

Stat 505 Assignment 9 Solutions

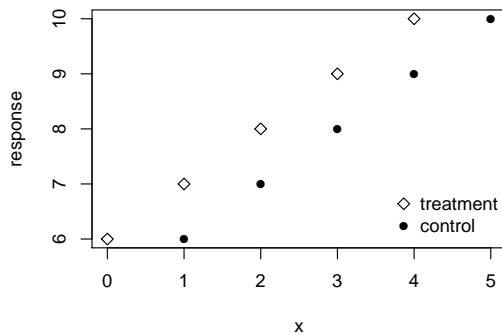
1. Linear trend

- (a) No treatment effect: Both circles and dots fall close to one line.
- (b) Constant treatment effect: circles in one line, dots in a parallel line.
- (c) Treatment effect increases in x . Lines grow apart as x increases.

2. Similar setup

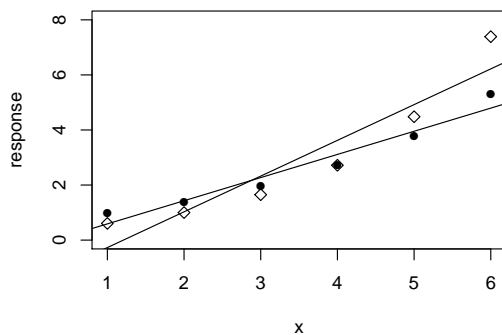
- (a) Treatment effect only shows when we use x as covariate.

```
> plot(1:5, 6:10, xlab = "x", ylab = "response", pch = 16, xlim = c(0, 5))
> points(0:4, 6:10, pch = 5)
> legend("bottomright", bty = "n", pch = c(5, 16), c("treatment", "control"))
```



- (b) Linear regression is wrong, nonlinear is right.

```
> plot(1:6, exp(0:5/3), xlab = "x", ylab = "response", pch = 16, ylim = c(0, 8))
> abline(lsfrit(1:6, exp(0:5/3)))
> points(1:6, exp(-1:4/2), pch = 5)
> abline(lsfrit(1:6, exp(-1:4/2)))
```



On log scale, these are lines with different slope and intercept.

3. Sesame 1

(a) Why randomize encouragement, not actual watching?

Seems terribly hard to enforce TV watching – and not ethical when it involves the ways families choose to spend time.

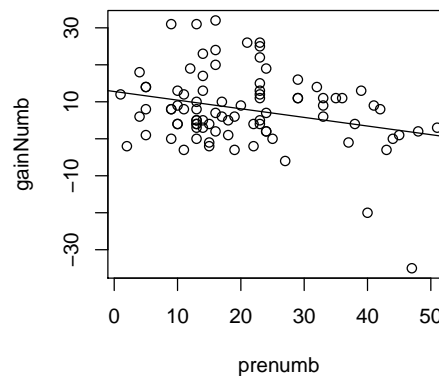
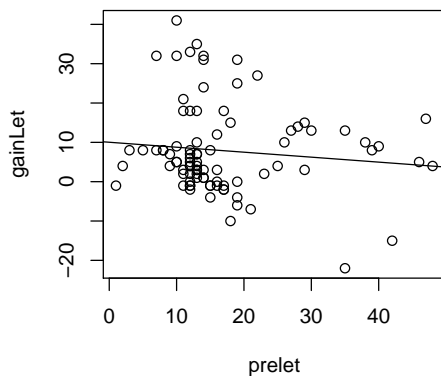
(b) Before-after comparison of control group.

```
> par(mfrow = c(1, 2))
> gainLet ← sesame$postlet - sesame$prelet
> gainNumb ← sesame$postnumb - sesame$prenumb
> plot(gainLet ~ prelet, data = sesame, subset = encour == 0)
> abline(letter.fit0 ← lm(gainLet ~ prelet, data = sesame, subset = encour == 0)
)
> plot(gainNumb ~ prenumb, data = sesame, subset = encour == 0)
> abline(number.fit0 ← lm(gainNumb ~ prenumb, data = sesame, subset = encour ==
0))
> display(letter.fit0)
```

```
lm(formula = gainLet ~ prelet, data = sesame, subset = encour ==
0)
      coef.est  coef.se
(Intercept)  10.03    2.40
prelet       -0.13    0.12
---
n = 88, k = 2
residual sd = 11.35, R-Squared = 0.01
```

```
> display(number.fit0)
```

```
lm(formula = gainNumb ~ prenumb, data = sesame, subset = encour ==
0)
      coef.est  coef.se
(Intercept)  12.78    2.08
prenumb      -0.23    0.09
---
n = 88, k = 2
residual sd = 9.68, R-Squared = 0.08
```

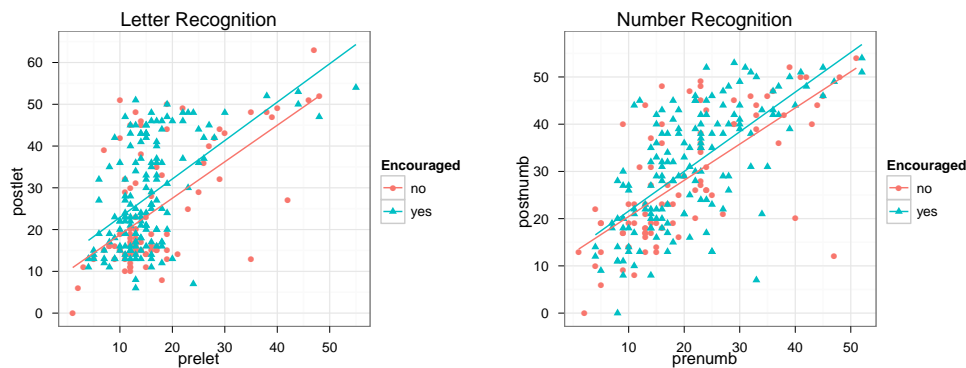


Kids differ in many ways, in particular they have different abilities in number and letter recognition at the beginning of the study before applying random treatments. It seems kids who are more (less) able at the beginning may show smaller (larger) gains over the course of the study, so we need to adjust for pre-existing abilities

before computing treatment effects. The above summaries show this is the case for number recognition, but might not be so important for letter recognition. However, it seems prudent to make the same adjustment for pretreatment measures in both cases. I will also fit site as a factor to the models assuming it's a random block effect.

4. Sesame 2

- (a) Effects on postlet and postnumb as a function of `viewenc`. Note we may need an interaction, but I tried them, and they had large SE relative to slope estimates, so I did not use them.



```
> display(lm(postlet ~ prelet + site + Encouraged, sesame))
```

```
lm(formula = postlet ~ prelet + site + Encouraged, data = sesame)
      coef.est coef.se
(Intercept)  11.75    2.00
prelet       0.78    0.08
site2        8.76    1.81
site3       -5.70    1.79
site4       -3.85    1.95
site5       -1.78    2.61
Encouragedyes 4.61    1.34
```

```
n = 240, k = 7
residual sd = 9.65, R-Squared = 0.49
```

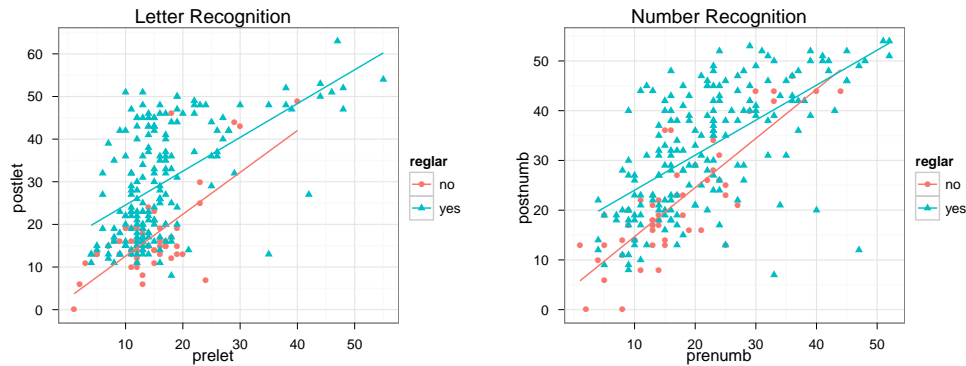
```
> display(lm(postnumb ~ prenumb + site + Encouraged, sesame))
```

```
lm(formula = postnumb ~ prenumb + site + Encouraged, data = sesame)
      coef.est coef.se
(Intercept)  12.89    1.87
prenumb      0.73    0.06
site2        5.45    1.73
site3       -0.90    1.72
site4       -2.01    1.85
site5        1.60    2.49
Encouragedyes 1.67    1.27
```

```
n = 240, k = 7
residual sd = 9.18, R-Squared = 0.50
```

Encouragement seems to improve postlet (after adjusting for prelet), since 4.6 is more than twice 1.34, but the relationship is weak for postnumb (after adjusting for prenumb) as 1.67 is not twice 1.27, its SE.

(b) Effect of regular Sesame Street watching.



```
> display(lm(postlet ~ prelet + site + reglar, sesame))
```

```
lm(formula = postlet ~ prelet + site + reglar, data = sesame)
      coef.est coef.se
(Intercept)  6.88   2.12
prelet       0.73   0.07
site2       8.58   1.71
site3      -4.41   1.67
site4      -0.61   1.93
site5       1.11   2.47
reglaryes   9.66   1.53
-----
n = 240, k = 7
residual sd = 9.14, R-Squared = 0.54
```

```
> display(lm(postnumb ~ prenumb + site + reglar, sesame))
```

```
lm(formula = postnumb ~ prenumb + site + reglar, data = sesame)
      coef.est coef.se
(Intercept)  8.95   2.02
prenumb     0.70   0.06
site2       5.28   1.67
site3      -0.43   1.62
site4       0.28   1.86
site5       3.18   2.40
reglaryes   6.56   1.50
-----
n = 240, k = 7
residual sd = 8.86, R-Squared = 0.53
```

Effects are much stronger. We can say there is a strong association between regular viewing and gain in number and letter recognition.

(c) *Because encourage was randomly applied, we can make causal conclusions about the effect of encouragement on postnumb and postlet. Regular viewing was observed, not applied, so causal connections are not possible without large ignorability assumptions.*