ToothGrowth

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Tooth Growth

The description of the data set “Tooth Growth”:

The Effect of Vitamin C on Tooth Growth in Guinea Pigs

Description

The response is the length of odontoblasts (cells responsible for tooth growth) in 60 guinea pigs. Each animal received one of three dose levels of vitamin C (0.5, 1, and 2 mg/day) by one of two delivery methods, (orange juice or ascorbic acid (a form of vitamin C and coded as VC).

Usage

ToothGrowth Format

A data frame with 60 observations on 3 variables.

[,1] len numeric Tooth length [,2] supp factor Supplement type (VC or OJ). [,3] dose numeric Dose in milligrams/day

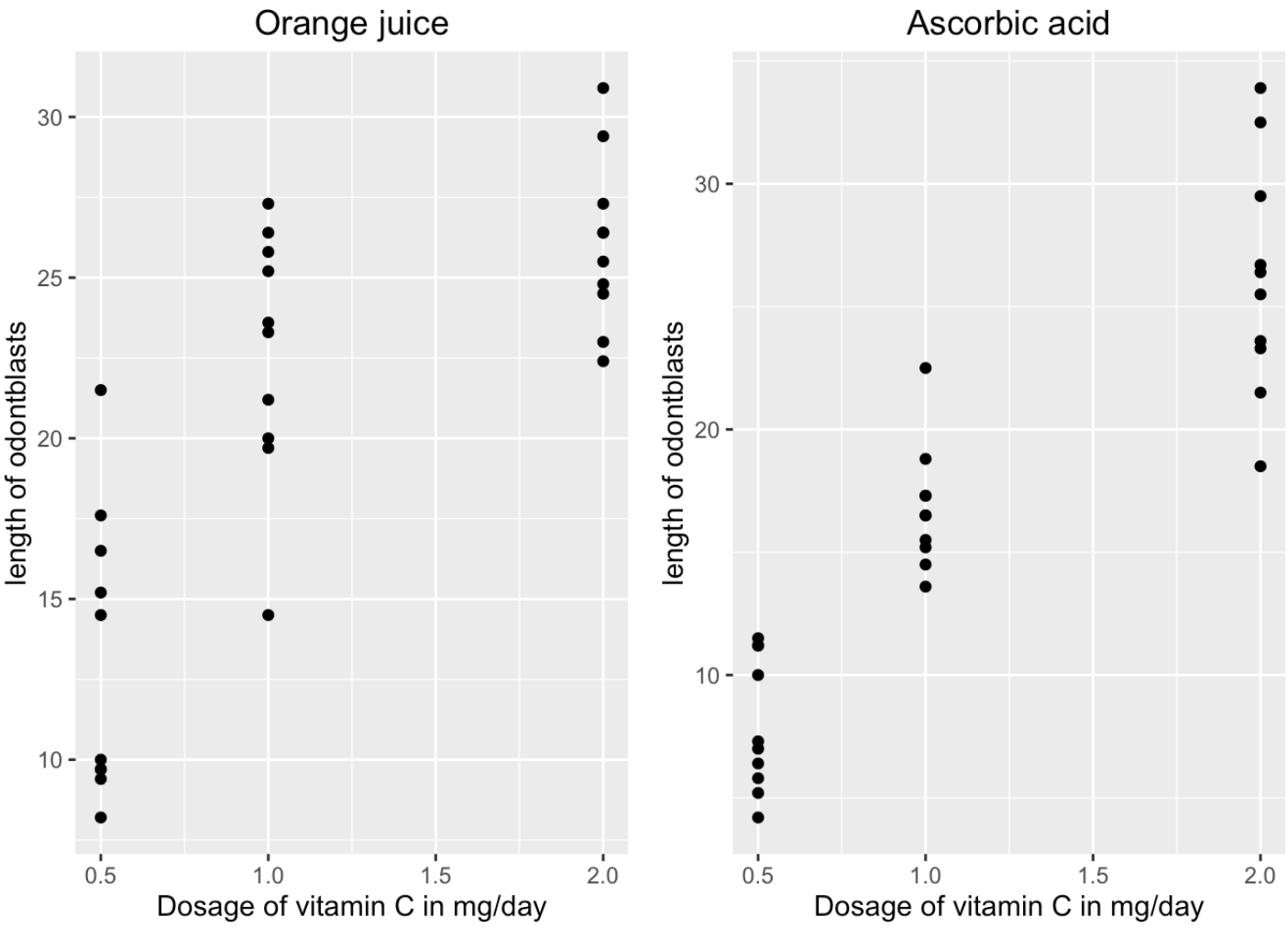
What to look for

Based on the description of the data, we want to see if there is a relationship between the lenght of the odontoblasts and the delivery method and the dosage of vitamin C. So our dependent variable is “len”, the length.

Looking at delivery methods

Let’s make some plots of the data

```
 OJ <- data.frame(subset(ToothGrowth, supp == "OJ"))
 VC <- data.frame(subset(ToothGrowth, supp == "VC"))
 poj <- ggplot(OJ, aes(dose, len))
 poj <- poj + geom_point()
 poj <- poj +  xlab("Dosage of vitamin C in mg/day") +  ylab("length of odontblasts")
+ ggtitle("Orange juice")
 pvc <- ggplot(VC, aes(dose, len))
 pvc <- pvc + geom_point()
 pvc <- pvc + xlab("Dosage of vitamin C in mg/day") +  ylab("length of odontblasts")
+ ggtitle("Ascorbic acid")
 grid.arrange(poj, pvc, ncol = 2)
```

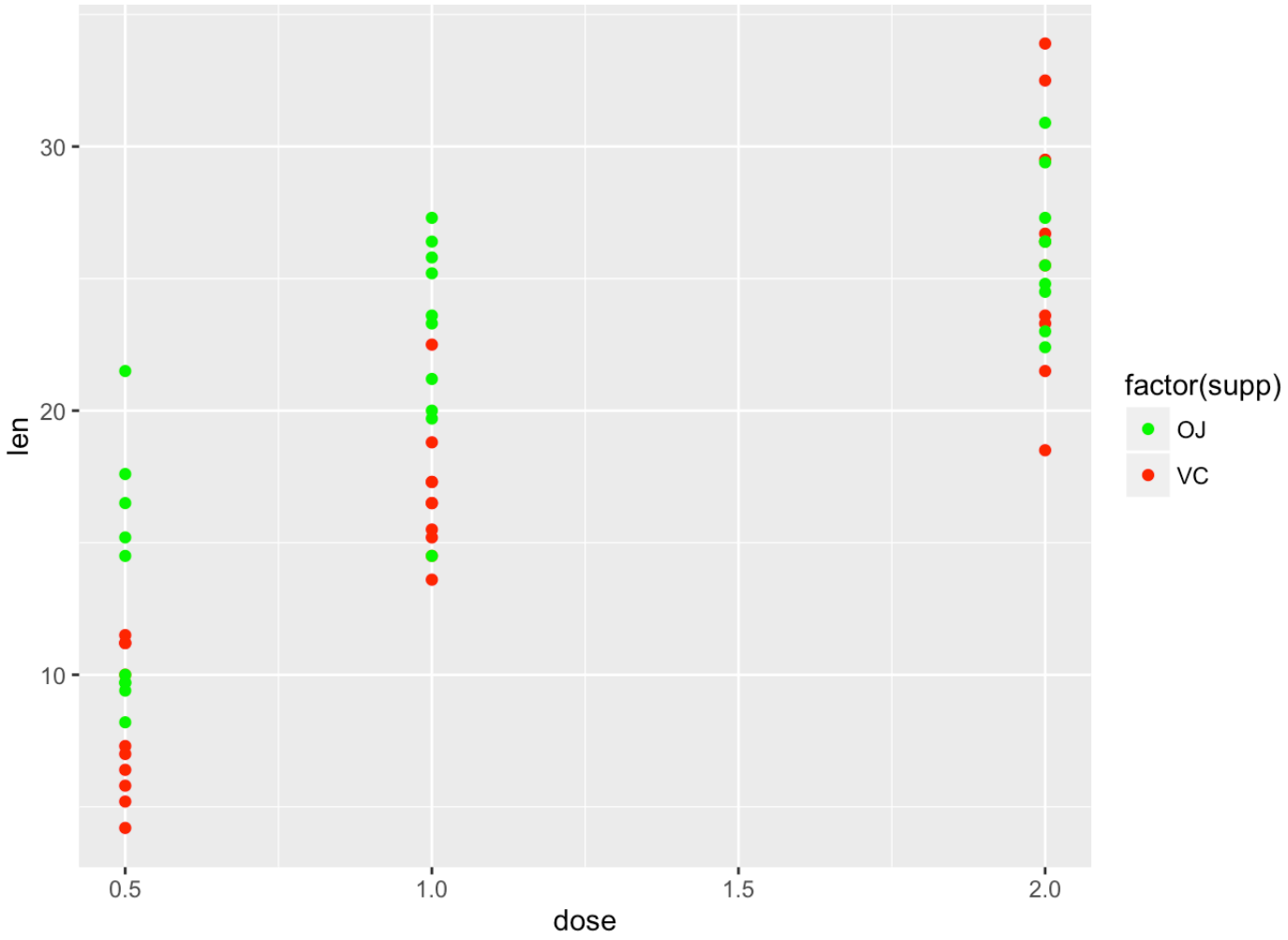


Quick Conclusions

We can see that in both cases, an increase in dosage of vitamin C appears to increase the length of odontblasts.

Looking at dosage

```
allover <- ggplot(ToothGrowth, aes(dose, len, color=factor(supp)))
allover <- allover + geom_point() + scale_color_manual(values = c("green", "red"))
allover
```




```
summary(ToothGrowth)
```

```
##       len        supp         dose
##  Min.   : 4.20   OJ:30   Min.   :0.500
##  1st Qu.:13.07   VC:30   1st Qu.:0.500
##  Median :19.25           Median :1.000
##  Mean   :18.81           Mean   :1.167
##  3rd Qu.:25.27           3rd Qu.:2.000
##  Max.   :33.90           Max.   :2.000
```

```
p5 <- subset(ToothGrowth, ToothGrowth$dose == 0.5)
b5 <- t.test(len ~ supp, paired = FALSE, var.equal = TRUE, data = p5)
b5
```

```
##
##  Two Sample t-test
##
## data:  len by supp
## t = 3.1697, df = 18, p-value = 0.005304
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  1.770262 8.729738
## sample estimates:
## mean in group OJ mean in group VC
##            13.23             7.98
```

Hypothesis testing

Is there a difference in growth between delivery methods? We state our null hypothesis as: There is no significant difference in the lengths of hamster odontoblasts when equal doses of Vitamin C are given via orange juice versus the same dose given via ascorbic acid.

Here's what we see when we compare the lenght of the odontoblasts at a dose of 0.5 mg/day

For 0.5 mg/day

Based on the p-value of **0.0053037** we can reject the hypothesis that there is no difference in the growth of the odontoblasts at a dosage of **0.5 mg/day** when comparing the delivery method of **Orange Juice** compared to **Ascorbic Acid**. The odontoblasts are larger when the dose is given in Orange Juice.

```
p10 <- subset(ToothGrowth, ToothGrowth$dose == 1.0)
b10 <- t.test(len ~ supp, paired = FALSE, var.equal = TRUE, data = p10)
b10
```

```
##
##  Two Sample t-test
##
## data:  len by supp
## t = 4.0328, df = 18, p-value = 0.0007807
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  2.840692 9.019308
## sample estimates:
## mean in group OJ mean in group VC
##            22.70            16.77
```

For 1.0 mg/day

Based on the p-value of **7.807261710^{-4}** we can reject the hypothesis that there is no difference in the growth of the odontoblasts at a dosage of **1.0 mg/day** when comparing the delivery method of **Orange Juice** compared to **Ascorbic Acid**. The odontoblasts are larger when the dose is given in Orange Juice.

```
p20 <- subset(ToothGrowth, ToothGrowth$dose == 2.0)
b20 <- t.test(len ~ supp, paired = FALSE, var.equal = TRUE, data = p20)
b20
```

```
##
##  Two Sample t-test
##
## data:  len by supp
## t = -0.046136, df = 18, p-value = 0.9637
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -3.722999  3.562999
## sample estimates:
## mean in group OJ mean in group VC
##            26.06            26.14
```

For 2.0 mg/day

Based on the p-value of **0.9637098** we must accept the hypothesis that there is no difference in the growth of the odontoblasts at a dosage of **2.0 mg/day** when comparing the delivery method of **Orange Juice** compared to **Ascorbic Acid**. There is no statistically meaningful difference in the size of the odontoblasts when the dosage is 2.0mg/day.

Conclusion

At lower dosages, using orange juice as the delivery method will result in longer odontoblasts in hamsters as compared to ascorbic acid. But at the highest measured dosage of 2.0 mg/day, there was no difference in the delivery method - but the length of the odontoblasts did continue to increase with dosage.