

Example Suppose you want to determine whether the brand of laundry detergent used and the temperature affects the amount of dirt removed from your laundry. To this end, you buy two different brand of detergent (“Super” and “Best”) and choose three different temperature levels (“cold”, “warm”, and “hot”). The experiment has **two factors** (Factor Detergent, Factor Temperature) at $a = 2$ (Super and Best) and $b = 3$ (1cold, 2warm and 3hot) **levels**.

Thus there are $ab = 2 \times 3 = 6$ different combinations of detergent and temperature. With each combination you wash $r = 4$ loads. r is called the number of **replicates**. This sums up to $n = abr = 24$ loads in total. The amounts Y_{ijk} of dirt removed when washing pile k ($k = 1, 2, 3, 4$) with detergent i ($i = 1, 2$) at temperature j ($j = 1, 2, 3$) are recorded below.

brand	temp	y
super	1cold	4
super	1cold	5
super	1cold	6
super	1cold	5
super	2warm	7
super	2warm	9
super	2warm	8
super	2warm	12
super	3hot	10
super	3hot	12
super	3hot	11
super	3hot	9
best	1cold	6
best	1cold	6
best	1cold	4
best	1cold	4
best	2warm	13
best	2warm	15
best	2warm	12
best	2warm	12
best	3hot	12
best	3hot	13
best	3hot	10
best	3hot	13

Results for brand = best

Variable	temp	N	Mean
y	1cold	4	5.000
	2warm	4	13.000
	3hot	4	12.000

Results for brand = super

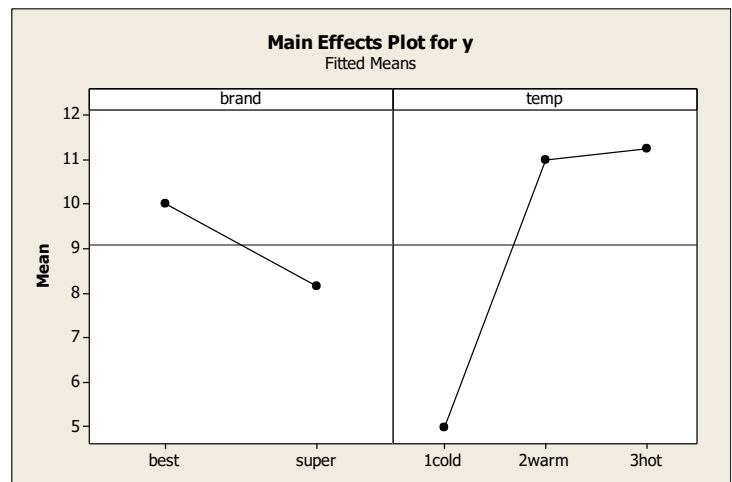
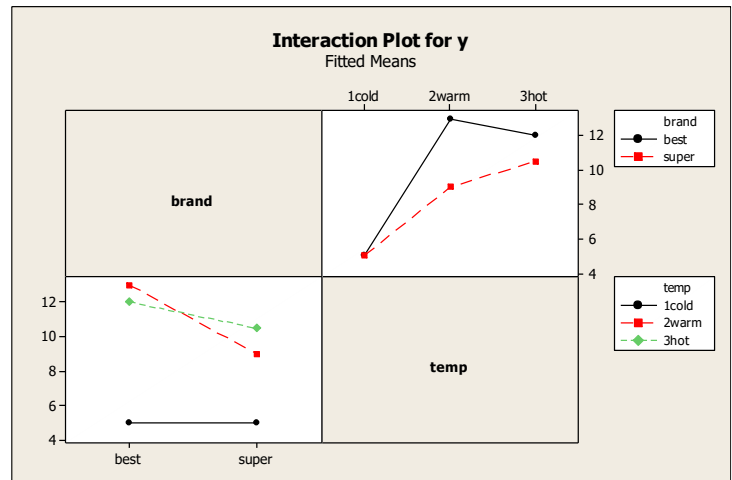
Variable	temp	N	Mean
y	1cold	4	5.000
	2warm	4	9.00
	3hot	4	10.500

Descriptive Statistics: y

Variable	brand	N	Mean
y	best	12	10.00
	super	12	8.167

Descriptive Statistics: y

Variable	temp	N	Mean
y	1cold	8	5.000
	2warm	8	11.000
	3hot	8	11.250



General Linear Model: y versus brand, temp

Factor	Type	Levels	Values
brand	fixed	2	best, super
temp	fixed	3	1cold, 2warm, 3hot

Analysis of Variance for y, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
brand	1	20.167	20.167	20.167	9.81	0.006
temp	2	200.333	200.333	100.167	48.73	0.000
brand*temp	2	16.333	16.333	8.167	3.97	0.037
Error	18	37.000	37.000	2.056		
Total	23	273.833				

S = 1.43372 R-Sq = 86.49% R-Sq(adj) = 82.73%

Tukey 95.0% Simultaneous Confidence Intervals

Response Variable y

All Pairwise Comparisons among Levels of brand*temp

brand = best

temp = 1cold subtracted from:

brand	temp	Lower	Center	Upper	
best	2warm	4.781	8.00000	11.219	(---*---)
best	3hot	3.781	7.00000	10.219	(---*---)
super	1cold	-3.219	-0.00000	3.219	(---*---)
super	2warm	0.781	4.00000	7.219	(---*---)
super	3hot	2.281	5.50000	8.719	(---*---)

-----+-----+-----+-----+
-7.0 0.0 7.0 14.0

brand = best

temp = 2warm subtracted from:

brand	temp	Lower	Center	Upper	
best	3hot	-4.22	-1.000	2.219	(---*---)
super	1cold	-11.22	-8.000	-4.781	(---*---)
super	2warm	-7.22	-4.000	-0.781	(---*---)
super	3hot	-5.72	-2.500	0.719	(---*---)

-----+-----+-----+-----+
-7.0 0.0 7.0 14.0

brand = best

temp = 3hot subtracted from:

brand	temp	Lower	Center	Upper	
super	1cold	-10.22	-7.000	-3.781	(---*---)
super	2warm	-6.22	-3.000	0.219	(---*---)
super	3hot	-4.72	-1.500	1.719	(---*---)

-----+-----+-----+-----+
-7.0 0.0 7.0 14.0

brand = super

temp = 1cold subtracted from:

brand	temp	Lower	Center	Upper	
super	2warm	0.7813	4.000	7.219	(---*---)
super	3hot	2.2813	5.500	8.719	(---*---)

-----+-----+-----+-----+
-7.0 0.0 7.0 14.0

brand = super

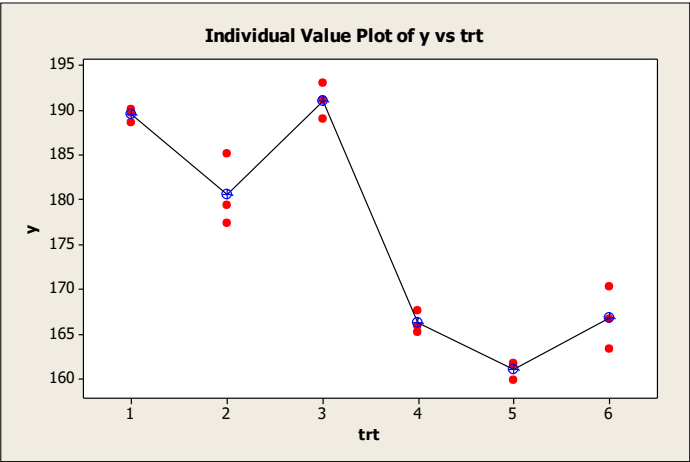
temp = 2warm subtracted from:

brand	temp	Lower	Center	Upper	
super	3hot	-1.719	1.500	4.719	(---*---)

-----+-----+-----+-----+
-7.0 0.0 7.0 14.0

An experiment to investigate whether yield from a certain chemical process depended on the formulation particular input and/or on mixer speed - 2 formulations and 3 mixer speeds considered.

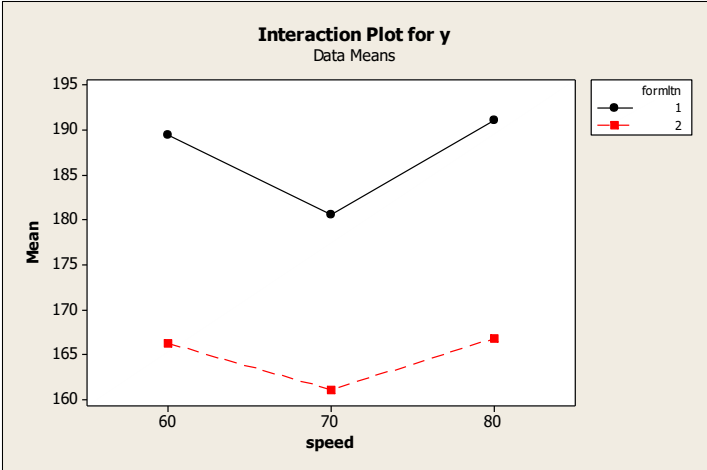
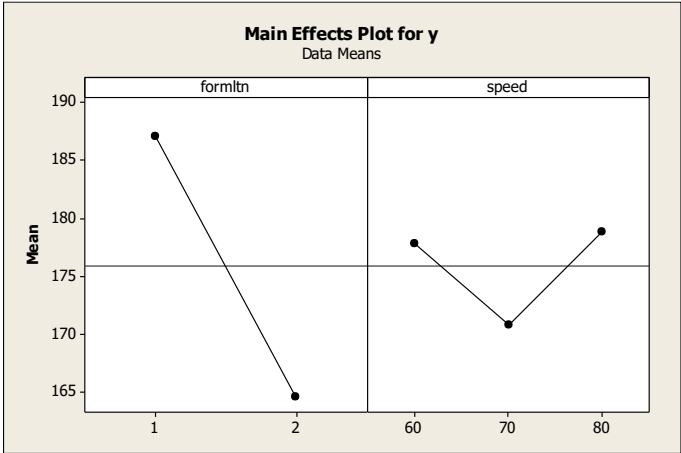
formltn	speed	y	trt
1	60	189.7	1
1	60	188.6	1
1	60	190.1	1
1	70	185.1	2
1	70	179.4	2
1	70	177.3	2
1	80	189.0	3
1	80	193.0	3
1	80	191.1	3
2	60	165.1	4
2	60	165.9	4
2	60	167.6	4
2	70	161.7	5
2	70	159.8	5
2	70	161.6	5
2	80	163.3	6
2	80	166.6	6
2	80	170.3	6



One-way ANOVA: y versus trt

Source	DF	SS	MS	F	P
trt	5	2502.84	500.57	83.58	0.000
Error	12	71.87	5.99		
Total	17	2574.70			

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Factor	Type	Levels	Values
formltn	fixed	2	1, 2
speed	fixed	3	60, 70, 80

Source	DF	Seq SS	Adj SS	Adj MS	F	P
formltn	1	2253.44	2253.44	2253.44	376.27	0.000
speed	2	230.81	230.81	115.41	19.27	0.000
formltn*speed	2	18.58	18.58	9.29	1.55	0.252
Error	12	71.87	71.87	5.99		
Total	17	2574.70				

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable y
All Pairwise Comparisons among Levels of formltn
formltn = 1 subtracted from:

