Main Effects vs Interaction Effects − Factorial ANOVA Report

Dependent variable: G3
Factor A: sex
Factor B: studytime

Method:
1. Fit a two−way/factorial ANOVA model: DV ~ Factor A + Factor B + Factor A x Factor B.
2. Interpret interaction first. If significant, prioritize simple effects and interaction plot.
3. If interaction is not significant, main effects can be interpreted more directly.

ANOVA table:

	effect	sum_sq	df	F_statistic	p_value	partial_eta_squared	alpha	decision_alpha_0_05
1	Main effect: Factor A	112.68277	1	11.645614	6.840454e−04	NA	0.05	Significant
2	Main effect: Factor B	383.46281	3	13.210123	2.233030e−08	NA	0.05	Significant
3	Interaction effect: Factor A x Factor B	64.81548	3	2.232865	8.322970e−02	NA	0.05	Not significant
4	Residual / error	6202.30551	641	NA	NA	NA	0.05	Not applicable

Interpretation summary:

	effect_checked	p_value	partial_eta_squared	statistical_decision	plain_language_interpretation	reporting_priority
1	Interaction: sex x studytime	0.0832297	NA	Not significant	Whether the effect of one factor changes across levels of the other factor.	Interpret main effect directly if interaction is not significant

Cell summary

	Factor_A	Factor_B	n	mean	standard_deviation	standard_error	ci95_low	ci95_high	minimum	maximum
1	F	1	89	11.19101	2.969069	0.3147207	10.574159	11.80786	0	17
2	M	1	123	10.59350	3.377450	0.3045344	9.996608	11.19038	0	18
3	F	2	198	12.19697	3.223737	0.2291010	11.747932	12.64601	0	18
4	M	2	107	11.89720	3.284999	0.3175728	11.274753	12.51964	0	19
5	F	3	75	13.12000	2.609546	0.3013244	12.529404	13.71060	8	18
6	M	3	22	13.59091	2.108014	0.4494301	12.710026	14.47179	9	17
7	F	4	21	14.19048	2.874353	0.6272352	12.961095	15.41986	10	19
8	M	4	14	11.35714	2.499450	0.6680062	10.047851	12.66644	6	17

Main−effect marginal means: Factor A

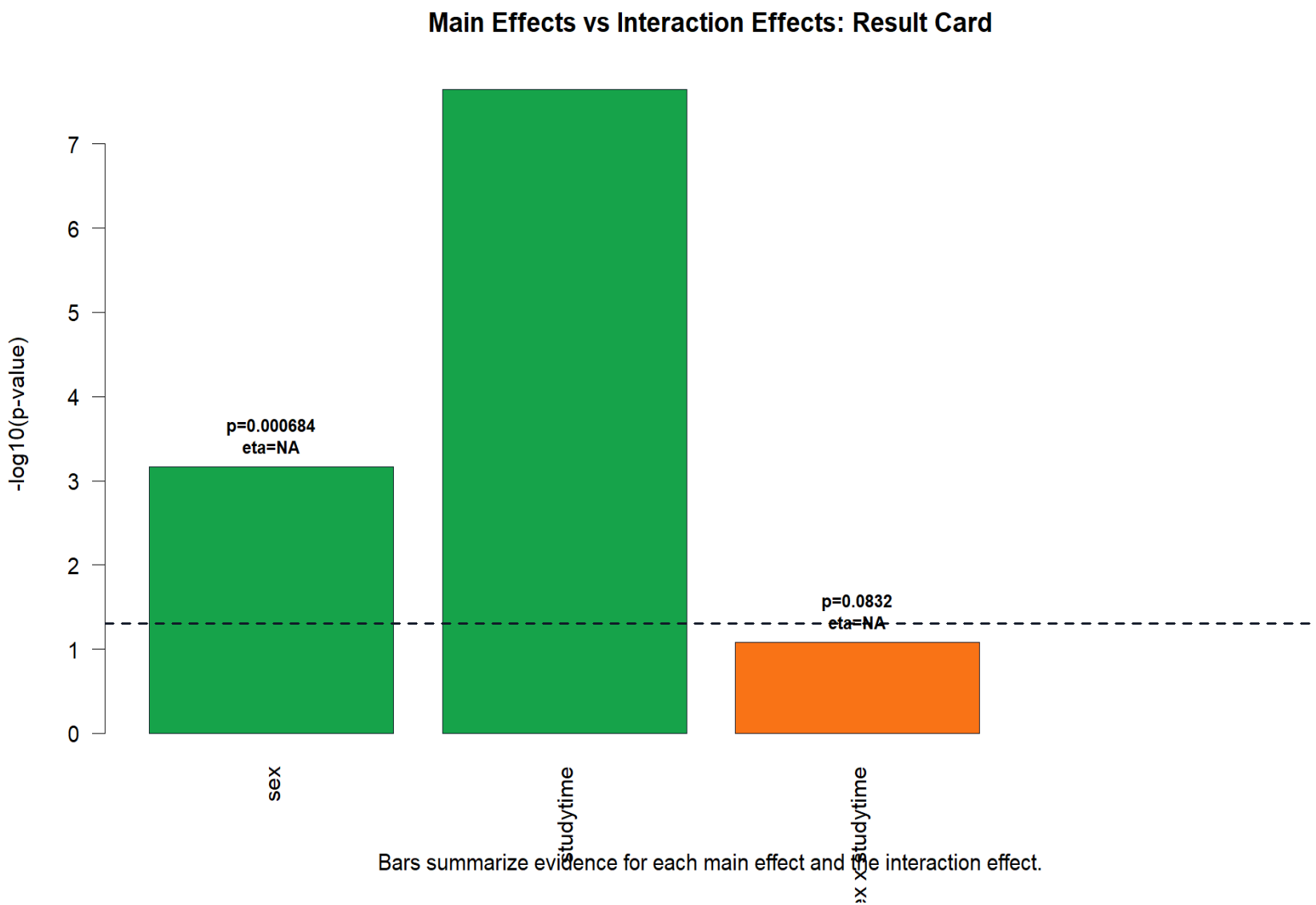
	Factor_A	n	mean	standard_deviation	standard_error	ci95_low	ci95_high	minimum	maximum
1	F	383	12.25326	3.124147	0.1596365	11.94038	12.56615	0	19
2	M	266	11.40602	3.320690	0.2036046	11.00695	11.80508	0	19

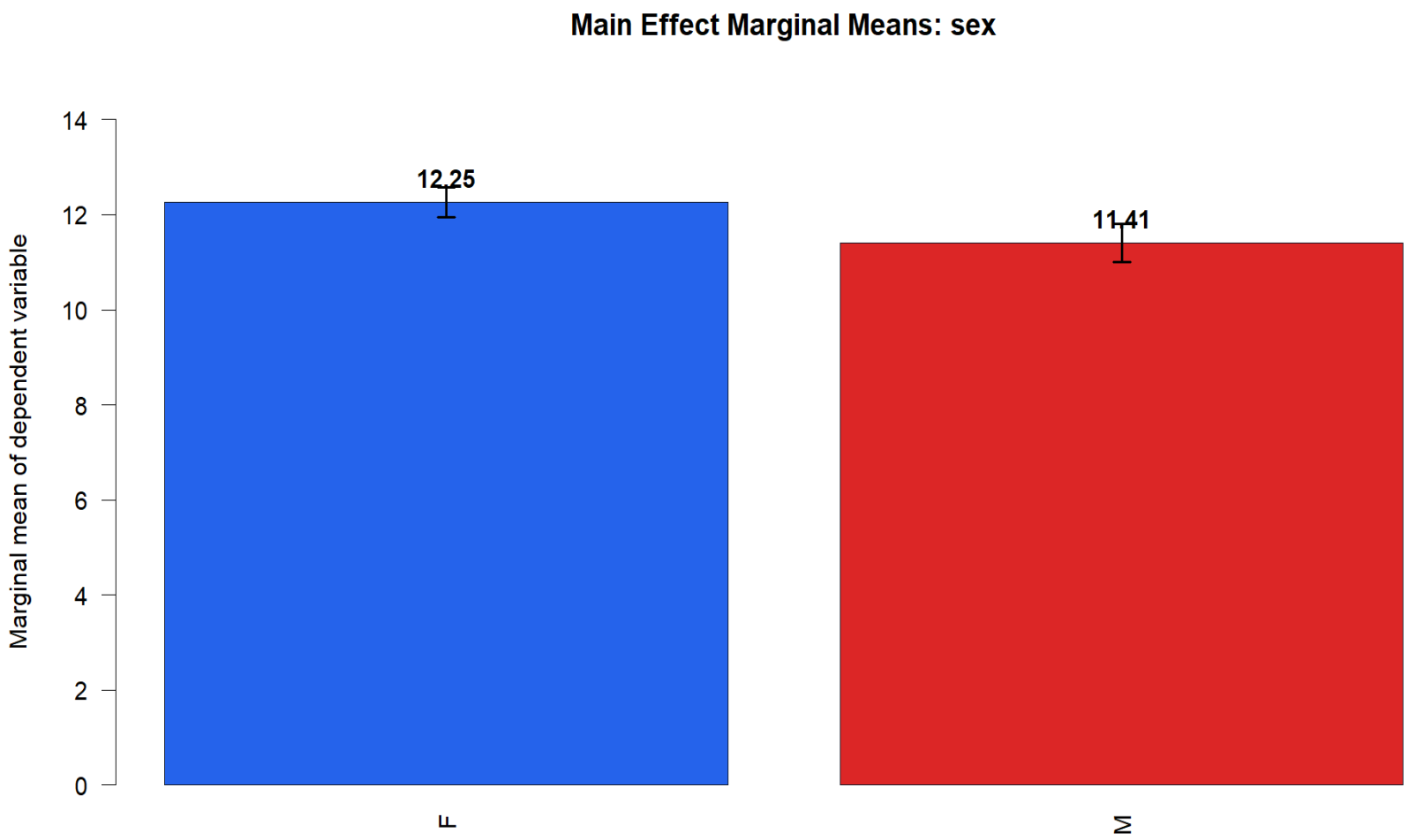
Main−effect marginal means: Factor B

	Factor_B	n	mean	standard_deviation	standard_error	ci95_low	ci95_high	minimum	maximum
1	1	212	10.84434	3.218624	0.2210560	10.41107	11.27761	0	18
2	2	305	12.09180	3.243125	0.1857008	11.72783	12.45578	0	19
3	3	97	13.22680	2.502104	0.2540502	12.72887	13.72474	8	18
4	4	35	13.05714	3.038410	0.5135850	12.05052	14.06377	6	19

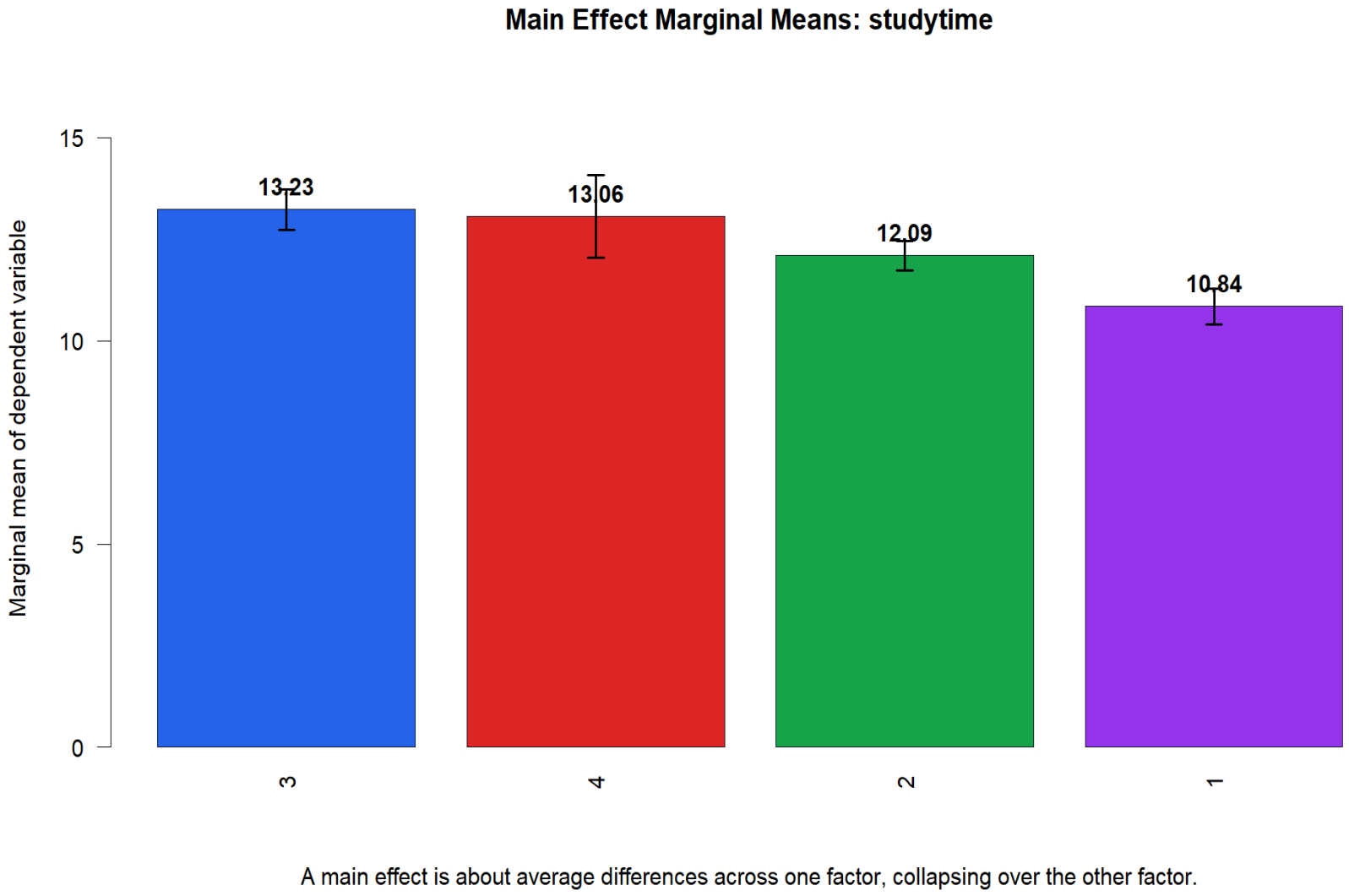
Simple effects

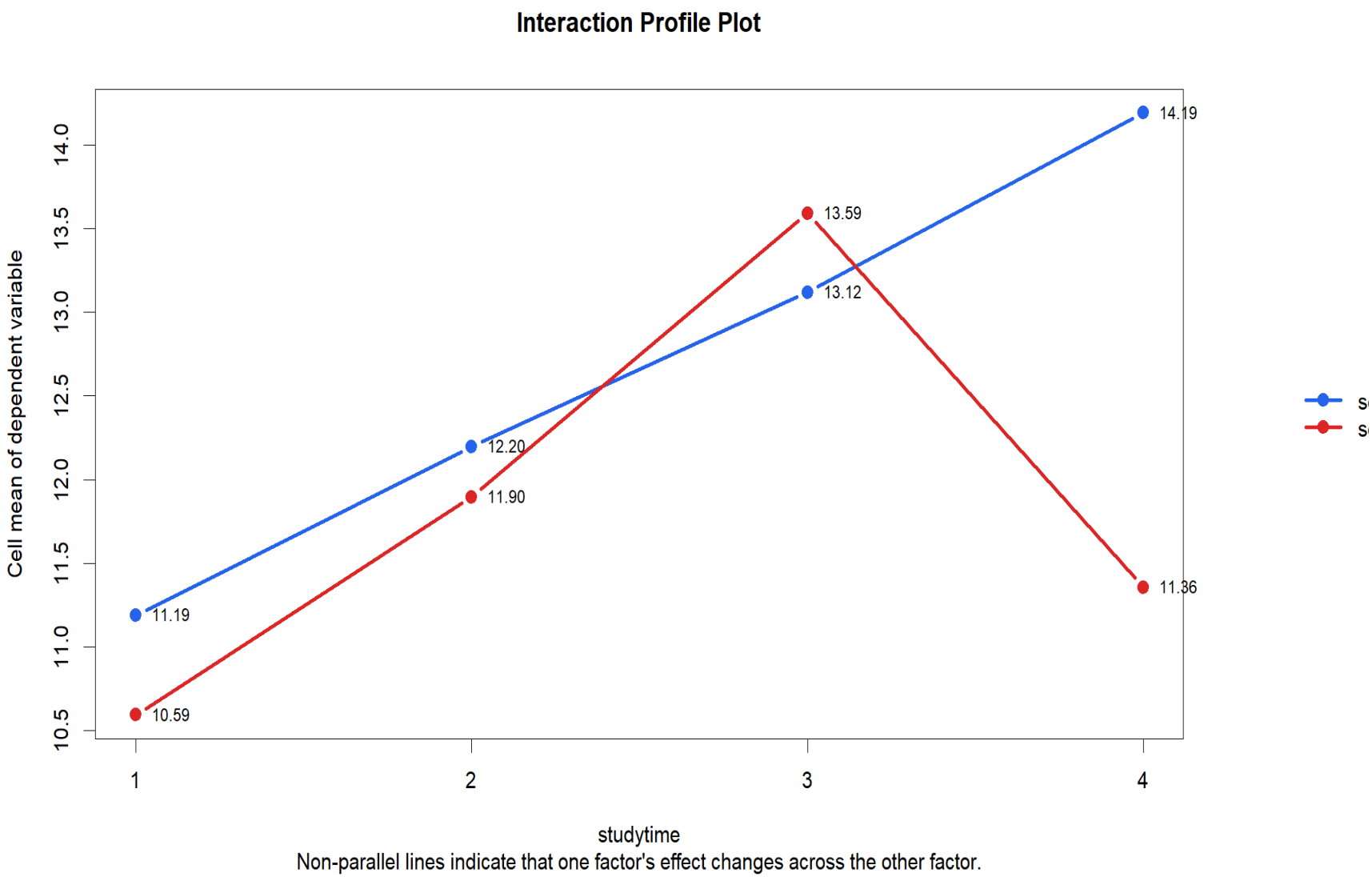
	simple_effect_question	fixed_factor	fixed_level	tested_factor	df_between	df_within	f_statistic	p_value	decision_alpha_0_05
1	Does studytime differ within sex = F?	sex	F	studytime	3	379	8.5448234	1.669868e-05	Significant
2	Does studytime differ within sex = M?	sex	M	studytime	3	262	6.8341708	1.887761e-04	Significant
3	Does sex differ within studytime = 1?	studytime	1	sex	1	210	1.7862079	1.828351e-01	Not significant
4	Does sex differ within studytime = 2?	studytime	2	sex	1	303	0.5926875	4.419815e-01	Not significant
5	Does sex differ within studytime = 3?	studytime	3	sex	1	95	0.6000154	4.404958e-01	Not significant
6	Does sex differ within studytime = 4?	studytime	4	sex	1	33	9.0293305	5.043376e-03	Significant

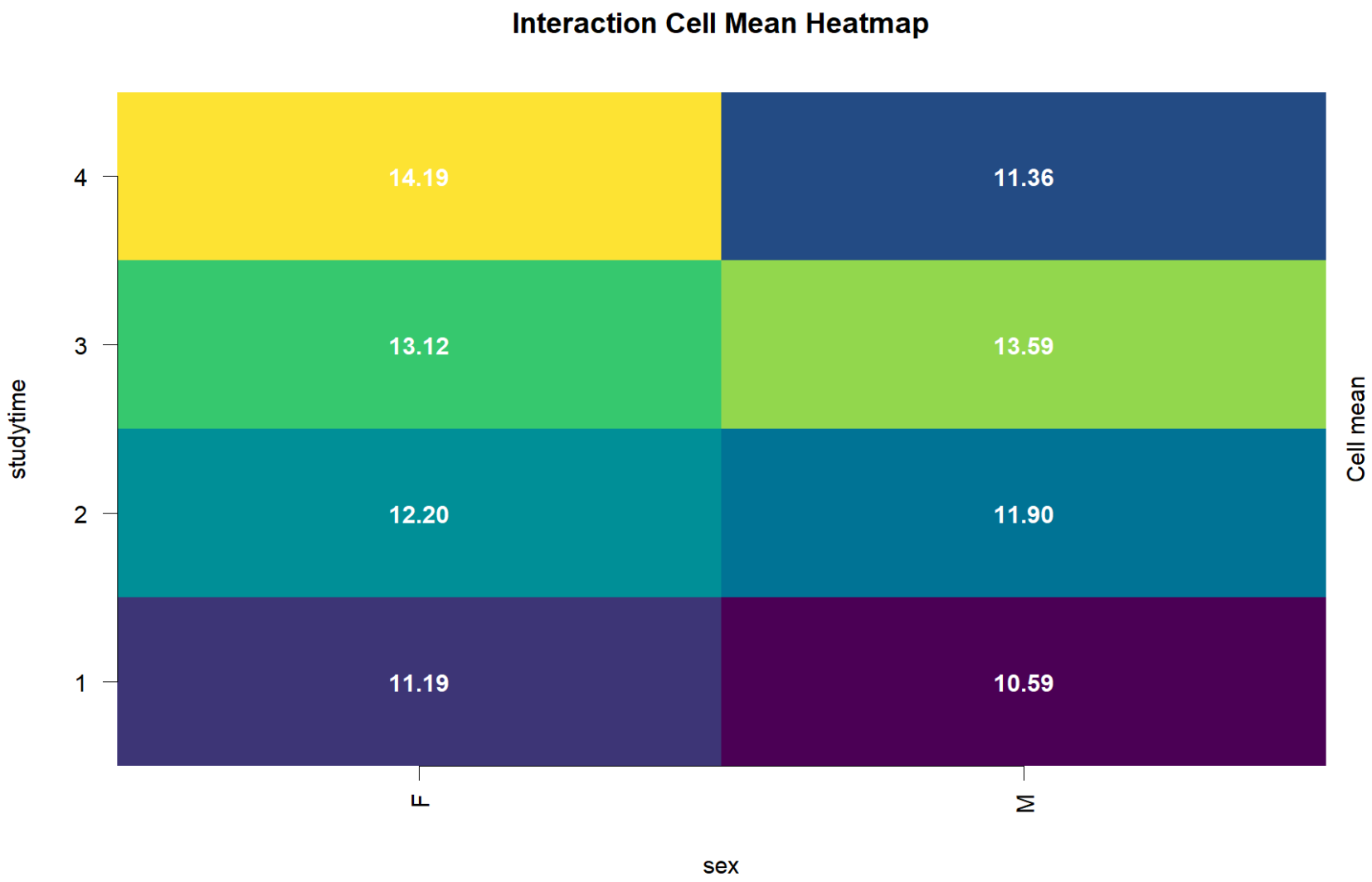

Main Effects vs Interaction Effects: Result Card
-log10(p-value)
0
1
2
3
4
5
6
7
p=0.000684
eta=NA
p=0.0832
eta=NA
sex
studytime
sex x studytime
Bars summarize evidence for each main effect and the interaction effect.

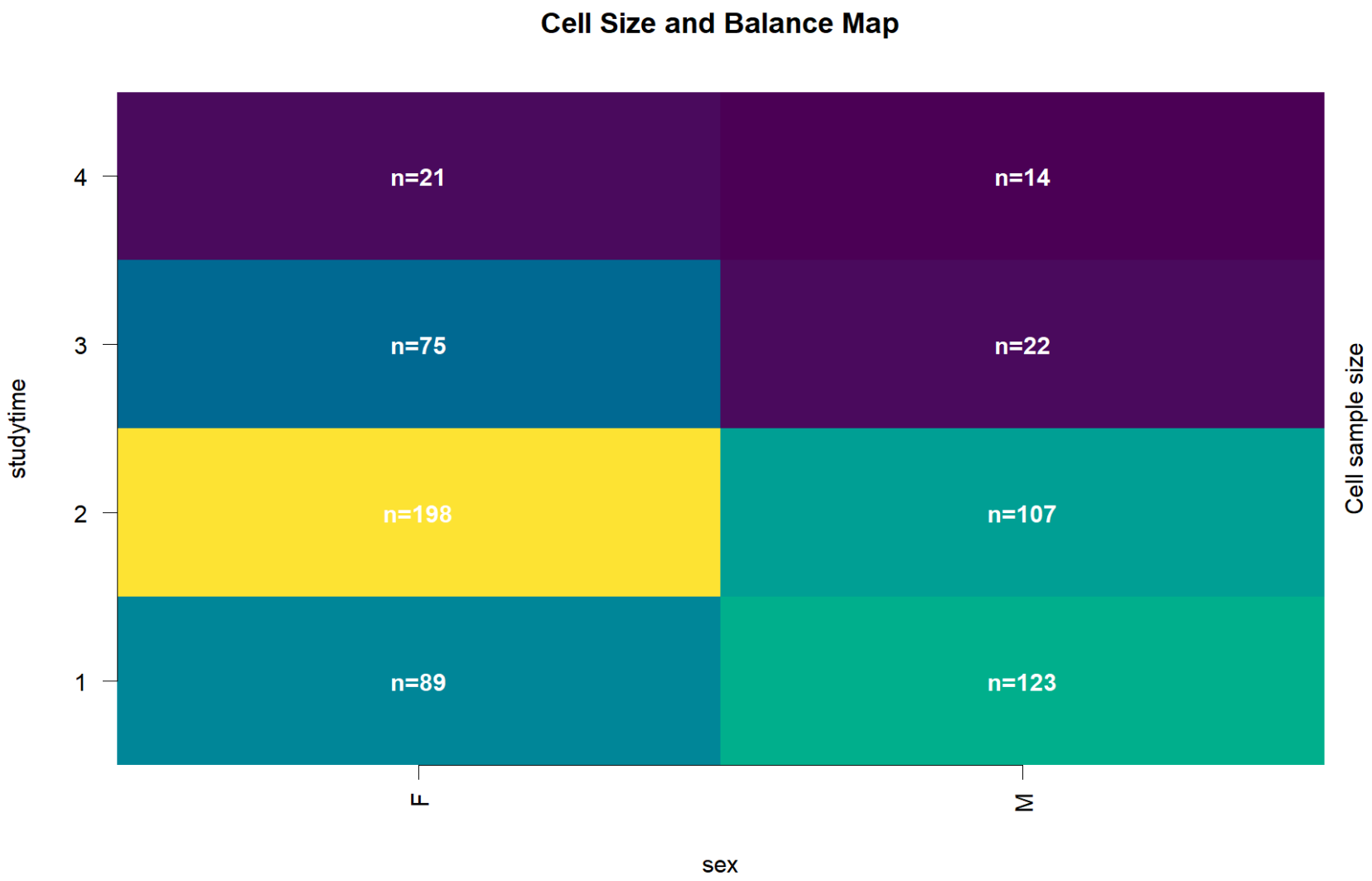


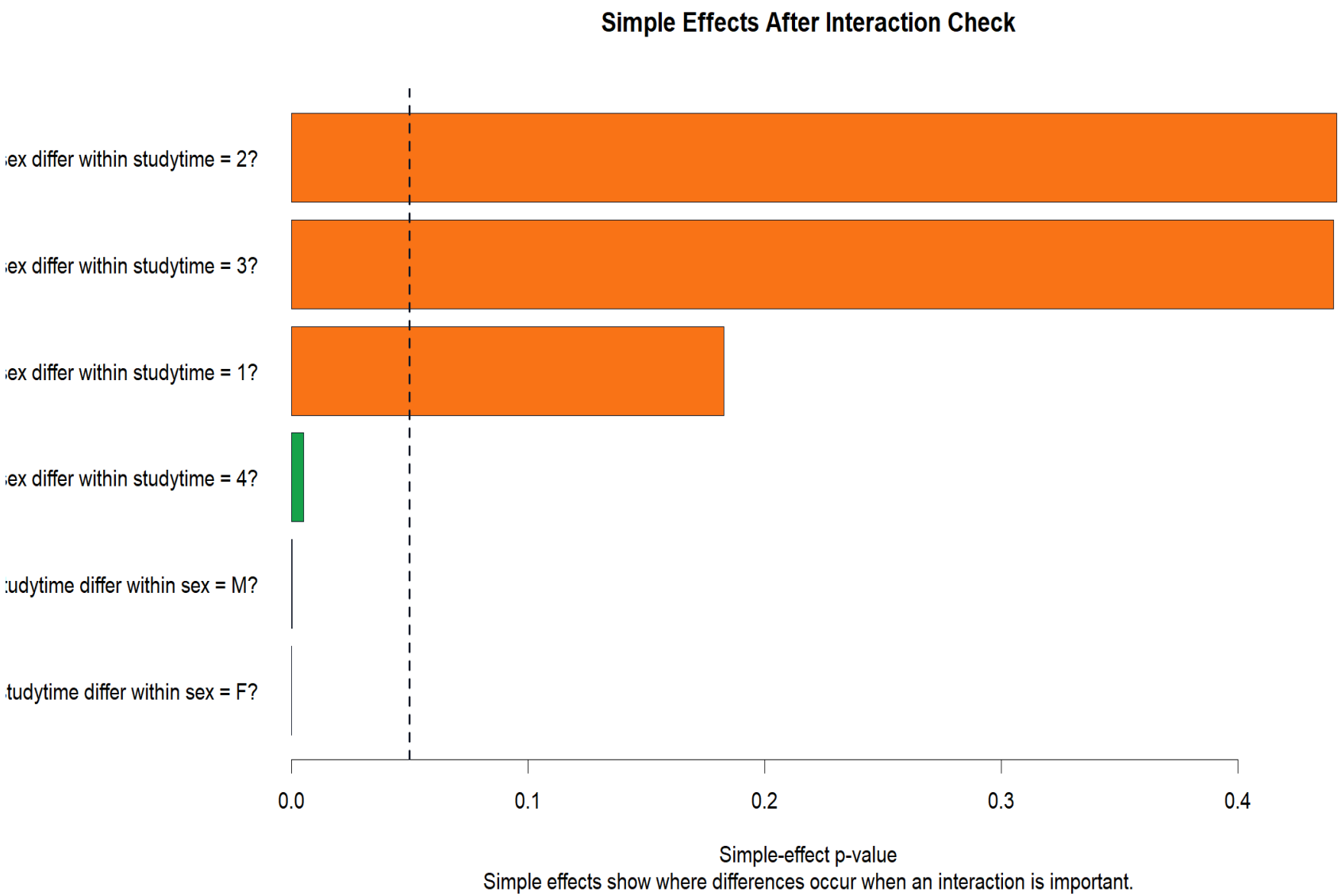
A main effect is about average differences across one factor, collapsing over the other factor.

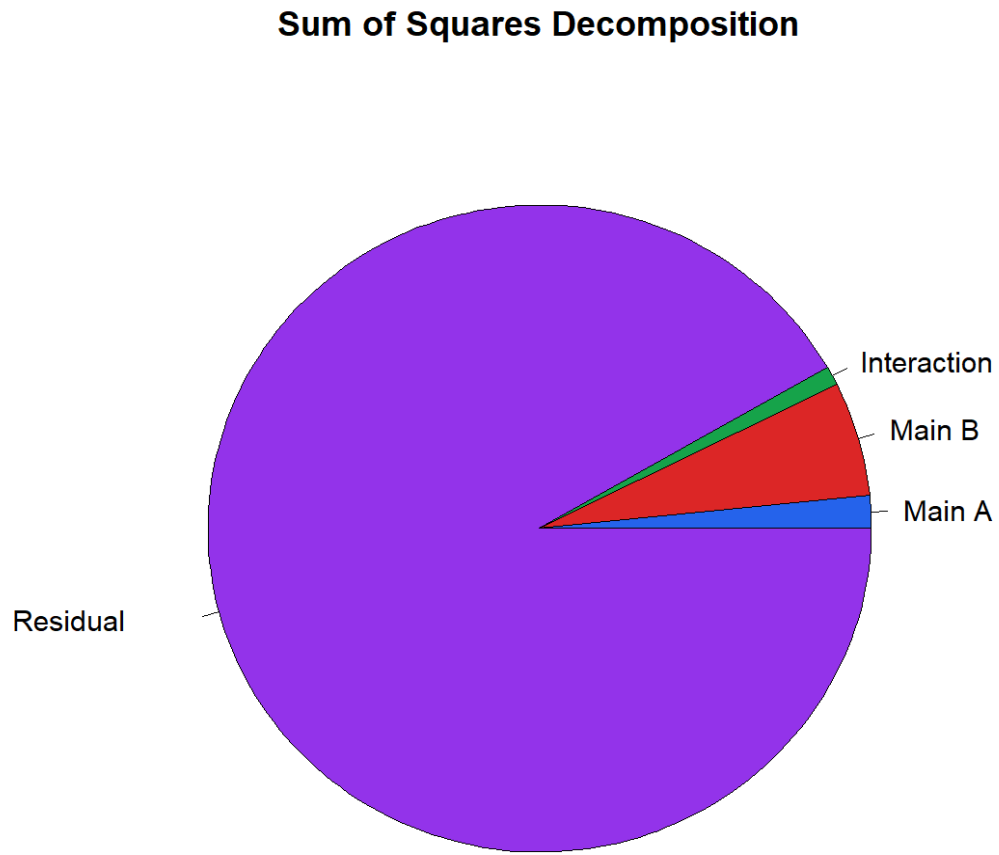

Main Effect Marginal Means: studytime
Marginal mean of dependent variable
15
10
5
0
13.23
13.06
12.09
10.84
3
4
2
1
A main effect is about average differences across one factor, collapsing over the other factor.

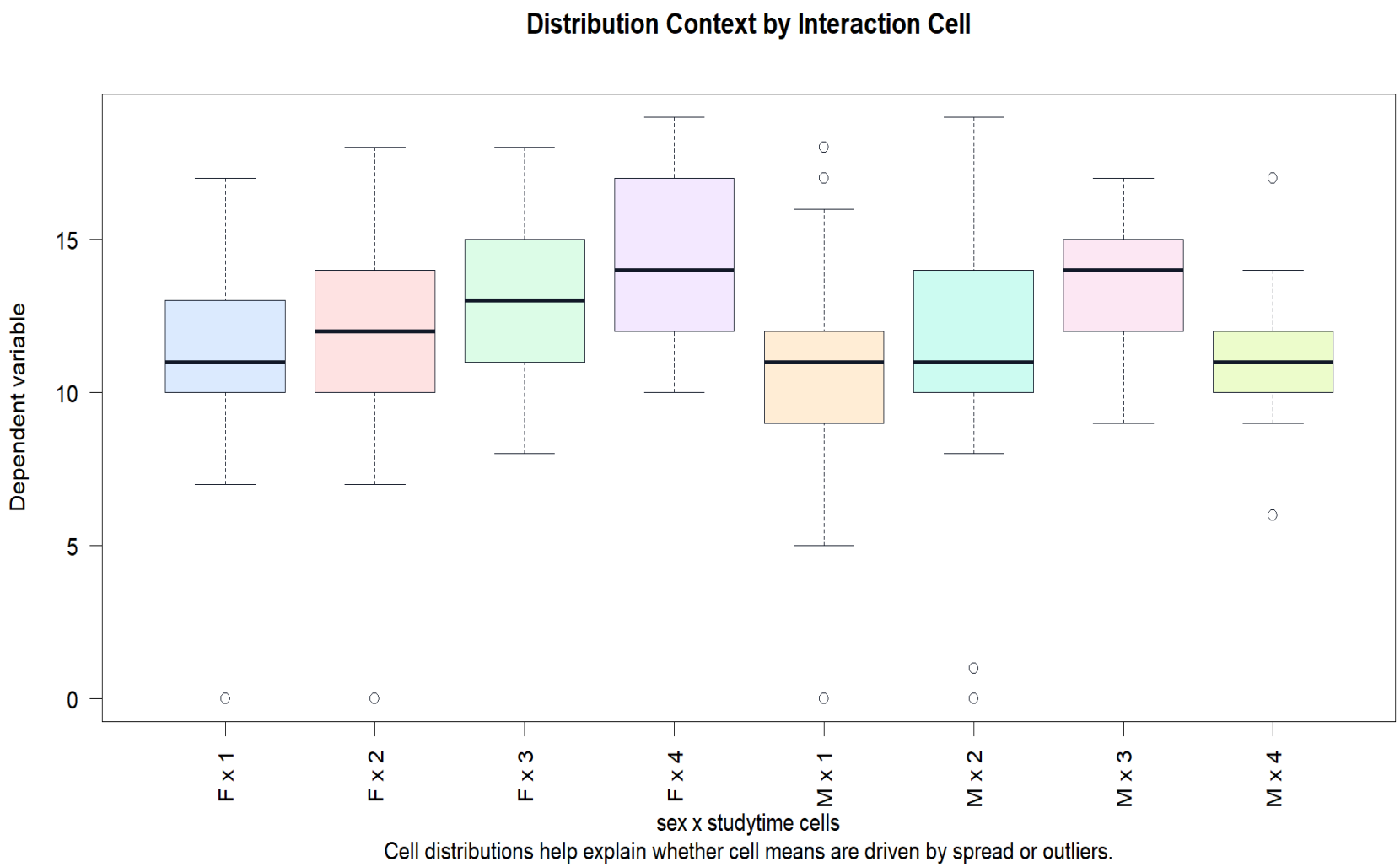

Interaction Profile Plot
Cell mean of dependent variable
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
1
2
3
4
studytime
Non-parallel lines indicate that one factor's effect changes across the other factor.
11.19
12.20
13.12
14.19
10.59
11.90
13.59
11.36


Interaction Cell Mean Heatmap
studytime
4
3
2
1
14.19
11.36
13.12
13.59
12.20
11.90
11.19
10.59
F
M
sex
Cell mean


Cell Size and Balance Map
studytime
4
3
2
1
n=21
n=14
n=75
n=22
n=198
n=107
n=89
n=123
F
M
sex
Cell sample size


Simple Effects After Interaction Check
ex differ within studytime = 2?
ex differ within studytime = 3?
ex differ within studytime = 1?
ex differ within studytime = 4?
udytime differ within sex = M?
tudytime differ within sex = F?
0.0
0.1
0.2
0.3
0.4
Simple-effect p-value
Simple effects show where differences occur when an interaction is important.


Sum of Squares Decomposition
Interaction
Main B
Main A
Residual


Distribution Context by Interaction Cell
Dependent variable
0
5
10
15
F x 1
F x 2
F x 3
F x 4
M x 1
M x 2
M x 3
M x 4
sex x studytime cells
Cell distributions help explain whether cell means are driven by spread or outliers.