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[1] (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

The examples use the `simulated_multilevel_data.dta` file from *Multilevel Thinking*. 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
1	69	4	1.4	1	0	0
1	69	5	1.5	1	0	4

[1] In R, I use the `ggplot2` (Wickham 2016) library.

country	HDI	family	id	identity	intervention	physical_punishment
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 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
```

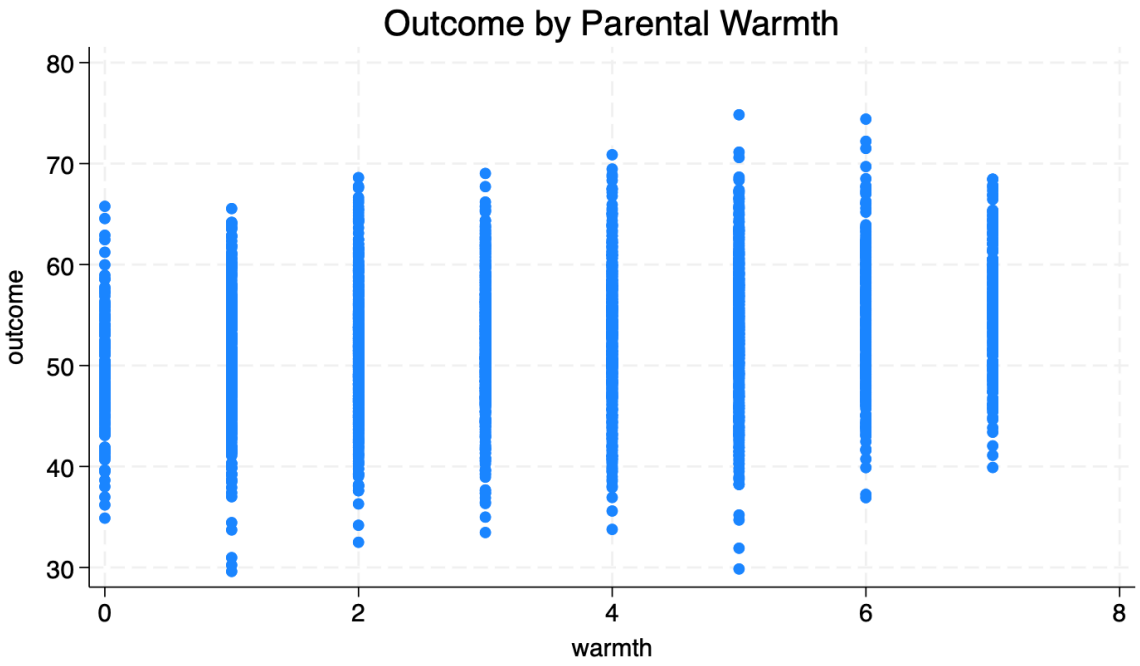

Figure 2.1: Outcome by Parental Warmth (Stata)

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")
```

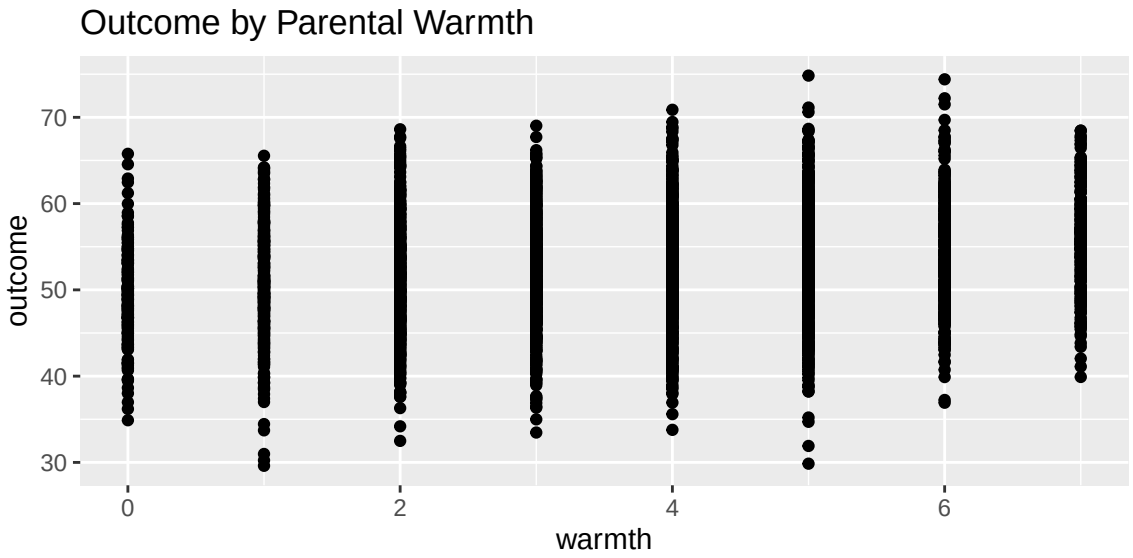

Figure 2.2: Outcome by Parental Warmth (R)

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")
```

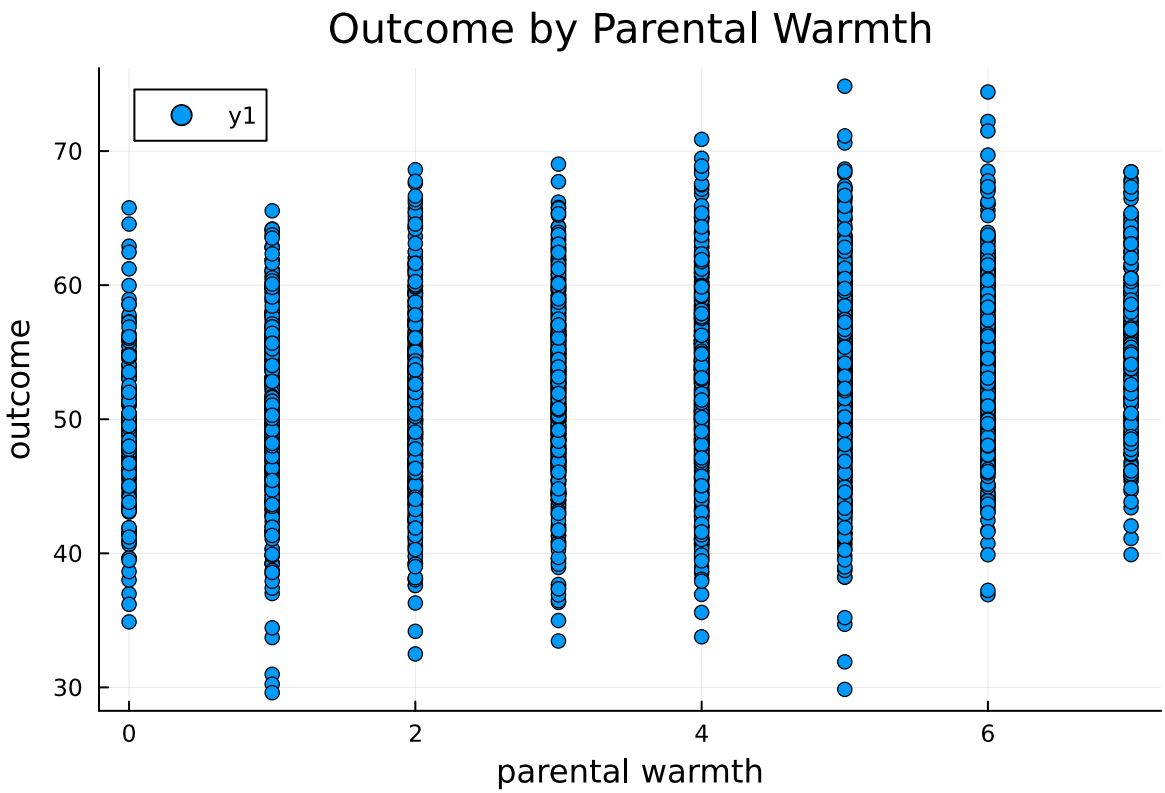

Figure 2.3: Outcome by Parental Warmth (Julia)

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
```

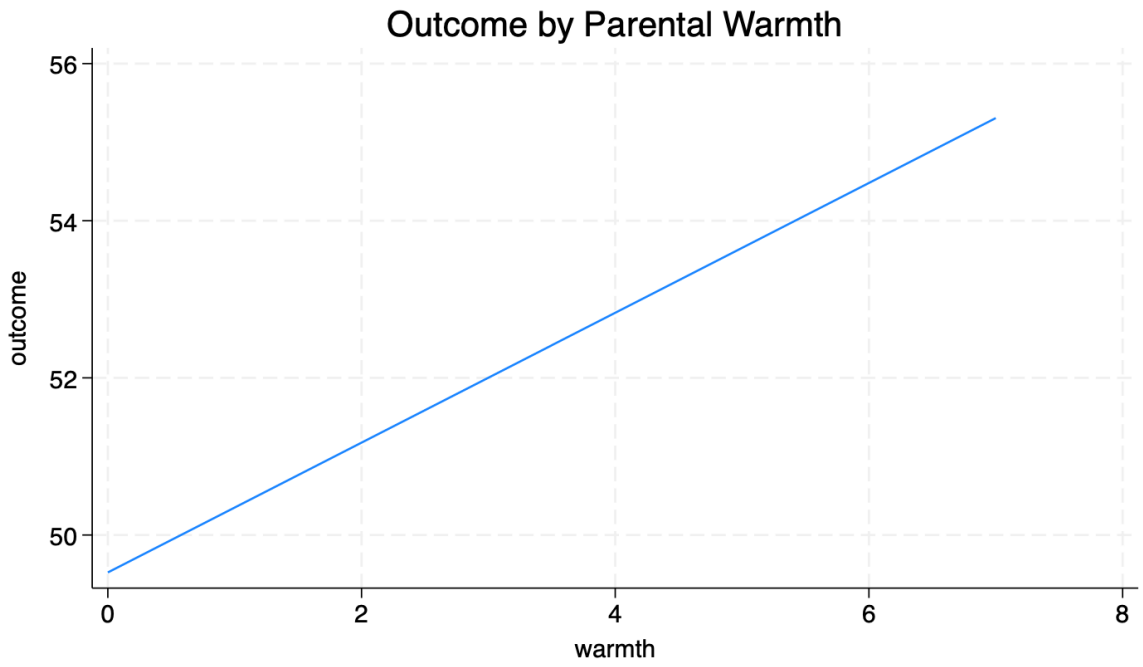

Figure 2.4: Outcome by Parental Warmth (Stata)

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")
```

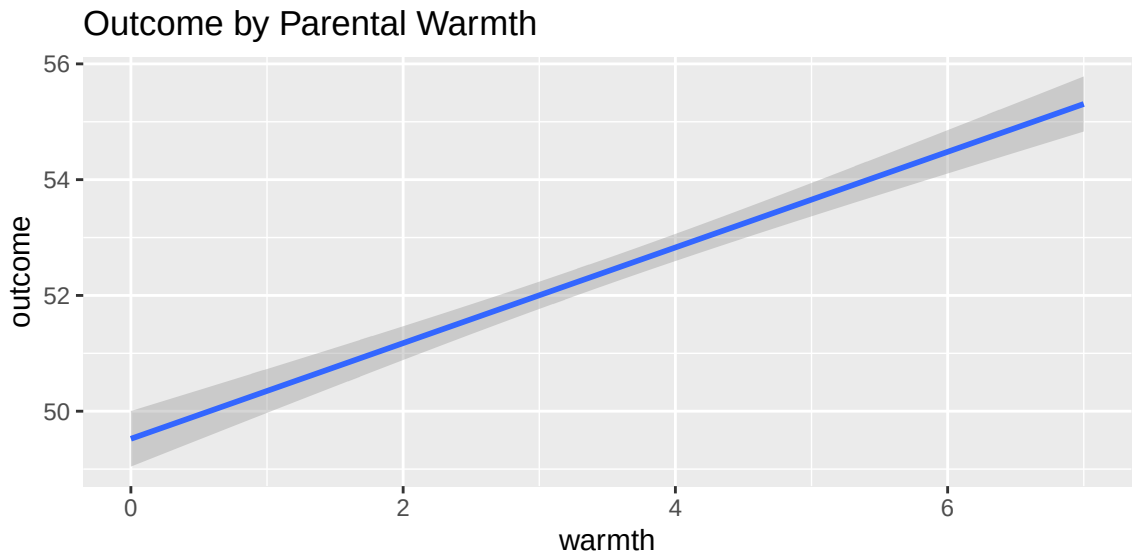

Figure 2.5: Outcome by Parental Warmth (R)

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)
```

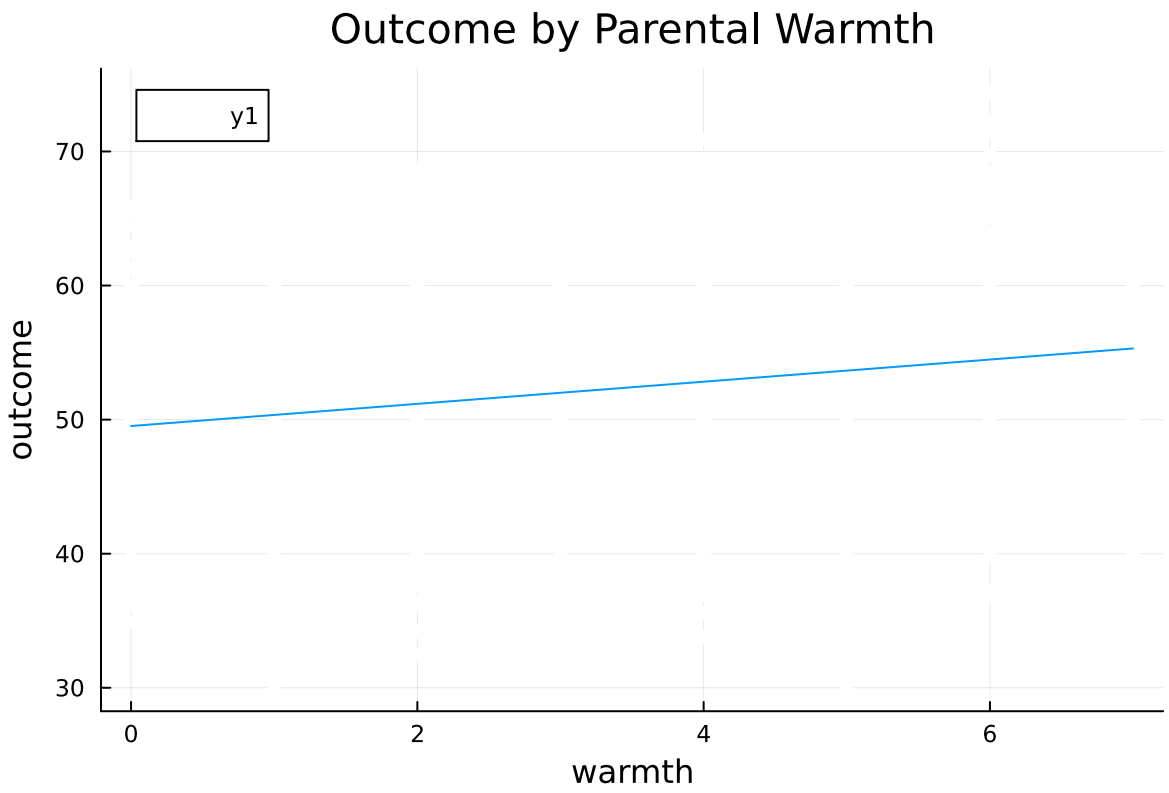

Figure 2.6: Outcome by Parental Warmth (Julia)

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")
```

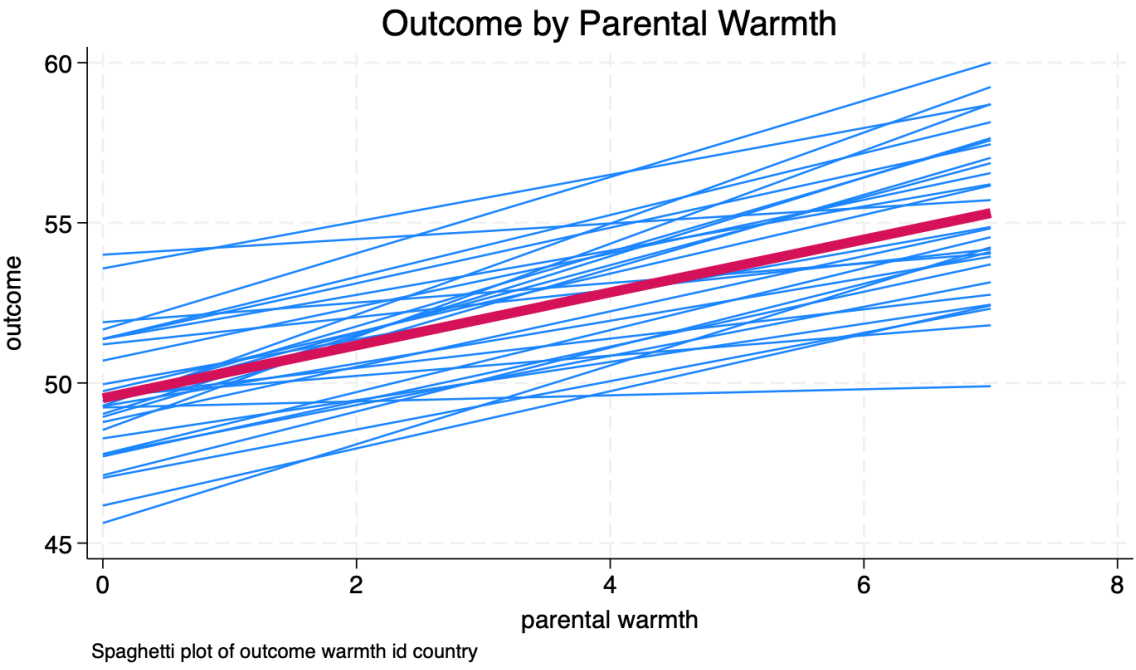

Figure 2.7: Outcome by Parental Warmth (Stata)

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")
```

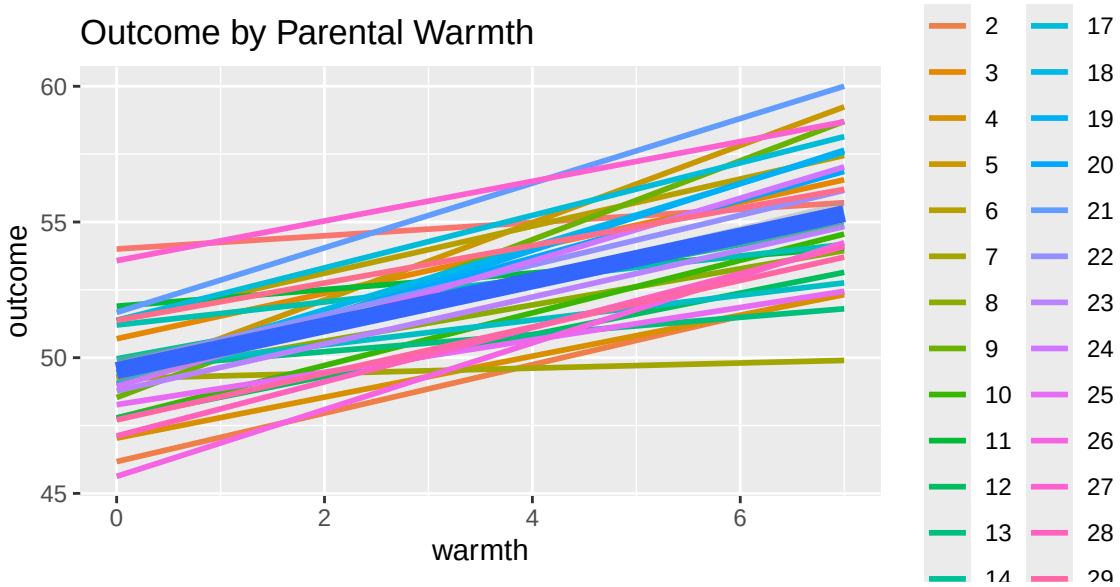

Figure 2.8: Outcome by Parental Warmth (R)

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)
```

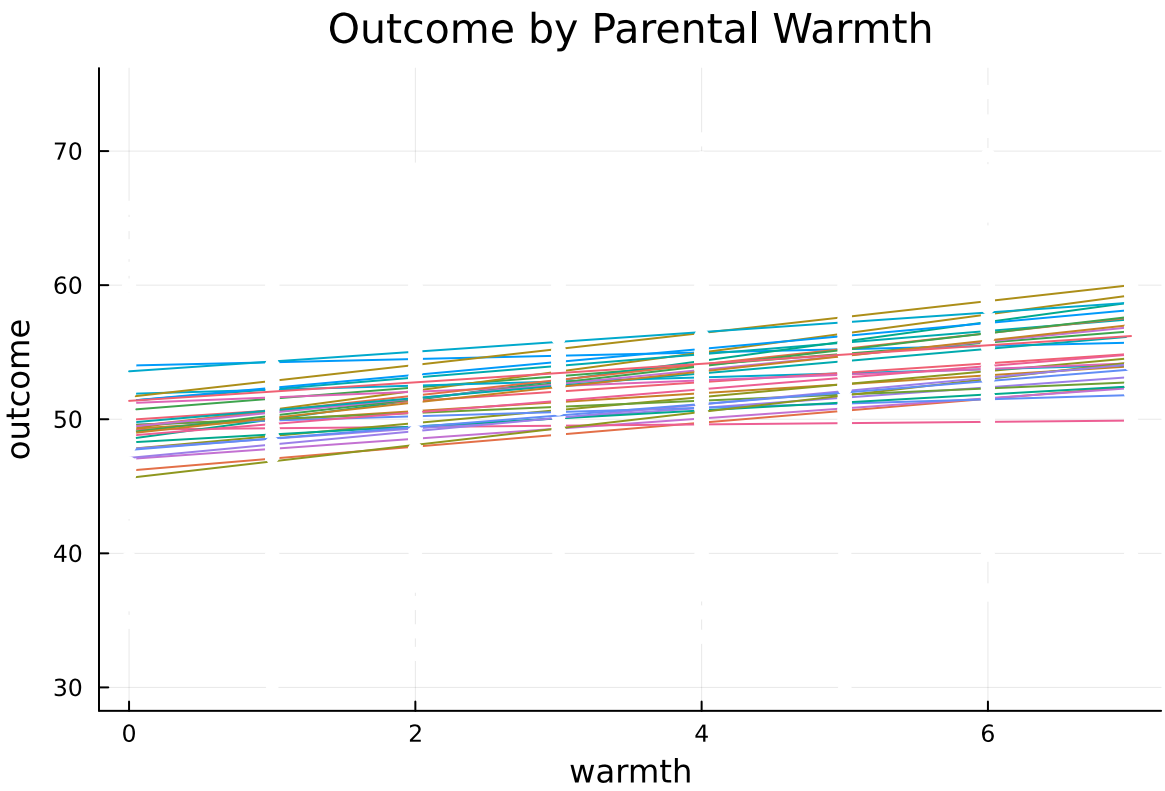

Figure 2.9: Outcome by Parental Warmth (Julia)

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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