

Tamhane's T2 Unequal-Variance Post Hoc Analysis

Workflow:

1. Load dataset.csv from the Tamhanes T2 folder.
2. Check descriptive statistics, Levene/Brown-Forsythe context, classic ANOVA, and Welch ANOVA.
3. Run Tamhane's T2-style pairwise tests using Welch SE, Welch df, and Sidak adjusted p-values.
4. Treat SPSS /POSTHOC=TAMHANE output as official when available.

Interpretation summary:

```

dependent_variable group_variable
1          G3          studytime

                                method
1 Tamhane's T2 unequal-variance post hoc test

                                why_this_method
1 Use when comparing group means under unequal variances and/or unequal sample sizes.
groups total_n largest_variance_ratio levene_p_value
1          4          649          1.680029          0.3803575
welch_anova_p_value classic_anova_p_value
1          5.188109e-10          5.705728e-10
significant_tamhane_pairs_alpha_0_05 total_pairwise_comparisons
1          4          6
smallest_tamhane_adjusted_p_value
1          1.024187e-10

                                overall_sentence
1 Tamhane's T2 found 4 significant pairwise difference(s) out of 6 comparisons at alpha = .05.
                                official_reference_note
1 When SPSS output is available, report SPSS /POSTHOC=TAMHANE results as the official table.

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Group summary:

```

group  n    mean standard_deviation standard_error  variance
1     1 212 10.84434          3.218624          0.2210560 10.359541
2     2 305 12.09180          3.243125          0.1857008 10.517860
3     3  97 13.22680          2.502104          0.2540502  6.260524
4     4  35 13.05714          3.038410          0.5135850  9.231933
minimum maximum welch_weight_n_over_variance ci95_low_unadjusted
1         0         18          20.464227          10.41107
2         0         19          28.998294          11.72783
3         8         18          15.493911          12.72887
4         6         19          3.791189          12.05052
ci95_high_unadjusted
1          11.27761
2          12.45578
3          13.72474
4          14.06377

```

Welch ANOVA context:

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                                test f_statistic
1 Welch one-way ANOVA context for unequal variances          18.18288
df_num  df_den  p_value alpha decision_alpha_0_05
1       3 139.1006 5.188109e-10 0.05  Reject equal means

                                method_note
1 Welch ANOVA is an unequal-variance omnibus context before Tamhane's T2 pairwise follow-up.

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Levene/Brown-Forsythe context:

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                                context_test
1 Median-centered Levene / Brown-Forsythe variance context

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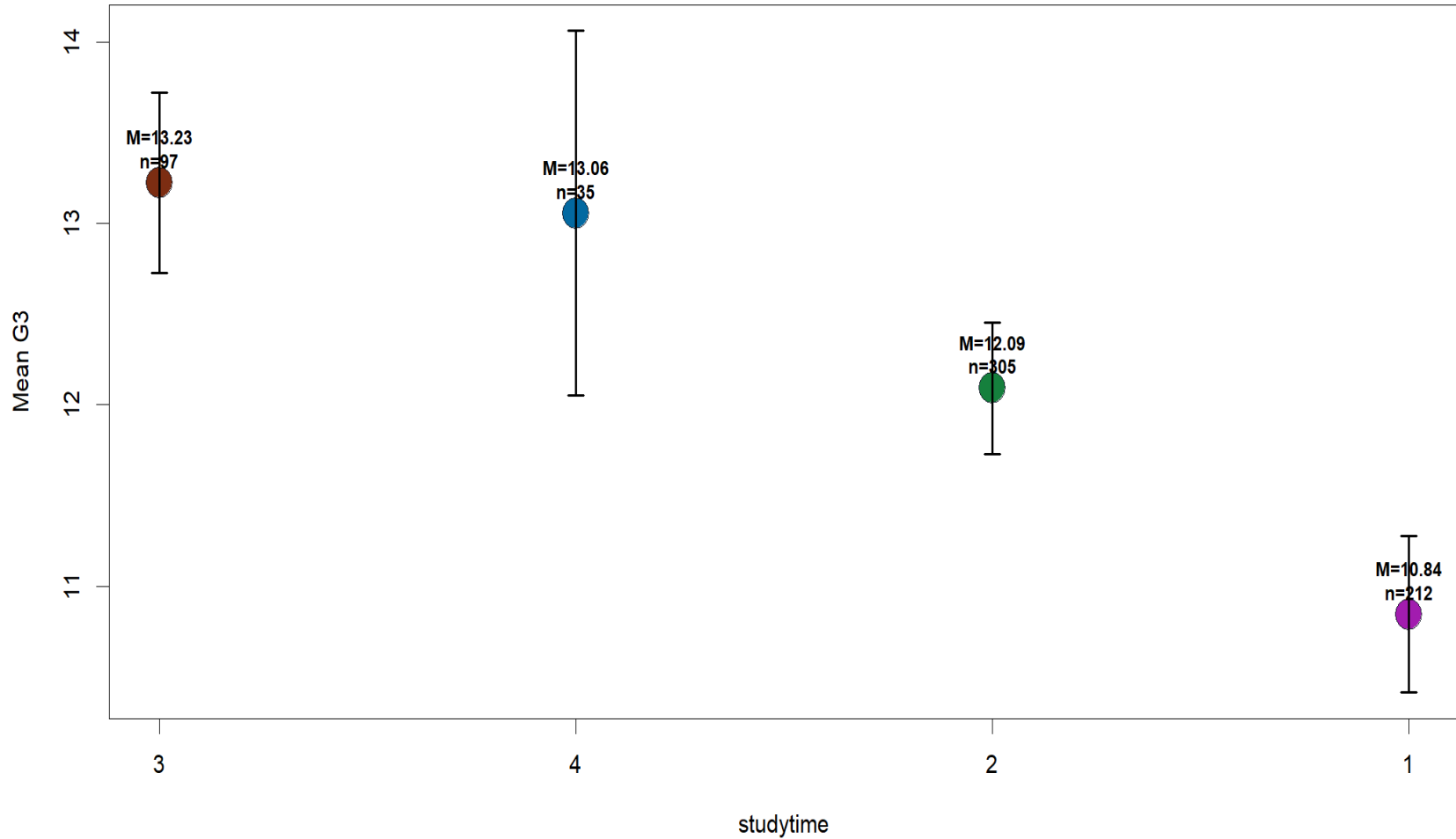
Tamhane's T2 pairwise comparison table

comparison_order	lower_mean_group	higher_mean_group	lower_mean	
1	1	1	2	10.84434
2	2	1	4	10.84434
3	3	1	3	10.84434
4	4	2	4	12.09180
5	5	2	3	12.09180
6	6	4	3	13.05714
higher_mean	mean_difference_high_minus_low	standard_error_welch		
1	12.09180	1.2474637		0.2887050
2	13.05714	2.2128032		0.5591380
3	13.22680	2.3824645		0.3367599
4	13.05714	0.9653396		0.5461266
5	13.22680	1.1350008		0.3146844
6	13.22680	0.1696613		0.5729843
welch_satterthwaite_df	t_statistic_abs			
1	456.19790	4.3208946		
2	47.50184	3.9575263		
3	235.08565	7.0746676		
4	43.38841	1.7676113		
5	207.30376	3.6067909		
6	51.58075	0.2961011		
unadjusted_two_sided_p_value	number_of_pairwise_comparisons			
1	1.908767e-05		6	
2	2.518983e-04		6	
3	1.706981e-11		6	
4	8.415812e-02		6	
5	3.884732e-04		6	
6	7.683418e-01		6	
sidak_alpha_per_comparison	t_critical_sidak_adjusted			
1	0.008512445		2.642508	
2	0.008512445		2.745163	
3	0.008512445		2.653381	
4	0.008512445		2.756456	
5	0.008512445		2.656402	
6	0.008512445		2.735807	
tamhane_t2_sidak_adjusted_p_value	adjusted_ci_low			
1	1.145205e-04		0.4845586	
2	1.510438e-03		0.6778786	
3	1.024187e-10		1.4889121	
4	4.099035e-01		-0.5400347	
5	2.328577e-03		0.2990725	
6	9.998454e-01		-1.3979130	
adjusted_ci_high	decision_alpha_0_05			
1	2.010369	Significant		
2	3.747728	Significant		
3	3.276017	Significant		
4	2.470714	Not significant		
5	1.970929	Significant		
6	1.737236	Not significant		
				method_note
1	Tamhane's T2-style	unequal-variance	pairwise comparison using Welch SE, Welch df, and Sidak adjustment;	SPSS Tamhane output is official.
2	Tamhane's T2-style	unequal-variance	pairwise comparison using Welch SE, Welch df, and Sidak adjustment;	SPSS Tamhane output is official.
3	Tamhane's T2-style	unequal-variance	pairwise comparison using Welch SE, Welch df, and Sidak adjustment;	SPSS Tamhane output is official.
4	Tamhane's T2-style	unequal-variance	pairwise comparison using Welch SE, Welch df, and Sidak adjustment;	SPSS Tamhane output is official.
5	Tamhane's T2-style	unequal-variance	pairwise comparison using Welch SE, Welch df, and Sidak adjustment;	SPSS Tamhane output is official.
6	Tamhane's T2-style	unequal-variance	pairwise comparison using Welch SE, Welch df, and Sidak adjustment;	SPSS Tamhane output is official.

Tamhane homogeneous subset letters

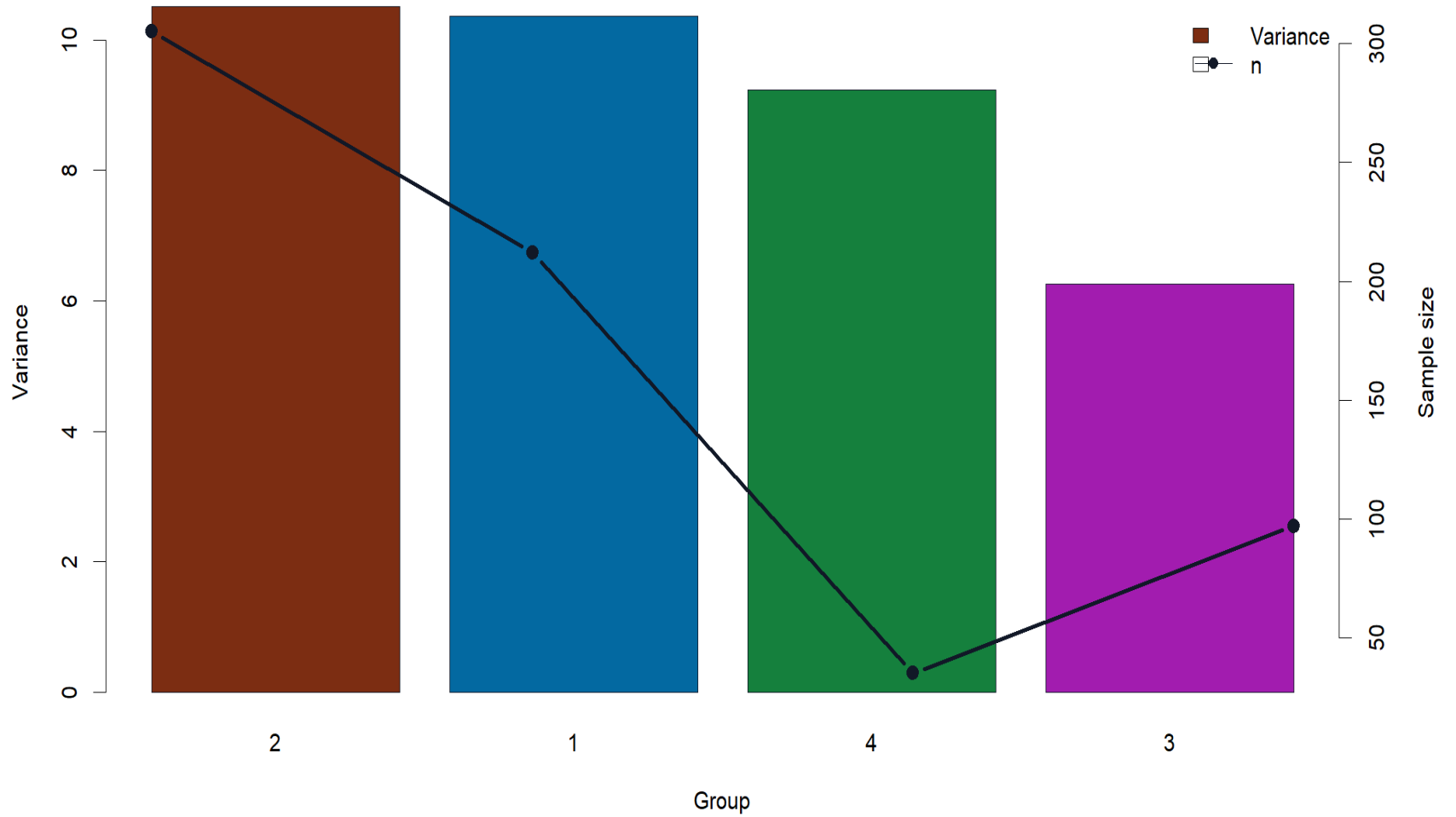
	group	mean	tamhane_homogeneous_subset_letters
3	3	13.22680	A
4	4	13.05714	A
2	2	12.09180	B
1	1	10.84434	C

Tamhane's T2: Unequal-Variance Group Profile



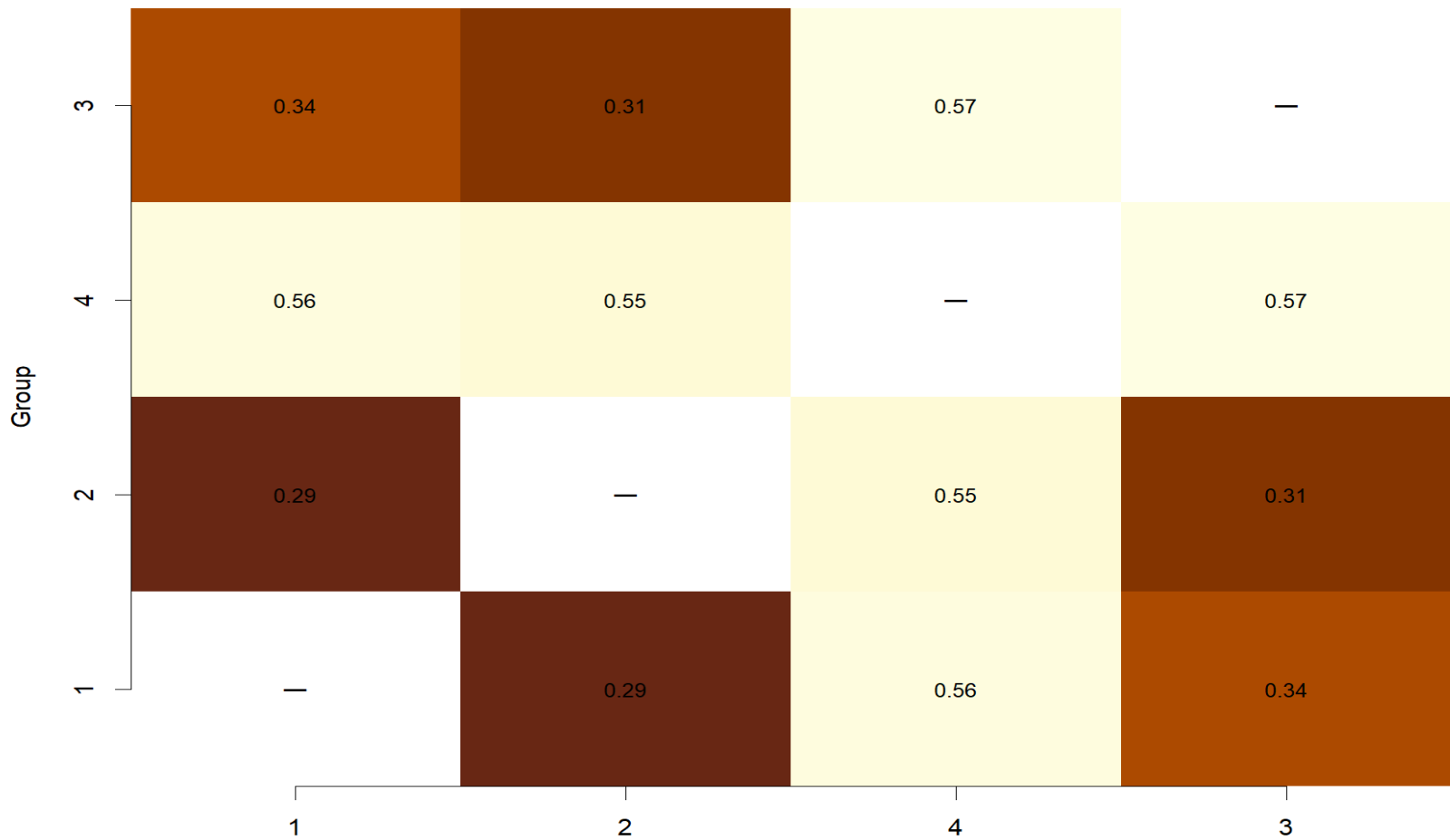
Point markers show means; error bars show unadjusted 95% intervals before Tamhane pairwise tests.

Variance and Sample Size Context



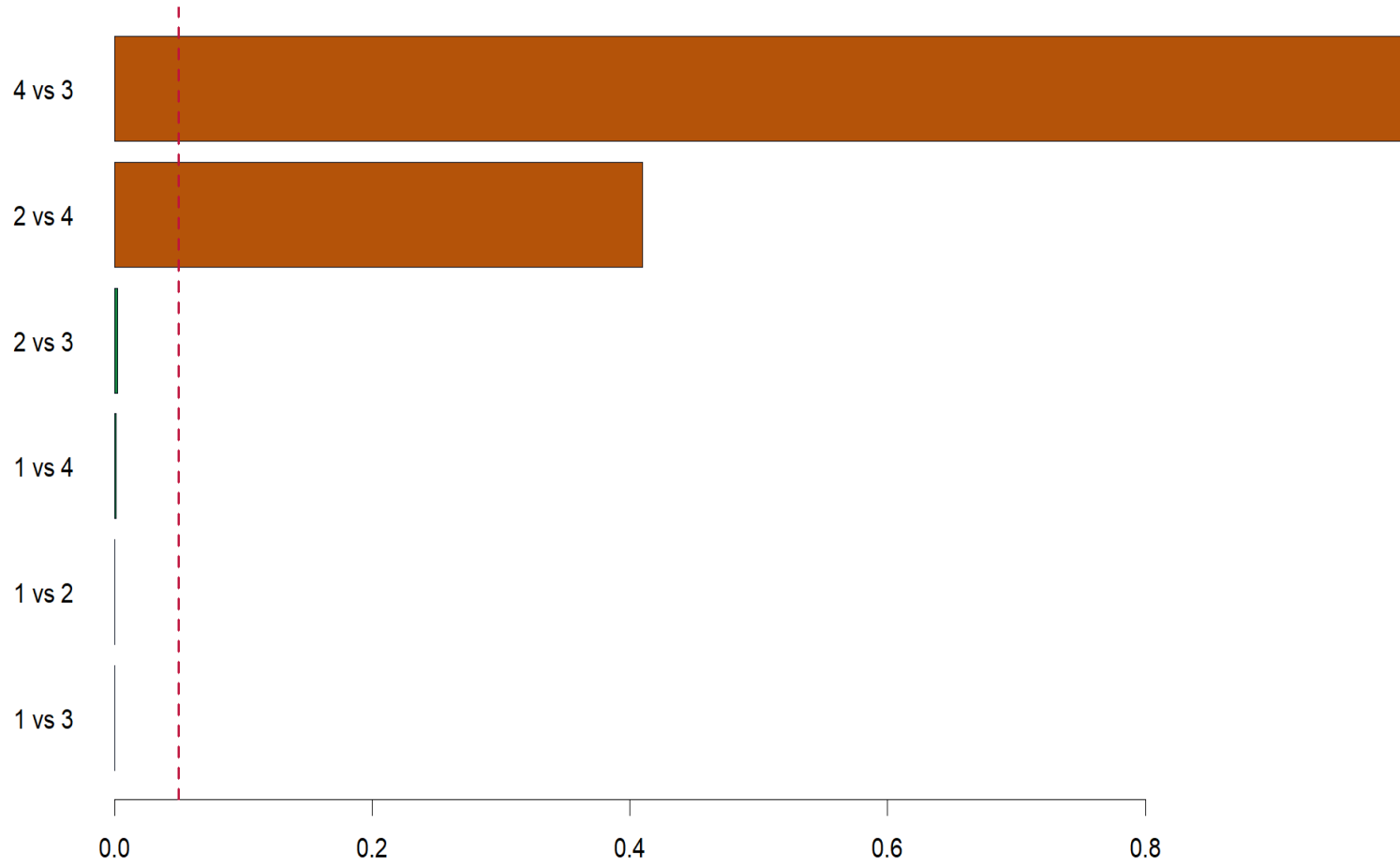
Tamhane's T2 is designed for comparisons when variance and sample size balance are questionable.

Tamhane Pairwise Welch Standard Error Map



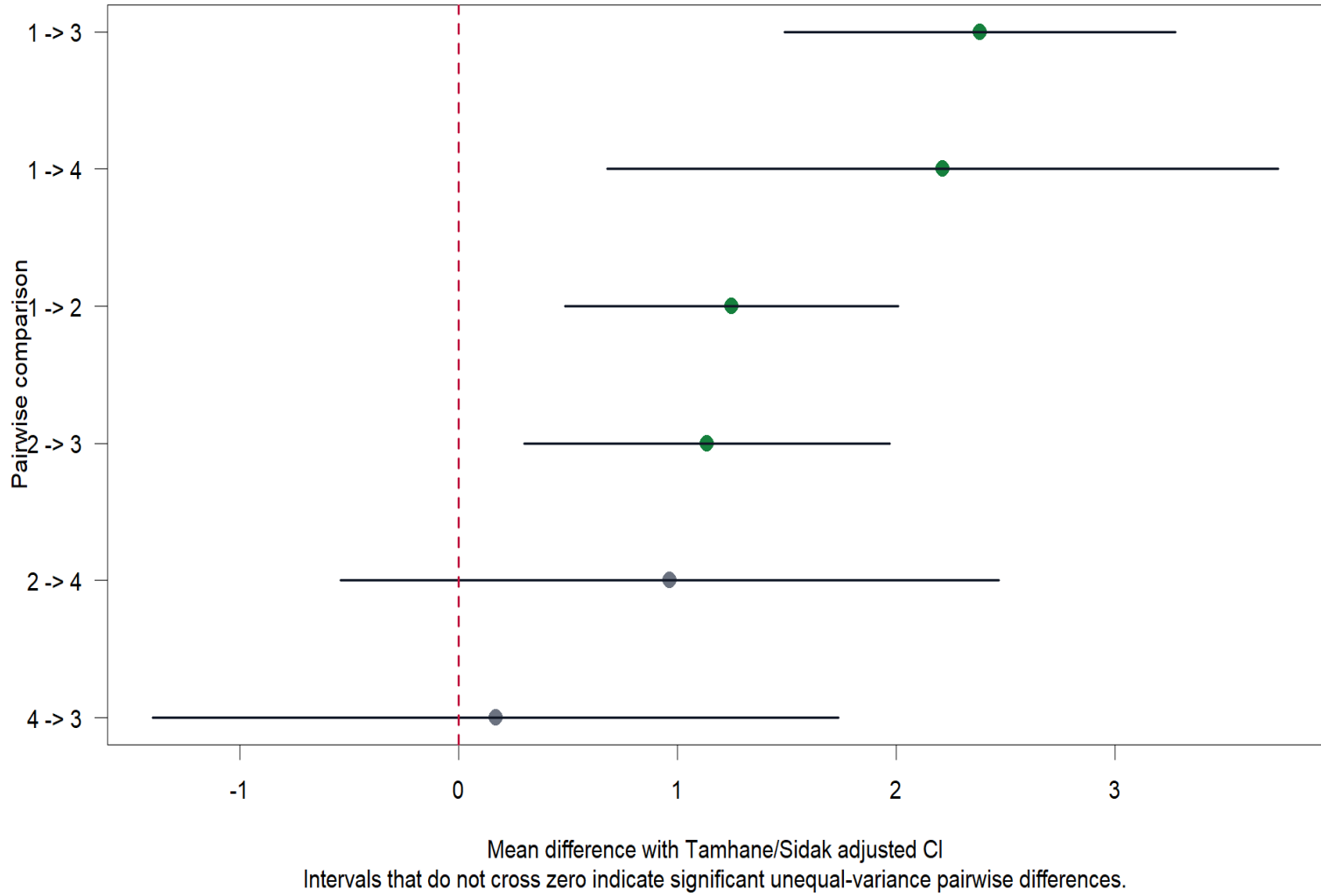
Larger values mean more pairwise uncertainty under unequal variances.

Tamhane's T2 Adjusted p-value Ranking

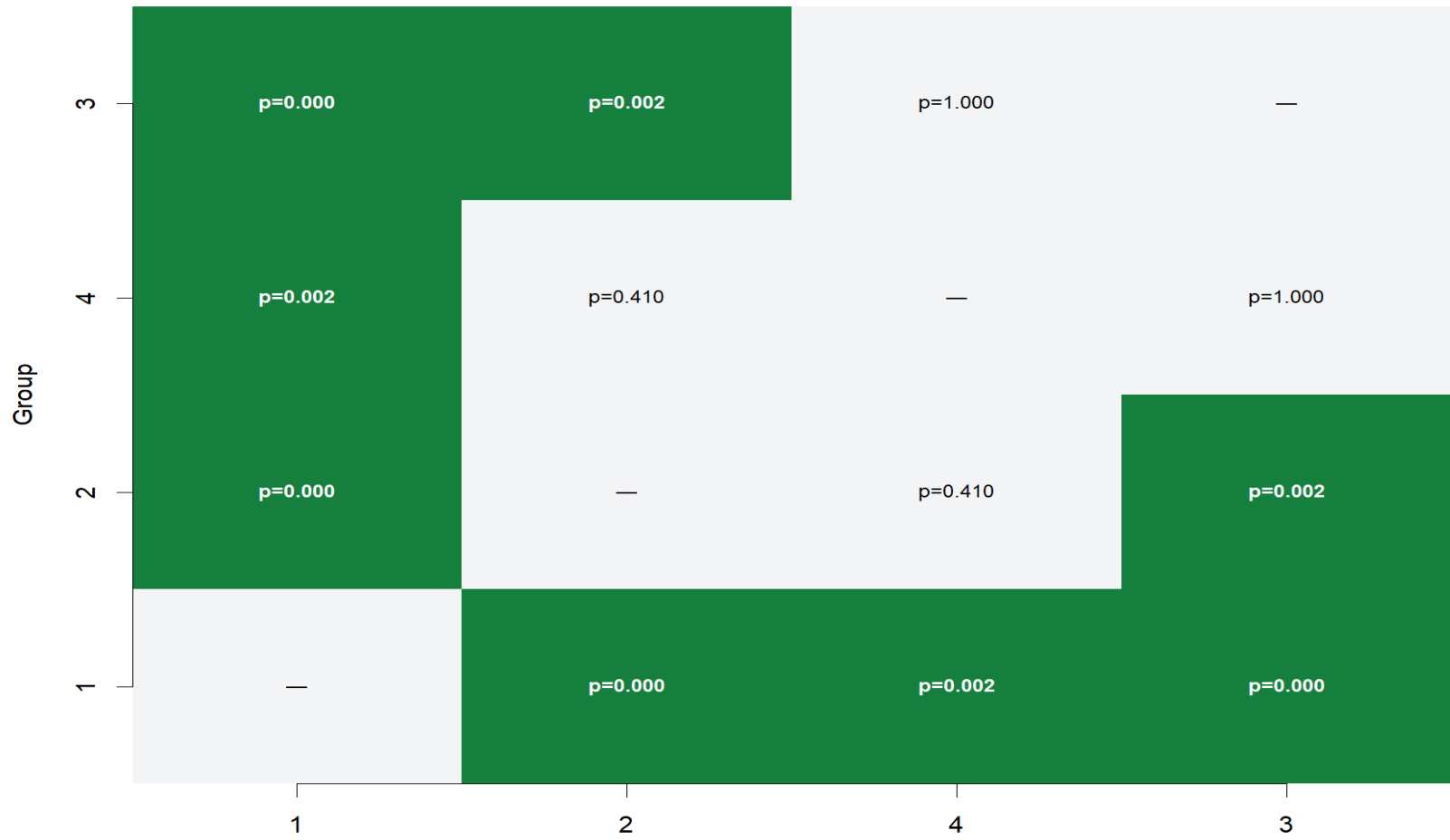


Tamhane's T2 Sidak-adjusted p-value
Significant pairs have adjusted p-values below .05 after unequal-variance correction.

Tamhane Mean Differences with Adjusted Confidence Intervals

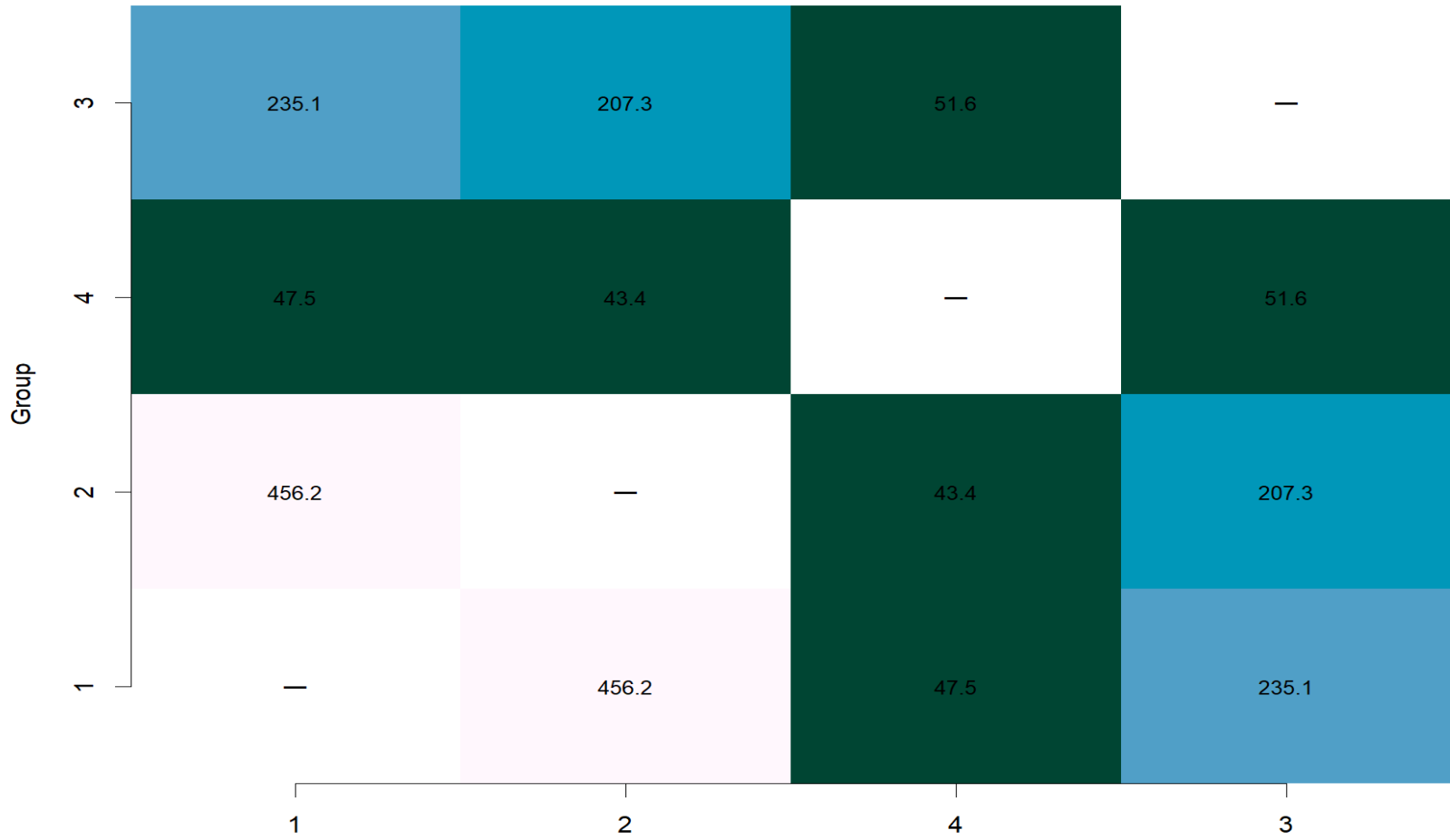


Tamhane's T2 Pairwise Decision Matrix



Green cells mark significant adjusted pairwise differences.

Welch-Satterthwaite Degrees of Freedom Heatmap



Each pair gets its own df because Tamhane's T2 does not assume pooled equal variance.

Tamhane's T2 Method Report Card

Method Tamhane's T2	Variance stance Unequal variances allowed	Welch ANOVA p 0.0000
Levene p 0.3804	Significant pairs 4/6	Smallest adj. p 0.0000

Tamhane's T2 found 4 significant pairwise difference(s) out of 6 comparisons at alpha = .05.