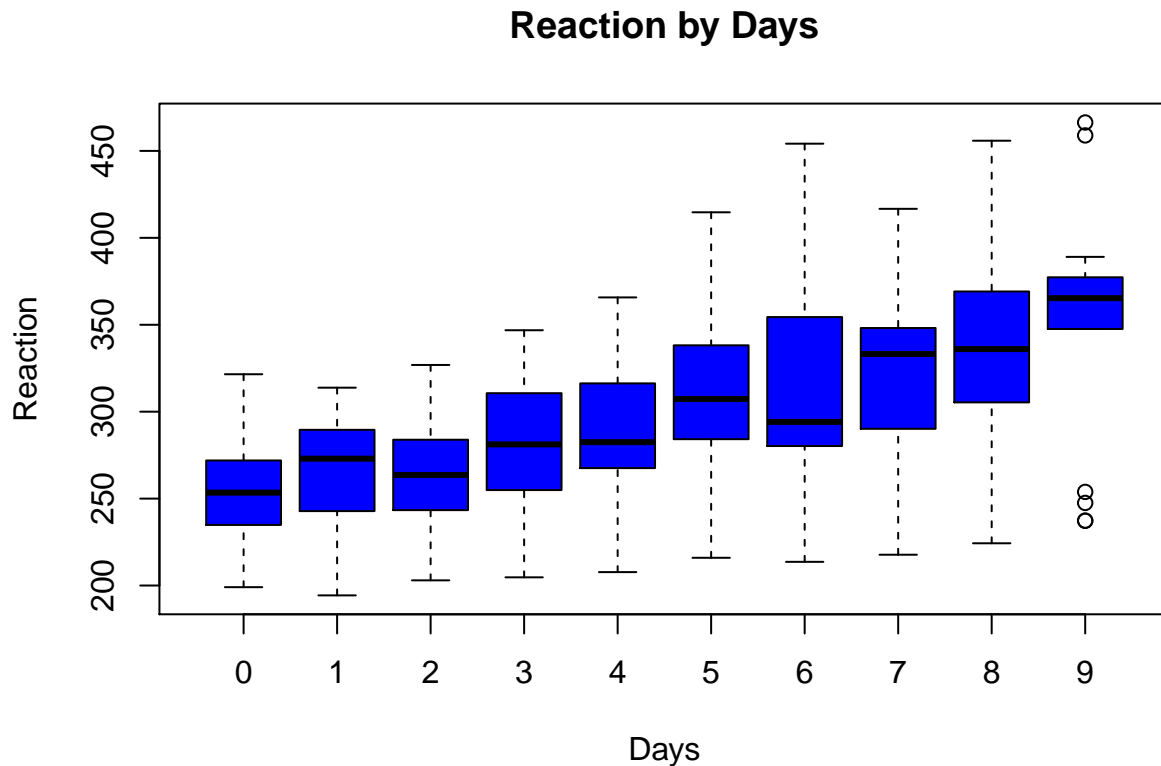


## Comparison of P values from linear and linear mixed models

This is illustrated with the documentation example.

```
require(lme4)
boxplot(Reaction~Days, data=sleepstudy, main="Reaction by Days",
        xlab="Days", ylab="Reaction", col="blue", border="black")
```



We see a trend of Reaction by Days, so it is reasonable to fit a simple linear regression,

```
l <- lm(Reaction ~ Days, sleepstudy)
s <- summary(l)
s
```

```
##
## Call:
## lm(formula = Reaction ~ Days, data = sleepstudy)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -110.848  -27.483    1.546   26.142  139.953
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   251.405      6.610  38.033 < 2e-16 ***
## Days          10.467      1.238   8.454 9.89e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Residual standard error: 47.71 on 178 degrees of freedom
## Multiple R-squared:  0.2865, Adjusted R-squared:  0.2825
## F-statistic: 71.46 on 1 and 178 DF,  p-value: 9.894e-15

names(s)

## [1] "call"          "terms"          "residuals"      "coefficients"
## [5] "aliases"        "sigma"          "df"             "r.squared"
## [9] "adj.r.squared" "fstatistic"     "cov.unscaled"

class(s)

## [1] "summary.lm"

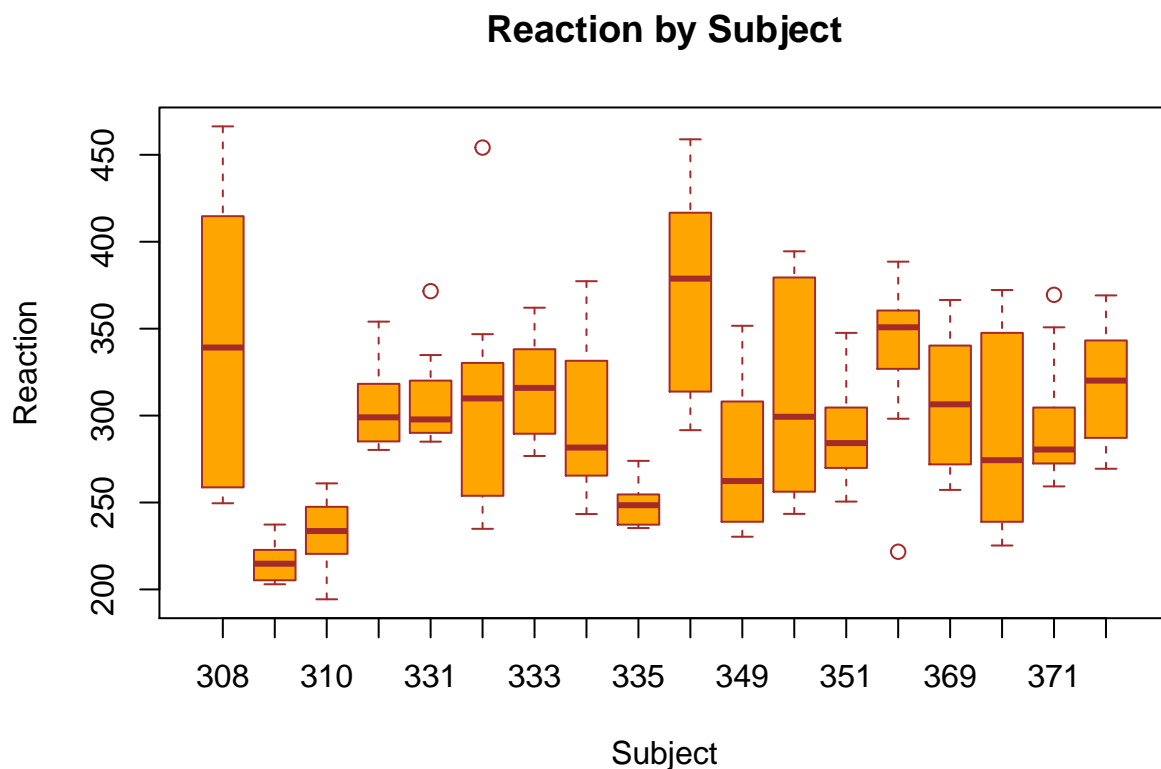
round(sqrt(s$fstatistic[1]),3)

## value
## 8.454

df <- with(s,df)
```

the F statistics is simply  $t^2$ . Maybe it is worthwhile to examine the effect of Subject as well; from

```
boxplot(Reaction~Subject, data=sleepstudy, main="Reaction by Subject",
        xlab="Subject", ylab="Reaction", col="orange", border="brown")
```



it is more appropriate to fit a random effect model

```
f <- lmer(Reaction ~ Days + (Days | Subject), sleepstudy)
s <- summary(f)
```

```
s
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: Reaction ~ Days + (Days | Subject)
## Data: sleepstudy
##
## REML criterion at convergence: 1743.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -3.9536 -0.4634  0.0231  0.4633  5.1793
##
## Random effects:
## Groups Name Variance Std.Dev. Corr
## Subject (Intercept) 611.90 24.737
## Days 35.08 5.923 0.07
## Residual 654.94 25.592
## Number of obs: 180, groups: Subject, 18
##
## Fixed effects:
## Estimate Std. Error t value
## (Intercept) 251.405 6.824 36.843
## Days 10.467 1.546 6.771
##
## Correlation of Fixed Effects:
## (Intr)
## Days -0.138
```

```
names(s)
```

```
## [1] "methTitle" "objClass" "devcomp" "isLmer"
## [5] "useScale" "logLik" "family" "link"
## [9] "ngrps" "coefficients" "sigma" "vcov"
## [13] "varcor" "AICtab" "call" "residuals"
## [17] "fitMsgs" "optinfo"
```

```
class(with(s,coefficients))
```

```
## [1] "matrix"
```

```
t <- with(s,coefficients)[,3]
```

```
p <- 2*(pnorm(-abs(t)))
```

```
p
```

```
## (Intercept) Days
## 3.851313e-297 1.281214e-11
```

```
pt <- 2*(pt(-abs(t),df[2]))
```

```
pt
```

```
## (Intercept) Days
## 3.287918e-85 1.794531e-10
```

Consequently, the effect of `Days` on `Reaction` became less pronounced after accounting for individual differences – as we saw the same estimate of effect but a larger standard error for `Days` in the linear mixed model compared to that in the linear regression model.