.54	51.05 46.58	(15) (17)	23.84
	Tactual ^b	50.50 (10.79)	48.79 (11.32)	46.04 (12.74)	39.04 43.89	43.89 43.89	(17) (17)	
Intake ^a		43.48 (10.89)	47.00 (10.55)	45.97 (11.25)	51.49 49.23	54.57 53.48	(13) (15)	14.59
	Intake ^b	50.50 (10.79)	48.79 (11.32)	46.04 (12.74)	46.57 48.60	50.62 52.41	(17) (13)	
Time of Day ^a		43.48 (10.89)	47.00 (10.55)	45.97 (11.25)	46.88 43.32	50.65 48.74	(15) (17)	8.81
	Afternoon ^b	45.39 (10.68)	47.75 (10.66)	50.03 (10.23)	41.85 44.75	45.11 49.25	(13) (15)	
Time of Day ^a		60.11 (11.50)	56.70 (10.58)	55.19 (11.35)	43.83 43.68	48.11 47.21	(17) (13)	11.22
	Afternoon ^b	55.83 (10.06)	55.12 (10.57)	51.98 (10.61)	47.52 52.54	52.54 57.39	(17) (17)	
Afternoon ^b		55.83 (10.06)	55.12 (10.57)	51.98 (10.61)	58.43 54.38	61.79 59.02	(13) (15)	16.85
	Afternoon ^b	55.83 (10.06)	55.12 (10.57)	51.98 (10.61)	52.99 54.06	57.39 57.53	(17) (13)	
Afternoon ^b		55.83 (10.06)	55.12 (10.57)	51.98 (10.61)	53.41 49.49	56.85 54.43	(15) (17)	8.10

Table 1

Brazilian and German Adolescents' Learning-Style Preferences by Age: Means, Standard Deviations, Confidence Intervals, Significant F-Values, and Effect Sizes (cont.)

Parent-Motivated ^a	56.41 (6.96)	55.29 (7.60)	53.20 (9.12)	55.24 53.69 51.68	57.57 56.89 54.72	(13) (15) (17)	13.46	.029
Parent-Motivated ^b	52.06 (8.36)	50.78 (9.13)	47.67 (9.45)	50.52 49.15 45.34	53.59 52.19 49.70	(13) (15) (17)	13.90	.031
Teacher-Motivated ^a	56.12 (8.27)	51.79 (9.96)	50.13 (10.41)	54.73 49.87 48.30	57.52 53.72 51.96	(13) (15) (17)	36.98	.076
Teacher-Motivated ^b	43.31 (9.91)	41.89 (9.77)	38.36 (9.77)	41.63 40.18 36.00	44.94 43.45 40.71	(13) (15) (17)	14.15	.032

Note: a indicates Brazilian
b indicates German

Table 2

Brazilian and German Adolescents' Learning-Style Preferences by Gender: Means, Standard Deviations, Degrees of Freedom, Significant *t* Ratios, and Effect Sizes

Element	Male	Female	<i>df</i>	<i>t</i> -ratio	Effect Size
	<i>M</i> <i>SD</i>	<i>M</i> <i>SD</i>			η^2
Light ^{a2}	49.13 10.06	51.33 10.36	867	-3.15*	.011
Motivation ^{b2}	45.75 9.59	49.16 8.41	786	-5.60***	.036
Responsibility ^{a1}	55.57 10.57	58.10 9.86	903	-3.68*	.015
Responsibility ^{a2}	51.99 10.62	55.79 10.21	867	-5.40***	.033
Learn Several Ways ^{b1}	46.26 11.28	48.76 10.20	714	-3.39*	.013
Learn Several Ways ^{a2}	43.33 11.40	46.78 10.54	867	-4.41***	.022
Intake ^{b2}	46.79 11.33	47.65 10.17	794	-1.17**	.002

Note.

* $p < .002$, ** $p < .001$, *** $p < .0001$.

1. indicates no significant difference in variance.

2. indicates significant difference in variance.

a. indicates Brazilian sample male ($n=360$) female ($n=545$).

b. indicates German sample male ($n=394$) female ($n=475$).

Achievement. An omnibus MANOVA was conducted with the Brazilian sample to determine the effect of the 3 levels of achievement on the 22 dependent learning-style elements, regardless of age or gender. The results of this procedure evidenced significant differences among the three achievement groups, Wilks' $\eta^2 = .92$, $F(44, 1762) = 1.82$, $p < .001$.

Follow-up level-specific MANOVAs revealed significant differences among all three pairwise combinations of achievement groups:

- (1) gifted- vs. low-achievers, Wilks' $\eta^2 = .85$, $F(22, 272) = 2.13$, $p < .002$;
- (2) gifted- vs. high/average-achievers, Wilks' $\eta^2 = .96$, $F(22, 635) = 1.34$, $p < .002$; and
- (3) high/average- vs. low-achievers, Wilks' $\eta^2 = .95$, $F(22, 834) = 2.12$, $p < .002$.

Furthermore, a Levene's test of homogeneity was conducted because assumptions of equal population variance were not made. Results revealed significance $\alpha = .05$, for one single element, that of *responsibility*. Adjusted via a Bonferroni correction, Tamahane's T2 post-hoc comparisons were conducted to evaluate differences among the dependent learning-style variables on the three achievement levels. Those revealed significant F values for 2 of the 22 elements—persistence and responsibility—with each pairwise comparison tested at the .002 level (.05 divided by 22).

An omnibus MANOVA revealed significant differences among the three achievement groups with the German sample, Wilks' $\eta^2 = 0.81$, $F(44, 1690) = 4.15$, $p < .001$. Follow-up level-specific MANOVA revealed significant differences among all three pairwise combinations of achievement groups:

- (1) gifted- vs. low achievers, Wilks' $\eta^2 = .78$, $F(22, 404) = 5.16$, $p < .001$;
- (2) gifted- vs. high/average achievers, Wilks' $\eta^2 = 0.89$, $F(22, 721) = 4.06$, $p < .001$; and
- (3) high/average- vs. low achievers, Wilks' $\eta^2 = .89$, $F(22, 544) = 3.06$, $p < .001$.

A Levene's test of homogeneity was conducted that revealed significant results, $\alpha = .05$, for four elements (persistence, structure, tactual and kinesthetic perceptual preferences). Bonferroni corrected, Tamahane's T2 post-hoc comparisons were conducted and revealed significant F values for 4 of the 22 elements (authority-figure present, mobility, parent-motivated, and teacher-motivated).

Although Brazilian academically gifted students were more persistent and responsible/conforming than the two other groups of learners, these same-ability Germans were less parent- and teacher-motivated than other learners. Brazilian high/average students were more persistent and responsible/conforming than low achievers, whereas these same German adolescents needed more mobility than gifted learners. In general, German low achievers were more authority- and teacher-oriented than high and average achievers. Significant means, standard deviations, 99.8% confidence intervals, F -values, and effect sizes were reported in Table 3. Only persistence and teacher-motivation evidenced any significant interaction effects between country-of-origin and academic achievement level at $p < .001$, both with small effect sizes ($\eta^2 = .007$ to $.013$, respectively).

Table 3
Adolescents' Learning-Style Preferences by Academic Achievement Level: Means, Standard Deviations, Confidence Intervals, Degrees of Freedom, Significant F-values, and Effect Sizes

Element	Gifted (G)	High/ Average Achievers (H/A)	Low Achievers (L)	99.8% Confidence Interval		F (df=2,902) (df=2,866)	Effect Size ? ²
	Brazil (n=48)	(n=610)	(n=247)				
	Germany (n=302)	(n=442)	(n=125)				
	M (SD)	M (SD)	M (SD)	Lower Bounds	Upper Bounds		
Persistence ^a	53.56 (9.93)	48.41 (9.43)	45.56 (10.42)	49.21 47.19 43.64	57.92 49.64 47.48	(G) (H/A) (L)	16.11 .034
Responsibility ^a	60.94 (9.47)	57.74 (9.74)	54.74 (11.06)	56.42 56.48 52.75	65.46 59.01 56.73	(G) (H/A) (L)	11.43 .025
Authority Figure ^b	44.02 (9.96)	43.35 (10.50)	47.27 (11.16)	53.46 54.42 55.57	56.72 57.11 60.63	(G) (H/A) (L)	6.93 .016
Mobility ^b	42.55 (11.65)	45.87 (11.60)	44.39 (11.17)	42.17 41.82 44.38	45.88 44.89 50.16	(G) (H/A) (L)	7.39 .017
Parent Motivated ^b	48.81 (9.22)	51.53 (8.95)	52.14 (8.15)	40.49 44.17 41.19	44.61 47.57 47.60	(G) (H/A) (L)	10.28 .023
Teacher Motivated ^b	38.93 (9.23)	42.17 (9.58)	47.12 (10.72)	47.03 50.11 49.59	50.32 52.84 54.70	(G) (H/A) (L)	32.77 .069

Note:

^a Variables associated with the Brazil sample

^b Variables associated with the German sample

Country comparisons. A series of independent-samples *t*-tests were conducted to assess any significant differences of learning-style preferences students would have dependant upon of country-of-origin. The *t*-tests for equality of means revealed significant differences between the Brazilian and German samples. Detected via a Levene's test, one variable with unequal variances (persistence) was detected; thus, a *t*-test with Satterwaithe adjusted degrees of freedom was performed. Utilizing a Bonferroni adjustment to amend the level of significance ($\alpha = .002$), the *t*-tests for equality of means revealed significant differences for 19 of the 22 learning-style variables (sound, light, temperature, design, motivation, persistence, responsibility, structure, authority, learn several ways, auditory, tactual, and kinesthetic perceptual preferences, intake, time of day, afternoon, mobility, and parent- and teacher-motivation) at a $p < .0001$ level. Refer to Table 4 for means, standard deviations, degrees of freedom, significant *t*-ratios,

and effect sizes. Figure 1 portrays a graphic representation of these findings. Note the large effect size for temperature and parent motivation, with strong moderate effect sizes for the remaining variables.

In general, Brazilian students compared to German students:

- (1) preferred less sound and warmth, but more light;
- (2) preferred more formal design, but less structure;
- (3) were more conforming/responsible, self-, authority-, parent-, and teacher-motivated, but were less persistent;
- (4) preferred learning in a variety of social settings and earlier in the day;
- (5) were more auditory, tactual, and kinesthetic; and
- (6) needed more intake and mobility while learning.

Table 4

*Adolescents' Learning-Style Preferences by Country-of-Origin: Means, Standard Deviations, Degrees of Freedom, Significant *t* Ratios, and Effect Sizes*

Element	Brazil (<i>n</i> =905)		Germany (<i>n</i> =869)		<i>df</i>	<i>t</i> -ratio	Effect Size η^2
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Sound ^a	43.03	10.69	48.88	9.282	1772	-12.280	.078
Light ^a	54.29	9.55	50.34	10.282	1772	8.379	.038
Temperature ^a	31.98	8.09	51.86	10.603	1772	-44.490	.528
Design ^a	57.51	12.36	51.32	9.754	1772	11.681	.071
Motivation ^a	56.32	7.55	47.61	9.137	1772	21.915	.213
Persistence ^b	47.91	9.90	48.91	10.609	1751	-2.062	.002
Responsibility ^a	57.09	10.22	54.07	10.566	1772	6.120	.021
Structure ^a	51.48	12.40	55.87	9.161	1772	-8.440	.039
Authority ^a	48.72	11.25	44.15	10.488	1772	8.848	.042
Learn Several Ways ^a	47.76	10.71	45.18	11.151	1772	4.983	.014
Auditory ^a	48.27	13.03	45.04	11.941	1772	5.428	.016
Tactual ^a	51.39	10.47	48.92	11.534	1751	4.723	.012
Kinesthetic ^a	54.99	10.36	44.89	10.823	1772	20.068	.185
Intake ^a	45.05	11.01	47.26	10.711	1772	-4.302	.010
Time of Day ^a	57.90	11.43	51.77	10.390	1772	11.800	.073
Mobility ^a	48.65	12.10	44.50	11.641	1772	-7.116	.028
Afternoon ^a	50.80	12.85	54.77	10.501	1772	7.355	.030
Parent Motivation ^a	55.24	7.87	50.60	9.330	1751	11.346	.068
Teacher Motivation ^a	53.39	9.70	41.72	10.081	1772	24.848	.258

Note.

$p < .0001$.

a. indicates no significant difference in variance.

b. indicates significant difference in variance.

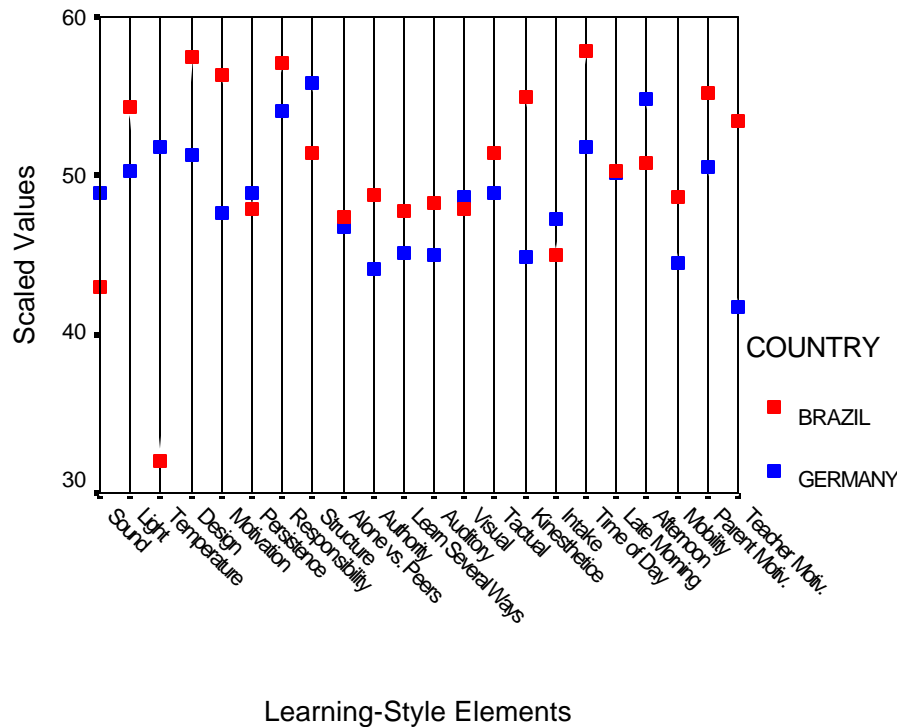


Figure 1. Line Chart of Group Means by Country

Multivariate Analysis of Countries by Age, Gender, and Academic Achievement

A multivariate analysis of variance (MANOVA) with 22 dependent learning-style variables and 4 between-subject factors (age, gender, academic achievement, and country) was conducted to evaluate the interaction effects among the four factors. The MANOVA was followed by simple main effects tests, a series of univariate ANOVAs, and post-hoc comparisons with a Bonferroni adjustment of the significance levels ($\alpha = .002$), as well as generated interaction profile plots. Confirming previous analyses, these findings revealed that significant differences in learning-style preferences varied among students by age, gender, academic achievement, and country (Honigfeld, 2001).

Overall interaction effects among the four factors of age, gender, academic achievement, and country on the linear composite of the 22 learning-style elements were explored. Four two-way interactions were statistically significant: age-by-country, gender-by-country, achievement-by-country, and achievement-by-age, each with a small to moderate effect sizes ($\eta^2 = .018$ to $.033$). A Bonferroni adjustment was made for each interaction ($\alpha = .002$). In addition, the practical interpretation (i.e., eta-square) of each significant learning-style variable was examined to determine how influential one component of the interaction was on the other component.

Discussion

Both trans-national and country-specific patterns emerged among the groups classified according to their academic achievement levels. Cultural, biological, and/or individual experiences could have shaped adolescents' learning-style characteristics (Restak, 1979; Dunn, Thies, & Honigsfeld, 2001). Variations between the groups were as numerous as those within the groups. Thorough examination of the individual learning-style profiles revealed that for each of the 22 learning-style variables, every possible combination of preferences (strong preference, preference, non-preference, non-preference, opposite preference, and strong opposite preference) existed within each of the 3 age- and academic achievement levels, as well as between the genders.

Brazilian adolescents' strong preferences for bright light, morning-learning, and cooler temperatures supported each other—morning hours usually being associated with bright illumination and less warmth. Another explanation for this sample's morning-learning preference might be attributed to Brazilian adolescents' full-time schedule in the afternoon, with academic extra-curricular activities, supplementary intellectual pursuits—foreign language instruction and tutoring—as well as some leisure events. Additionally, less-privileged youngsters utilized the afternoon and evening hours to perform duties for which they were remunerated.

Present findings that Brazilian adolescents tended to be more self-, authority-, parent-, and teacher-motivated than their German counterparts seemed to epitomize their resolute disposition to abide by whatever was necessary and expected of them so as to assure academic success. On the contrary, German adolescents' low levels of self-, peer-, authority-, parent- and teacher-motivation may be due to a new trend developing within German youth culture. With many students, good performance at school is not viewed as important as peer-acceptance. It has become, across all achievement levels, haute couture to perform poorly in studies, especially among the gifted. As young as fifth grade, youngsters are exulted by their peers because of their poor academic status, leading to decreased influence of adult-based motivation on behavior. In addition, students will opt to achieve poorly if they do not perceive relevance of subject content to their own experiences and situations--a decidedly global perspective (Dunn & Dunn, 1993). These youngsters are often gifted learners who no longer are interested in attending a university; therefore they may not be very self- or teacher- motivated to achieve well at school. It is possible that new economic prosperity within the country has manifested itself in the value of an extrinsic, rather than an intrinsic, reward. Differences in motivation toward parents and teachers may have been influenced by many factors, such as peer- and parental-support and the perceived connection between success at school and future employment. The impact of these aspects on academic achievement and vocational opportunities conceivably might have acted as the driving force behind students' motivation (Foraker, 1999; Milotich, 1999). Gifted achievers attending *Gymnasium* delayed career decisions until later in adolescence, although the majority of *Gymnasium* students planned to take the *Abitur* to qualify for study at a university or professional level school. By having a clear and focused future goal, low- and average-achievers may have been more motivated by those individuals

who assisted them in reaching those objectives, namely parents and teachers. In addition, both *Hauptschule* and *Realschule* teachers were permitted to include a grade for class participation, especially for students who were in academic jeopardy. Class participation was included as part of students' grades at the *Gymnasium*, but marks were more stringently calculated there than at the other schools.

Because parent- and teacher-motivation were more prevalent in the current sample's low-, average-, and high-achieving students, the academically gifted youngsters' profiles resulted in a smaller percentage of adult motivation, indicating these young adults' relative maturity and independence. Emerging as a new trend, students currently are being permitted to work as of 16 years-of-age. Because they may be employed, school and its emphasis on scholastic ability may have lost its appeal in light of potential monetary prosperity. Many gifted youngsters no longer place importance on pleasing their parents and teachers, since they view employment as an alternative route to embarking on a course of study at the university level.

German academically gifted students' levels of low parent- and teacher-motivation may have indicated their sense of self-enhanced learning. Educators should consider an individual, student-centered, or peer approach that capitalizes on these adolescents' characteristics. External rewards may not affect these learners' performance and should not be used as an incentive for academic achievement. Educators may consider utilizing German low-achievers' sense of parent- and teacher-motivation to form a professional rapport with these students to assist them to improve their academic performance.

This research contributed to the broad understanding of the literature of learning styles. Present findings should be of particular value to all involved with the educational process of our world's very diverse school populations. Moreover, because individuals' learning-style patterns affect their potential for achievement, as education is made more available to *all* human beings of different ages, gender, and achievement levels, knowledge of learning styles should be considered of paramount relevance—as evidenced in the results of this investigation. Personal success should encourage all youngsters to embrace learning as a lifelong pursuit.

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