Bonferroni Correction Post Hoc Analysis

Purpose: compare all pairs of group means while controlling familywise error.
H0 for each pair: the two group means are equal.
H1 for each pair: the two group means are different.

Analysis summary:

analysis	target_variable	group_variable	number_of_groups
Bonferroni correction post hoc	analysis	G3	studytime	4

number_of_pairwise_comparisons	familywise_alpha	per_comparison_alpha_bonferroni	anova_p_value
6	0.05	0.008333333	5.705728e−10

anova_decision_alpha_0_05	significant_bonferroni_pairs
Reject equal group means	4

note
Bonferroni controls familywise error by multiplying each pairwise p−value by the number of comparisons.

One−way ANOVA:

source	sum_of_squares	df	mean_square	f_value	p_value
Between groups	465.0778	3	155.025942	15.87627	5.705728e−10
Within groups	6298.1887	645	9.764634	NA	NA
Total	6763.2666	648	NA	NA	NA

Group summary:

group	n	mean	standard_deviation	variance	standard_error	minimum	maximum	mean_ci95_lower	mean_ci95_upper
1	212	10.84434	3.218624	10.359541	0.2210560	0	18	10.41107	11.27761
2	305	12.09180	3.243125	10.517860	0.1857008	0	19	11.72783	12.45578
3	97	13.22680	2.502104	6.260524	0.2540502	8	18	12.72887	13.72474
4	35	13.05714	3.038410	9.231933	0.5135850	6	19	12.05052	14.06377

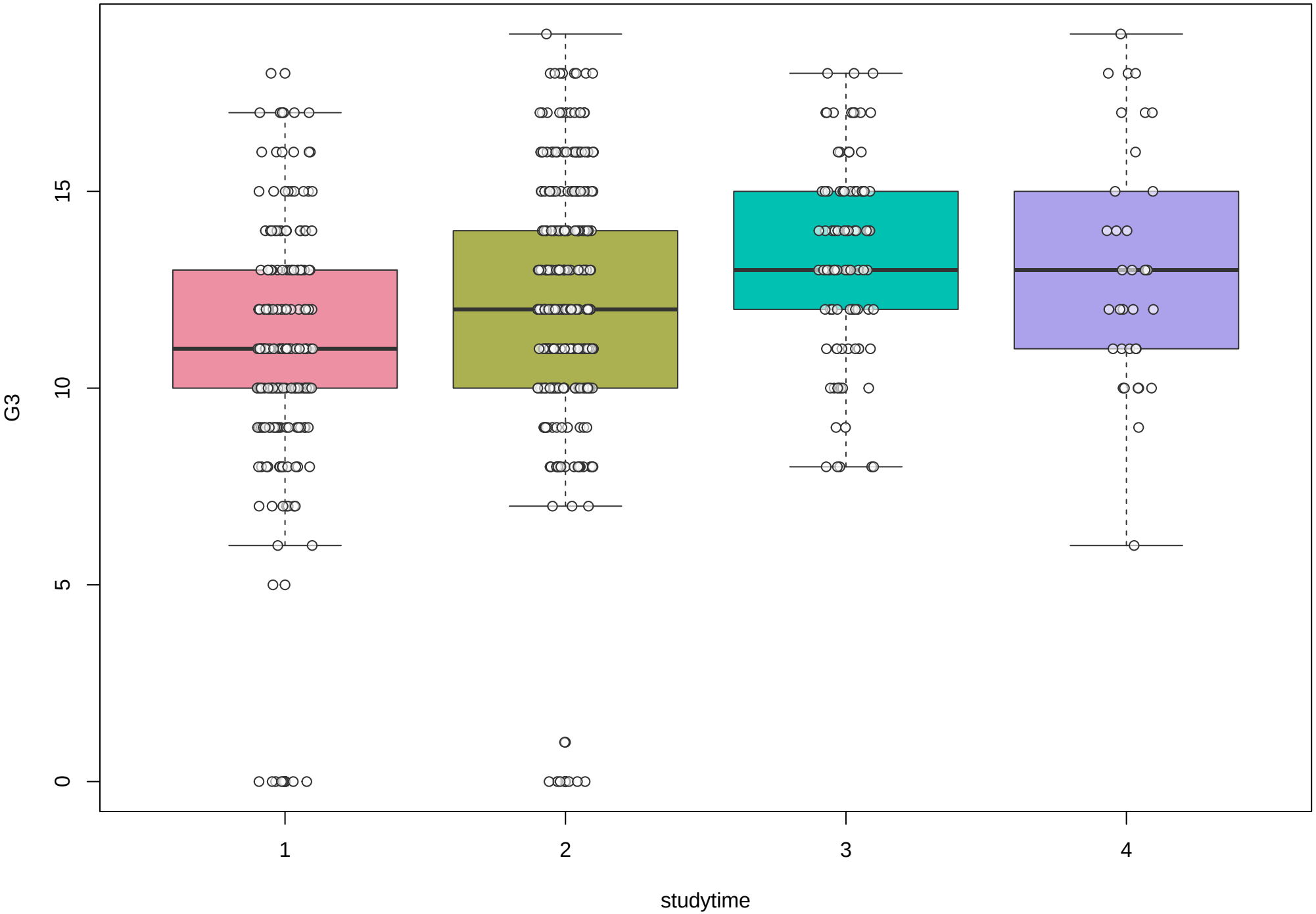
Bonferroni pairwise comparisons:

group_1	group_2	mean_group_1	mean_group_2	mean_difference_group_1_minus_group_2	standard_error	t_value
1	3	10.84434	13.22680	−2.3824645	0.3830482	−6.2197513
1	2	10.84434	12.09180	−1.2474637	0.2794187	−4.4644967
1	4	10.84434	13.05714	−2.2128032	0.5701308	−3.8812203
2	3	12.09180	13.22680	−1.1350008	0.3642547	−3.1159535
2	4	12.09180	13.05714	−0.9653396	0.5576780	−1.7309982
3	4	13.22680	13.05714	0.1696613	0.6161622	0.2753516

df_error	raw_p_value	bonferroni_adjusted_p_value	bonferroni_ci95_lower	bonferroni_ci95_upper	alpha	decision_alpha_0_05
645	8.952929e−10	5.371757e−09	−3.396171	−1.3687577	0.05	Significant after Bonferroni correction
645	9.473280e−06	5.683968e−05	−1.986923	−0.5080042	0.05	Significant after Bonferroni correction
645	1.146236e−04	6.877414e−04	−3.721609	−0.7039971	0.05	Significant after Bonferroni correction
645	1.914916e−03	1.148950e−02	−2.098972	−0.1710294	0.05	Significant after Bonferroni correction
645	8.393031e−02	5.035818e−01	−2.441190	0.5105112	0.05	Not significant after Bonferroni correction
645	7.831343e−01	1.000000e+00	−1.460963	1.8002859	0.05	Not significant after Bonferroni correction

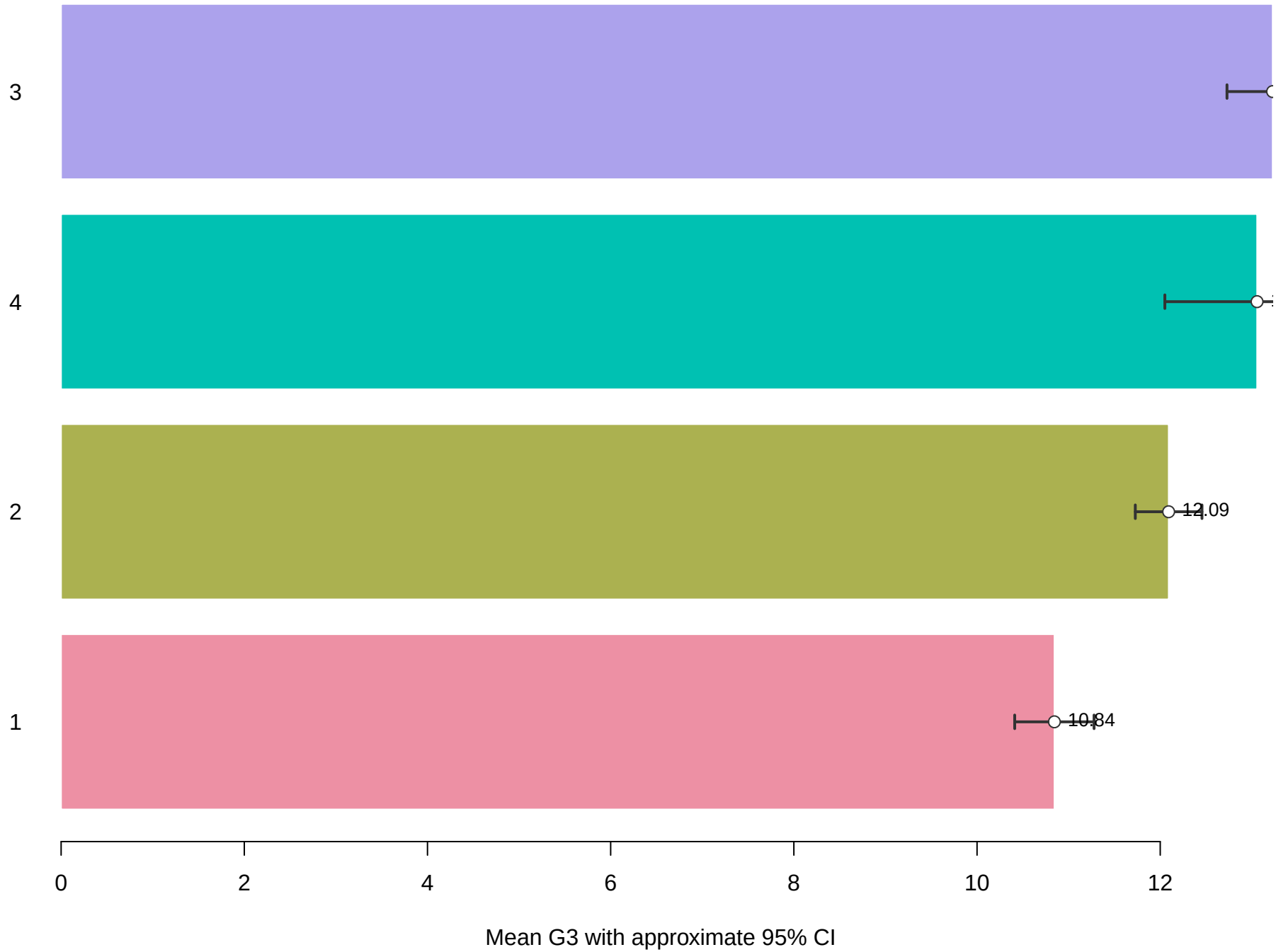
Bonferroni Post Hoc: Group Distributions

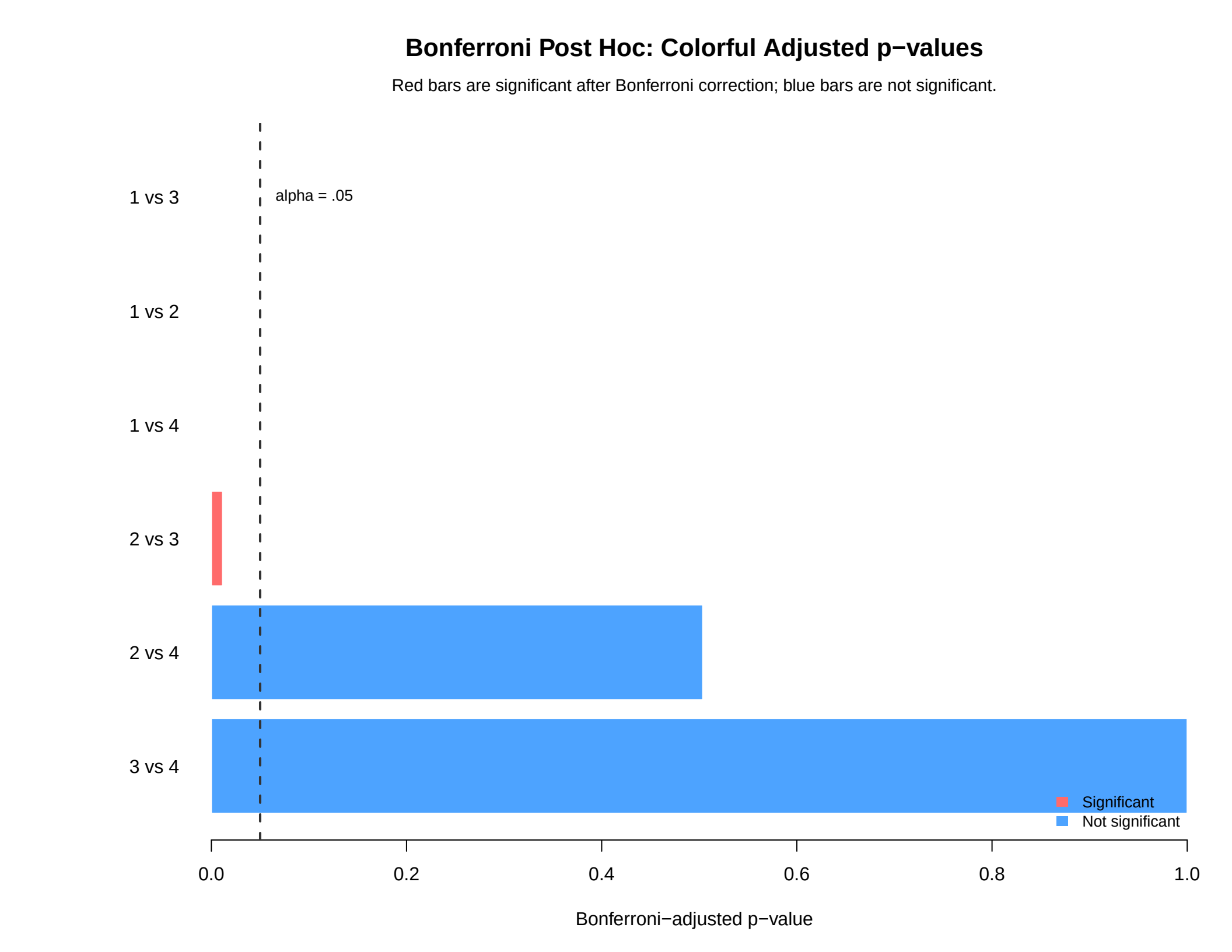
Colorful boxplots show score distributions before pairwise mean comparisons.

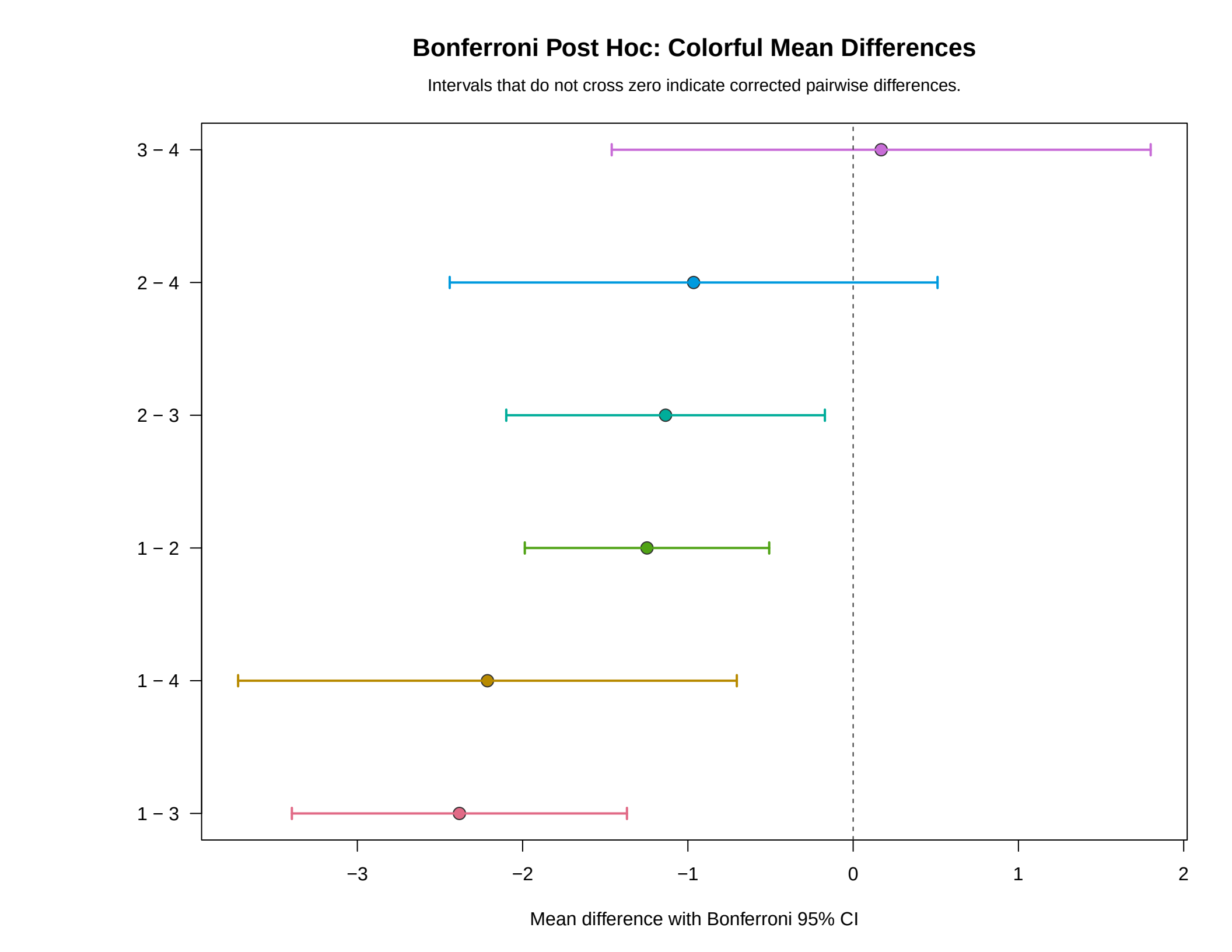


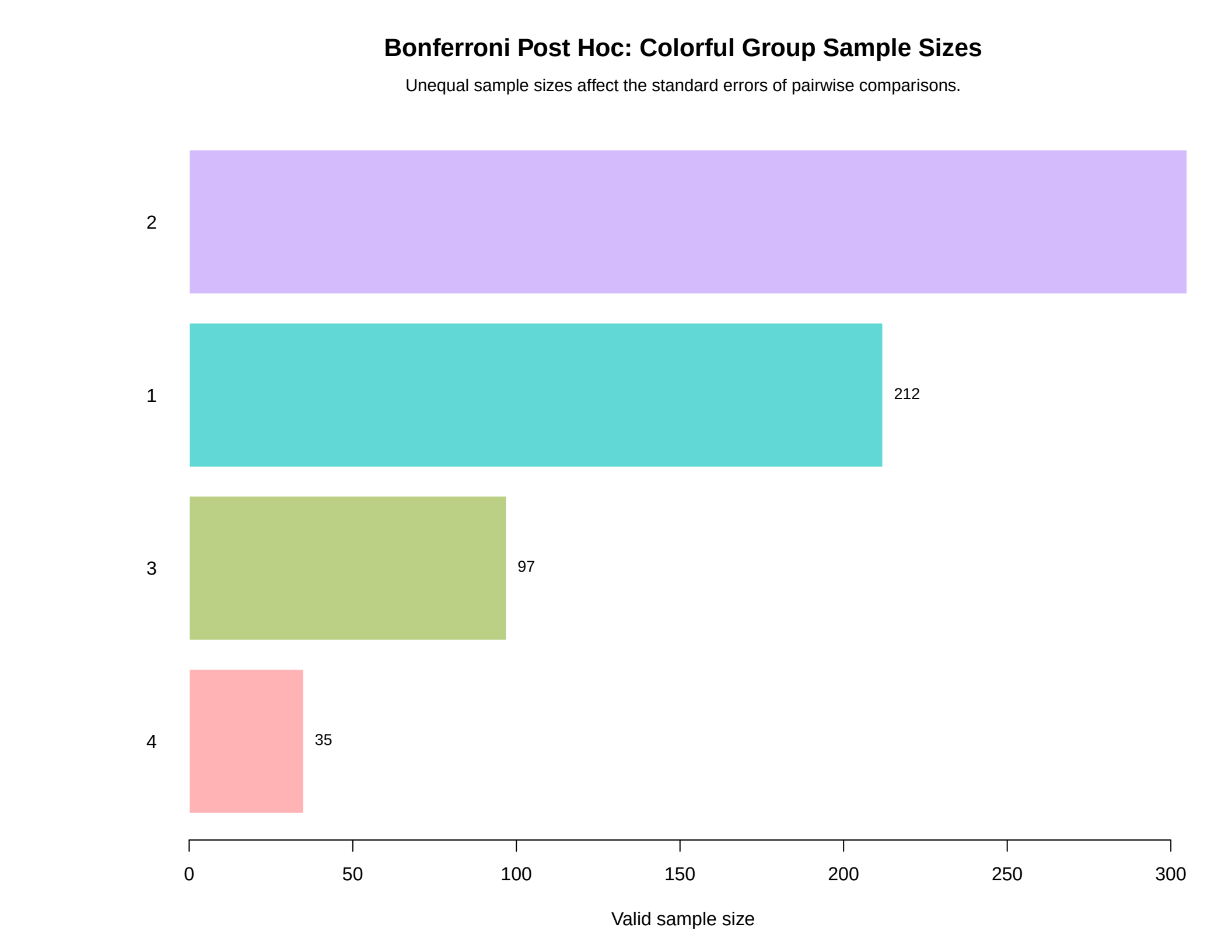
Bonferroni Post Hoc: Colorful Group Means

Bonferroni comparisons test which group means differ after correction.




Bonferroni Post Hoc: Colorful Adjusted p−values
Red bars are significant after Bonferroni correction; blue bars are not significant.
alpha = .05
1 vs 3
1 vs 2
1 vs 4
2 vs 3
2 vs 4
3 vs 4
Significant
Not significant
0.0
0.2
0.4
0.6
0.8
1.0
Bonferroni−adjusted p−value


Bonferroni Post Hoc: Colorful Mean Differences
Intervals that do not cross zero indicate corrected pairwise differences.
3 − 4
2 − 4
2 − 3
1 − 2
1 − 4
1 − 3
−3
−2
−1
0
1
2
Mean difference with Bonferroni 95% CI


Bonferroni Post Hoc: Colorful Group Sample Sizes
Unequal sample sizes affect the standard errors of pairwise comparisons.
2
1
212
3
97
4
35
0
50
100
150
200
250
300
Valid sample size