

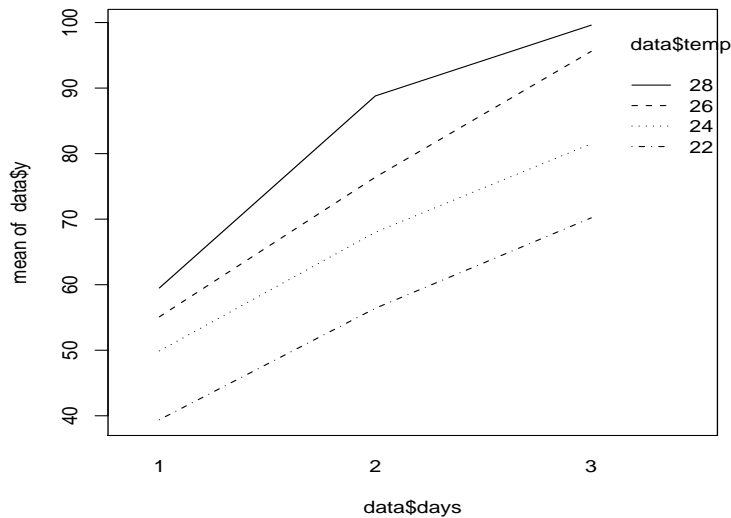
Stat 8311, Fall 2006, Linear by linear interaction

This handout uses Exercise 8.2 from Oehlert, p. 166. The response is y = free alpha amino nitrogen content of rice malt, $days$ = germination time, and $temp$ = temperature.

```
> data <- data.frame(y = c(39.4, 56.4, 70.2, 49.9, 68, 81.5,
+ 55.1, 76.4, 95.6, 59.5, 88.8, 99.6), days = as.numeric(rep(1:3,
+ 4)), temp = rep(c(22, 24, 26, 28), rep(3, 4)))
> data$Fdays <- factor(data$days, ordered = TRUE)
> data$Ftemp <- factor(data$temp, ordered = TRUE)
> xtabs(y ~ days + temp, data = data)
```

```
      temp
days  22  24  26  28
  1 39.4 49.9 55.1 59.5
  2 56.4 68.0 76.4 88.8
  3 70.2 81.5 95.6 99.6
```

```
> interaction.plot(data$days, data$temp, data$y, cex = 2)
```



```
> anova(m1 <- lm(y ~ days + Fdays + temp + Ftemp + days:temp,
+ data = data))
```

Analysis of Variance Table

```
Response: y
      Df Sum Sq Mean Sq F value    Pr(>F)
days   1 2556.12  2556.12  344.0060 8.384e-06
Fdays  1   33.61   33.61    4.5228 0.08677
temp    1 1245.79 1245.79  167.6601 4.896e-05
Ftemp   2   13.25    6.63    0.8919 0.46639
days:temp 1   33.86   33.86    4.5564 0.08591
Residuals 5    37.15    7.43
```

```
> round(model.matrix(m1)[, ], 3)
```

	(Intercept)	days	Fdays.L	Fdays.Q	temp	Ftemp.L	Ftemp.Q	Ftemp.C	days:temp
1	1	1	-0.707	0.408	22	-0.671	0.5	-0.224	22
2	1	2	0.000	-0.816	22	-0.671	0.5	-0.224	44
3	1	3	0.707	0.408	22	-0.671	0.5	-0.224	66
4	1	1	-0.707	0.408	24	-0.224	-0.5	0.671	24
5	1	2	0.000	-0.816	24	-0.224	-0.5	0.671	48
6	1	3	0.707	0.408	24	-0.224	-0.5	0.671	72
7	1	1	-0.707	0.408	26	0.224	-0.5	-0.671	26
8	1	2	0.000	-0.816	26	0.224	-0.5	-0.671	52
9	1	3	0.707	0.408	26	0.224	-0.5	-0.671	78
10	1	1	-0.707	0.408	28	0.671	0.5	0.224	28
11	1	2	0.000	-0.816	28	0.671	0.5	0.224	56
12	1	3	0.707	0.408	28	0.671	0.5	0.224	84

```
> summary(m1)$coef
```

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-33.63333333	23.3696234	-1.43919021	0.20963048
days	-5.12500000	10.8180336	-0.47374599	0.65564495
Fdays.Q	-2.89856286	1.3629441	-2.12669238	0.08676682
temp	2.71666667	0.9310681	2.91779593	0.03309839
Ftemp.Q	-2.10000000	1.5737923	-1.33435650	0.23962735
Ftemp.C	-0.08944272	1.5737923	-0.05683261	0.95687978
days:temp	0.92000000	0.4310008	2.13456694	0.08590600

```
> anova(m2 <- lm(y ~ days + temp + days:temp, data = data))
```

Analysis of Variance Table

Response: y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
days	1	2556.12	2556.12	243.4028	2.840e-07
temp	1	1245.79	1245.79	118.6286	4.471e-06
days:temp	1	33.86	33.86	3.2239	0.1103
Residuals	8	84.01	10.50		

```
> summary(m2)$coef
```

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-33.633333	27.7825384	-1.2105925	0.26060077
days	-5.125000	12.8608162	-0.3984973	0.70068799
temp	2.716667	1.1068828	2.4543399	0.03966734
days:temp	0.920000	0.5123872	1.7955172	0.11030604