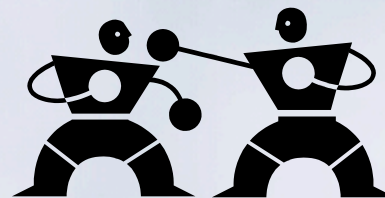
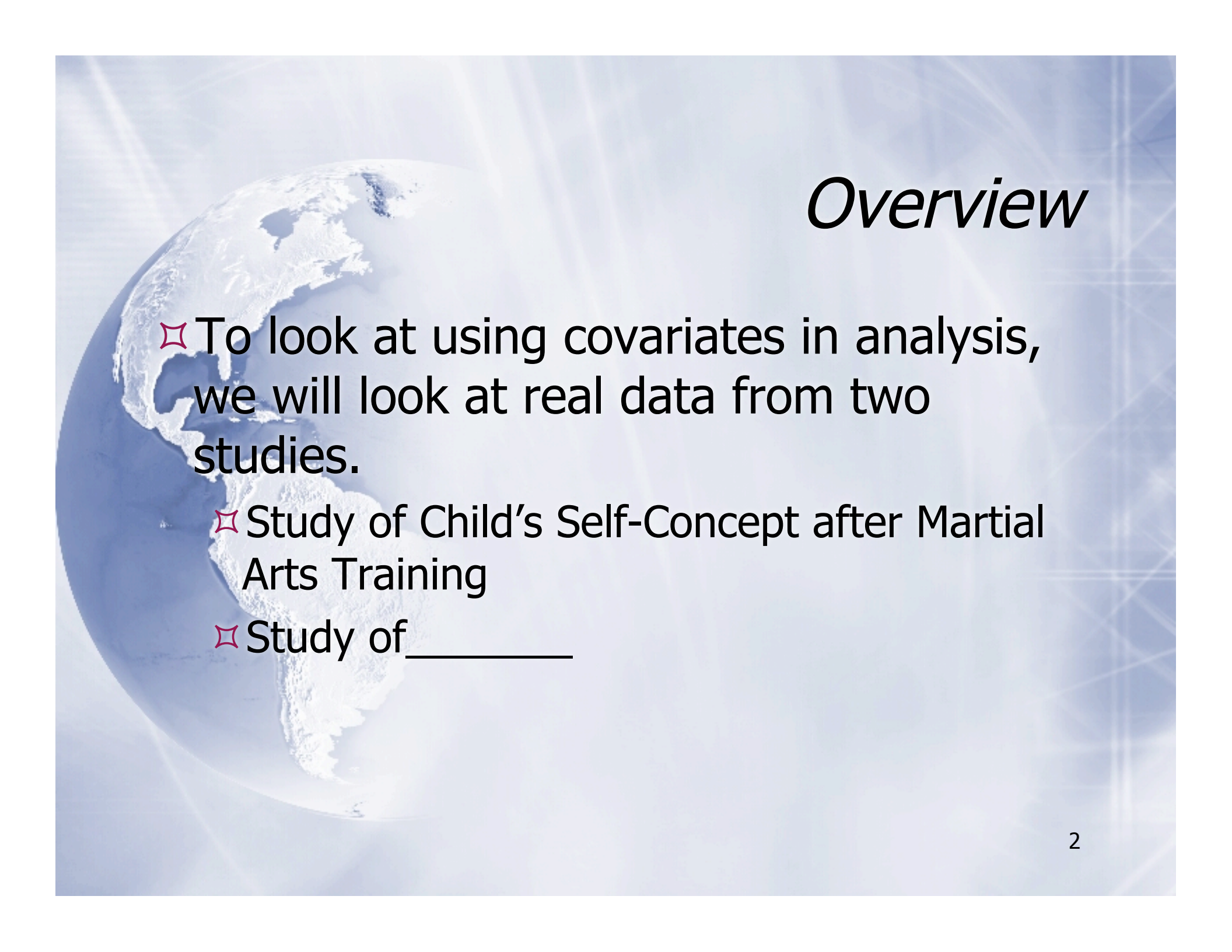


Studies With Covariates

*ANOVA vs. ANCOVA
and
MANOVA vs. MANCOVA*



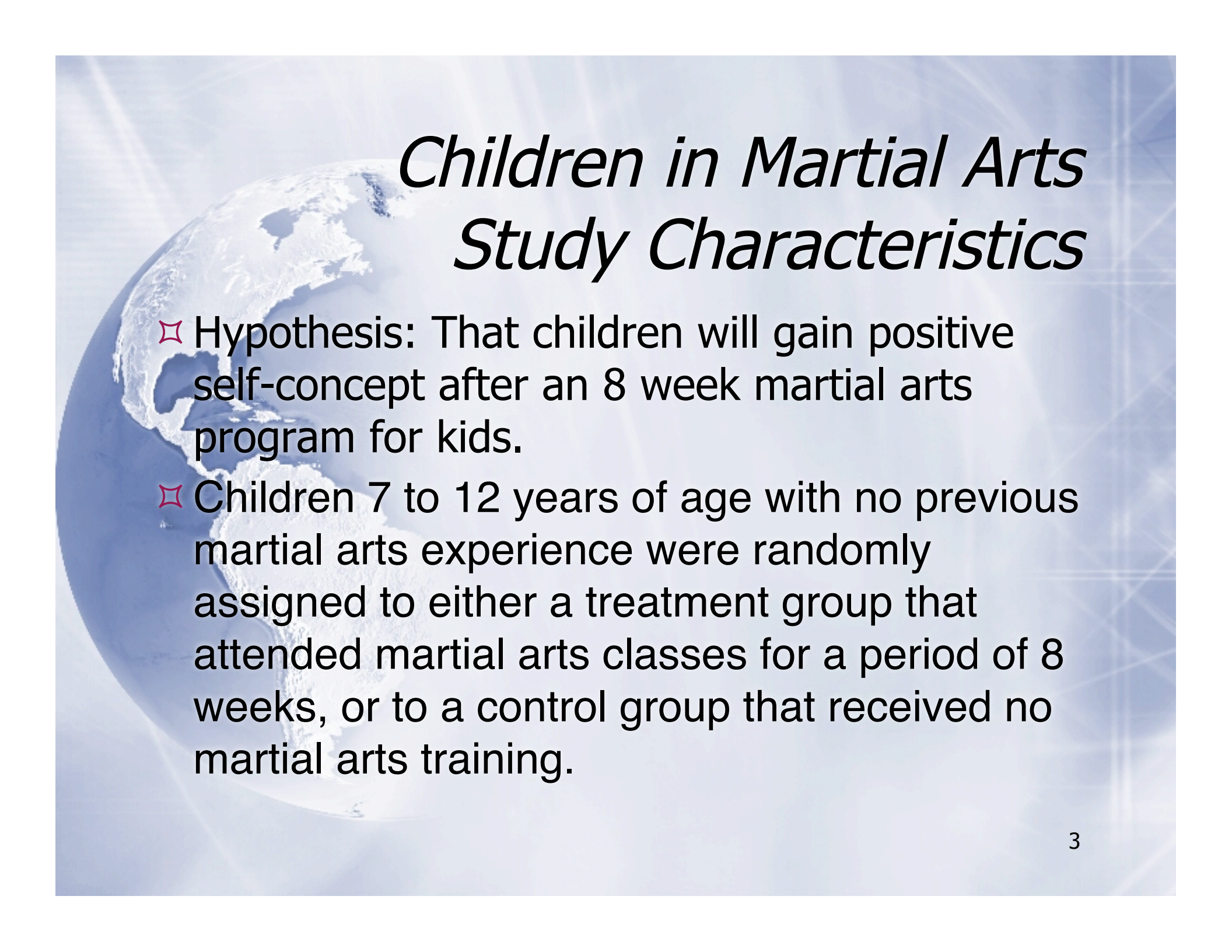


Overview

- ✧ To look at using covariates in analysis, we will look at real data from two studies.

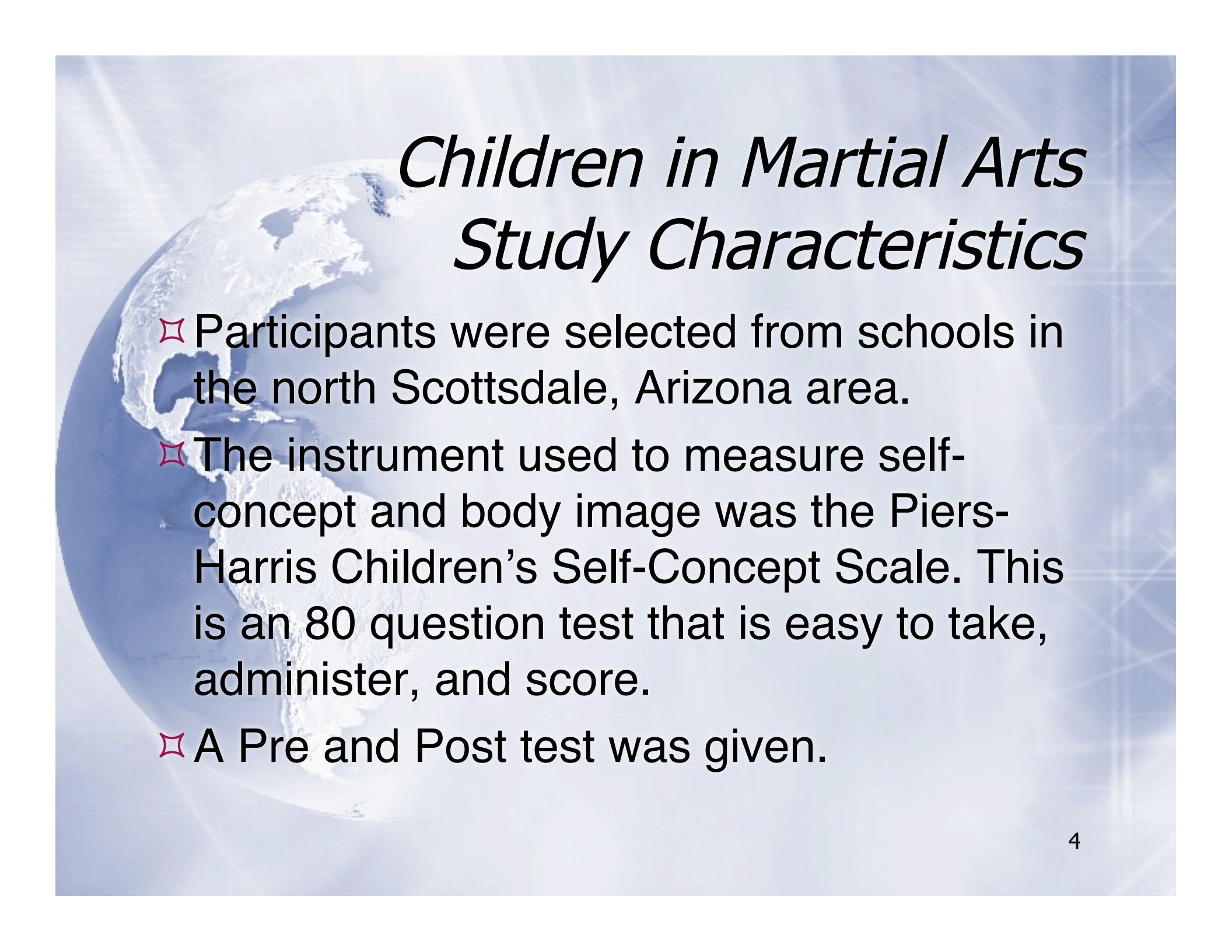
- ✧ Study of Child's Self-Concept after Martial Arts Training

- ✧ Study of _____



Children in Martial Arts Study Characteristics

- ✧ Hypothesis: That children will gain positive self-concept after an 8 week martial arts program for kids.
- ✧ Children 7 to 12 years of age with no previous martial arts experience were randomly assigned to either a treatment group that attended martial arts classes for a period of 8 weeks, or to a control group that received no martial arts training.



Children in Martial Arts Study Characteristics

- ✧ Participants were selected from schools in the north Scottsdale, Arizona area.
- ✧ The instrument used to measure self-concept and body image was the Piers-Harris Children's Self-Concept Scale. This is an 80 question test that is easy to take, administer, and score.
- ✧ A Pre and Post test was given.

Children in Martial Arts Study Characteristics

✧ Data

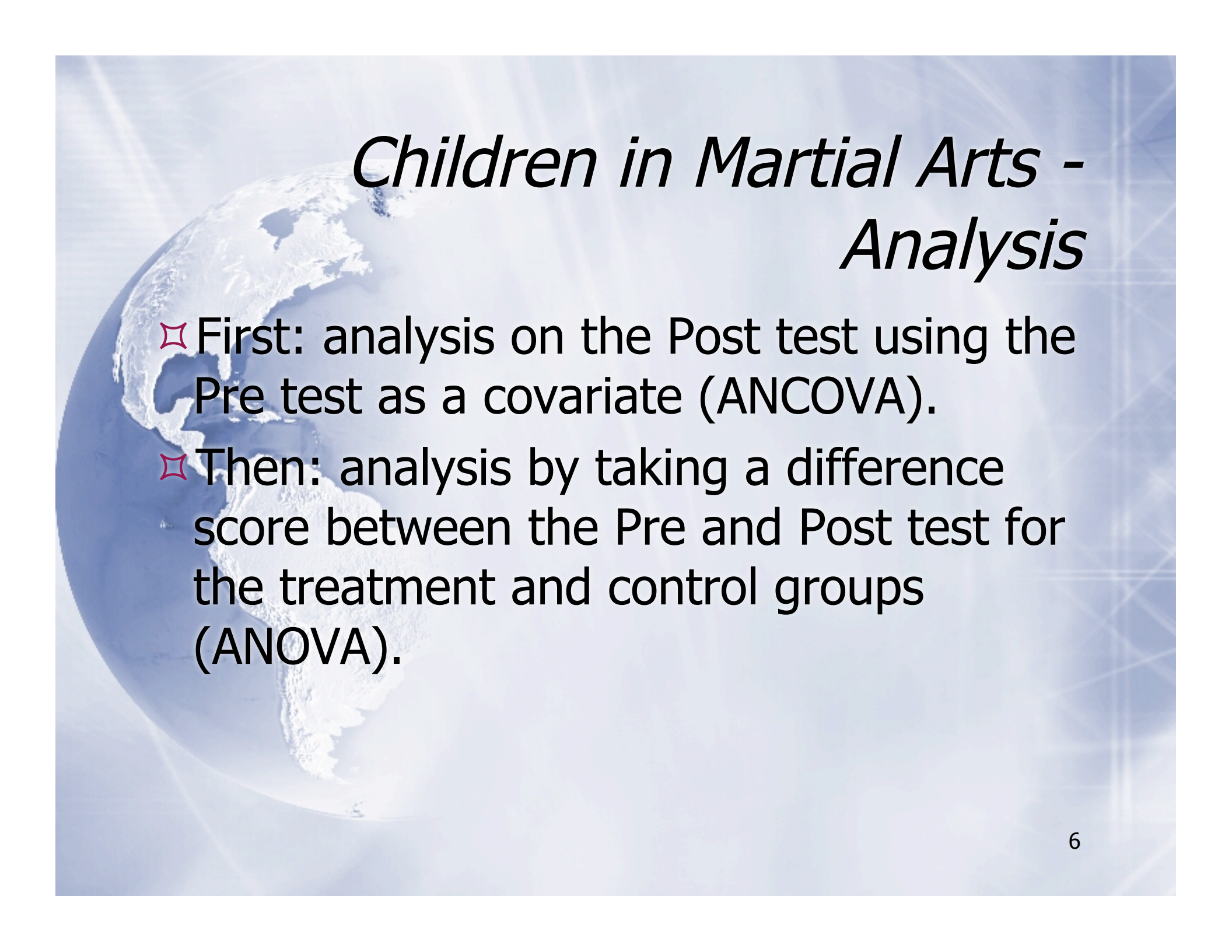
Group	PreTest	PostTest	Difference
1	73.00	68.00	-5.00
1	55.00	64.00	9.00
1	66.00	71.00	5.00
1	54.00	52.00	-2.00
1	65.00	64.00	-1.00
1	62.00	53.00	-9.00
1	67.00	72.00	5.00
1	73.00	68.00	-5.00
1	65.00	66.00	1.00
1	62.00	46.00	-16.00
1	68.00	74.00	6.00
1	76.00	78.00	2.00
2	78.00	79.00	1.00
2	76.00	77.00	1.00
2	58.00	60.00	2.00
2	76.00	79.00	3.00
2	67.00	73.00	6.00
2	77.00	77.00	.00
2	67.00	69.00	2.00
2	69.00	67.00	-2.00
2	71.00	75.00	4.00
2	47.00	56.00	9.00
2	63.00	75.00	12.00
2	72.00	70.00	-2.00
2	80.00	77.00	-3.00
2	75.00	78.00	3.00

Group 1

No Martial
Arts Training

Group 2

Martial Arts
Trained



Children in Martial Arts - Analysis

- ✧ First: analysis on the Post test using the Pre test as a covariate (ANCOVA).
- ✧ Then: analysis by taking a difference score between the Pre and Post test for the treatment and control groups (ANOVA).

Children in Martial Arts - ANCOVA

✧ The Pretest scores are not significantly different between groups

Descriptive Statistics

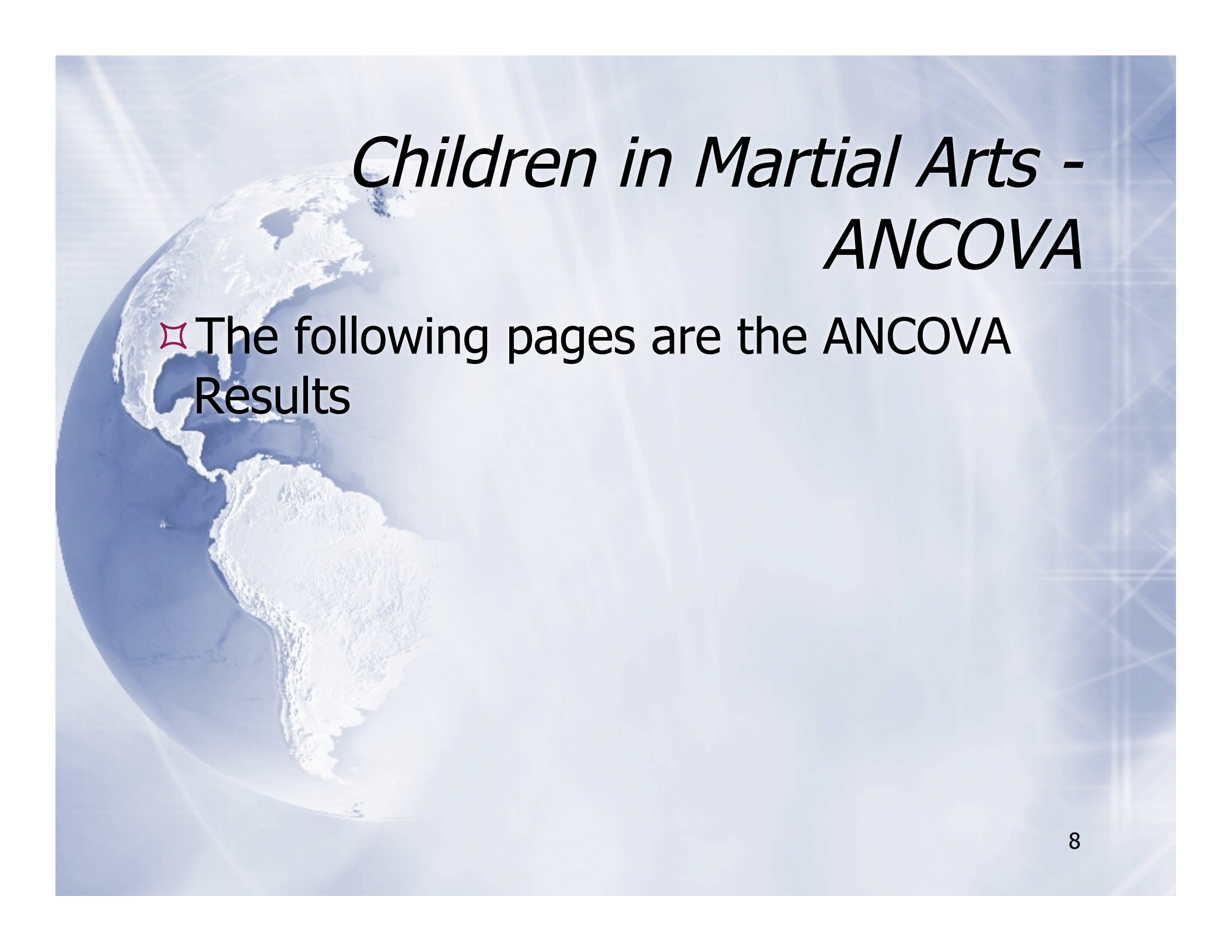
Dependent Variable: PRETEST

GROUP	Mean	Std. Deviation	N
1	65.5000	6.73525	12
2	69.7143	9.00793	14
Total	67.7692	8.16974	26

Estimates

Dependent Variable: PRETEST

GROUP	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	65.500	2.323	60.706	70.294
2	69.714	2.150	65.276	74.153



Children in Martial Arts - ANCOVA

✧ The following pages are the ANCOVA
Results

Univariate Analysis of Variance

Between-Subjects Factors

	N
GROUP 1	12
2	14

Levene's Test of Equality of Error Variances^a

Dependent Variable: POSTTEST

F	df1	df2	Sig.
6.066	1	24	.021

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept+PRETEST+GROUP

Tests of Between-Subjects Effects

Dependent Variable: POSTTEST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1350.543 ^a	2	675.272	21.629	.000	.653
Intercept	74.595	1	74.595	2.389	.136	.094
PRETEST	975.452	1	975.452	31.244	.000	.576
GROUP	110.225	1	110.225	3.531	.073	.133
Error	718.072	23	31.221			
Total	125028.000	26				
Corrected Total	2068.615	25				

a. R Squared = .653 (Adjusted R Squared = .623)

Parameter Estimates

Dependent Variable: POSTTEST

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Intercept	17.050	9.994	1.706	.101	-3.624	37.724	.112
PRETEST	.792	.142	5.590	.000	.499	1.086	.576
[GROUP=1]	-4.280	2.278	-1.879	.073	-8.992	.432	.133
[GROUP=2]	0 ^a	.	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Estimated Marginal Means

GROUP

Estimates

Dependent Variable: POSTTEST

GROUP	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	66.465 ^a	1.645	63.062	69.867
2	70.745 ^a	1.519	67.603	73.886

a. Evaluated at covariates appeared in the model: PRETEST = 67.7692.

Pairwise Comparisons

Dependent Variable: POSTTEST

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig. ^a	95% Confidence Interval for Difference ^a	
					Lower Bound	Upper Bound
1	2	-4.280	2.278	.073	-8.992	.432
2	1	4.280	2.278	.073	-.432	8.992

Based on estimated marginal means

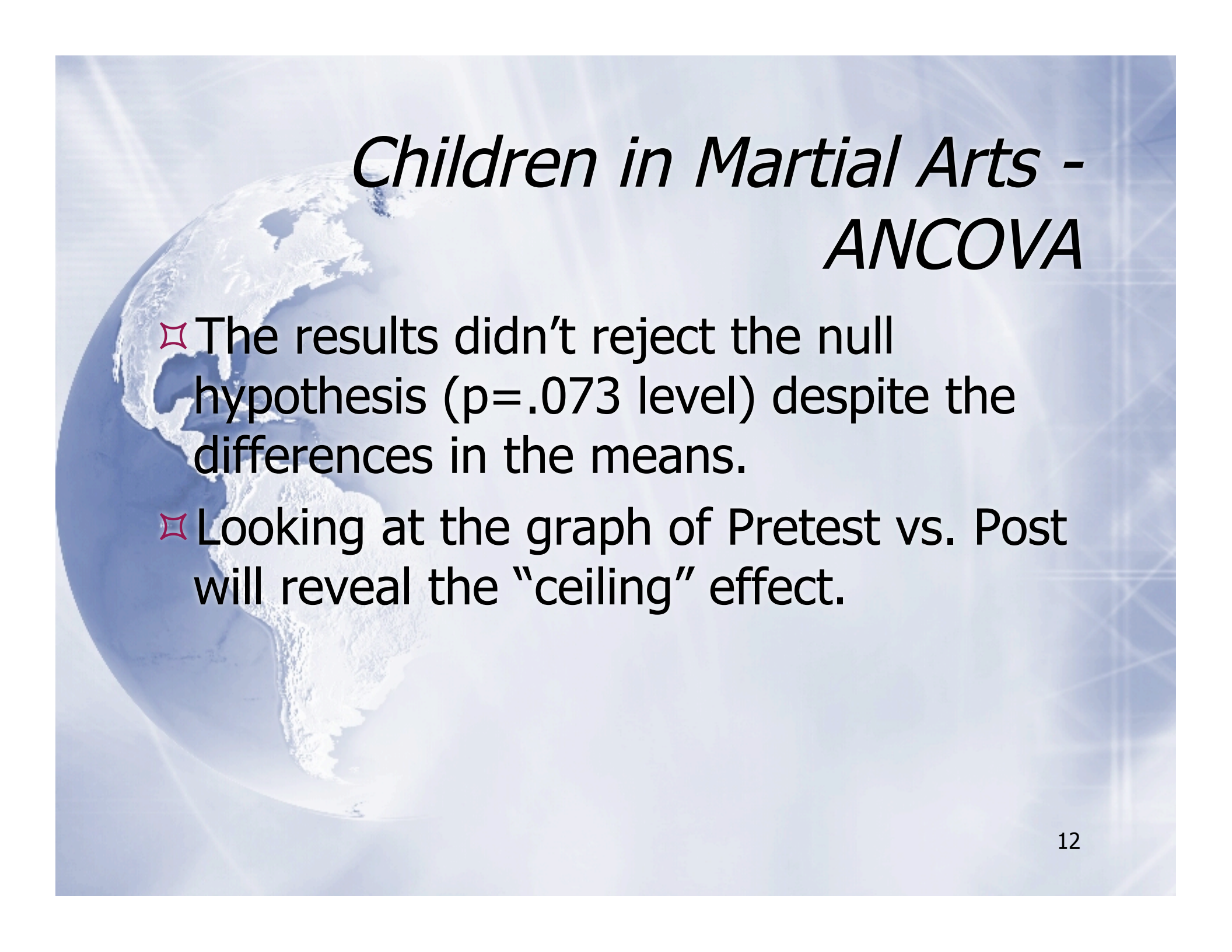
a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Univariate Tests

Dependent Variable: POSTTEST

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	110.225	1	110.225	3.531	.073	.133
Error	718.072	23	31.221			

The F tests the effect of GROUP. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

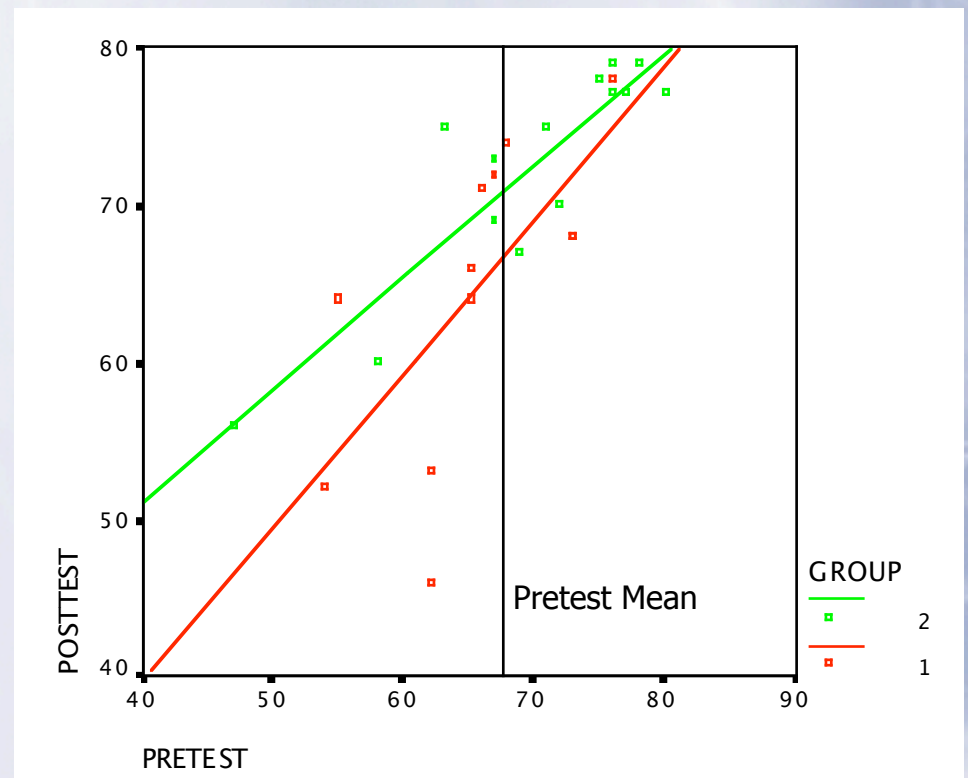


Children in Martial Arts - ANCOVA

- ✧ The results didn't reject the null hypothesis ($p=.073$ level) despite the differences in the means.
- ✧ Looking at the graph of Pretest vs. Post will reveal the "ceiling" effect.

Children in Martial Arts - ANCOVA

✧ As the scores approach the maximum (80), the differences between the scores are minimized.





Children in Martial Arts - ANOVA/Difference Scores

- ✧ Now to repeat the analysis with difference scores.

Univariate Analysis of Variance

Between-Subjects Factors

	N
GROUP 1	12
2	14

Levene's Test of Equality of Error Variances^a

Dependent Variable: Difference

F	df1	df2	Sig.
3.137	1	24	.089

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept+GROUP

Tests of Between-Subjects Effects

Dependent Variable: Difference

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	74.905 ^a	1	74.905	2.290	.143	.087
Intercept	19.520	1	19.520	.597	.447	.024
GROUP	74.905	1	74.905	2.290	.143	.087
Error	785.095	24	32.712			
Total	886.000	26				
Corrected Total	860.000	25				

a. R Squared = .087 (Adjusted R Squared = .049)

Parameter Estimates

Dependent Variable: Difference

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Intercept	2.571	1.529	1.682	.105	-.583	5.726	.105
[GROUP=1]	-3.405	2.250	-1.513	.143	-8.049	1.239	.087
[GROUP=2]	0 ^a	.	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Estimated Marginal Means

GROUP

Estimates

Dependent Variable: Difference

GROUP	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	-.833	1.651	-4.241	2.574
2	2.571	1.529	-.583	5.726

Pairwise Comparisons

Dependent Variable: Difference

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig. ^a	95% Confidence Interval for Difference ^a	
					Lower Bound	Upper Bound
1	2	-3.405	2.250	.143	-8.049	1.239
2	1	3.405	2.250	.143	-1.239	8.049

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Univariate Tests

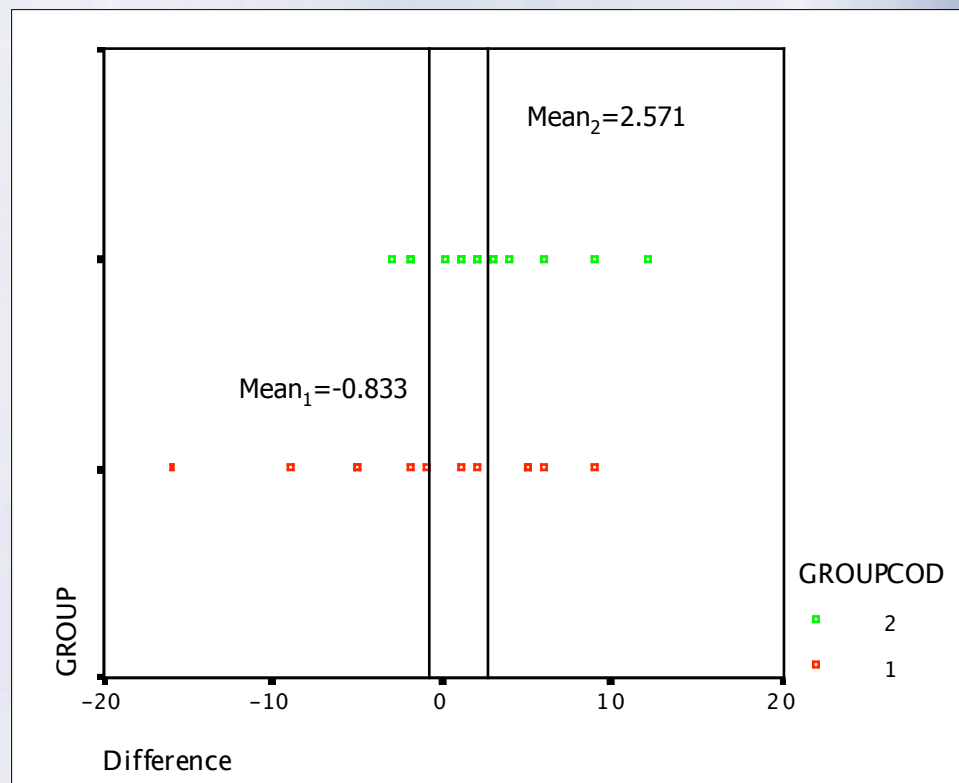
Dependent Variable: Difference

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	74.905	1	74.905	2.290	.143	.087
Error	785.095	24	32.712			

The F tests the effect of GROUP. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Children in Martial Arts - ANOVA/Difference Scores

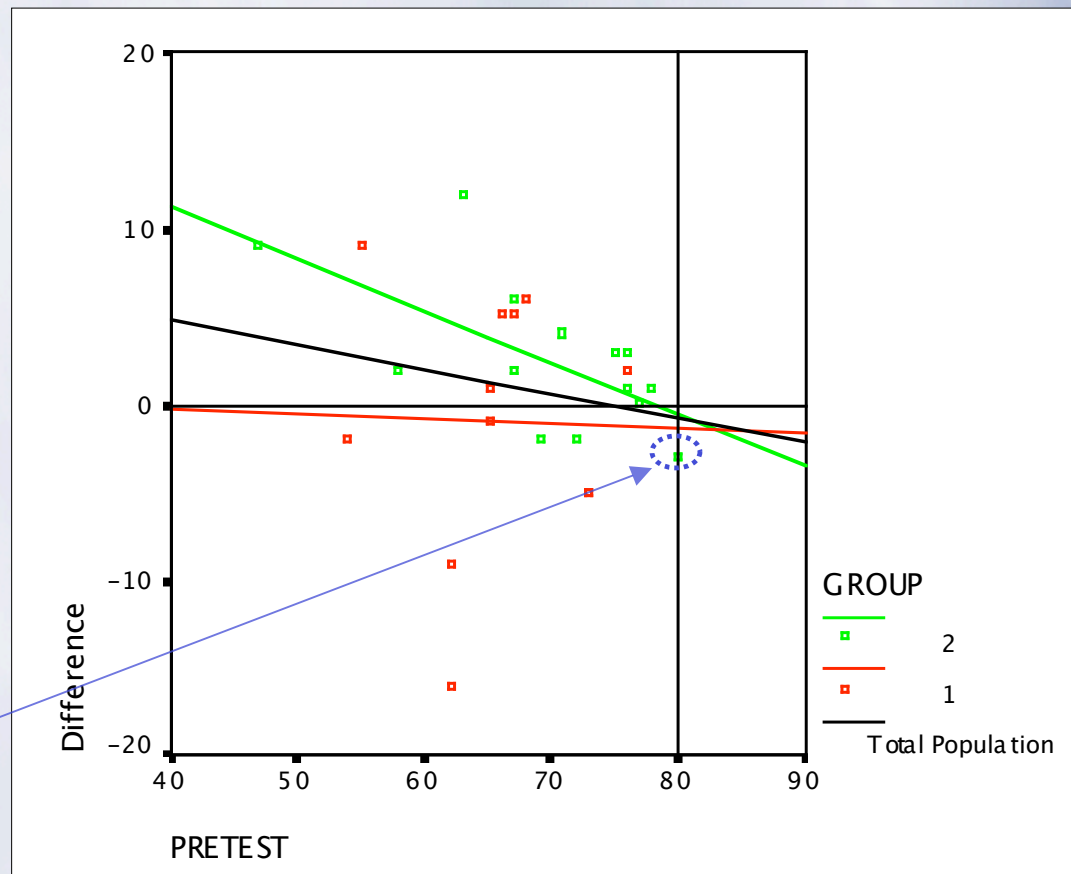
✧ The difference scores

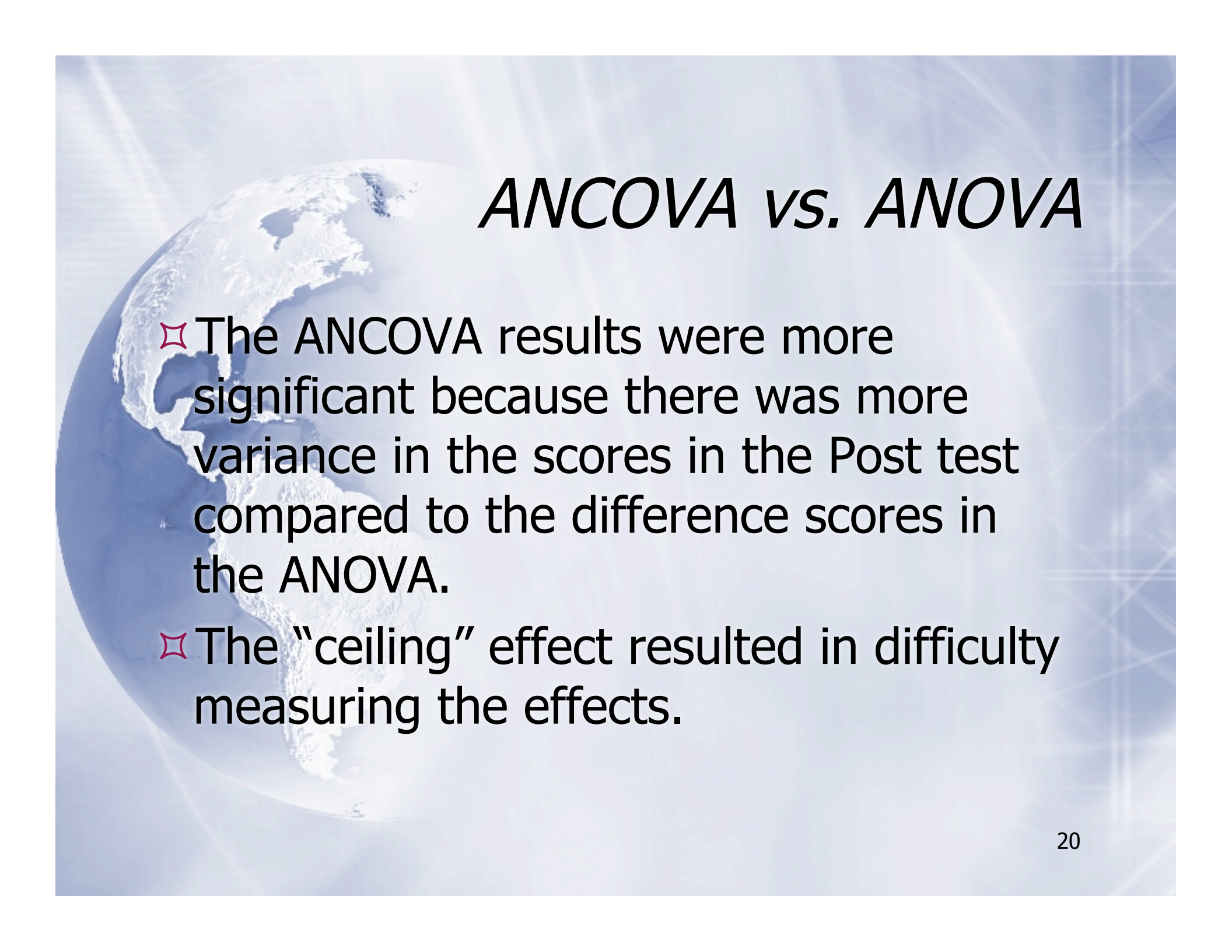


Children in Martial Arts - ANOVA/Difference Scores

✧ This Graph also illustrates “Ceiling Effect” at maximum Pre scores.

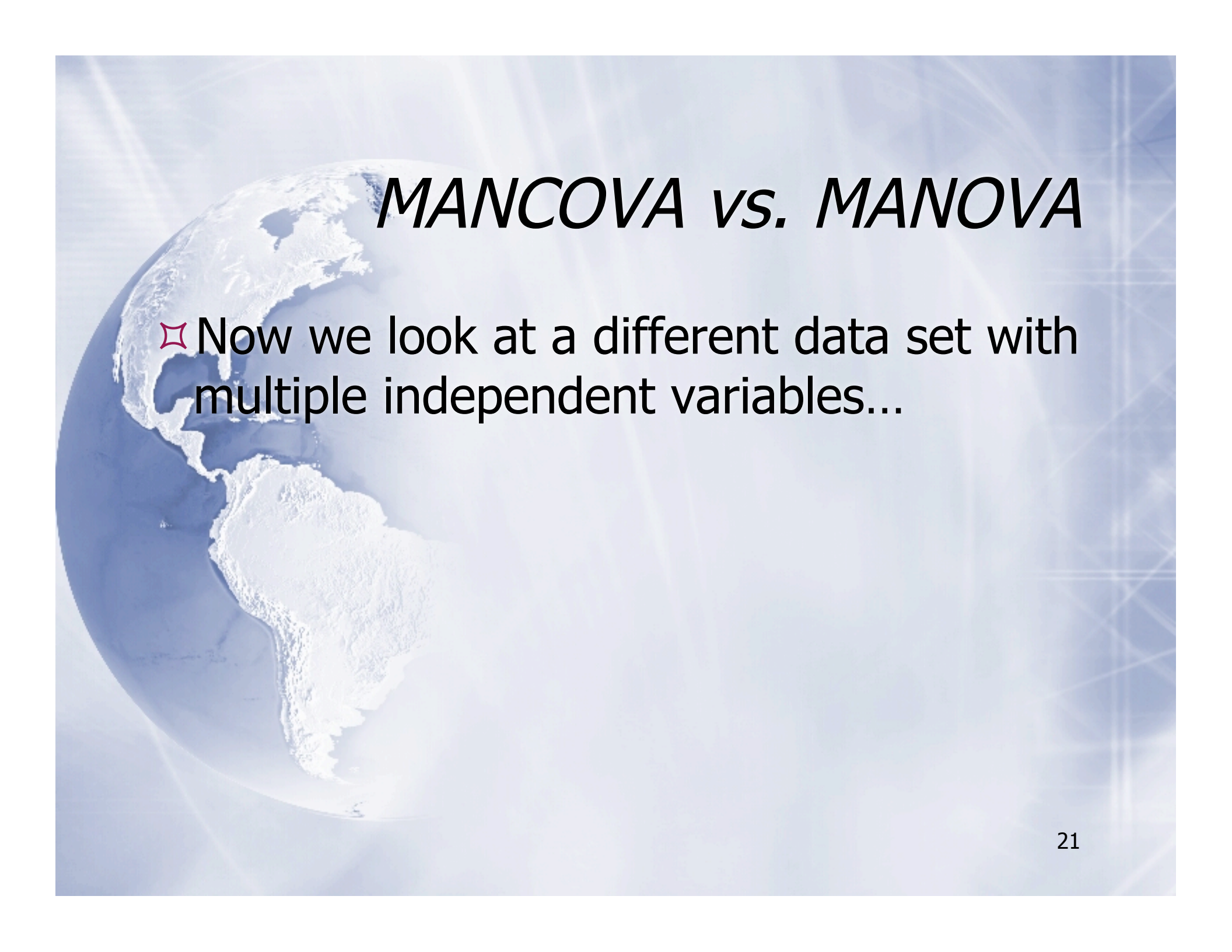
✧ No where to go but DOWN





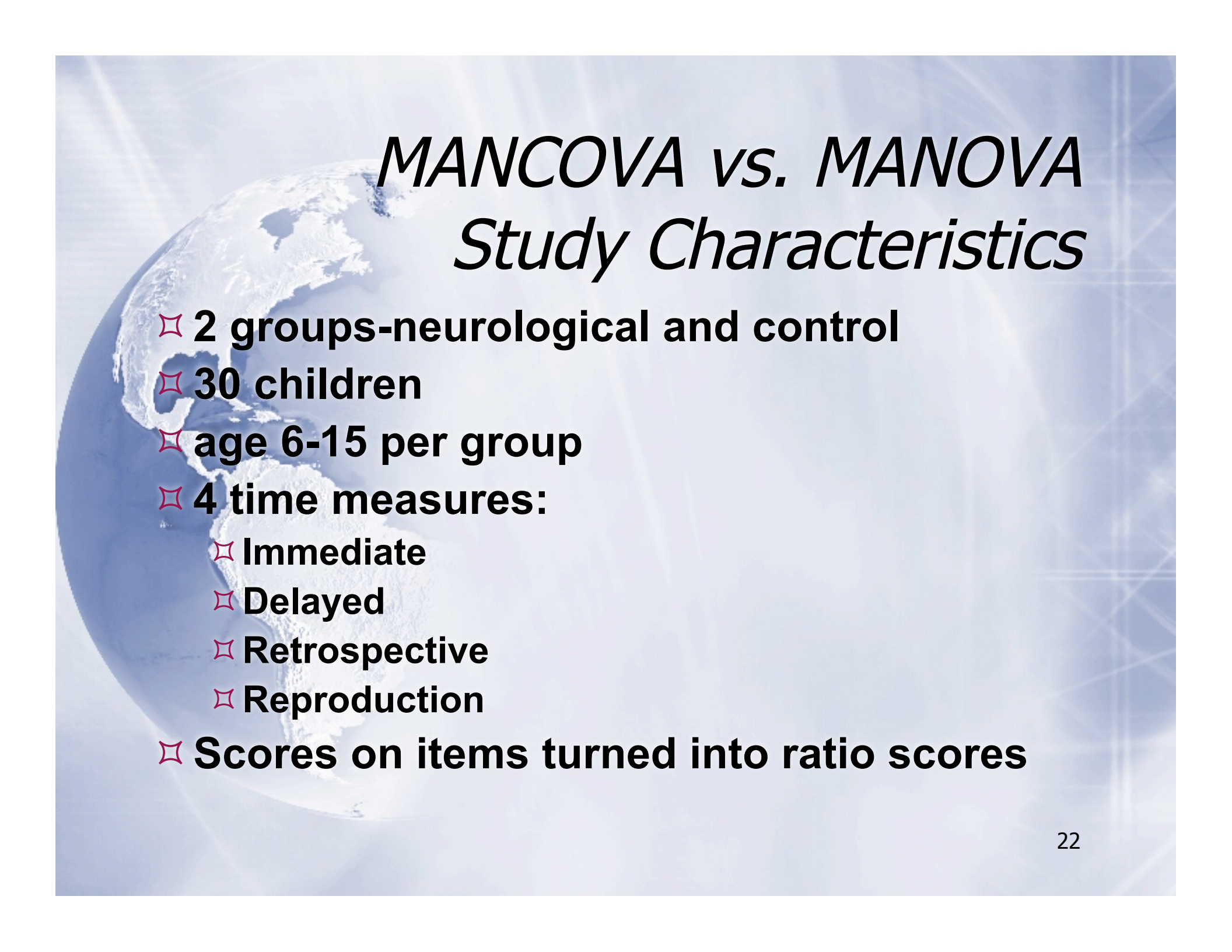
ANCOVA vs. ANOVA

- ✧ The ANCOVA results were more significant because there was more variance in the scores in the Post test compared to the difference scores in the ANOVA.
- ✧ The “ceiling” effect resulted in difficulty measuring the effects.



MANCOVA vs. MANOVA

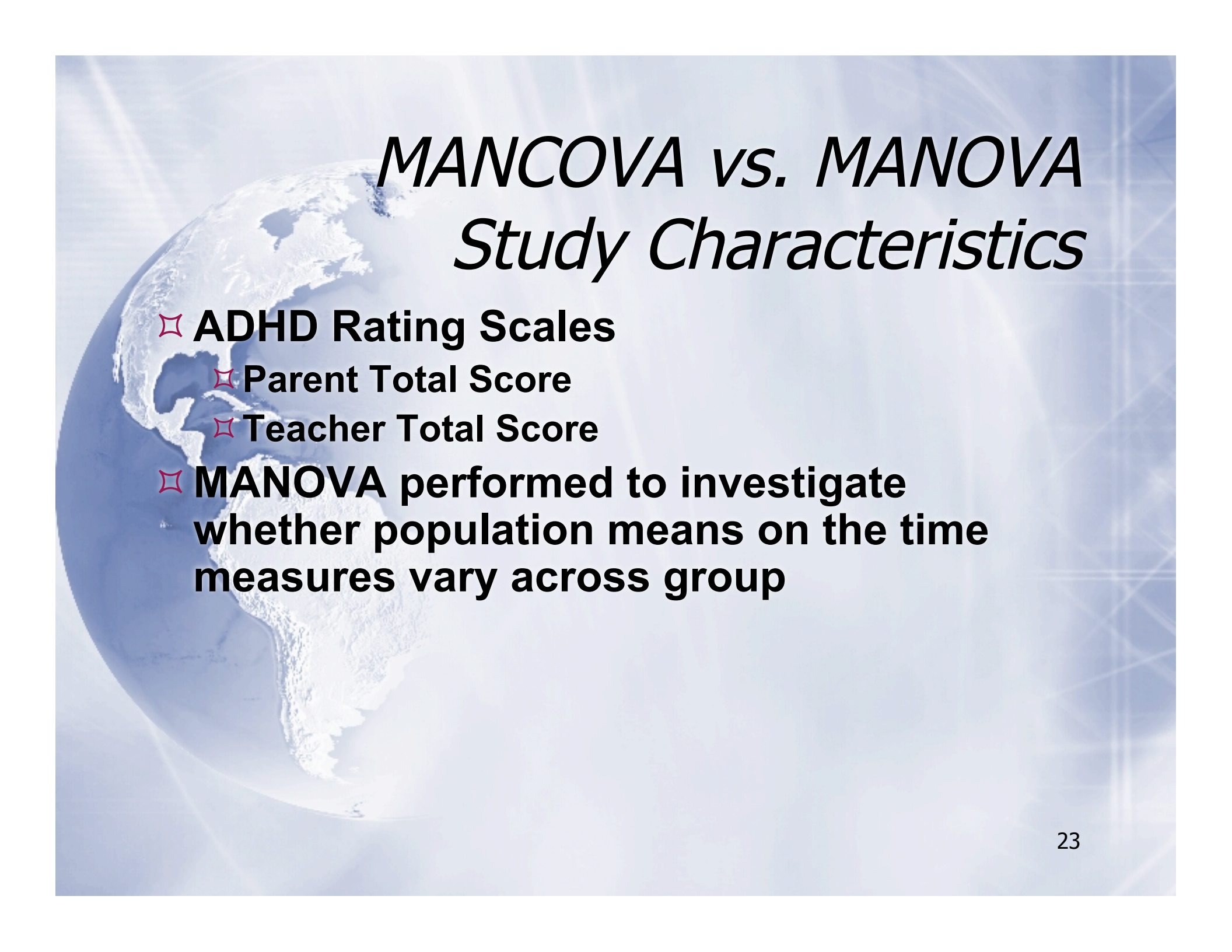
✧ Now we look at a different data set with multiple independent variables...



MANCOVA vs. MANOVA

Study Characteristics

- ✧ **2 groups-neurological and control**
- ✧ **30 children**
- ✧ **age 6-15 per group**
- ✧ **4 time measures:**
 - ✧ **Immediate**
 - ✧ **Delayed**
 - ✧ **Retrospective**
 - ✧ **Reproduction**
- ✧ **Scores on items turned into ratio scores**



MANCOVA vs. MANOVA

Study Characteristics

- ✧ **ADHD Rating Scales**

- ✧ **Parent Total Score**

- ✧ **Teacher Total Score**

- ✧ **MANOVA performed to investigate whether population means on the time measures vary across group**

MANOVA Results

Multivariate Tests(b)

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.978	615.711(a)	4.000	55.000	.000	.978
	Wilks'	.022	615.711(a)	4.000	55.000	.000	.978
	Lambda						
	Hotelling's	44.779	615.711(a)	4.000	55.000	.000	.978
	Trace						
group	Roy's	44.779	615.711(a)	4.000	55.000	.000	.978
	Largest Root						
	Pillai's Trace	.038	.536(a)	4.000	55.000	.710	.038
	Wilks'	.962	.536(a)	4.000	55.000	.710	.038
	Lambda						
	Hotelling's	.039	.536(a)	4.000	55.000	.710	.038
	Trace						
	Roy's	.039	.536(a)	4.000	55.000	.710	.038
	Largest Root						

a Exact statistic

b Design: Intercept+group

MANOVA Results

Descriptive Statistics

Dependent Variable: age

group	Mean	Std. Deviation	N
school group	8.3667	1.99107	30
hospital group	11.3333	3.41733	30
Total	9.8500	3.15060	60

Tests of Between-Subjects Effects

Dependent Variable: age

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	132.017(a)	1	132.017	16.879	.000	.225
Intercept	5821.350	1	5821.350	744.298	.000	.928
group	132.017	1	132.017	16.879	.000	.225
Error	453.633	58	7.821			
Total	6407.000	60				
Corrected Total	585.650	59				

a. R Squared = .225 (Adjusted R Squared = .212)

MANOVA Results

Multivariate Tests(b)							
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.675	27.498(a)	4.000	53.000	.000	.675
	Wilks'	.325	27.498(a)	4.000	53.000	.000	.675
	Lambda						
	Hotelling's Trace	2.075	27.498(a)	4.000	53.000	.000	.675
	Roy's Largest Root	2.075	27.498(a)	4.000	53.000	.000	.675
group	Pillai's Trace	.037	.509(a)	4.000	53.000	.729	.037
	Wilks'	.963	.509(a)	4.000	53.000	.729	.037
	Lambda						
	Hotelling's Trace	.038	.509(a)	4.000	53.000	.729	.037
	Roy's Largest Root	.038	.509(a)	4.000	53.000	.729	.037
age	Pillai's Trace	.385	8.293(a)	4.000	53.000	.000	.385
	Wilks'	.615	8.293(a)	4.000	53.000	.000	.385
	Lambda						
	Hotelling's Trace	.626	8.293(a)	4.000	53.000	.000	.385
	Roy's Largest Root	.626	8.293(a)	4.000	53.000	.000	.385
group * age	Pillai's Trace	.056	.793(a)	4.000	53.000	.535	.056
	Wilks'	.944	.793(a)	4.000	53.000	.535	.056
	Lambda						
	Hotelling's Trace	.060	.793(a)	4.000	53.000	.535	.056
	Roy's Largest Root	.060	.793(a)	4.000	53.000	.535	.056

a Exact statistic

b Design: Intercept+group+age+group * age

MANOVA Results

Descriptive Statistics

	group	Mean	Std. Deviation	N
coding	school group	.55307	.275379	30
	hospital group	.62733	.315299	30
	Total	.59020	.295873	60
symbol	school group	.5349	.29164	30
	hospital group	.5303	.27997	30
	Total	.5326	.28344	60
birthday	school group	.5661	.30099	30
	hospital group	.5353	.29399	30
	Total	.5507	.29539	60
totalflash	school group	.8245	.10798	30
	hospital group	.8050	.14640	30
	Total	.8148	.12792	60

MANOVA Results

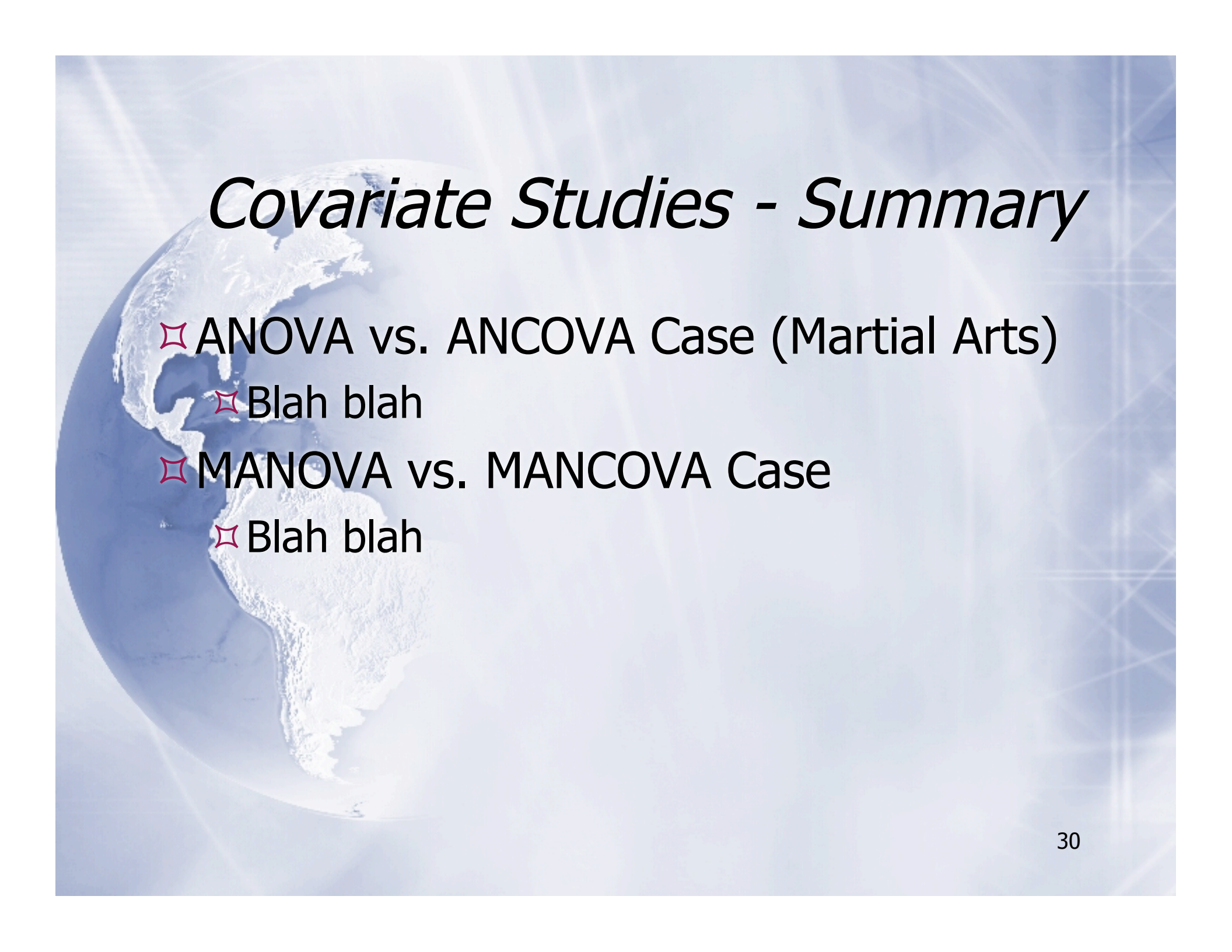
- - - PARTIAL CORRELATION COEFFICIENTS
- - -

Controlling for.. AGE

	CODING	SYMBOL	BIRTHDAY	TOTALFLA	ADHDPT
CODING	1.0000 (0) P= .	.4862 (57) P= .000	.2568 (57) P= .050	.2290 (57) P= .081	-.0420 (57) P= .752
SYMBOL	.4862 (57) P= .000	1.0000 (0) P= .	.2694 (57) P= .039	.3525 (57) P= .006	-.1352 (57) P= .307
BIRTHDAY	.2568 (57) P= .050	.2694 (57) P= .039	1.0000 (0) P= .	.3815 (57) P= .003	-.2591 (57) P= .048
TOTALFLA	.2290 (57) P= .081	.3525 (57) P= .006	.3815 (57) P= .003	1.0000 (0) P= .	-.4745 (57) P= .000
ADHDPT	-.0420 (57) P= .752	-.1352 (57) P= .307	-.2591 (57) P= .048	-.4745 (57) P= .000	1.0000 (0) P= .

(Coefficient / (D.F.) / 2-tailed Significance)





Covariate Studies - Summary

- ✧ ANOVA vs. ANCOVA Case (Martial Arts)

- ✧ Blah blah

- ✧ MANOVA vs. MANCOVA Case

- ✧ Blah blah