

# R12 - Interactions

HCI/PSYCH 522  
Iowa State University

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# Independent variables

- Functions ( $f(X)$ )
- Dummy variables for categorical variables ( $X_1 = I()$ )
- Higher order terms ( $X^2$ )
- Additional explanatory variables ( $X_1, X_2$ )
- Interactions ( $X_1 X_2$ )
  - Continuous-continuous
  - Continuous-categorical
  - Categorical-categorical

## Definition

Two independent variables are said to **interact** if the effect that one of them has on the mean of the dependent variable depends on the value of the other.

## When to include interaction terms

Adapted from The Statistical Sleuth (3rd ed) page 250:

- when a research question pertains to an interaction
- when good reason exists to suspect an interaction or
- when statistical evidence exists to include the interaction.

# R code for interaction

```
longnosedace <- read_csv("longnosedace.csv")
lm_dace <- lm(log(count) ~ do2 + no3 + do2:no3, data = longnosedace)
summary(lm_dace)$coef
```

```
##              Estimate Std. Error    t value   Pr(>|t|)
## (Intercept) -1.9149442  2.25394656 -0.8495961 0.39876678
## do2          0.5111851  0.26781104  1.9087529 0.06085177
## no3          1.0972513  0.85554847  1.2825121 0.20436193
## do2:no3     -0.1023408  0.09821613 -1.0419953 0.30139605
```

```
lm_dace2 <- lm(log(count) ~ do2 * no3, data = longnosedace)
summary(lm_dace2)$coef
```

```
##              Estimate Std. Error    t value   Pr(>|t|)
## (Intercept) -1.9149442  2.25394656 -0.8495961 0.39876678
## do2          0.5111851  0.26781104  1.9087529 0.06085177
## no3          1.0972513  0.85554847  1.2825121 0.20436193
## do2:no3     -0.1023408  0.09821613 -1.0419953 0.30139605
```

# R code for interaction

```
glm_dace <- glm(count ~ do2 + no3 + do2:no3, data = longnosedace, family = poisson)
summary(glm_dace)$coef
```

```
##              Estimate Std. Error    z value    Pr(>|z|)
## (Intercept) -0.2297477 0.41254423 -0.5569044 5.775927e-01
## do2          0.3883040 0.04764847  8.1493475 3.658932e-16
## no3          1.2056535 0.13101995  9.2020603 3.511513e-20
## do2:no3      -0.1171250 0.01504934 -7.7827322 7.097476e-15
```

```
glm_dace2 <- glm(count ~ do2 * no3, data = longnosedace, family = poisson)
summary(glm_dace2)$coef
```

```
##              Estimate Std. Error    z value    Pr(>|z|)
## (Intercept) -0.2297477 0.41254423 -0.5569044 5.775927e-01
## do2          0.3883040 0.04764847  8.1493475 3.658932e-16
## no3          1.2056535 0.13101995  9.2020603 3.511513e-20
## do2:no3      -0.1171250 0.01504934 -7.7827322 7.097476e-15
```

# F-test or Chi-squared test to help assess the need for an interaction

```
lm_dace <- lm(log(count) ~ do2 * no3, data = longnosedace)
drop1(lm_dace, test="F")

## Single term deletions
##
## Model:
## log(count) ~ do2 * no3
##           Df Sum of Sq    RSS    AIC F value Pr(>F)
## <none>                81.141 20.831
## do2:no3   1      1.3984 82.540 19.975  1.0858 0.3014

glm_dace <- glm(count ~ do2 * no3, data = longnosedace, family = poisson)
drop1(glm_dace, test="Chi")

## Single term deletions
##
## Model:
## count ~ do2 * no3
##           Df Deviance    AIC    LRT Pr(>Chi)
## <none>                2310.6 2646.6
## do2:no3   1      2375.8 2709.9 65.273 6.521e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

# F-test or Chi-squared test to help assess the need for an interaction

```
glm_breaks <- glm(breaks ~ wool*tension, data = warpbreaks, family = poisson)
summary(glm_breaks)$coef
```

```
##              Estimate Std. Error  z value    Pr(>|z|)
## (Intercept)   3.7967368 0.04993753 76.029734 0.000000e+00
## woolB         -0.4566272 0.08019202 -5.694172 1.239721e-08
## tensionM      -0.6186830 0.08440012 -7.330357 2.295399e-13
## tensionH      -0.5957987 0.08377723 -7.111702 1.146202e-12
## woolB:tensionM 0.6381768 0.12215312  5.224400 1.747203e-07
## woolB:tensionH 0.1883632 0.12989529  1.450115 1.470263e-01
```

```
drop1(glm_breaks, test="Chi")
```

```
## Single term deletions
##
## Model:
## breaks ~ wool * tension
##              Df Deviance    AIC    LRT Pr(>Chi)
## <none>          182.31 468.97
## wool:tension   2    210.39 493.06 28.087 7.962e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

# F-test or Chi-squared test to help assess the need for an interaction

```
glm_breaks <- glm(breaks ~ wool*tension, data = warpbreaks, family = poisson)
summary(glm_breaks)$coef
```

```
##              Estimate Std. Error  z value    Pr(>|z|)
## (Intercept)   3.7967368  0.04993753  76.029734 0.000000e+00
## woolB         -0.4566272  0.08019202 -5.694172 1.239721e-08
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## woolB:tensionM  0.6381768  0.12215312  5.224400 1.747203e-07
## woolB:tensionH  0.1883632  0.12989529  1.450115 1.470263e-01
```

```
drop1(glm_breaks, test="Chi")
```

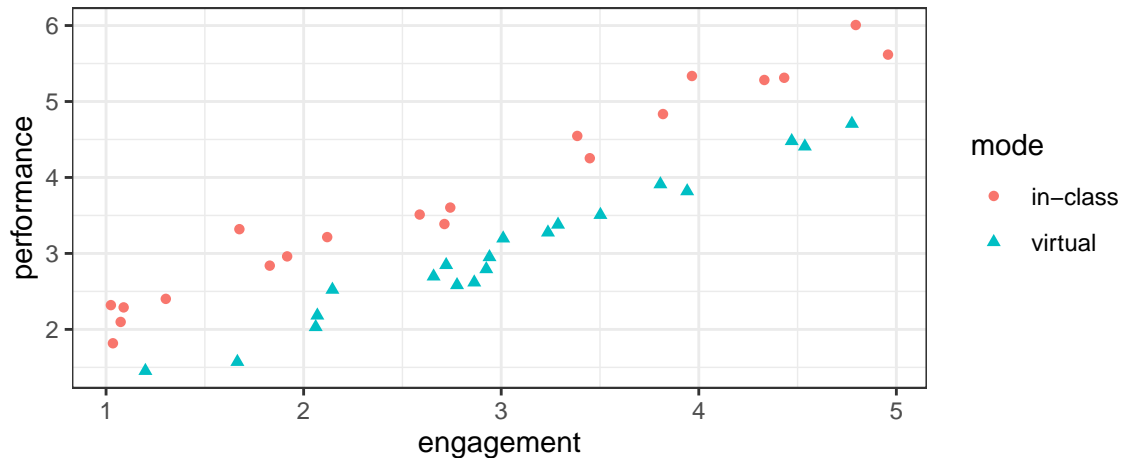
```
## Single term deletions
##
## Model:
## breaks ~ wool * tension
##              Df Deviance    AIC    LRT  Pr(>Chi)
## <none>          182.31 468.97
## wool:tension   2    210.39 493.06 28.087 7.962e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```



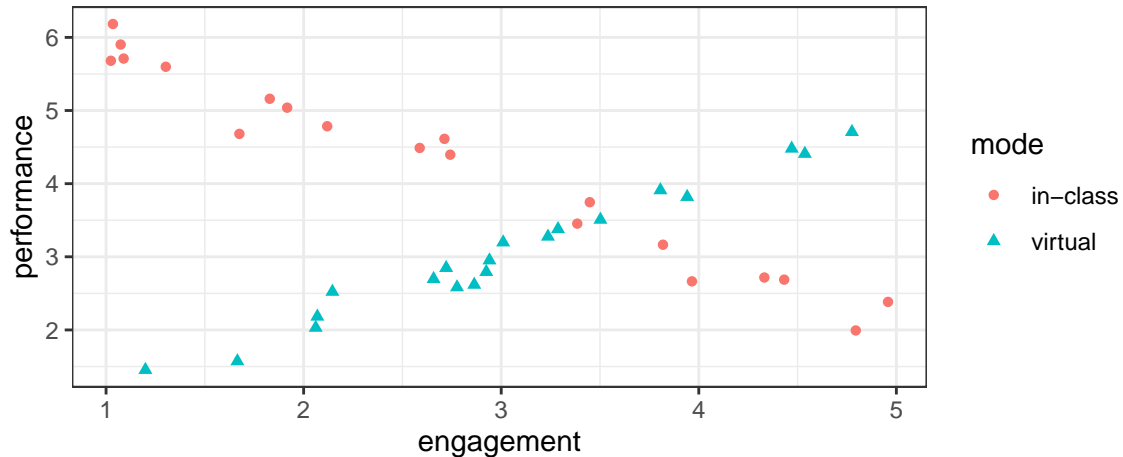
## No Interaction = Parallel Lines

A model without an interaction is often referred to as a **main effects** model. Models without an interaction result in parallel lines.

# No interaction



## With interaction (extreme)



## With interaction (not so extreme)

