General Linear Model (GLM)

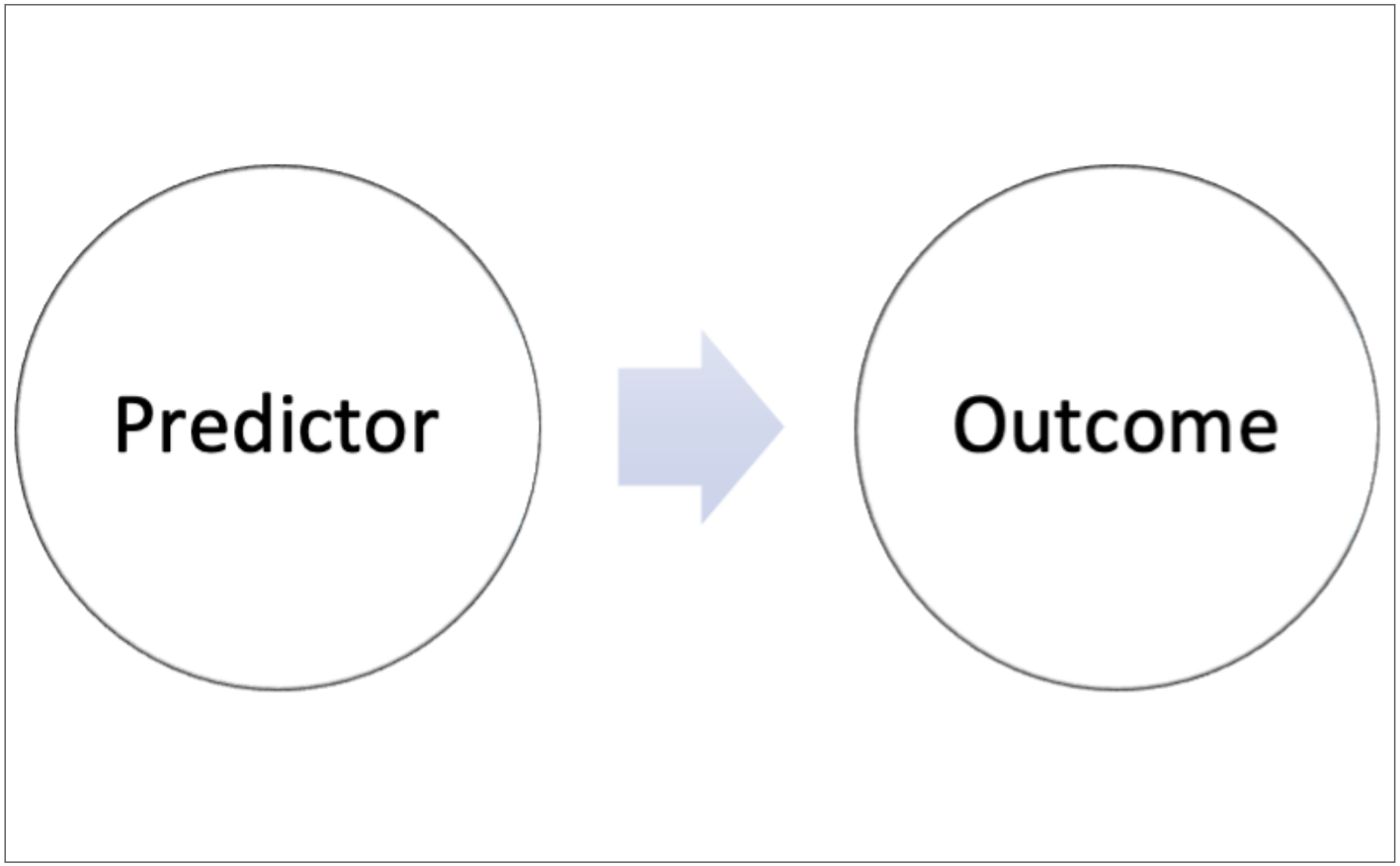
Mario E. Bermonti-Pérez, MA, PhD

Objectives

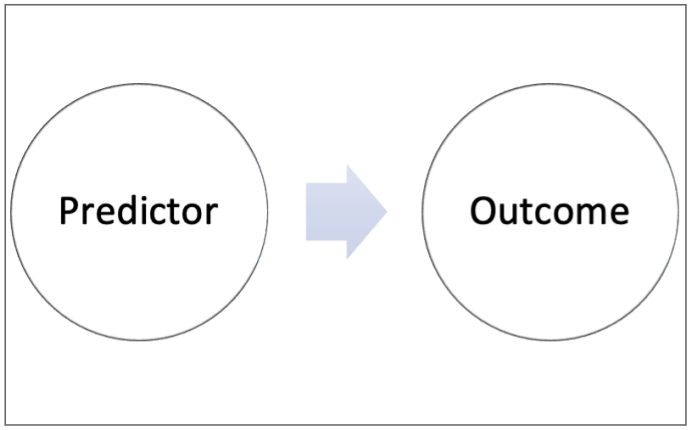
- Understand the basic concepts of the GLM
- Understand the usefulness of the GLM
- Understand how the GLM underlies most stats methods
- Understand the basic process of applying the GLM

GLM basics

Form

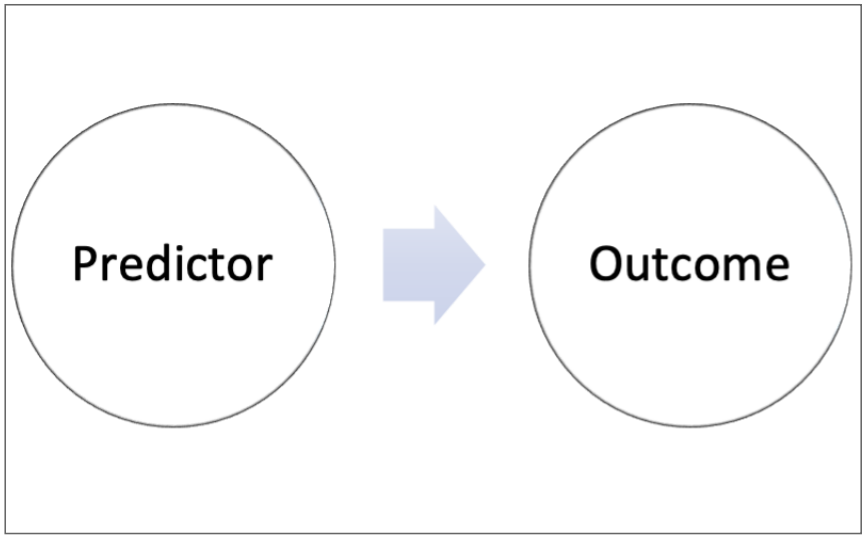


Examples



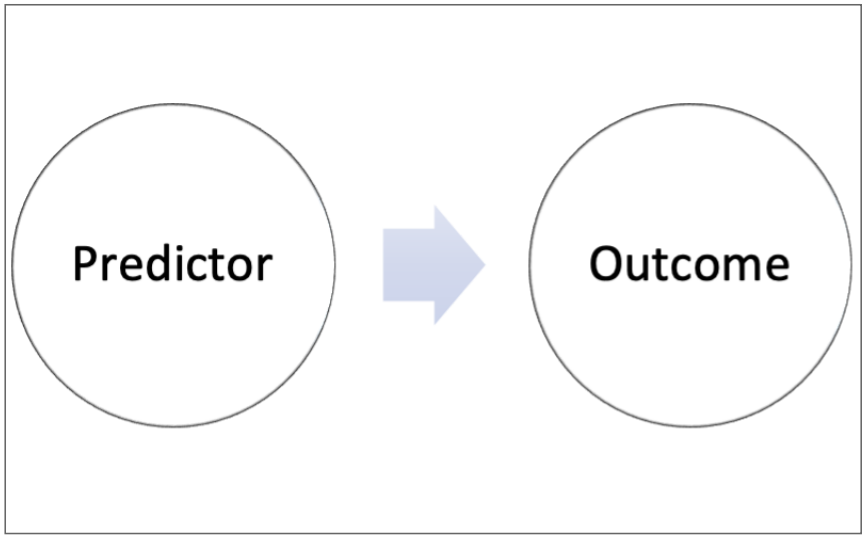
- Attention -> WM
- Art -> Sustained attention
- ADHD -> Innatention
- Celiac disease -> Processing speed
- Intervention -> Selective attention
- Musical training -> EF

Form



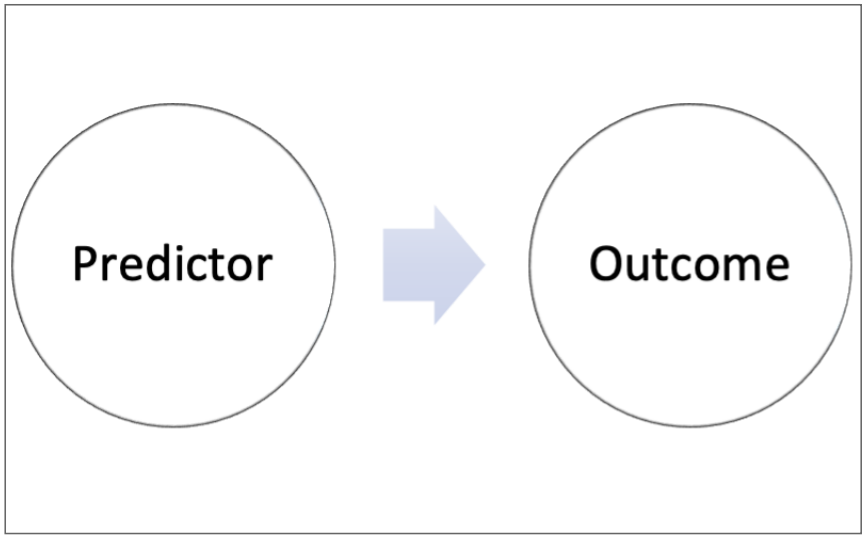
- $Outcome = (Predictor)$
- $Outcome = (Predictor) + error$
- $Y = (\beta) + \varepsilon$
- $Y = (\beta 0 + \beta 1) + \varepsilon$
- $Y = (\beta 0 + \beta 1 + \beta 2) + \varepsilon$

Study effects



- Relationship
- Difference between groups

Usefulness



- Existence: statistical significance
- Size: effect size, parameter

GLM with different variables

Lets see the variables

Phonological loop span

Ready?

8

4

3

7

1

2

Numbers?

Selective attention

Ready?

Go

azul amarillo rojo

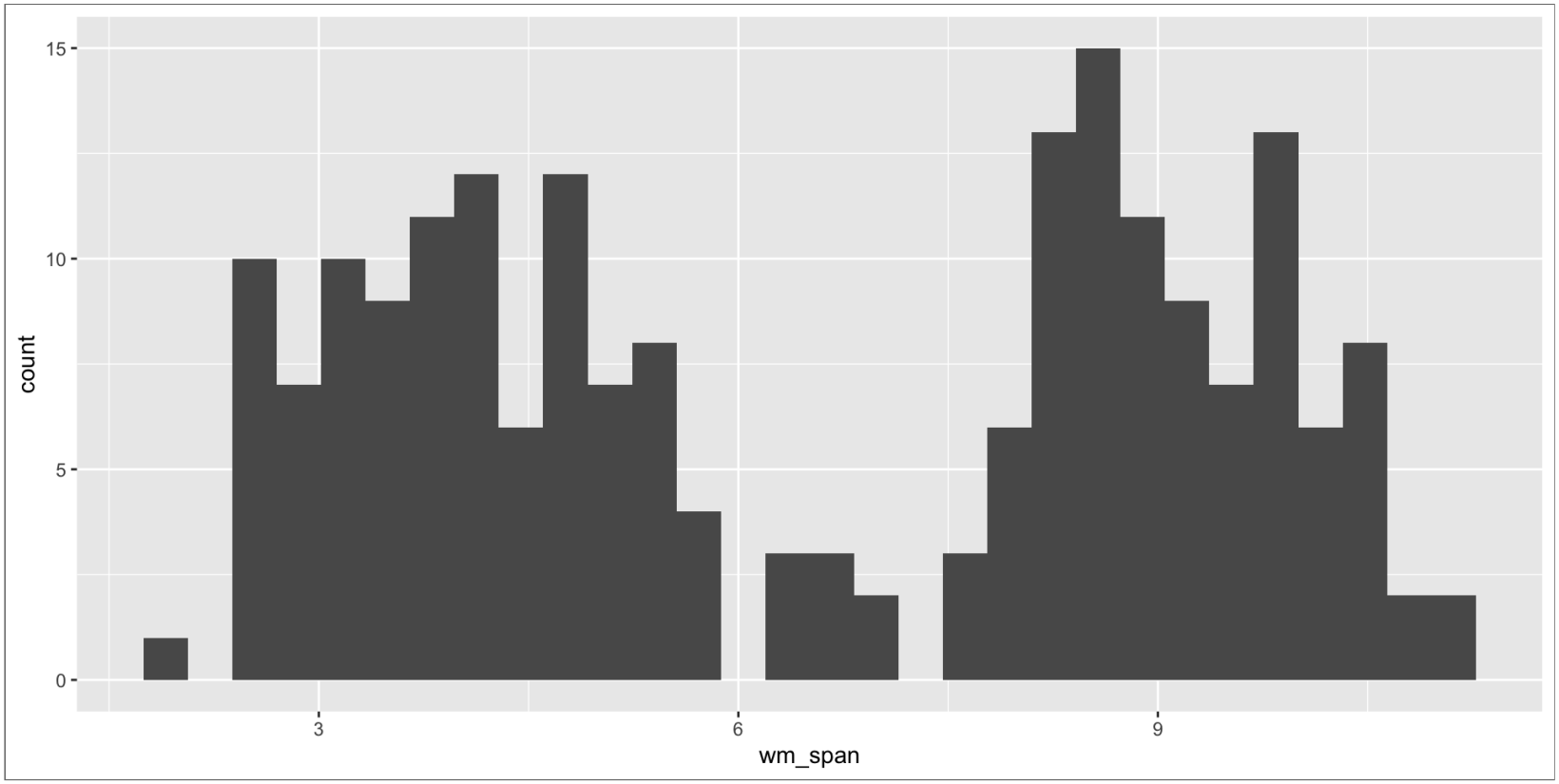
marrón azul naranja

rojo blanco verde

azul rojo blanco

Back to GLM with different variables

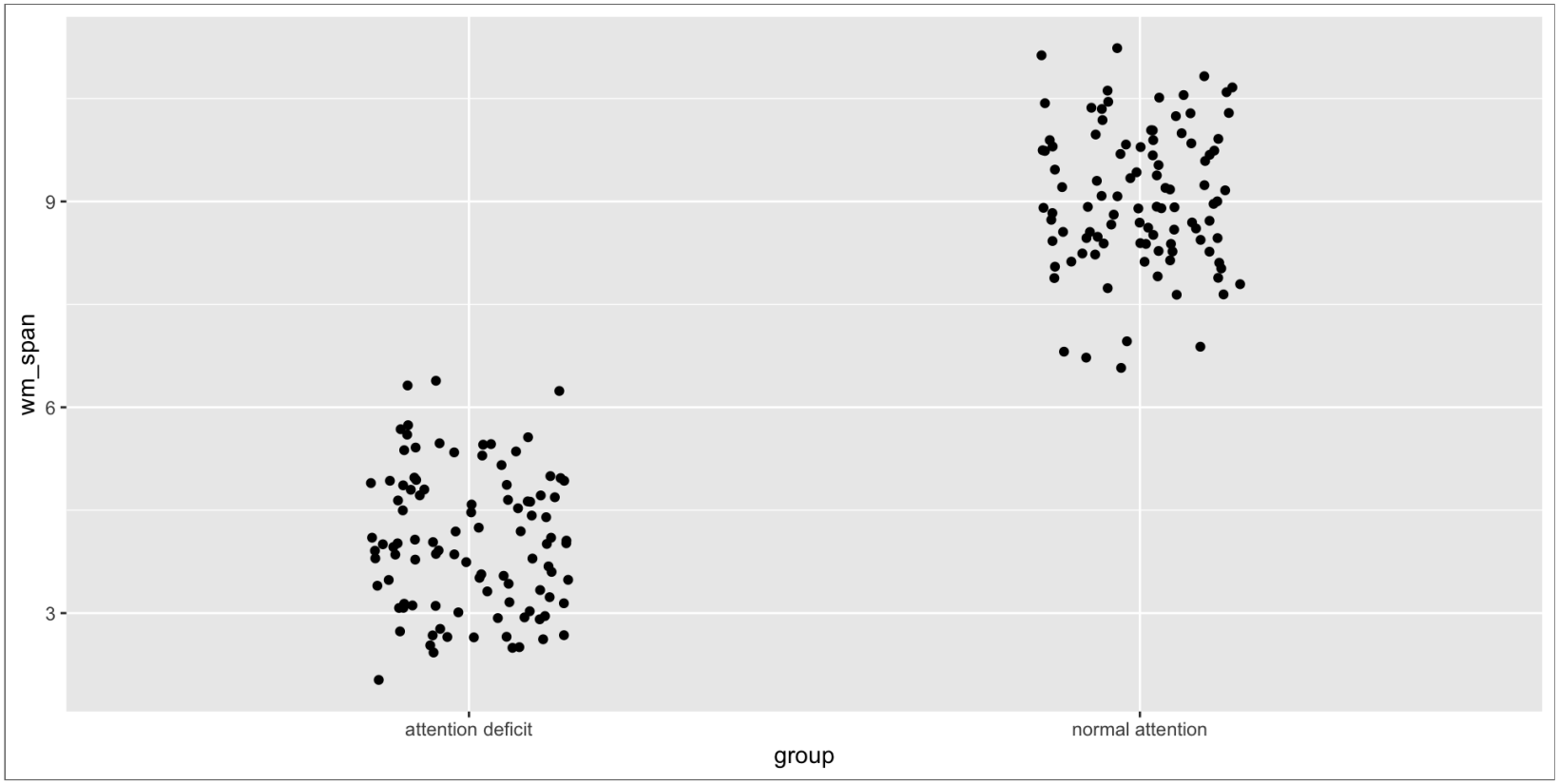
First, there were data



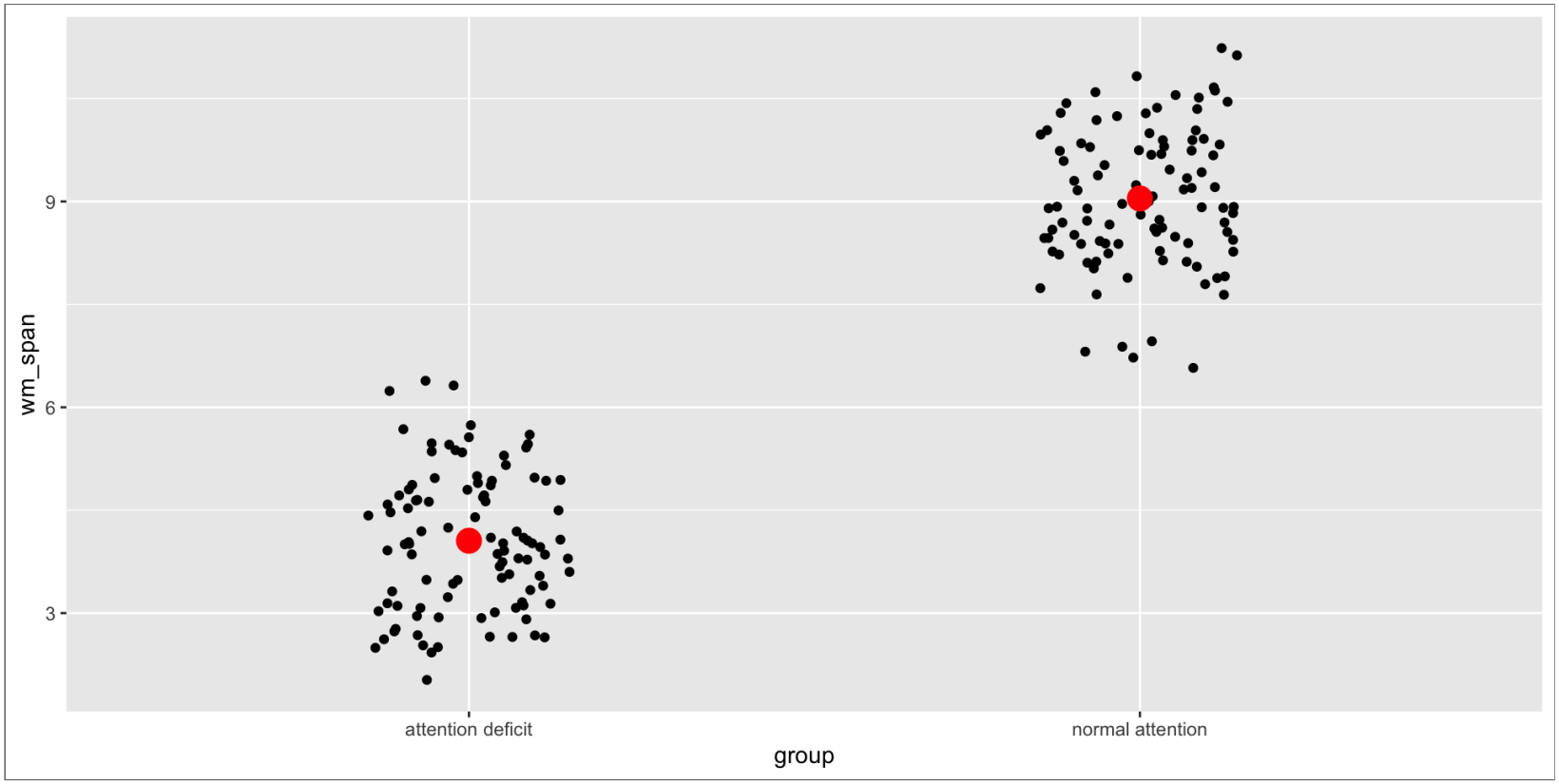
Differences between 2 groups?

Process

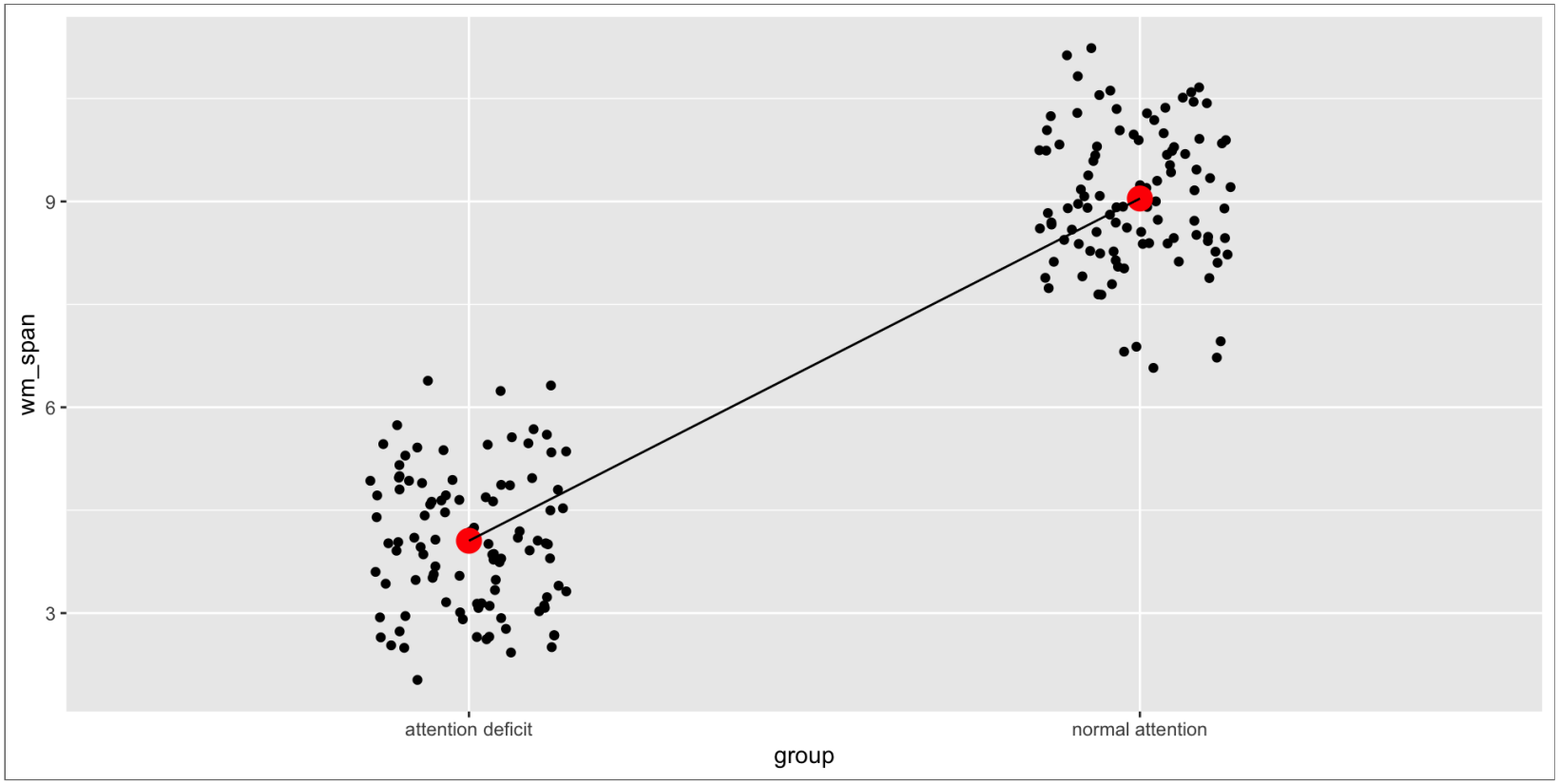
Group by attentional level



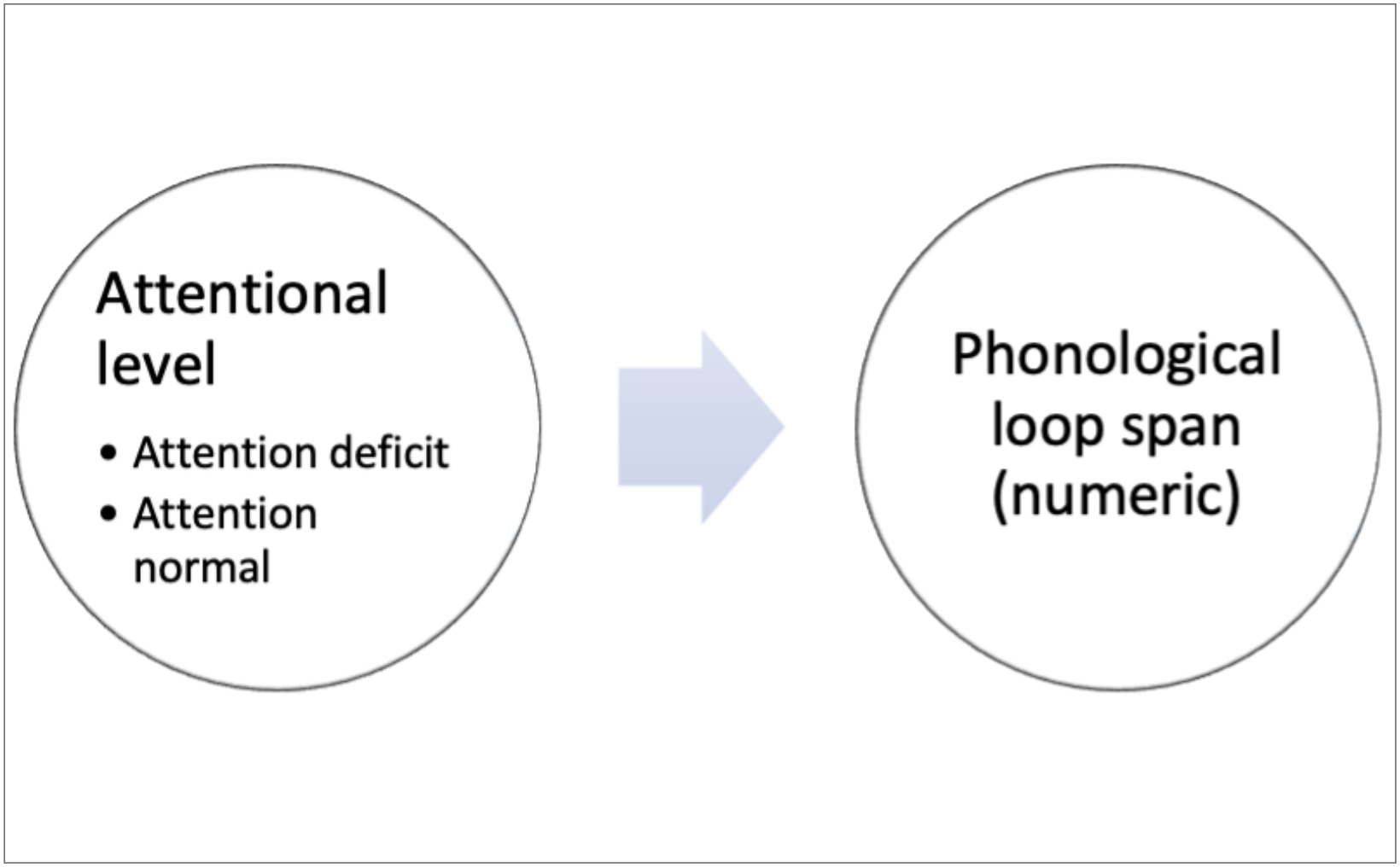
Estimate mean



Estimate relationship (difference)



GLM form


Attentional level
• Attention deficit
• Attention normal
Phonological loop span (numeric)

GLM analysis

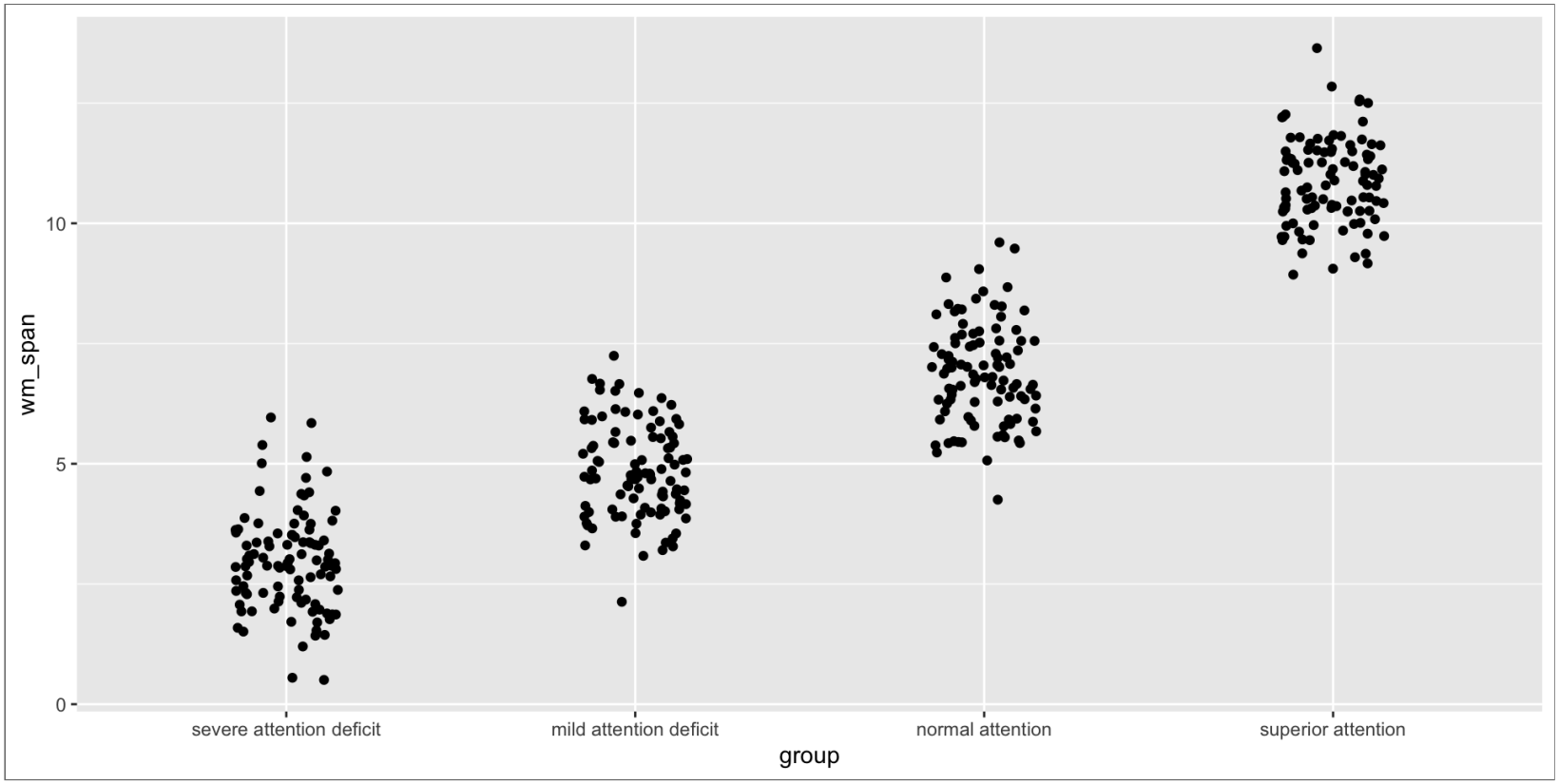
```
Call:
lm(formula = wm_span ~ group, data = data_2_groups)

Residuals:
    Min      1Q  Median      3Q     Max
-2.4693 -0.7450 -0.0649  0.7651  2.3321

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)            4.0547     0.1007   40.26   <2e-16 ***
groupnormal attention  4.9890     0.1424   35.03   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.007 on 198 degrees of freedom
```

A step further…

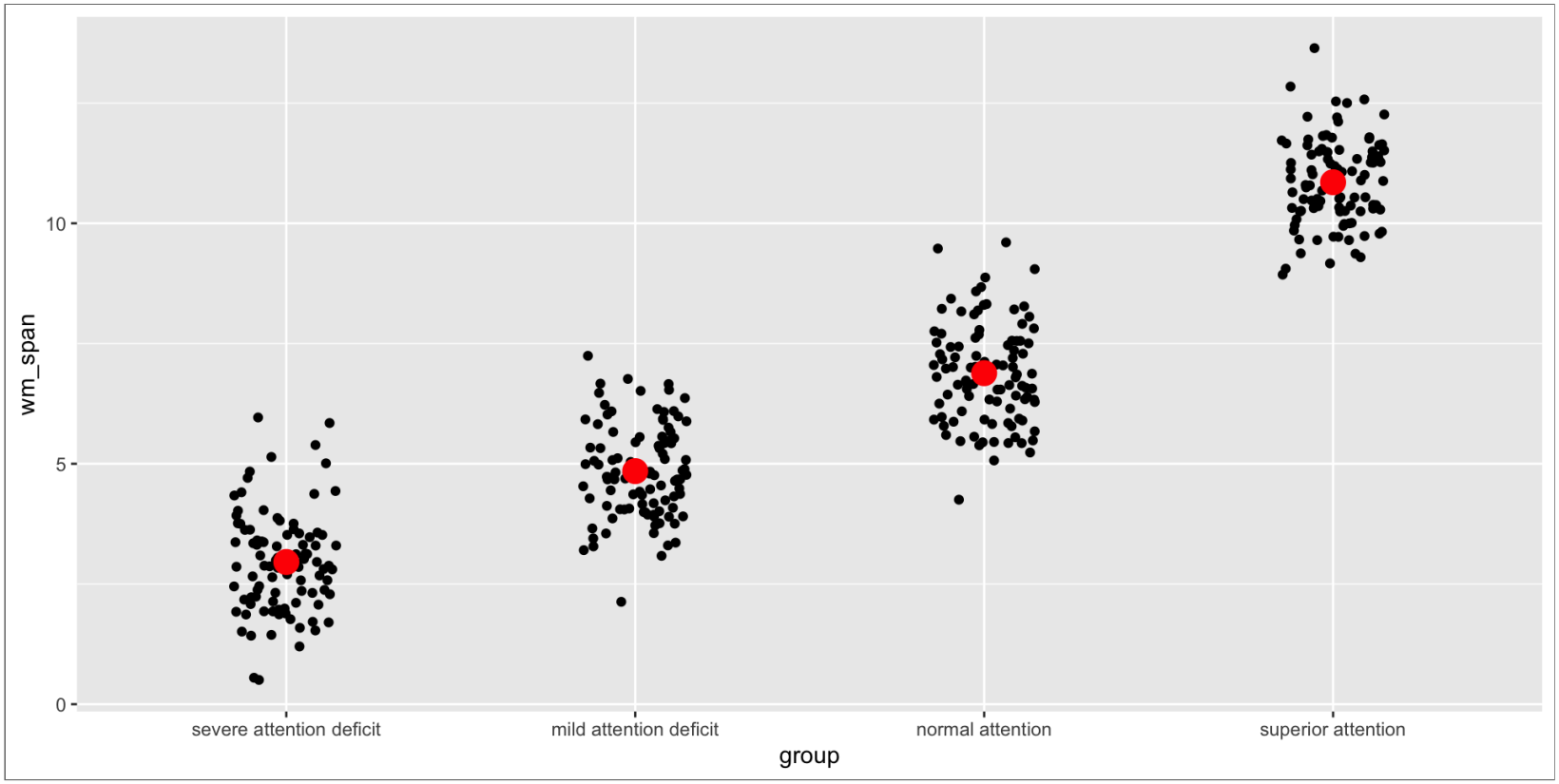
Differences between 4 groups

Process

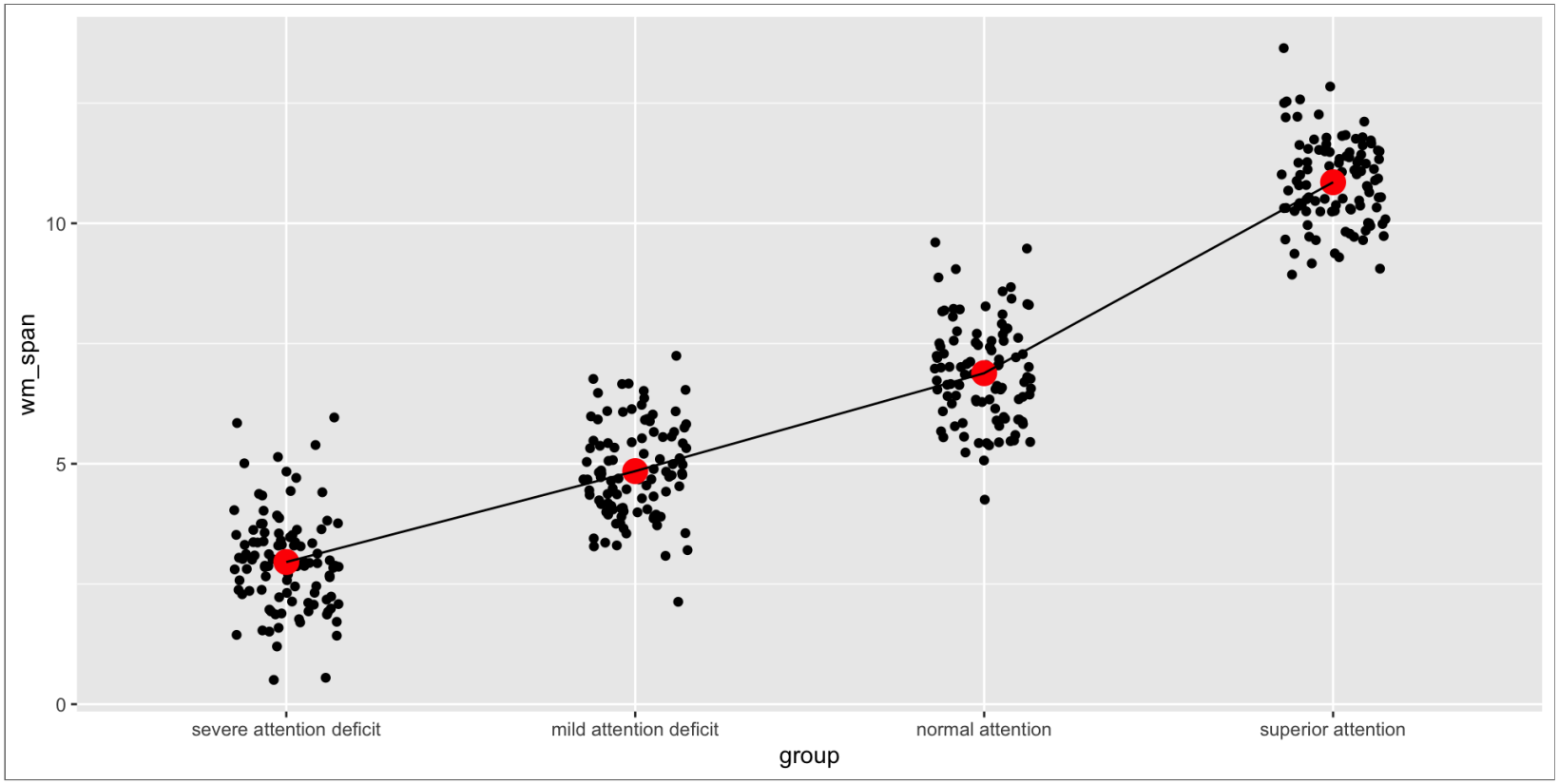
Group by attentional level



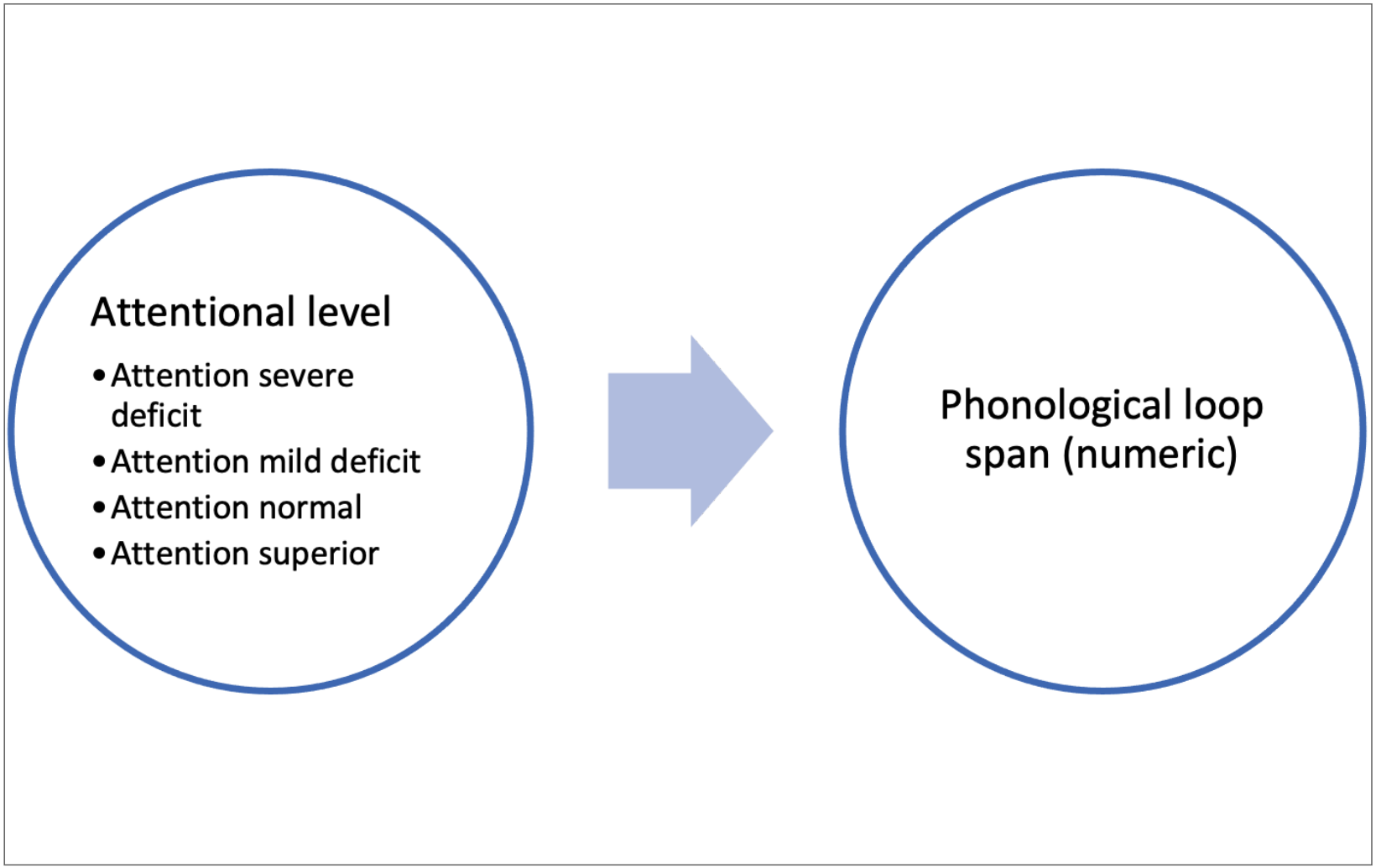
Estimate mean



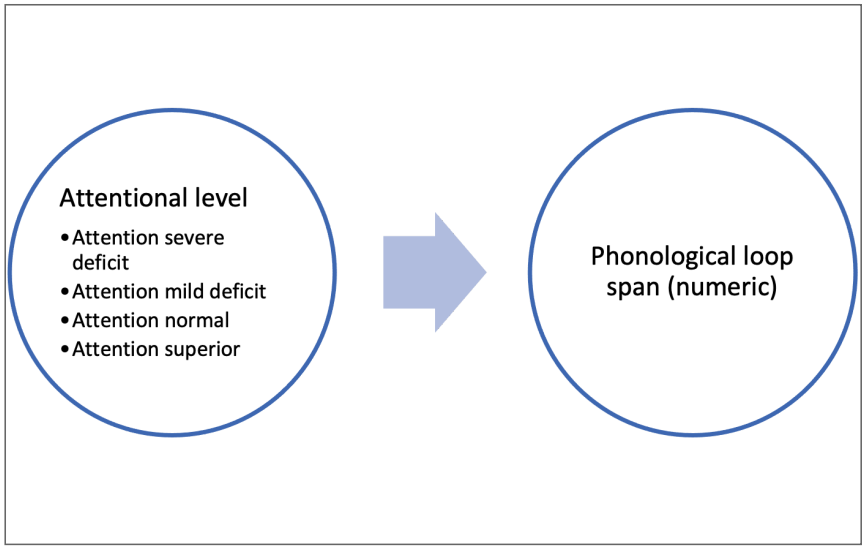
Estimate relationship (difference)

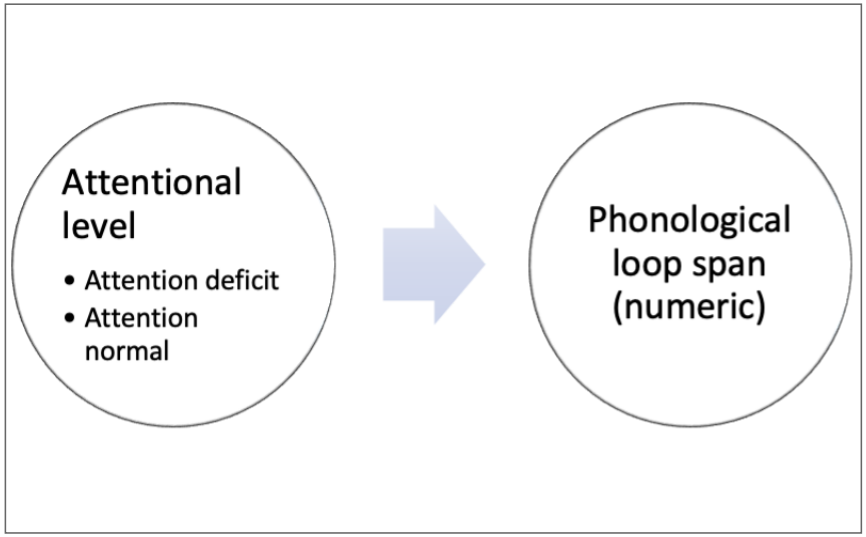


GLM form


Attentional level
• Attention severe deficit
• Attention mild deficit
• Attention normal
• Attention superior
Phonological loop span (numeric)

GLM form 2 vs 4 groups





GLM analysis

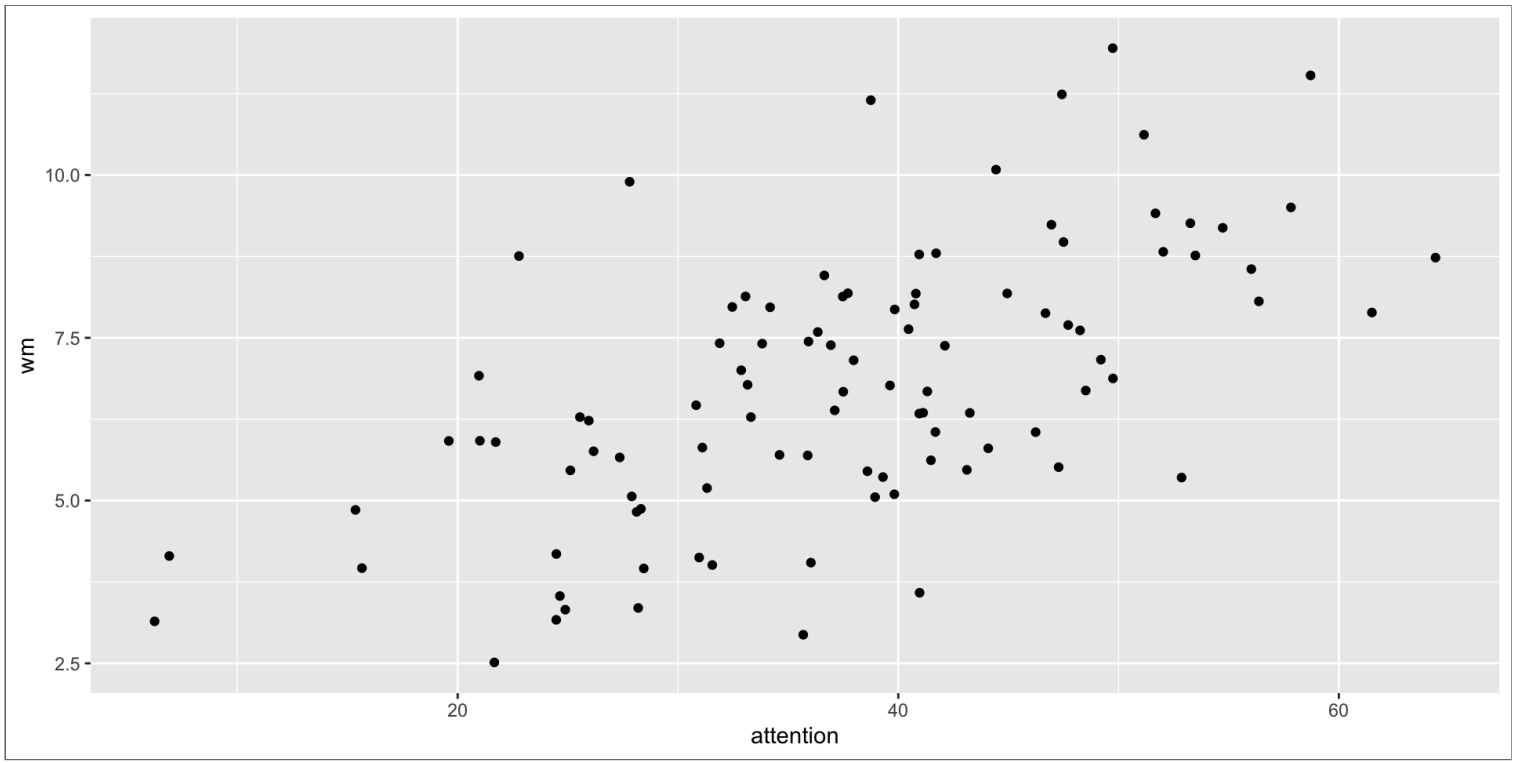
```
Call:
lm(formula = wm_span ~ group, data = data_4_groups)

Residuals:
     Min       1Q   Median       3Q      Max 
-2.71741 -0.69447 -0.06123  0.63348  3.00594 

Coefficients:
                            Estimate Std. Error t value Pr(>|t|)    
(Intercept)                  2.95692    0.09861   29.98   <2e-16 ***
groupmild attention deficit  1.89012    0.13946   13.55   <2e-16 ***
groupnormal attention        3.92689    0.13946   28.16   <2e-16 ***
groupsuperior attention      7.89711    0.13946   56.63   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

A step further…

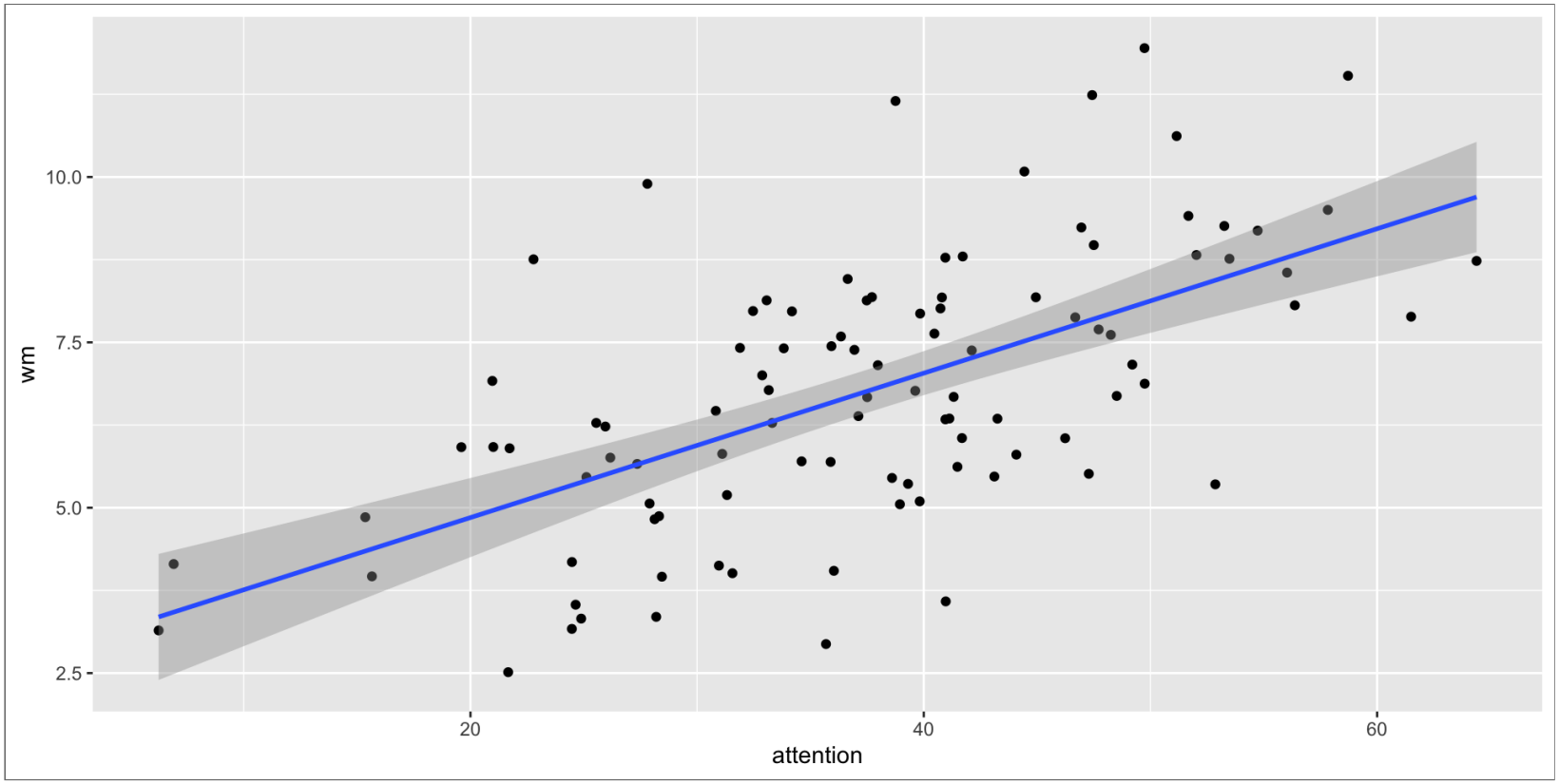
Numeric predictors

Attention and WM

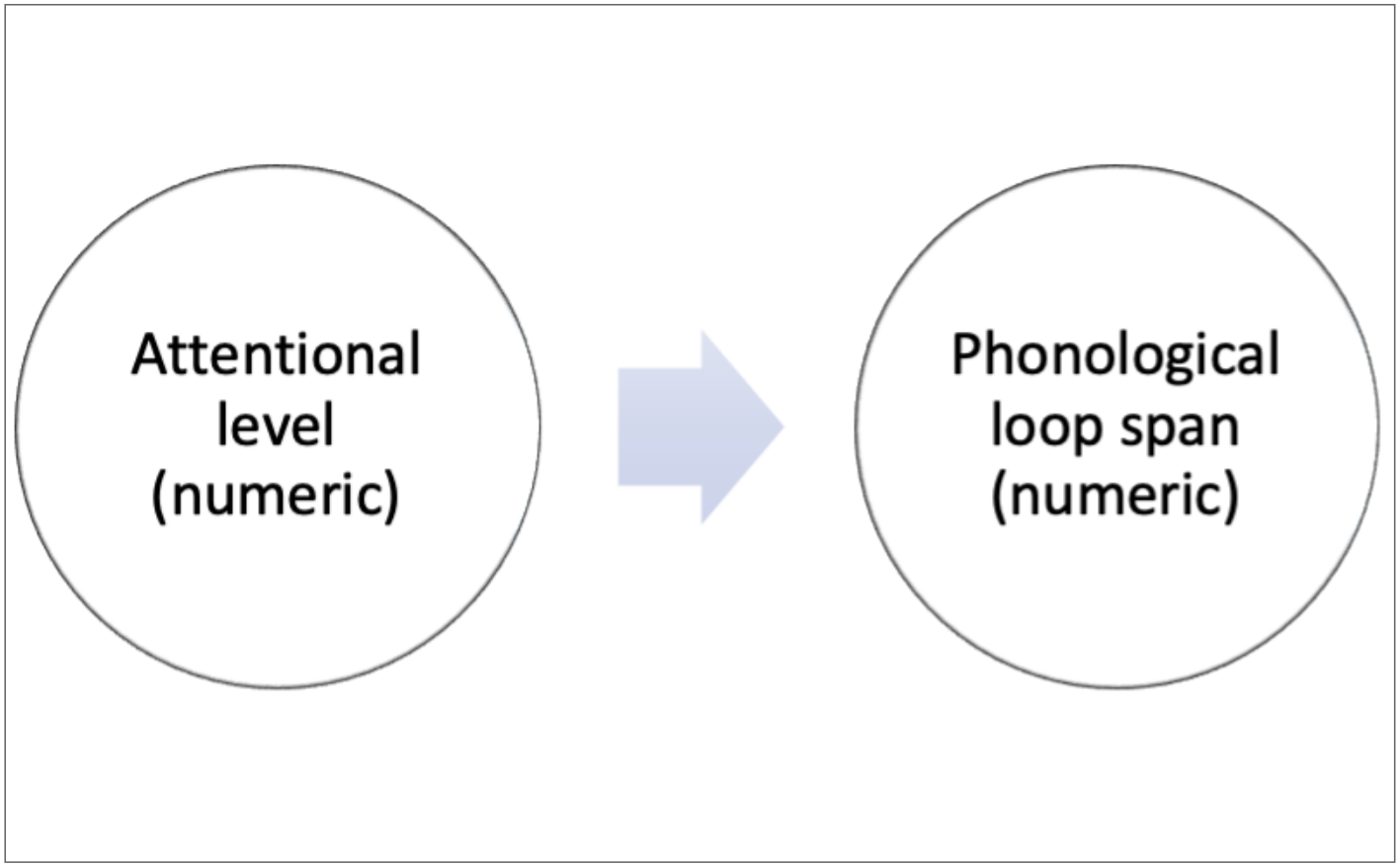
Estimate relationship



Estimate relationship line



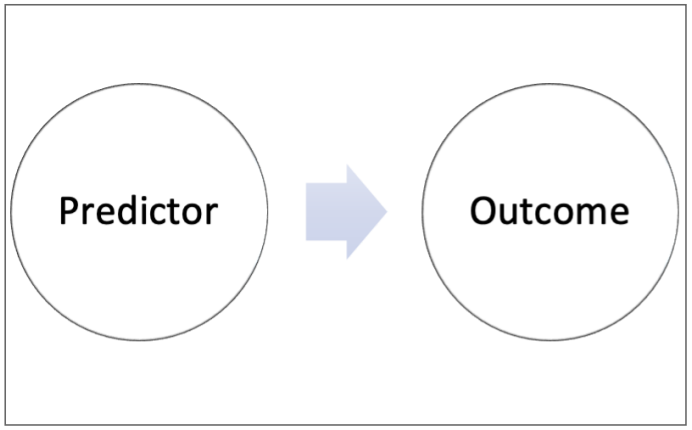
GLM form

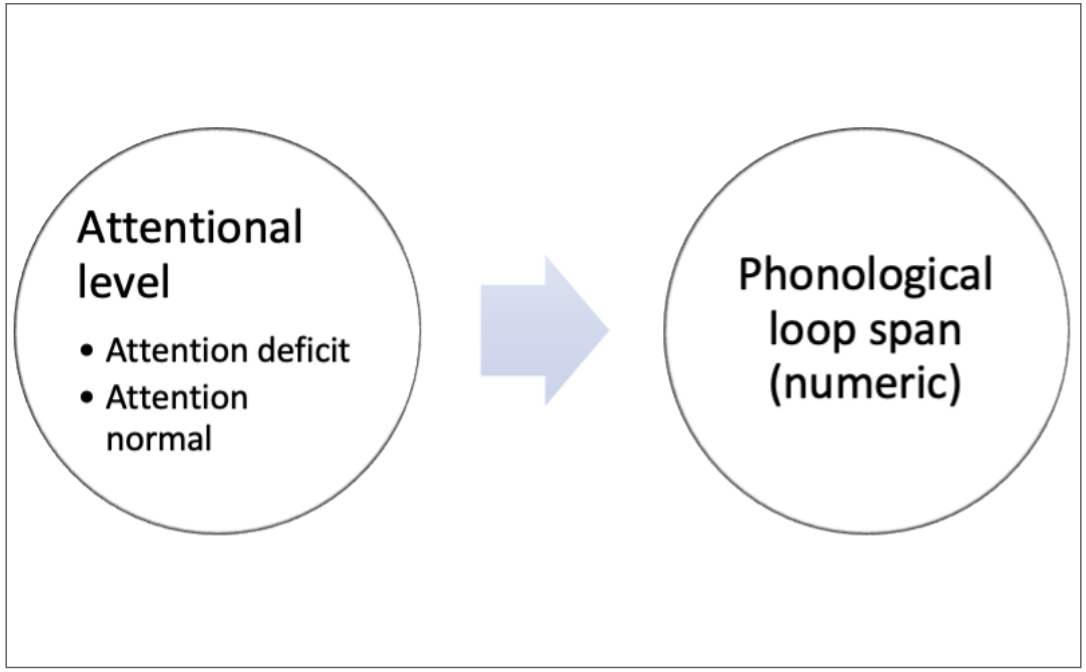

Attentional level (numeric)
Phonological loop span (numeric)

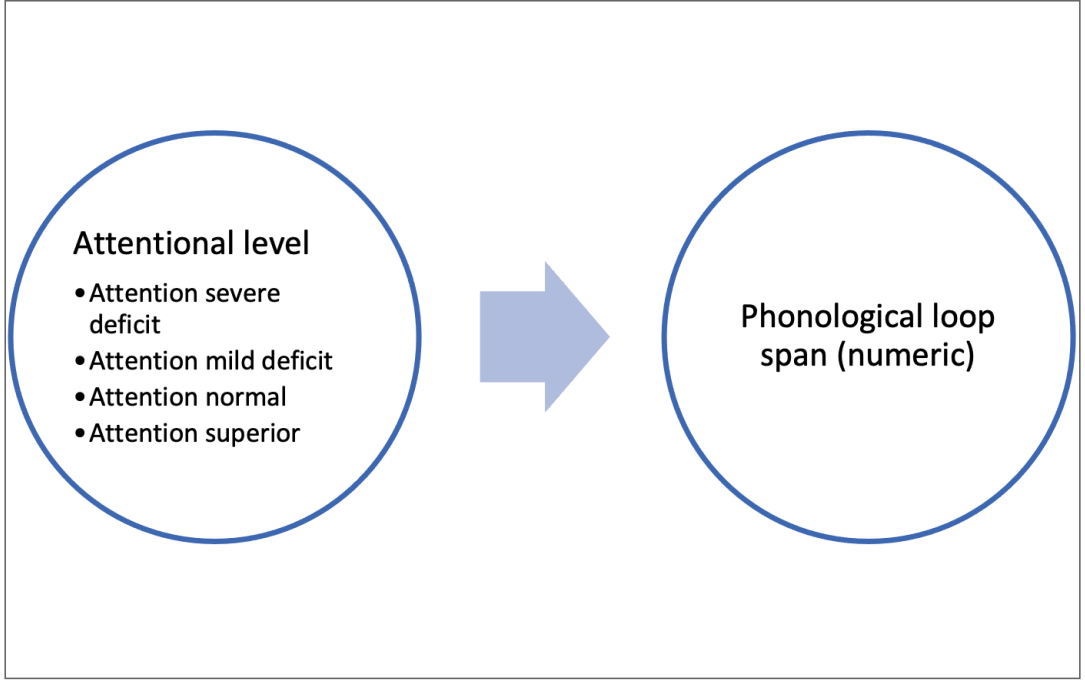
GLM analysis

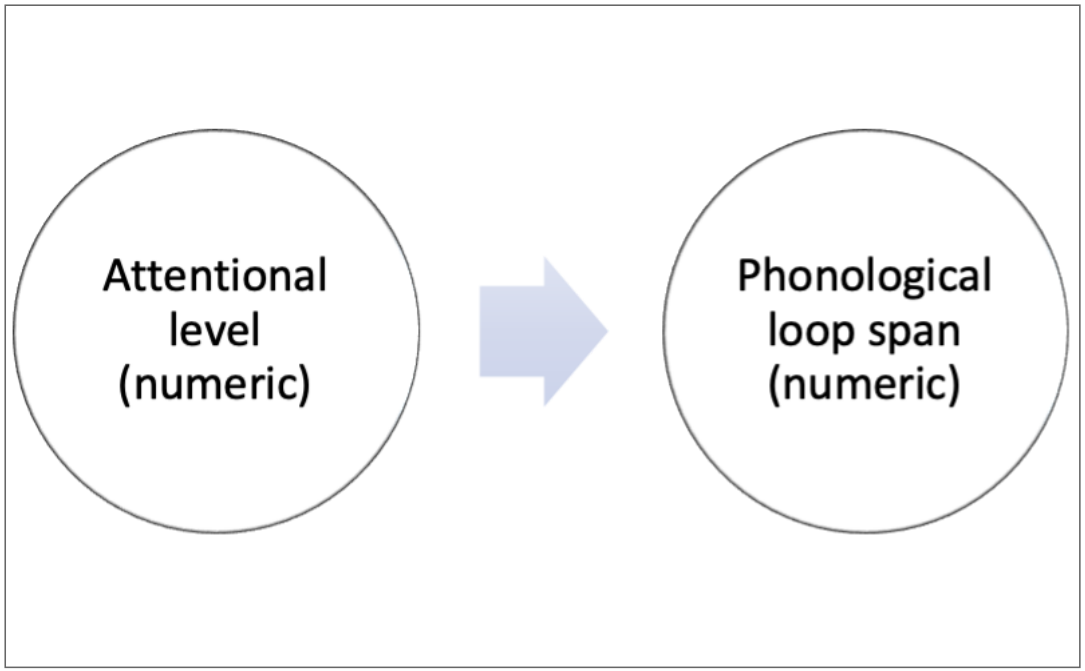
```
Call:
lm(formula = wm ~ attention, data = data_cont_vars)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.6246 -1.1619  0.0310  0.9539  4.2508 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  2.66748    0.56520   4.720 7.86e-06 ***
attention    0.10918    0.01441   7.577 2.01e-11 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.638 on 98 degrees of freedom
```

Summary of models






Attentional level
• Attention severe deficit
• Attention mild deficit
• Attention normal
• Attention superior
Phonological loop span (numeric)


Attentional level (numeric)
Phonological loop span (numeric)

Closing

Conclusions

- GLM underlies most stats methods
- Simple but powerful idea
- Use variables to predict variables
- Effects = relationships, differences

Questions or Comments

Further resources

- **Andy Field Lectures - YouTube**
- Field, A. (2017). Discovering Statistics Using IBM SPSS Statistics (5th ed.). London: Sage Publications. Chapter 2.

Bonus

- Always GLM

GLM subtypes