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 × Factor B.
2. Interpret the interaction first. If significant, prioritize interaction plot and simple effects.
3. If interaction is not significant, main effects can be interpreted more directly.

ANOVA table:

effect	raw_model_term	sum_sq	df	F_statistic	p_value	partial_eta_squared	alpha	decision_alpha_0_05
Main effect: Factor A	C(Factor_A)	31.067749	1.0	3.210810	7.362479e-02	0.004984	0.05	Not significant
Main effect: Factor B	C(Factor_B)	383.462806	3.0	13.210123	2.233030e-08	0.058226	0.05	Significant
Interaction effect: Factor A x Factor B	C(Factor_A):C(Factor_B)	64.815481	3.0	2.232865	8.322970e-02	0.010342	0.05	Not significant
Residual / error	Residual	6202.305509	641.0	NaN	NaN	NaN	0.05	Not applicable

Interpretation summary:

effect_checked	p_value	partial_eta_squared	statistical_decision	plain_language_interpretation	reporting_priority
Main effect of sex	7.362479e-02	0.004984	Not significant	Average sex differences after accounting for studytime.	Interpret main effect directly if interaction is not significant
Main effect of studytime	2.233030e-08	0.058226	Significant	Average studytime differences after accounting for sex.	Interpret main effect directly if interaction is not significant
Interaction: sex x studytime	8.322970e-02	0.010342	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	original_factor_a	original_factor_b
F	1	89	11.191011	2.969069	0.314721	10.574159	11.807864	0.0	17.0	sex	studytime
F	2	198	12.196970	3.223737	0.229101	11.747932	12.646008	0.0	18.0	sex	studytime
F	3	75	13.120000	2.609546	0.301324	12.529404	13.710596	8.0	18.0	sex	studytime
F	4	21	14.190476	2.874353	0.627235	12.961095	15.419857	10.0	19.0	sex	studytime
M	1	123	10.593496	3.377450	0.304534	9.996608	11.190383	0.0	18.0	sex	studytime
M	2	107	11.897196	3.284999	0.317573	11.274753	12.519639	0.0	19.0	sex	studytime
M	3	22	13.590909	2.108014	0.449430	12.710026	14.471792	9.0	17.0	sex	studytime
M	4	14	11.357143	2.499450	0.668006	10.047851	12.666435	6.0	17.0	sex	studytime

Main-effect marginal means: Factor A

Factor_A	n	mean	standard_deviation	standard_error	ci95_low	ci95_high	minimum	maximum	original_factor
F	383	12.253264	3.124147	0.159636	11.940376	12.566151	0.0	19.0	sex
M	266	11.406015	3.320690	0.203605	11.006950	11.805080	0.0	19.0	sex

Main-effect marginal means: Factor B

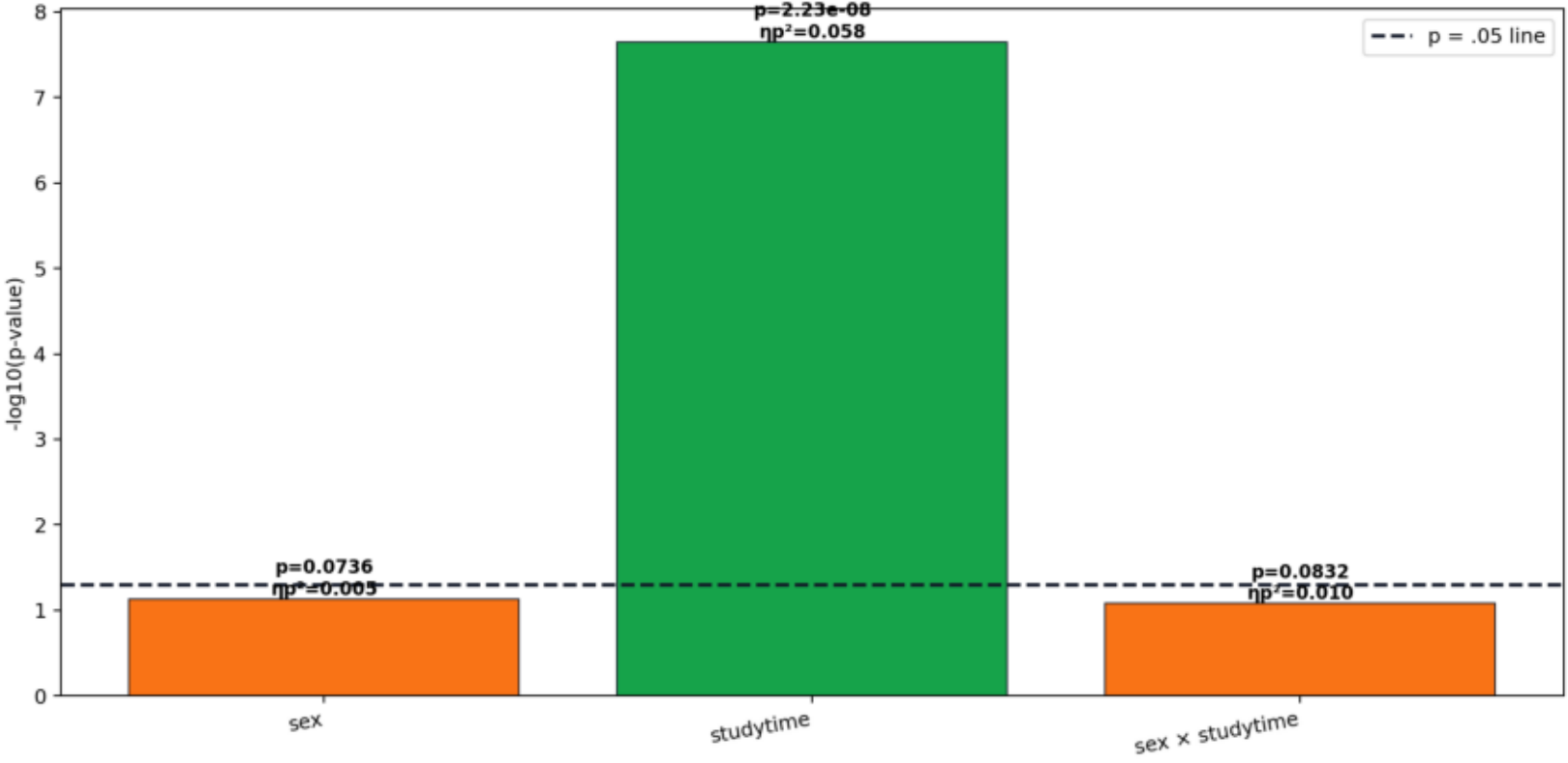
Factor_B	n	mean	standard_deviation	standard_error	ci95_low	ci95_high	minimum	maximum	original_factor
1	212	10.844340	3.218624	0.221056	10.411070	11.277609	0.0	18.0	studytime
2	305	12.091803	3.243125	0.185701	11.727830	12.455777	0.0	19.0	studytime
3	97	13.226804	2.502104	0.254050	12.728866	13.724742	8.0	18.0	studytime
4	35	13.057143	3.038410	0.513585	12.050516	14.063769	6.0	19.0	studytime

Simple effects

simple_effect_question	fixed_factor	fixed_level	tested_factor	df_between	df_within	f_statistic	p_value	decision_alpha_0_05
Does studytime differ within sex = F?	sex	F	studytime	3	379	8.544823	0.000017	Significant
Does studytime differ within sex = M?	sex	M	studytime	3	262	6.834171	0.000189	Significant
Does sex differ within studytime = 1?	studytime	1	sex	1	210	1.786208	0.182835	Not significant
Does sex differ within studytime = 2?	studytime	2	sex	1	303	0.592687	0.441982	Not significant
Does sex differ within studytime = 3?	studytime	3	sex	1	95	0.600015	0.440496	Not significant
Does sex differ within studytime = 4?	studytime	4	sex	1	33	9.029330	0.005043	Significant

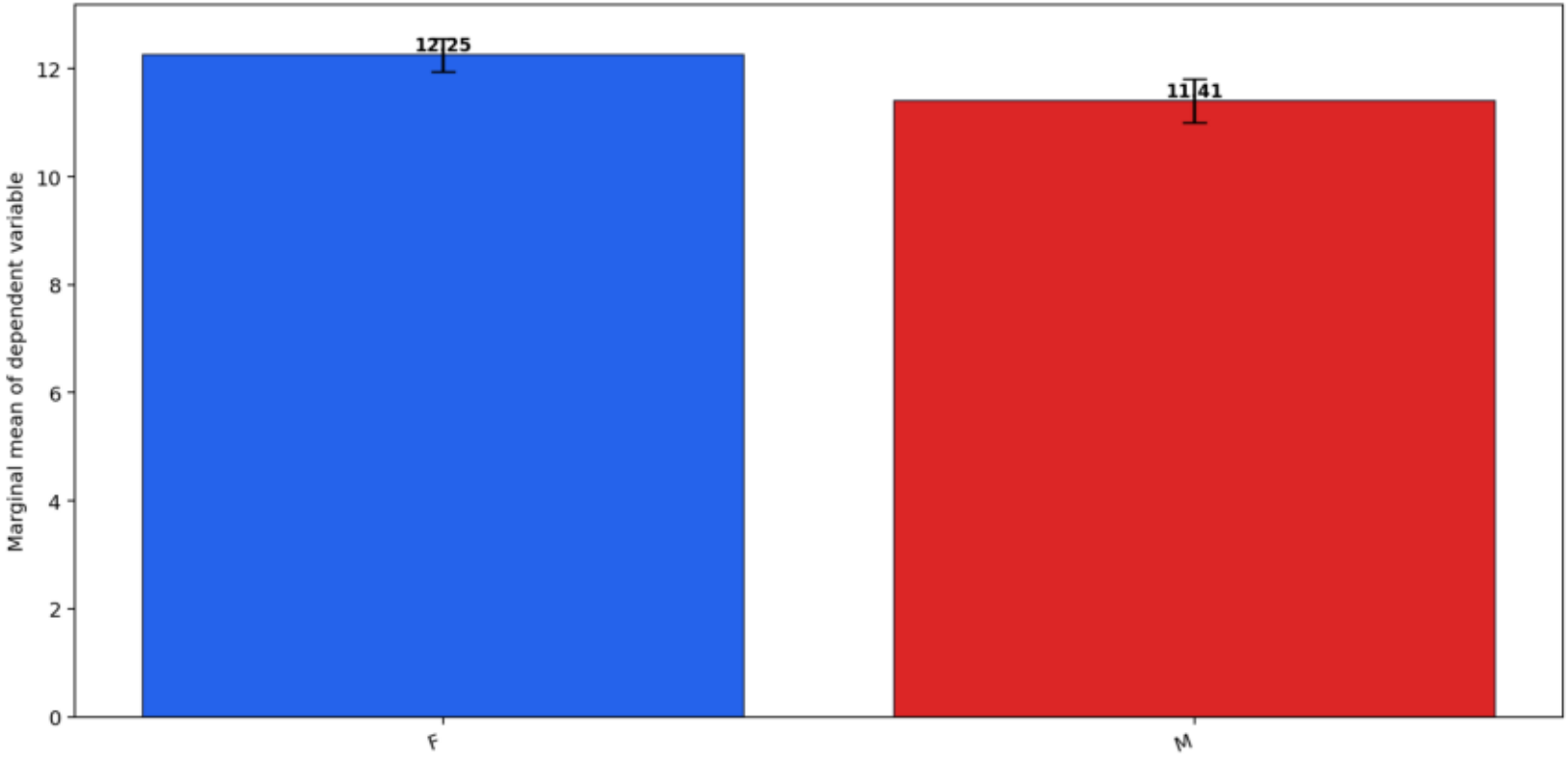
Main Effects vs Interaction Effects: Result Card

Bars summarize evidence for each main effect and the interaction effect.



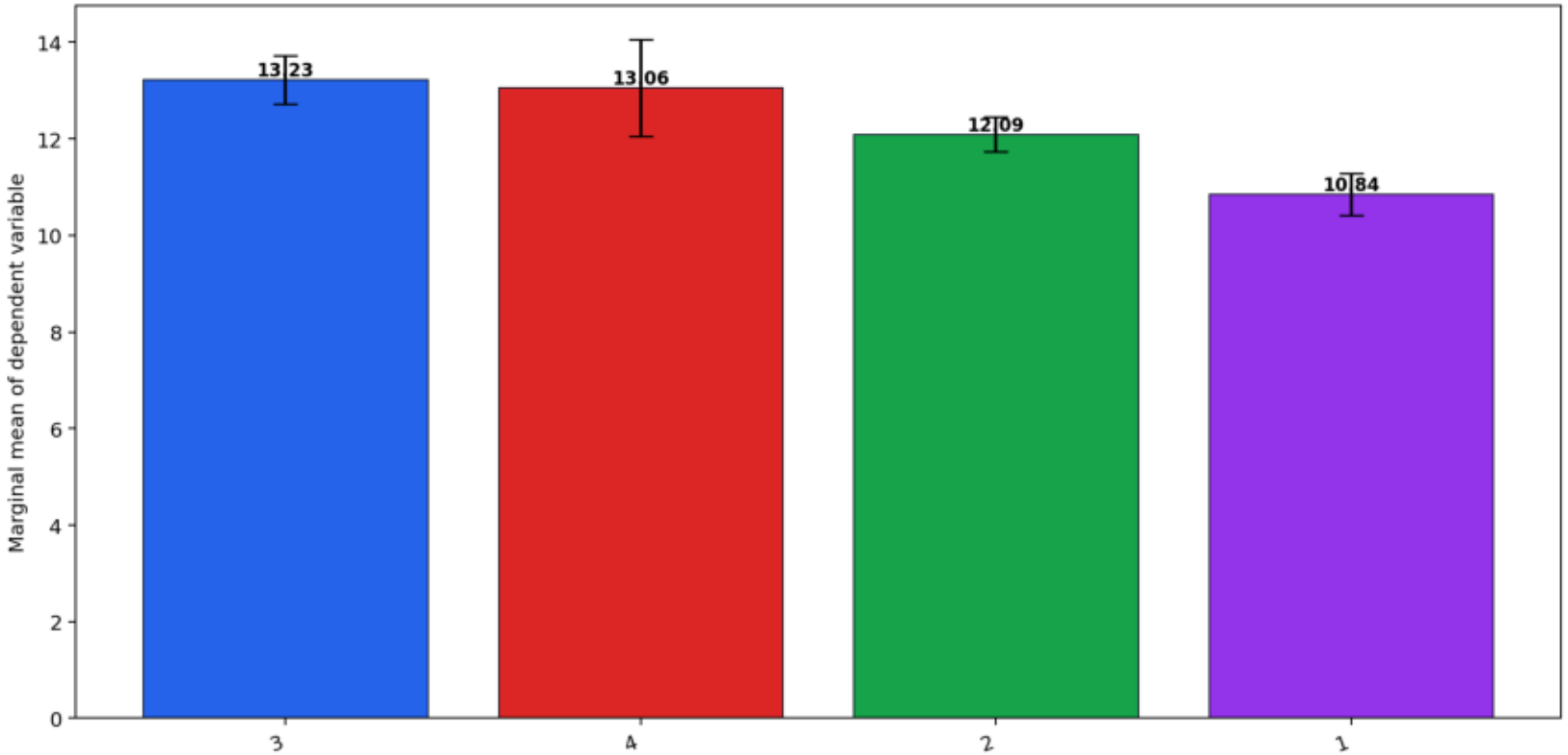
Main Effect Marginal Means: sex

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



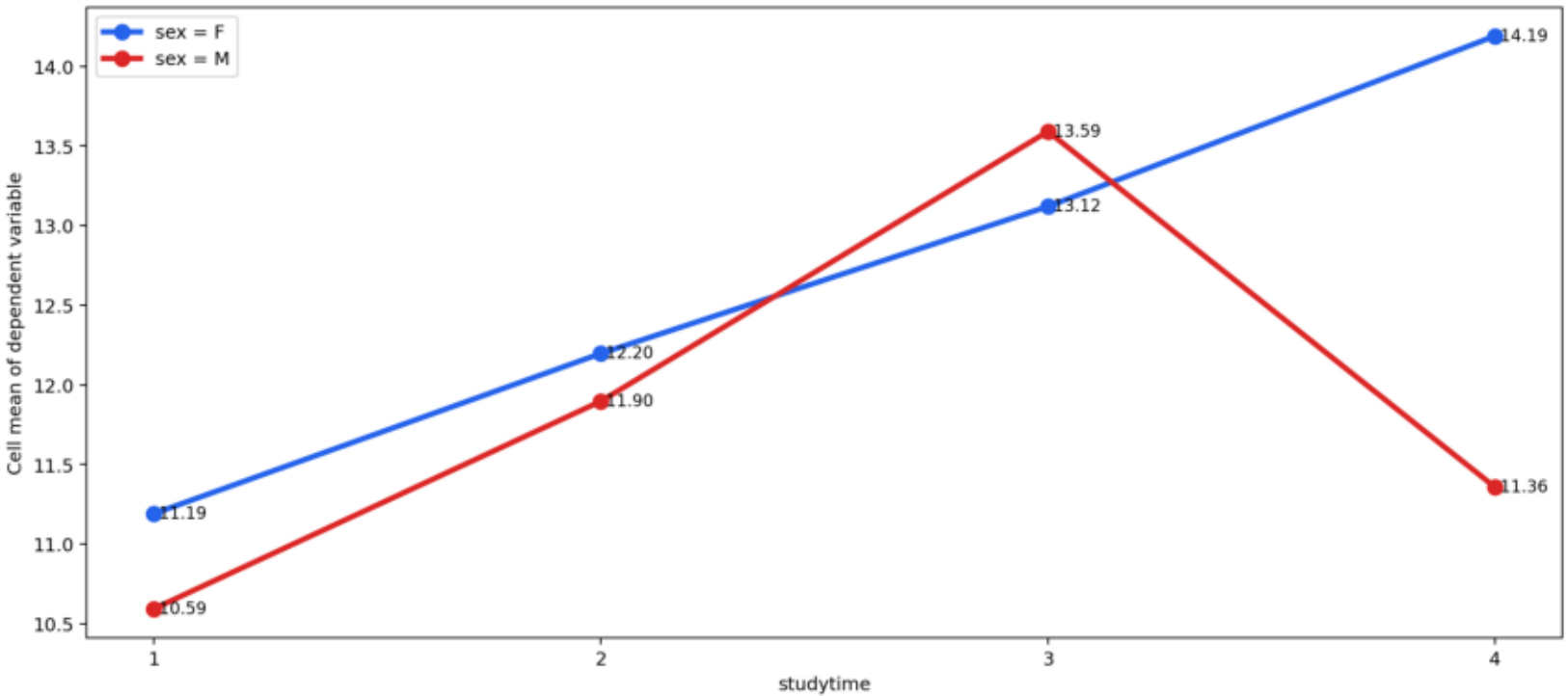
Main Effect Marginal Means: studytime

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



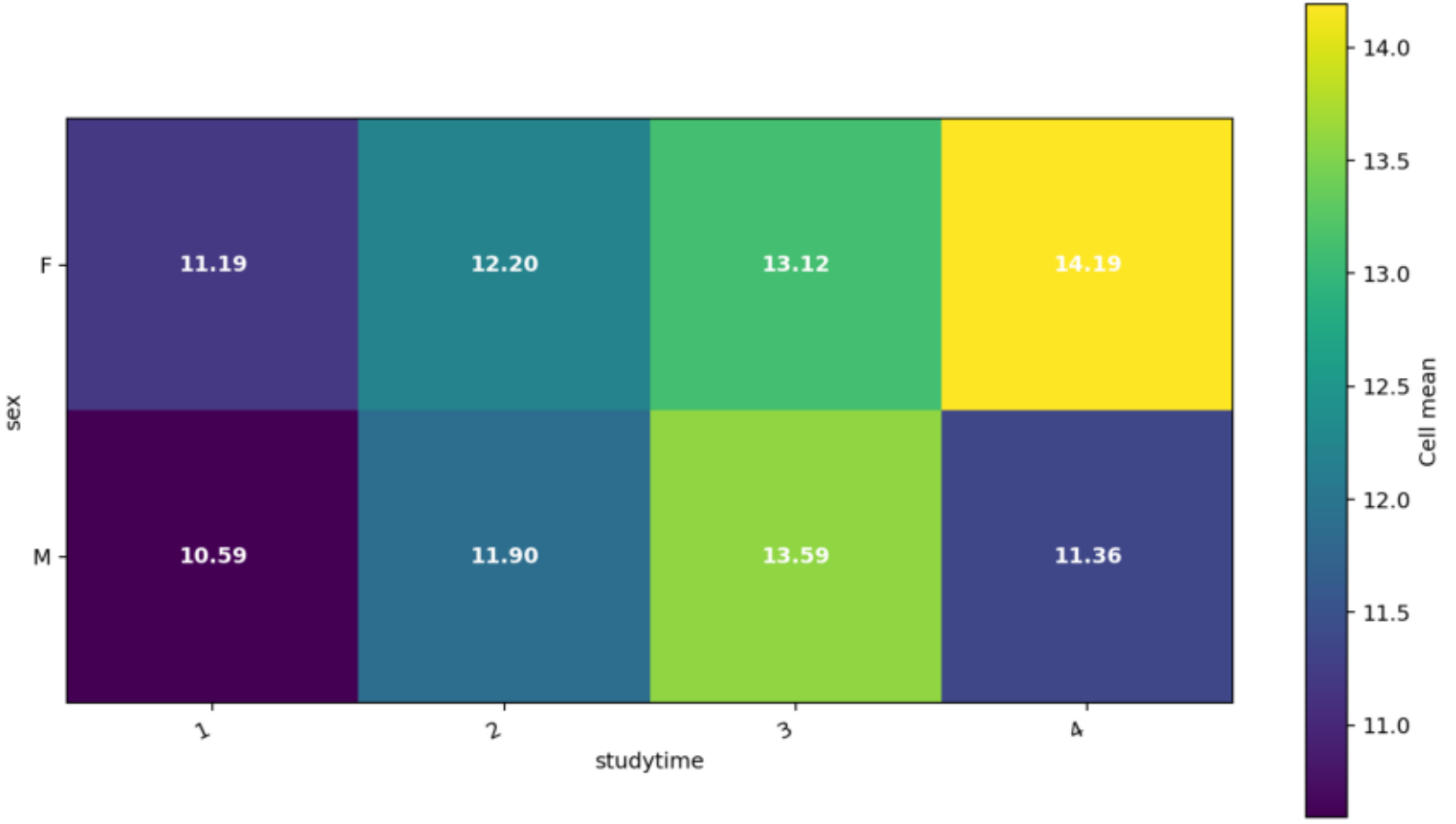
Interaction Profile Plot

Non-parallel lines indicate that the effect of one factor changes across the other factor.



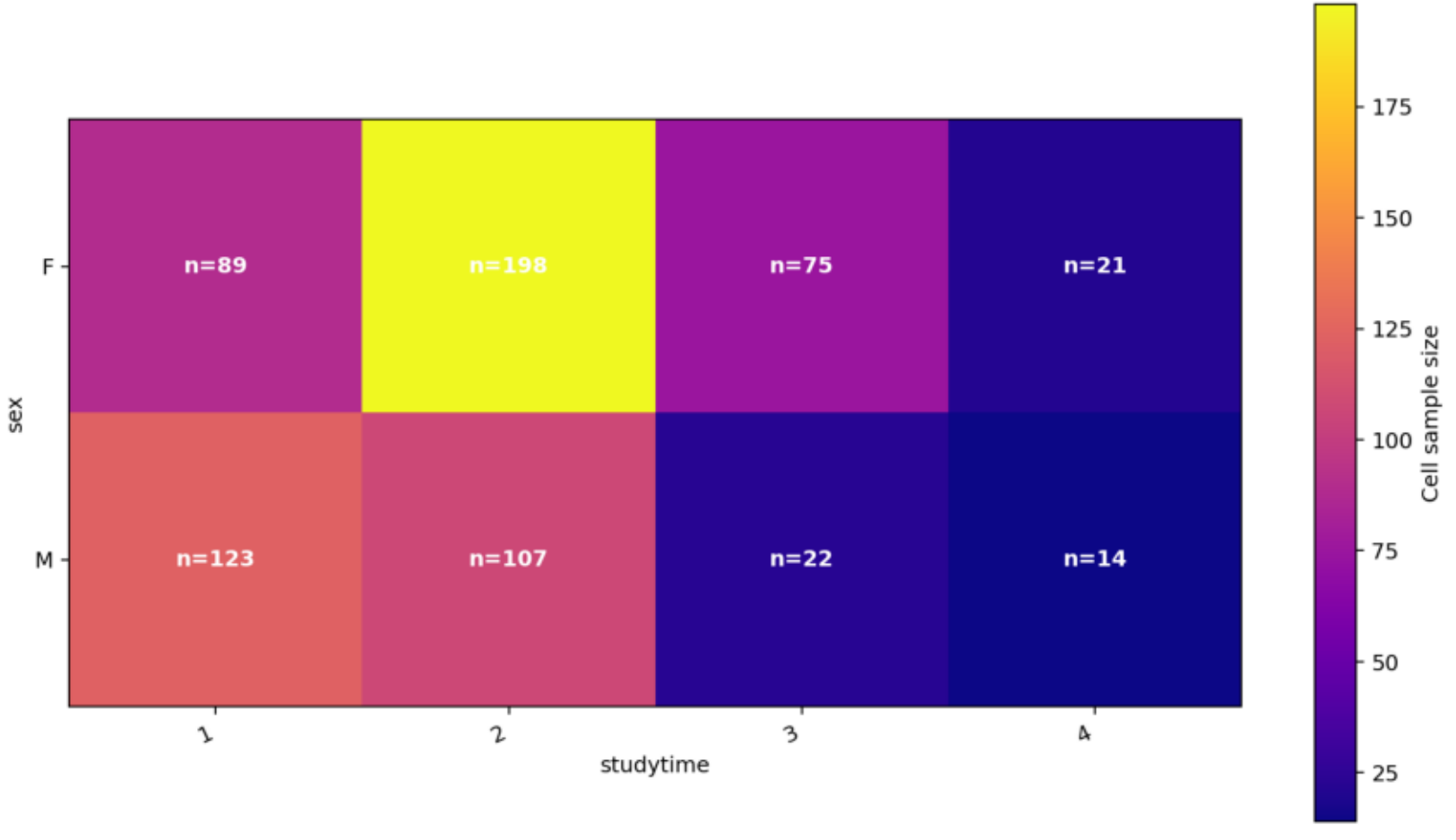
Interaction Cell Mean Heatmap

Each cell shows the mean outcome for a unique combination of the two factors.



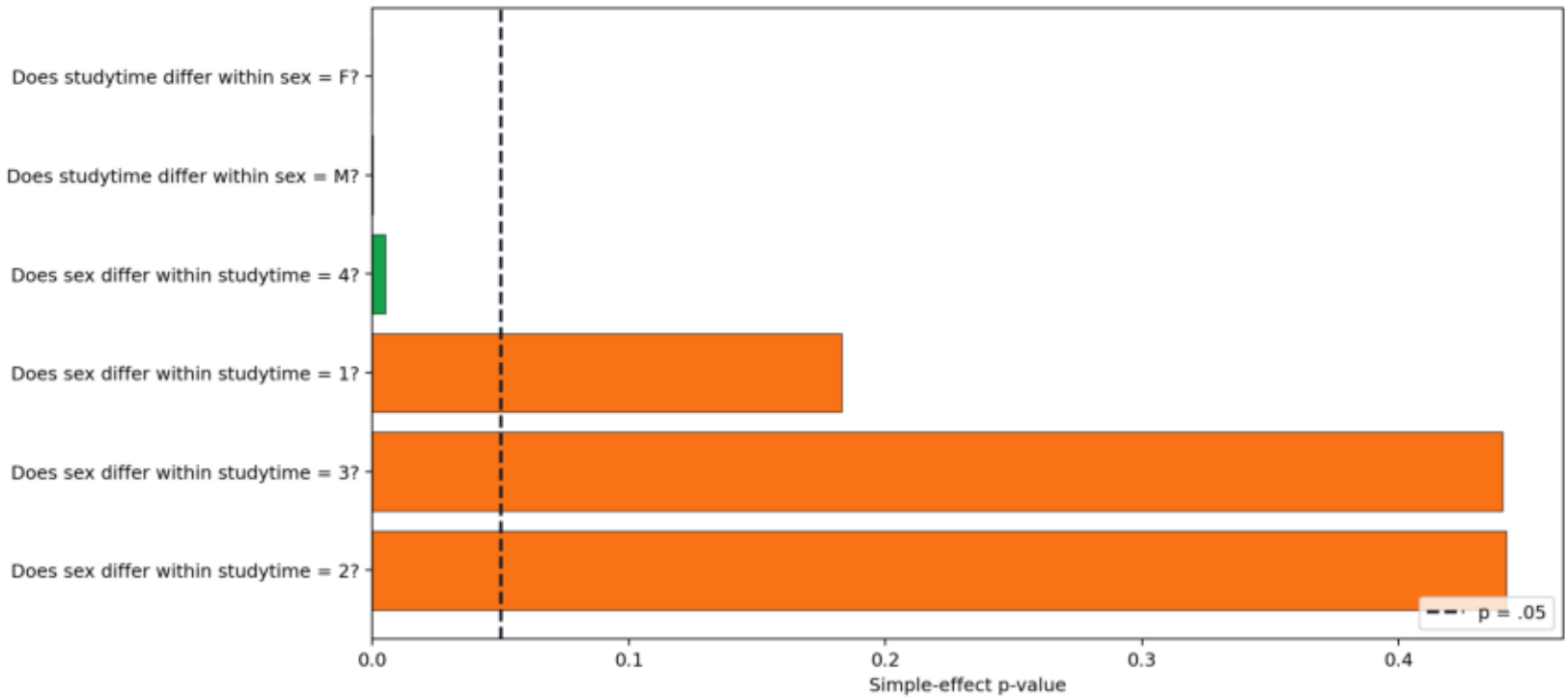
Cell Size and Balance Map

Balanced cells make main-effect and interaction-effect interpretation more stable.



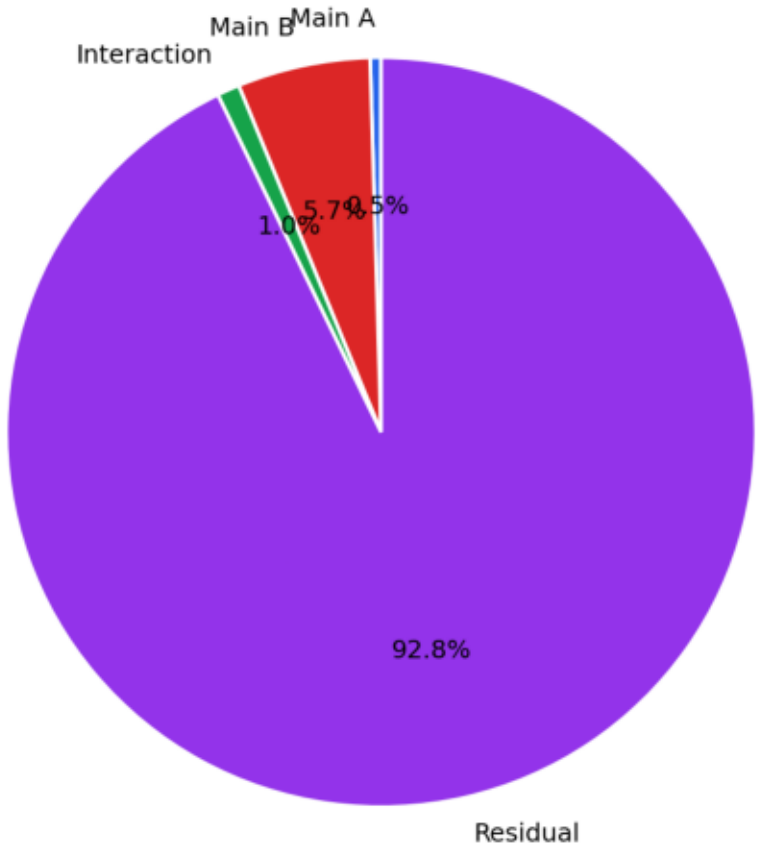
Simple Effects After Interaction Check

Simple effects show where group differences occur when an interaction is important.



Sum of Squares Decomposition

This chart separates variation explained by each main effect, interaction, and residual error.



Distribution Context by Interaction Cell

Cell distributions help explain whether cell means are driven by spread or outliers.