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Brown Forsythe ANOVA
Import data

Brown Forsythe ANOVA descriptives

Brown Forsythe ANOVA descriptives
Dependent variable G3 by studytime groups

Means

[BrownForsytheANOVAData] D:\DATA ANALYSIS\E ANOVA Family\Brown Forsythe ANOVA\SPSS_Output\sav\Brown-Forsythe-ANOVA-data.sav

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
G3 * studytime	649	100.0%	0	0.0%	649	100.0%

Report

G3

studytime	N	Mean	Median	Std. Deviation	Variance	Minimum	Maximum
1	212	10.84	11.00	3.219	10.360	0	18
2	305	12.09	12.00	3.243	10.518	0	19
3	97	13.23	13.00	2.502	6.261	8	18
4	35	13.06	13.00	3.038	9.232	6	19
Total	649	11.91	12.00	3.231	10.437	0	19

```
>Warning # 2004.  Command name: SUBTITLE
>The subtitle given exceeds 60 characters in length.  The first 60 characters
>will be used.
```

Brown Forsythe ANOVA: Robust tests of equality of means
SPSS ONEWAY output includes Brown-Forsythe and Welch robust

Oneway

Descriptives

G3

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum
					Lower Bound	Upper Bound	
1	212	10.84	3.219	.221	10.41	11.28	0
2	305	12.09	3.243	.186	11.73	12.46	0
3	97	13.23	2.502	.254	12.72	13.73	8
4	35	13.06	3.038	.514	12.01	14.10	6
Total	649	11.91	3.231	.127	11.66	12.16	0

Descriptives

G3

	Maximum
1	18
2	19
3	18
4	19
Total	19

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
G3	Based on Mean	.985	3	645	.400
	Based on Median	1.026	3	645	.380
	Based on Median and with adjusted df	1.026	3	609.885	.380
	Based on trimmed mean	1.081	3	645	.356

Brown Forsythe ANOVA: Robust tests of equality of means
SPSS ONEWAY output includes Brown-Forsythe and Welch robust

ANOVA

G3

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	465.078	3	155.026	15.876	.000
Within Groups	6298.189	645	9.765		
Total	6763.267	648			

Robust Tests of Equality of Means

G3

	Statistic[a]	df1	df2	Sig.
Welch	18.183	3	139.101	.000
Brown-Forsythe	17.478	3	246.552	.000

a. Asymptotically F distributed.

Post Hoc Tests

Multiple Comparisons

Dependent Variable: G3

Tukey HSD

(I) studytime	(J) studytime	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-1.247*	.279	.000	-1.97	-.53
	3	-2.382*	.383	.000	-3.37	-1.40
	4	-2.213*	.570	.001	-3.68	-.74
2	1	1.247*	.279	.000	.53	1.97
	3	-1.135*	.364	.010	-2.07	-.20
	4	-.965	.558	.308	-2.40	.47
3	1	2.382*	.383	.000	1.40	3.37
	2	1.135*	.364	.010	.20	2.07
	4	.170	.616	.993	-1.42	1.76

Brown Forsythe ANOVA: Robust tests of equality of means
SPSS ONEWAY output includes Brown-Forsythe and Welch robust

Multiple Comparisons

Dependent Variable: G3

Tukey HSD

(I) studytime	(J) studytime	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
4	1	2.213*	.570	.001	.74	3.68
	2	.965	.558	.308	-.47	2.40
	3	-.170	.616	.993	-1.76	1.42

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

G3

Tukey HSD[a,b]

studytime	N	Subset for alpha = 0.05	
		1	2
1	212	10.84	
2	305		12.09
4	35		13.06
3	97		13.23
Sig.		1.000	.083

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 85.331.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Brown Forsythe ANOVA: GLM with effect size
Partial eta squared is shown through ETASQ output

General Linear Model

Between-Subjects Factors

		Value Label	N
studytime	1	Study time group 1	212
	2	Study time group 2	305
	3	Study time group 3	97
	4	Study time group 4	35

Descriptive Statistics

Dependent Variable: G3

studytime	Mean	Std. Deviation	N
1	10.84	3.219	212
2	12.09	3.243	305
3	13.23	2.502	97
4	13.06	3.038	35
Total	11.91	3.231	649

Levene's Test of Equality of Error Variances[a,b]

		Levene Statistic	df1	df2	Sig.
G3	Based on Mean	.985	3	645	.400
	Based on Median	1.026	3	645	.380
	Based on Median and with adjusted df	1.026	3	609.885	.380
	Based on trimmed mean	1.081	3	645	.356

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

a. Dependent variable: G3

b. Design: Intercept + studytime

Brown Forsythe ANOVA: GLM with effect size
Partial eta squared is shown through ETASQ output

Tests of Between-Subjects Effects

Dependent Variable: G3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	465.078[a]	3	155.026	15.876	.000	.069
Intercept	51680.984	1	51680.984	5292.670	.000	.891
studytime	465.078	3	155.026	15.876	.000	.069
Error	6298.189	645	9.765			
Total	98761.000	649				
Corrected Total	6763.267	648				

a. R Squared = .069 (Adjusted R Squared = .064)

Parameter Estimates

Dependent Variable: G3

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	13.057	.528	24.720	.000	12.020	14.094
[studytime=1]	-2.213	.570	-3.881	.000	-3.332	-1.093
[studytime=2]	-.965	.558	-1.731	.084	-2.060	.130
[studytime=3]	.170	.616	.275	.783	-1.040	1.380
[studytime=4]	0[a]	.	.	.	.	.

Parameter Estimates

Dependent Variable: G3

Parameter	Partial Eta Squared
Intercept	.487
[studytime=1]	.023
[studytime=2]	.005
[studytime=3]	.000
[studytime=4]	.

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

```
>Warning # 2004.  Command name: SUBTITLE
>The subtitle given exceeds 60 characters in length.  The first 60 characters
>will be used.
```

Brown Forsythe ANOVA: Median-based deviation variable
Create absolute deviations from group median for Brown-Forsy

```
>Warning # 2003.  Command name: TITLE
>The title given exceeds 60 characters in length.  The first 60 characters wil
l
>be used.
```

```
>Warning # 2004.  Command name: SUBTITLE
>The subtitle given exceeds 60 characters in length.  The first 60 characters
>will be used.
```

Brown Forsythe ANOVA: ANOVA on absolute deviations from medi
This table shows the median-based spread test behind Brown-F

Oneway

Descriptives

abs_dev_median

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum
					Lower Bound	Upper Bound	
1	212	2.1934	2.35586	.16180	1.8744	2.5124	.00
2	305	2.4000	2.17885	.12476	2.1545	2.6455	.00
3	97	2.0000	1.50693	.15301	1.6963	2.3037	.00
4	35	2.4000	1.81821	.30733	1.7754	3.0246	.00
Total	649	2.2727	2.13681	.08388	2.1080	2.4374	.00

Descriptives

abs_dev_median

	Maximum
1	11.00
2	12.00
3	5.00
4	7.00
Total	12.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
abs_dev_median	Based on Mean	2.109	3	645	.098
	Based on Median	1.308	3	645	.271
	Based on Median and with adjusted df	1.308	3	586.103	.271
	Based on trimmed mean	1.288	3	645	.277

Brown Forsythe ANOVA: ANOVA on absolute deviations from medi
This table shows the median-based spread test behind Brown-F

ANOVA

abs_dev_median

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14.057	3	4.686	1.026	.380
Within Groups	2944.671	645	4.565		
Total	2958.727	648			

```
>Warning # 2004.  Command name: SUBTITLE
>The subtitle given exceeds 60 characters in length.  The first 60 characters
>will be used.
```

Brown Forsythe ANOVA: Absolute deviation boxplot
Spread comparison using absolute deviations from group media

Explore

Study time factor

Case Processing Summary

		Cases					
		Valid		Missing		Total	
	studytime	N	Percent	N	Percent	N	Percent
abs_dev_median	1	212	100.0%	0	0.0%	212	100.0%
	2	305	100.0%	0	0.0%	305	100.0%
	3	97	100.0%	0	0.0%	97	100.0%
	4	35	100.0%	0	0.0%	35	100.0%

Descriptives

	studytime			Statistic	Std. Error
abs_dev_median	1	Mean		2.1934	.16180
		95% Confidence Interval for Mean	Lower Bound	1.8744	
			Upper Bound	2.5124	
		5% Trimmed Mean		1.8889	
		Median		2.0000	
		Variance		5.550	
		Std. Deviation		2.35586	
		Minimum		.00	
		Maximum		11.00	
		Range		11.00	
		Interquartile Range		2.00	
		Skewness		2.084	.167
		Kurtosis		5.173	.333
	2	Mean		2.4000	.12476
		95% Confidence Interval for Mean	Lower Bound	2.1545	
			Upper Bound	2.6455	
		5% Trimmed Mean		2.1585	
		Median		2.0000	
		Variance		4.747	
		Std. Deviation		2.17885	

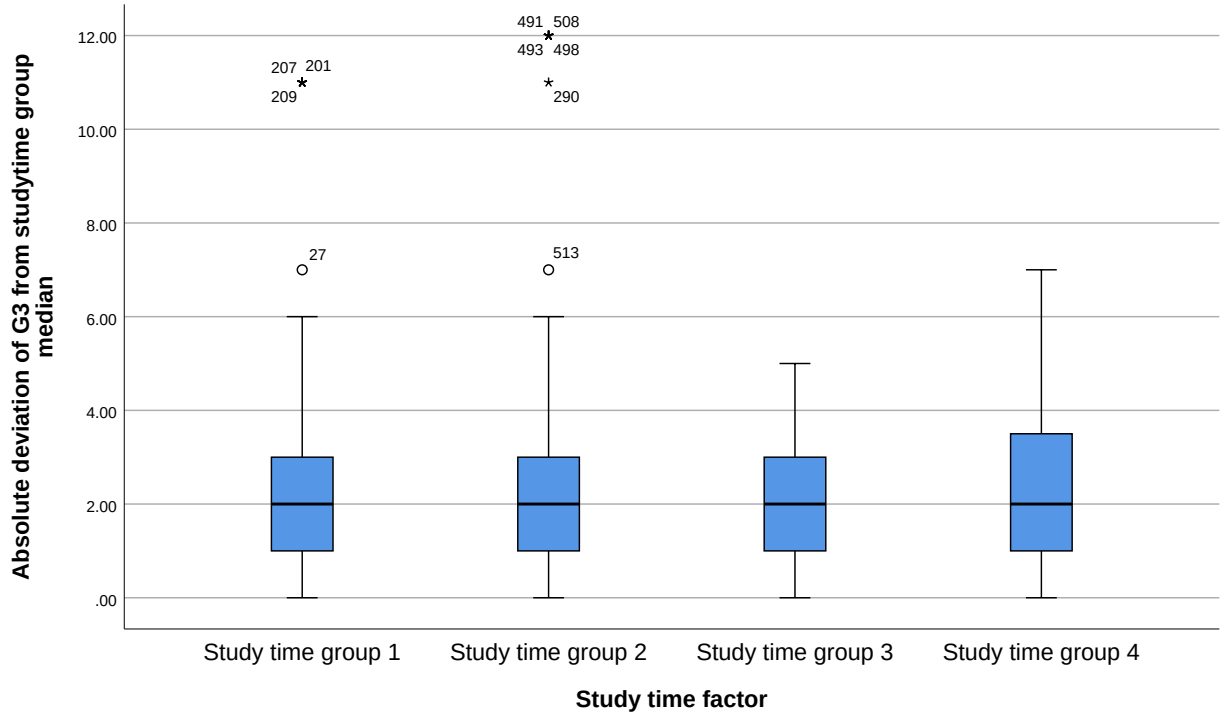
Brown Forsythe ANOVA: Absolute deviation boxplot
Spread comparison using absolute deviations from group media

Descriptives

studytime			Statistic	Std. Error
	Minimum		.00	
	Maximum		12.00	
	Range		12.00	
	Interquartile Range		2.00	
	Skewness		2.248	.140
	Kurtosis		7.263	.278
3	Mean		2.0000	.15301
	95% Confidence Interval for Mean	Lower Bound	1.6963	
		Upper Bound	2.3037	
	5% Trimmed Mean		1.9444	
	Median		2.0000	
	Variance		2.271	
	Std. Deviation		1.50693	
	Minimum		.00	
	Maximum		5.00	
	Range		5.00	
	Interquartile Range		2.00	
	Skewness		.466	.245
	Kurtosis		-.692	.485
4	Mean		2.4000	.30733
	95% Confidence Interval for Mean	Lower Bound	1.7754	
		Upper Bound	3.0246	
	5% Trimmed Mean		2.3016	
	Median		2.0000	
	Variance		3.306	
	Std. Deviation		1.81821	
	Minimum		.00	
	Maximum		7.00	
	Range		7.00	
	Interquartile Range		3.00	
	Skewness		.638	.398
	Kurtosis		-.148	.778

Brown Forsythe ANOVA: Absolute deviation boxplot
Spread comparison using absolute deviations from group media

Absolute deviation of G3 from studytime group median



Brown Forsythe ANOVA: Group boxplot

Brown Forsythe ANOVA: Group boxplot
Boxplot of G3 by studytime group

Explore

Study time factor

Case Processing Summary

		Cases					
		Valid		Missing		Total	
	studytime	N	Percent	N	Percent	N	Percent
G3	1	212	100.0%	0	0.0%	212	100.0%
	2	305	100.0%	0	0.0%	305	100.0%
	3	97	100.0%	0	0.0%	97	100.0%
	4	35	100.0%	0	0.0%	35	100.0%

Descriptives

	studytime			Statistic	Std. Error
G3	1	Mean		10.84	.221
		95% Confidence Interval for Mean	Lower Bound	10.41	
			Upper Bound	11.28	
		5% Trimmed Mean		11.04	
		Median		11.00	
		Variance		10.360	
		Std. Deviation		3.219	
		Minimum		0	
		Maximum		18	
		Range		18	
		Interquartile Range		3	
		Skewness		-1.078	.167
		Kurtosis		3.117	.333
	2	Mean		12.09	.186
		95% Confidence Interval for Mean	Lower Bound	11.73	
			Upper Bound	12.46	
		5% Trimmed Mean		12.25	
		Median		12.00	
		Variance		10.518	
		Std. Deviation		3.243	

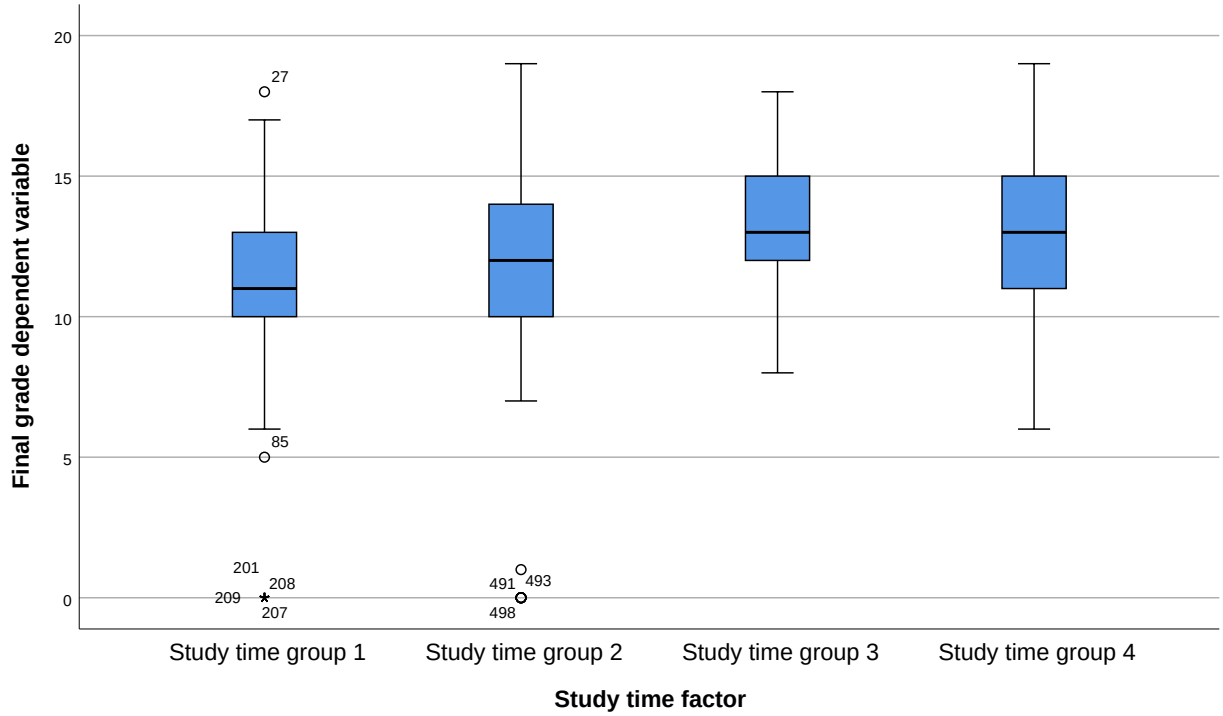
Brown Forsythe ANOVA: Group boxplot
Boxplot of G3 by studytime group

Descriptives

studytime			Statistic	Std. Error
	Minimum		0	
	Maximum		19	
	Range		19	
	Interquartile Range		4	
	Skewness		-1.028	.140
	Kurtosis		3.044	.278
3	Mean		13.23	.254
	95% Confidence Interval for Mean	Lower Bound	12.72	
		Upper Bound	13.73	
	5% Trimmed Mean		13.27	
	Median		13.00	
	Variance		6.261	
	Std. Deviation		2.502	
	Minimum		8	
	Maximum		18	
	Range		10	
	Interquartile Range		4	
	Skewness		-.190	.245
	Kurtosis		-.502	.485
4	Mean		13.06	.514
	95% Confidence Interval for Mean	Lower Bound	12.01	
		Upper Bound	14.10	
	5% Trimmed Mean		13.07	
	Median		13.00	
	Variance		9.232	
	Std. Deviation		3.038	
	Minimum		6	
	Maximum		19	
	Range		13	
	Interquartile Range		4	
	Skewness		.209	.398
	Kurtosis		-.339	.778

Brown Forsythe ANOVA: Group boxplot
Boxplot of G3 by studytime group

Final grade dependent variable

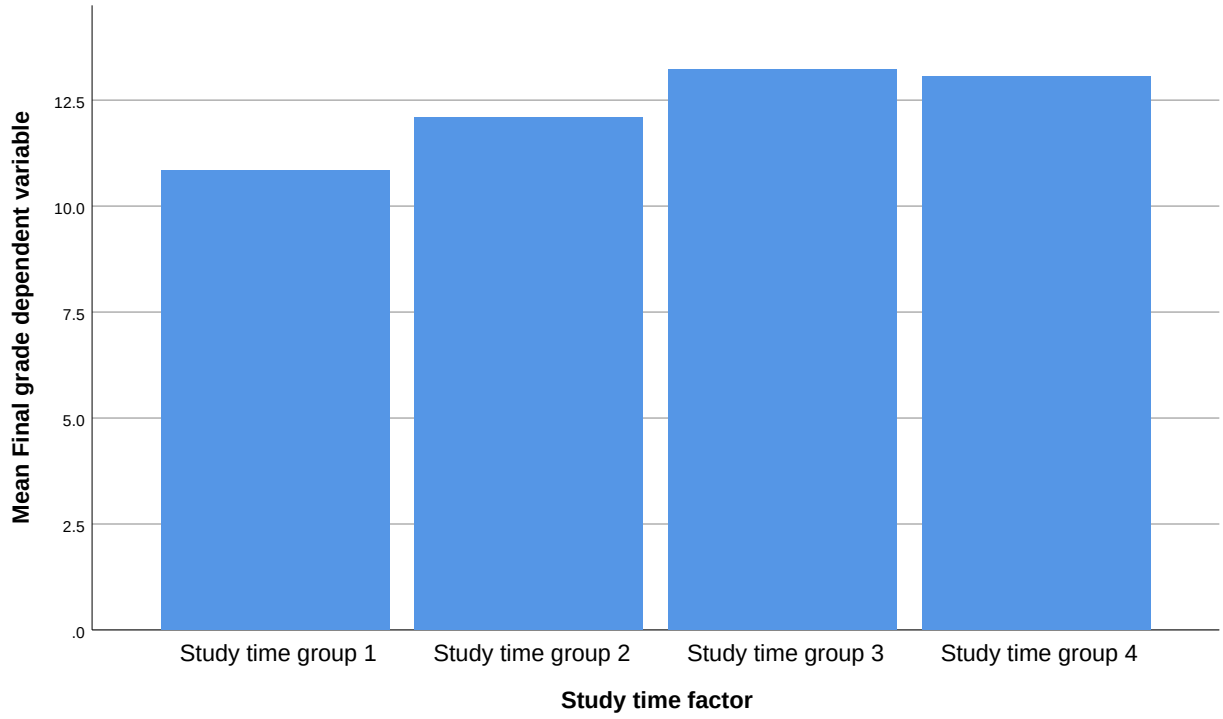


Brown Forsythe ANOVA: Means plot

Brown Forsythe ANOVA: Means plot
Mean G3 across studytime groups

Graph

```
>Warning # 17848
>The requested bar chart type cannot be drawn with the provided data.  Instead
,
>Graphics will attempt to draw a simple bar chart.
```



```
>Warning # 2004.  Command name: SUBTITLE
>The subtitle given exceeds 60 characters in length.  The first 60 characters
>will be used.
```

Brown Forsythe ANOVA: Residual diagnostics
Save predicted values and residuals for checking classical m

General Linear Model

Between-Subjects Factors

		Value Label	N
studytime	1	Study time group 1	212
	2	Study time group 2	305
	3	Study time group 3	97
	4	Study time group 4	35

Tests of Between-Subjects Effects

Dependent Variable: G3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	465.078[a]	3	155.026	15.876	.000
Intercept	51680.984	1	51680.984	5292.670	.000
studytime	465.078	3	155.026	15.876	.000
Error	6298.189	645	9.765		
Total	98761.000	649			
Corrected Total	6763.267	648			

a. R Squared = .069 (Adjusted R Squared = .064)

Brown Forsythe ANOVA: Residual histogram

Graph