

# **Multilevel Visualization**

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# 1 Multilevel Visualization

“Persist and verify... The power that we abdicate to others out of our insecurity - to others who insult us with their faux-intuition or their authoritarian smugness - that comes back to hurt us so deeply... But the power we wrest from our own certitude - that saves us.” (Cash 2017)

## 1.1 Introduction

Below, I describe the use of [Stata](#) (StataCorp 2023), [R](#)<sup>1</sup> (R Core Team 2023; Wickham 2016), and [Julia](#) (Bezanson et al. 2017) to visualize multilevel models.



### Comparison of Software

See my discussion of the advantages and disadvantages of different software in the Appendix on estimation of multilevel models with different software.

## 1.2 The Data



### Dataset

The examples use the `simulated_multilevel_data.dta` file. Here is a [direct link](#) to download the data.

Table 1.1: Sample of Simulated Multilevel Data

Table 1.1: Table continues below

country	HDI	family	id	identity	intervention	physical_punishment
1	69	1	1.1	1	0	3
1	69	2	1.2	1	1	2
1	69	3	1.3	0	1	3

<sup>1</sup>In R, I use the `ggplot2` (Wickham 2016) library.

country	HDI	family	id	identity	intervention	physical_punishment
1	69	4	1.4	1	0	0
1	69	5	1.5	1	0	4
1	69	6	1.6	0	1	5

Table 1.2: Sample of Simulated Multilevel Data

warmth	outcome
3	57.47
1	50.1
2	52.92
5	60.17
4	55.05
3	49.81

## 2 Graphs

### Order of Variables

Across software platforms, pay attention to the order of variables. I generally use  $x$  for an *independent* variable along the horizontal axis and  $y$  for a *dependent* variable along the vertical axis. Different software asks for the variables to be listed in different order, or different ways, so it is worth paying close attention to the syntax.

### 2.1 Scatterplots

A scatterplot is one of the most basic of all data visualizations. At the same time, a scatterplot can be tremendously informative because it provides: the location of every data point (data points may be overprinted); a sense of the distribution of both the  $x$  and  $y$  variables; and a sense of the overall trend in the relationship between the two variables, if there is one.

#### 2.1.1 Stata

##### 2.1.1.1 Get The Data

```
use simulated_multilevel_data.dta
```

##### 2.1.1.2 Scatterplot

```
twoway scatter outcome warmth, ///  
  xtitle("warmth") ytitle("outcome") ///  
  title("Outcome by Parental Warmth")  
  
quietly graph export scatter.png, replace
```

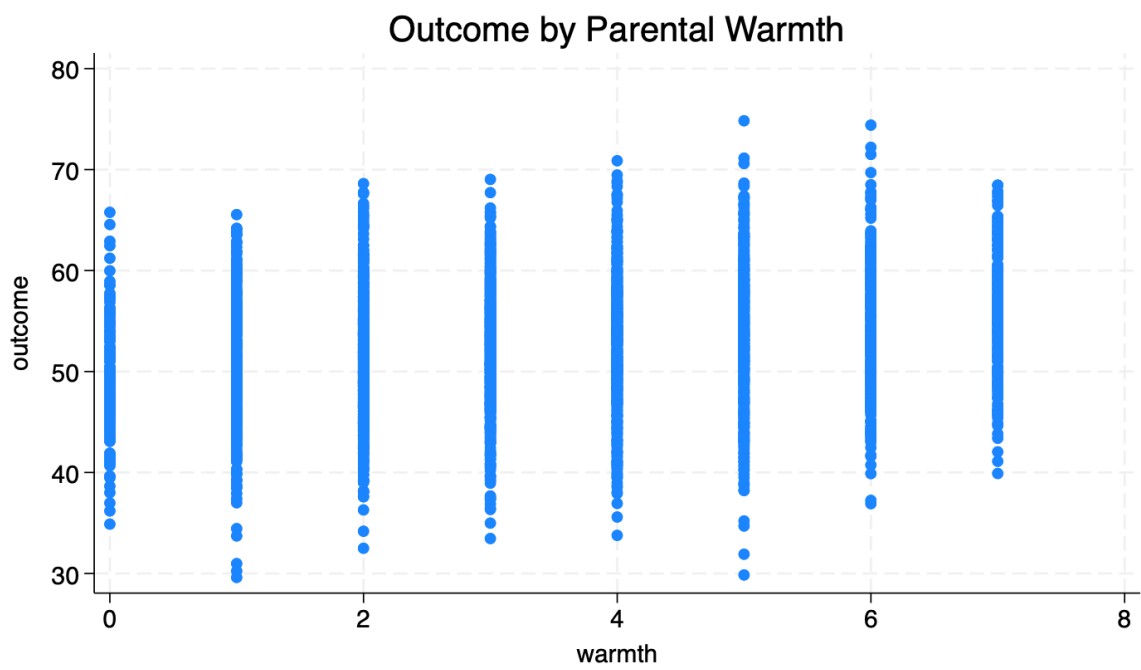


Figure 2.1: Outcome by Parental Warmth (Stata)



## 2.1.2 R

### 2.1.2.1 Get The Data

```
library(haven)

df <- read_dta("simulated_multilevel_data.dta")
```

### 2.1.2.2 Scatterplot

```
library(ggplot2)

ggplot(df,
       aes(x = warmth,
           y = outcome)) +
  geom_point() +
  labs(title = "Outcome by Parental Warmth")
```

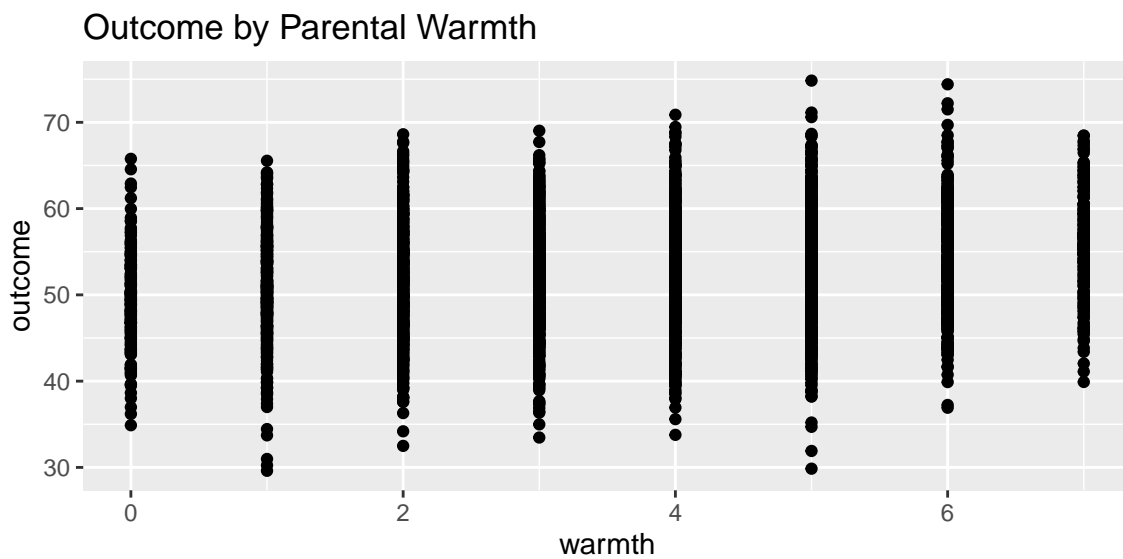


Figure 2.2: Outcome by Parental Warmth (R)

## 2.1.3 Julia

### 2.1.3.1 Get The Data

```
using Tables, MixedModels, StatFiles, DataFrames, CategoricalArrays, DataFramesMeta  
  
df = DataFrame(load("simulated_multilevel_data.dta"))
```

### 2.1.3.2 Scatterplot

```
using StatsPlots  
  
@df df scatter(:warmth, :outcome,  
               title = "Outcome by Parental Warmth",  
               ylabel = "outcome",  
               xlabel = "parental warmth")
```

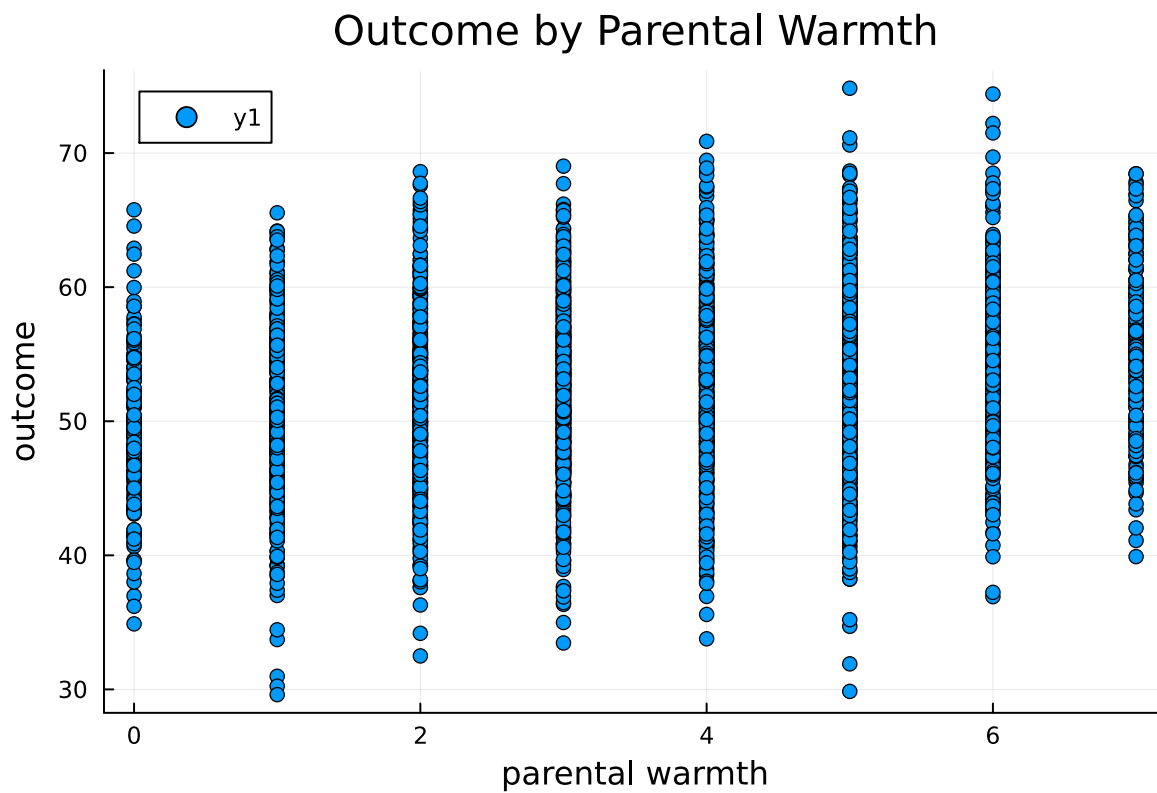


Figure 2.3: Outcome by Parental Warmth (Julia)

## 2.2 Line Graph (Linear Trend)

A line graph of the data focuses in on the linear trend in the data.

### 2.2.1 Stata

#### 2.2.1.1 Get The Data

```
use simulated_multilevel_data.dta
```

### 2.2.1.2 Line Graph

```
twoway lfit outcome warmth, ///  
  xtitle("warmth") ytitle("outcome") ///  
  title("Outcome by Parental Warmth")  
  
quietly graph export lfit.png, replace
```

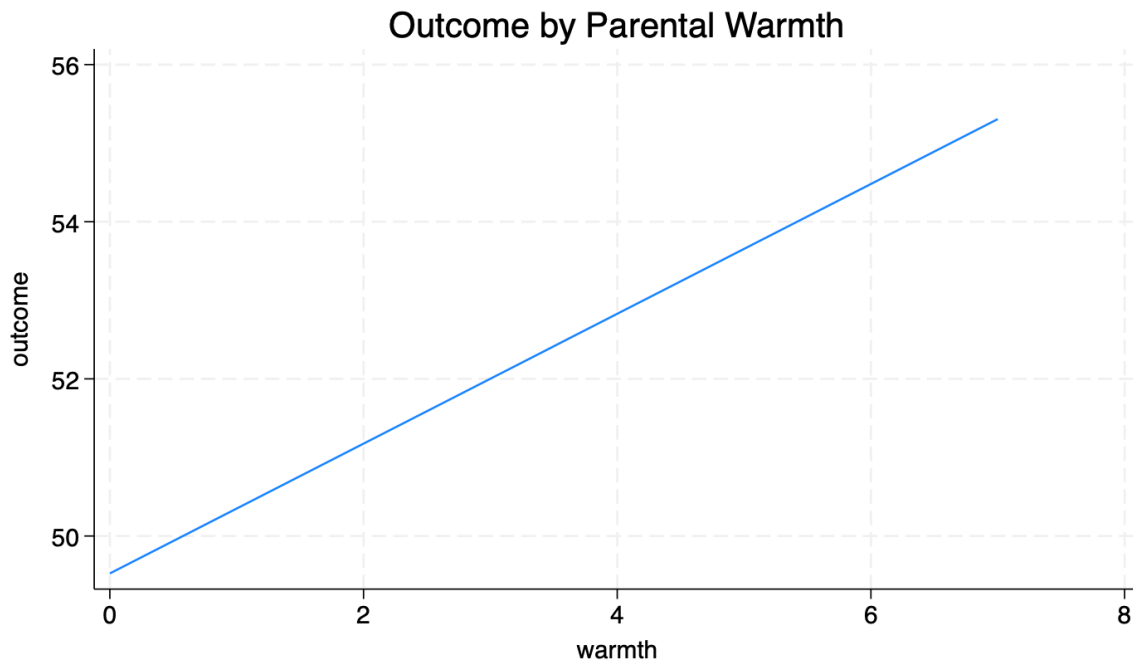


Figure 2.4: Outcome by Parental Warmth (Stata)

## 2.2.2 R

### 2.2.2.1 Get The Data

```
library(haven)  
  
df <- read_dta("simulated_multilevel_data.dta")
```

### 2.2.2.2 Line Graph

```
library(ggplot2)

ggplot(df,
       aes(y = outcome,
           x = warmth)) +
  geom_smooth(method = "lm") +
  labs(title = "Outcome by Parental Warmth")
```

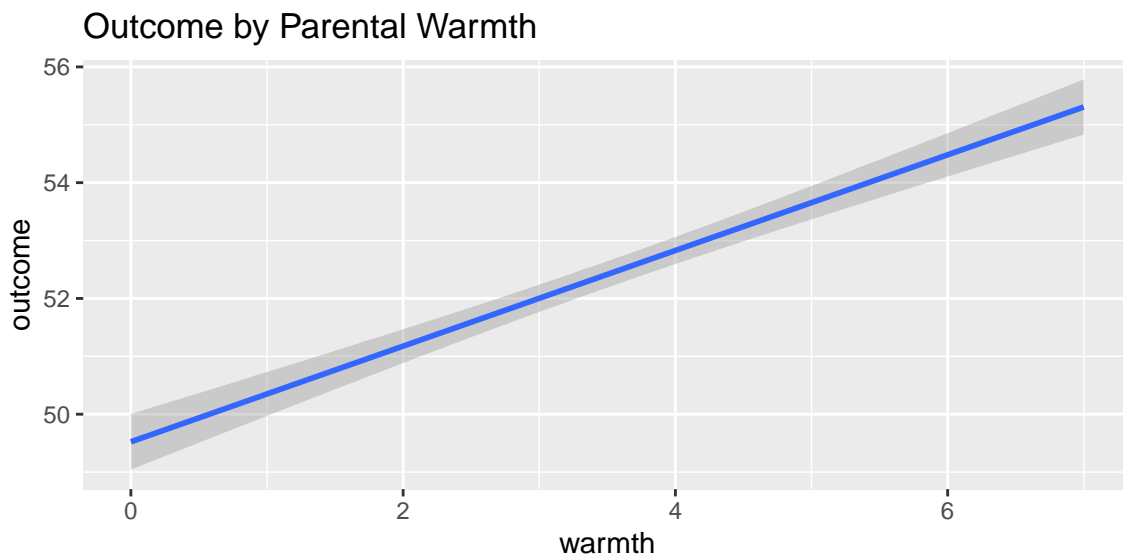


Figure 2.5: Outcome by Parental Warmth (R)

### 2.2.3 Julia

#### 2.2.3.1 Get The Data

```
using Tables, MixedModels, StatFiles, DataFrames, CategoricalArrays, DataFramesMeta

df = DataFrame(load("simulated_multilevel_data.dta"))
```

### 2.2.3.2 Line Graph

To make our plot with a smoother in Julia, we set the `markercolor` and `markerstrokecolor` to be *white*, and the `smooth` option to `:true`.

```
using StatsPlots

@df df scatter(:warmth, :outcome,
               title = "Outcome by Parental Warmth",
               ylabel = "outcome",
               xlabel = "warmth",
               markercolor = "white",
               markerstrokecolor = "white",
               smooth=:true)
```

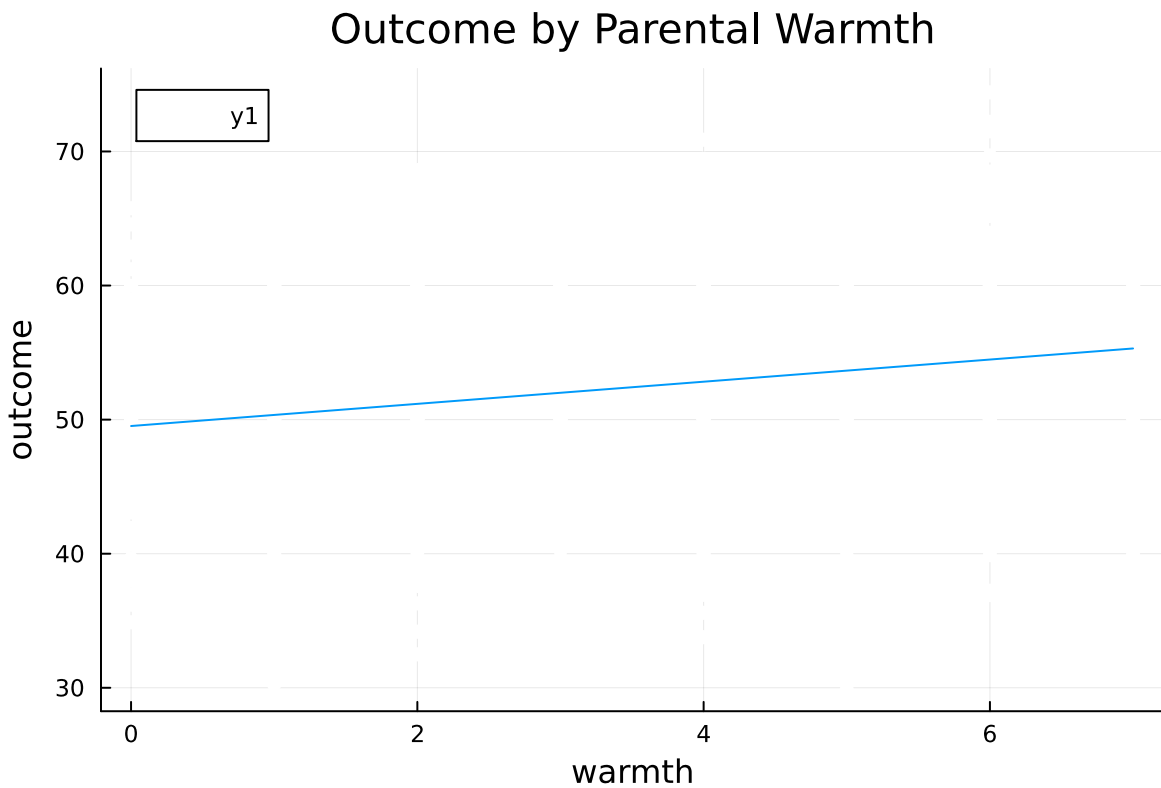


Figure 2.6: Outcome by Parental Warmth (Julia)

## 2.3 Spaghetti Plots

A *spaghetti plot* might be considered the most *multilevel* of the visualizations here considered. A spaghetti plot shows the group specific slopes and intercepts for all of the groups in the data.

### 2.3.1 Stata

In Stata, spaghetti plots are most easily generated using the user written `spagplot` command. Type `findit spagplot` to install this command.

#### 2.3.1.1 Get The Data

```
use simulated_multilevel_data.dta
```

#### 2.3.1.2 Spaghetti Plot

💡 Installing `spagplot`

`spagplot` is a user written command. Type `findit spagplot` to install.

```
spagplot outcome warmth, ///  
  id(country) ///  
  xtitle("parental warmth") ytitle("outcome") ///  
  title("Outcome by Parental Warmth")  
  
quietly graph export spagplot.png, replace
```

### 2.3.2 R

#### 2.3.2.1 Get The Data

```
library(haven)  
  
df <- read_dta("simulated_multilevel_data.dta")
```

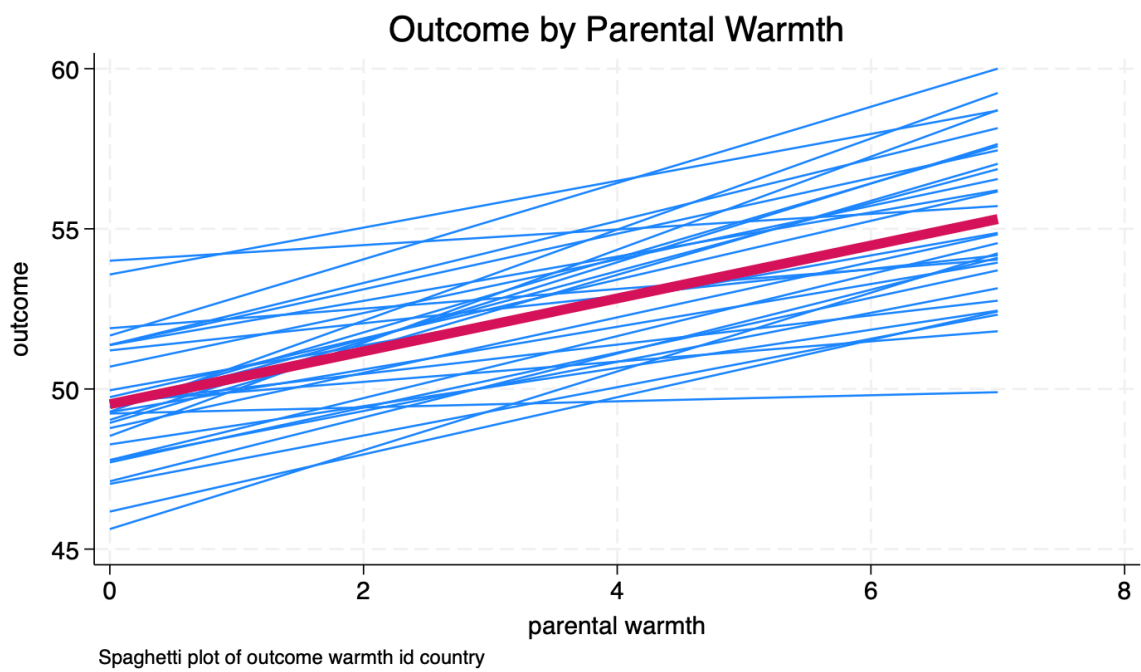


Figure 2.7: Outcome by Parental Warmth (Stata)



### 2.3.2.2 Spaghetti Plot

```
library(ggplot2)

df$country <- factor(df$country)

ggplot(df,
  aes(y = outcome,
      x = warmth)) +
  geom_smooth(aes(color = country,
                  group = country),
              method = "lm",
              se = FALSE) +
  geom_smooth(method = "lm", linewidth = 3) +
  labs(title = "Outcome by Parental Warmth")
```

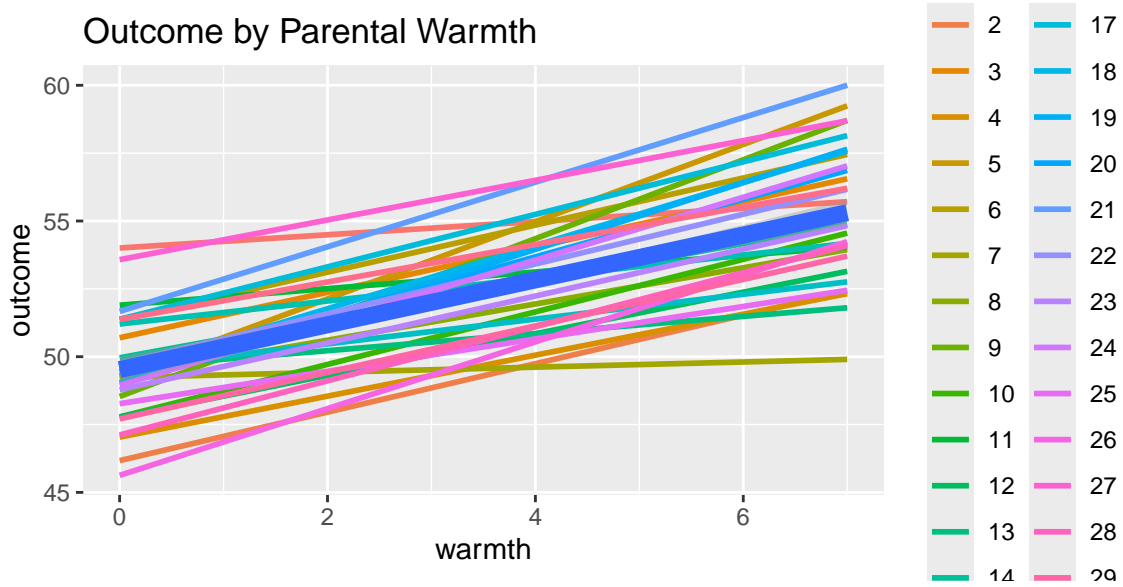


Figure 2.8: Outcome by Parental Warmth (R)

## 2.3.3 Julia

### 2.3.3.1 Get The Data

```
using Tables, MixedModels, StatFiles, DataFrames, CategoricalArrays, DataFramesMeta

df = DataFrame(load("simulated_multilevel_data.dta"))
```

### 2.3.3.2 Spaghetti Plot

```
using StatsPlots

@df df scatter(:warmth, :outcome,
               title = "Outcome by Parental Warmth",
               ylabel = "outcome",
               xlabel = "warmth",
               markercolor = "white",
               markerstrokecolor = "white",
               group = :country,
               legend = false,
               smooth=:true)
```

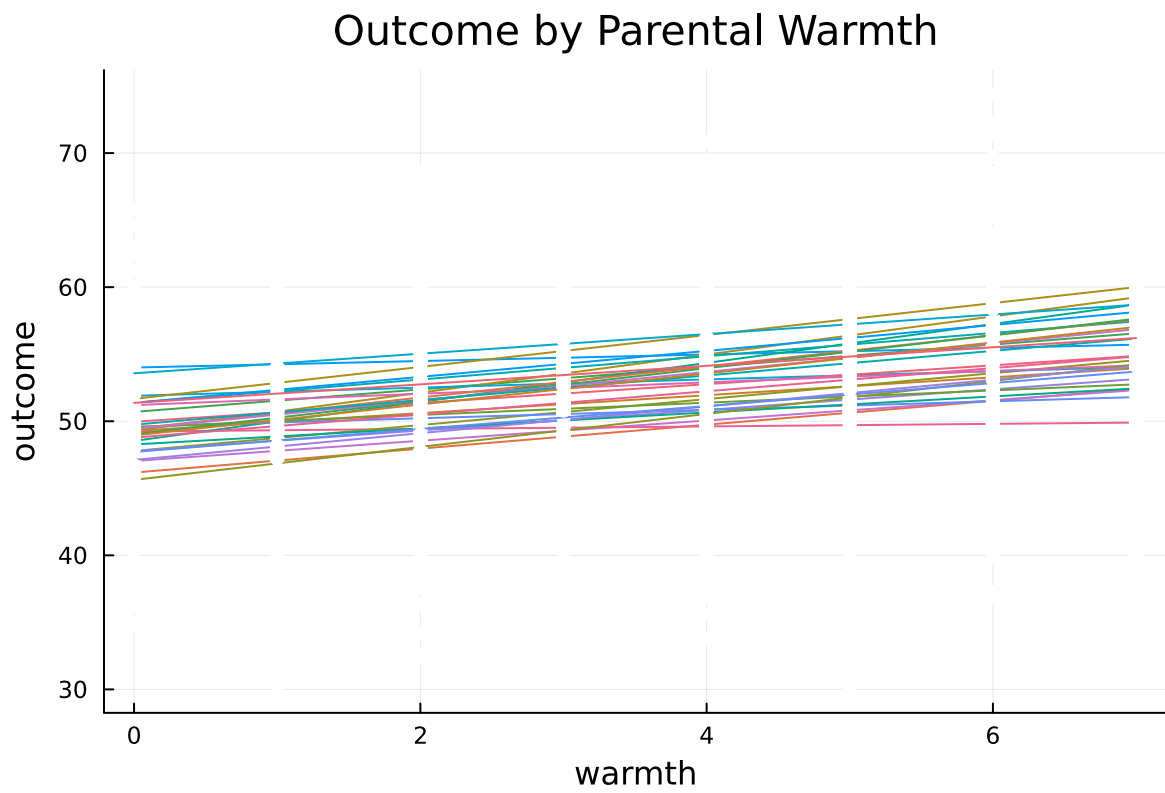


Figure 2.9: Outcome by Parental Warmth (Julia)

# References

- Bezanson, Jeff, Alan Edelman, Stefan Karpinski, and Viral B. Shah. 2017. “Julia: A Fresh Approach to Numerical Computing.” *SIAM Review* 59 (1): 65–98. <https://doi.org/10.1137/141000671>.
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- R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. <https://www.R-project.org/>.
- StataCorp. 2023. *Stata 18 Graphics Reference Manual*. Stata Press.
- Wickham, Hadley. 2016. *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. <https://ggplot2.tidyverse.org>.