

# Supplemental Material 3: Preprocessed Effect Sizes from Invididual Source Data

Author

2023-08-10

## Table of Contents

<b>I. Statement</b>	<b>1</b>
<b>II. Formulas</b>	<b>2</b>
Pearson Product-Moment Correlation Coefficient . . . . .	2
Circular-Linear Correlation Coefficient . . . . .	2
Declarative Memory Retention Rate . . . . .	2
<b>III. Effect Sizes</b>	<b>3</b>
Schreiner2021 . . . . .	3
Denis2021a . . . . .	4
Hahn2020 . . . . .	6
Kurz2023 . . . . .	8
Donnelly2022 . . . . .	10
Denis2022 . . . . .	12
Mylonas2020 . . . . .	14
Hahn2022 . . . . .	15
Mylonas2022 . . . . .	16
Solano2022 . . . . .	16
<b>IV. References</b>	<b>20</b>

## I. Statement

All studies that provided processed individual sleep and memory measurement data by authors have undergone preprocessing or reanalysis to estimate correlation coefficients using standardized measurement methods selected for the meta-analysis. We are unable to disclose the source

data due to copyright restrictions associated with the original studies. Instead, we will directly report the preprocessed effect sizes and formulas used. Individuals or groups who are interested in any source dataset should contact the authors of the original studies directly.

In cases where meta-analysis authors reached out to the original study authors via email to obtain effect sizes, if the original study authors chose to provide processed individual datasets rather than reporting effect sizes directly, neither party requested or exchanged any information that could potentially expose the personal identities of individual participants. The data may have been sorted, merged or excluded based on the methods outlined in the original studies and the moderator selection in the meta-analysis. All data processing was performed within the Quarto document of R Studio version 2023.6.1.524 (Posit Team, 2023) using the R language (R Core Team, 2022) Not all effect sizes reported in this material will necessarily be used in the meta-analysis, contingent upon the inclusion criteria and moderators.

## II. Formulas

### Pearson Product-Moment Correlation Coefficient

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \sum_{i=1}^n (y_i - \bar{y})^2}} \quad (1)$$

### Circular-Linear Correlation Coefficient

$$R = \sqrt{\frac{r_{12}^2 + r_{13}^2 + 2 \cdot r_{12} \cdot r_{13} \cdot r_{23}}{1 - r_{23}^2}} \quad (2)$$

where

$$r_{12} = \text{corr}(x, \cos \theta), r_{13} = \text{corr}(x, \sin \theta), \text{ and } r_{23} = \text{corr}(\cos \theta, \sin \theta)$$

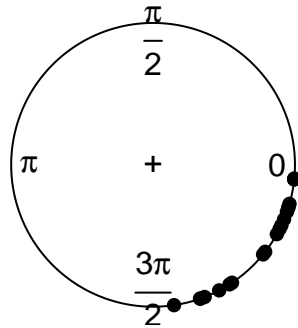
*corr* function refers to the Pearson's r formula in (1) (Mardia, 1976)

### Declarative Memory Retention Rate

$$MRR(\%) = \frac{Recall_{\text{post.sleep}}}{Recall_{\text{pre.sleep}}} \times 100\% \quad (3)$$

### III. Effect Sizes

Schreiner2021



Circular–Linear Correlation Scatter Plot with Quadratic Fit

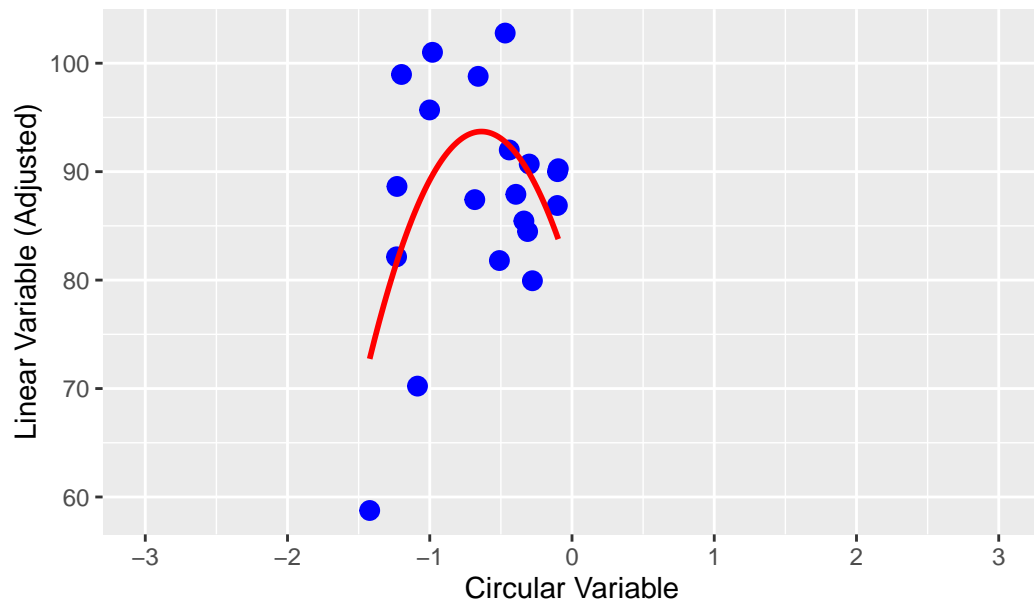


Table 1: Schreiner 2021 Coupling and Memory Correlation Table (WIP)

Phase.Circlin.R	Phase.R.squared	Amplitude	Strength	SPcSO	SOcSP
0.5152	0.2654	0.1685	0.1275	0.0251	-0.1166

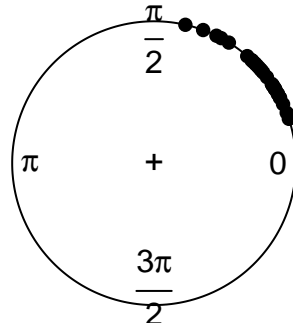
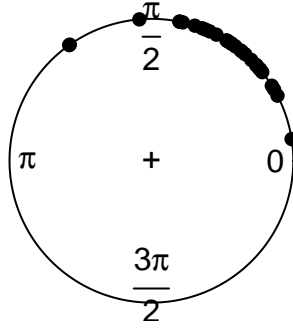
Table 2: Schreiner 2021 Coupling and Memory Correlation Table (TMR)

Phase.Circlin.R	Phase.R.squared	Amplitude	Strength	SPcSO	SOcSP
0.3868	0.1496	-0.2115	0.1638	-0.1982	-0.3942

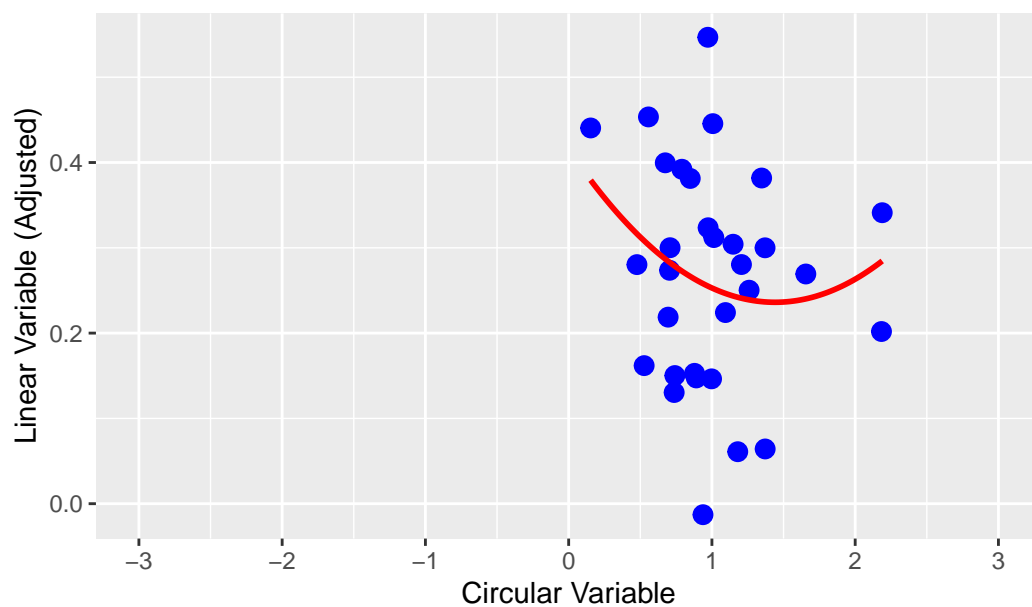
### Denis2021a

Table 3: Denis 2021 (TMR) CP Phase and Memory Circular Linear Correlation Table

	Circlin.R	R.squared
N2 Neutral	0.2393	0.0572
N2 Emotional	0.2107	0.0444
N2 Weighted	0.2282	0.0521
N3 Neutral	0.1469	0.0216
N3 Emotional	0.1270	0.0161
N3 Weighted	0.1403	0.0197



Circular–Linear Correlation Scatter Plot with Quadratic Fit



Circular–Linear Correlation Scatter Plot with Quadratic Fit

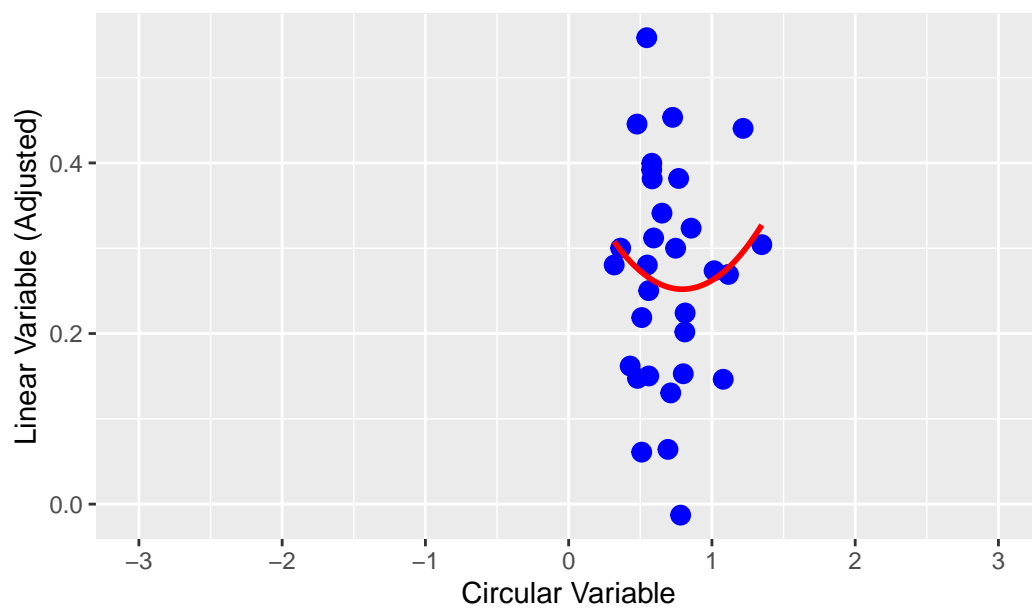


Table 4: Denis 2021 (TMR) SP Amplitude and Memory Pearson's r Correlation Table

	nREM2	nREM3
Neutral	-0.2098	-0.2458
Emotional	-0.1747	-0.2705
Weighted	-0.1984	-0.2802

Table 5: Denis 2021 (TMR) CP Strength and Memory Pearson's r Correlation Table

	nREM2	nREM3
Neutral	0.1797	0.1981
Emotional	0.1777	0.2963
Weighted	0.1901	0.2832

Table 6: Denis 2021 (TMR) CP Percentage and Memory Pearson's r Correlation Table

	nREM2	nREM3
Neutral	-0.0573	0.1915
Emotional	-0.3933	-0.0754
Weighted	-0.3074	0.0085

## Hahn2020

Table 7: Hahn 2020 Child CP Phase and Memory Circular Linear Correlation Table

	Circlin.R	R.squared
Frontal	0.3191	0.1018
Central	0.2569	0.0660
Parietal and Occipital	0.3059	0.0936

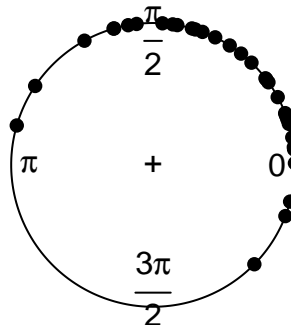
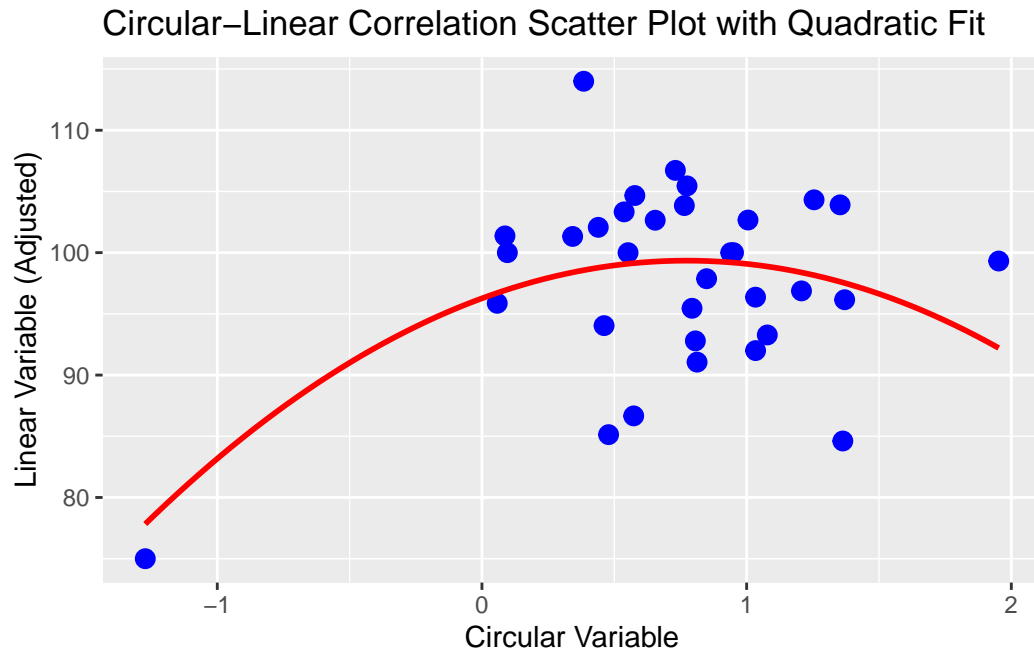


Table 8: Hahn 2020 Adolescent CP Phase and Memory Circular Linear Correlation Table

	Circlin.R	R.squared
Frontal	0.4859	0.2361
Central	0.0971	0.0094
Parietal and Occipital	0.5138	0.2640

Table 9: Hahn 2020 SP Amplitude and Memory Pearson's r Correlation Table

	Child	Adolescent
Frontal	-0.1877	0.2143
Central	-0.2250	0.3446
Parietal and Occipital	-0.2796	0.2990

Table 10: Hahn 2020 CP Strength and Memory Pearson's r Correlation Table

	Child	Adolescent
Frontal	-0.0568	0.3792
Central	0.1827	-0.0797
Parietal and Occipital	-0.1048	-0.0129

Table 11: Hahn 2020 CP Percentage and Memory Pearson's r Correlation Table

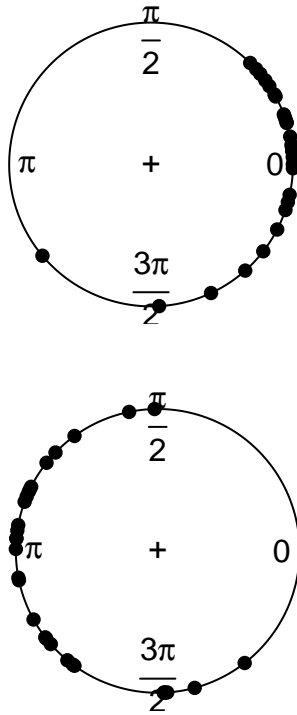
	N2	N3
Child	0.0584	0.1432
Adolescent	-0.5107	-0.2487

### Kurz2023

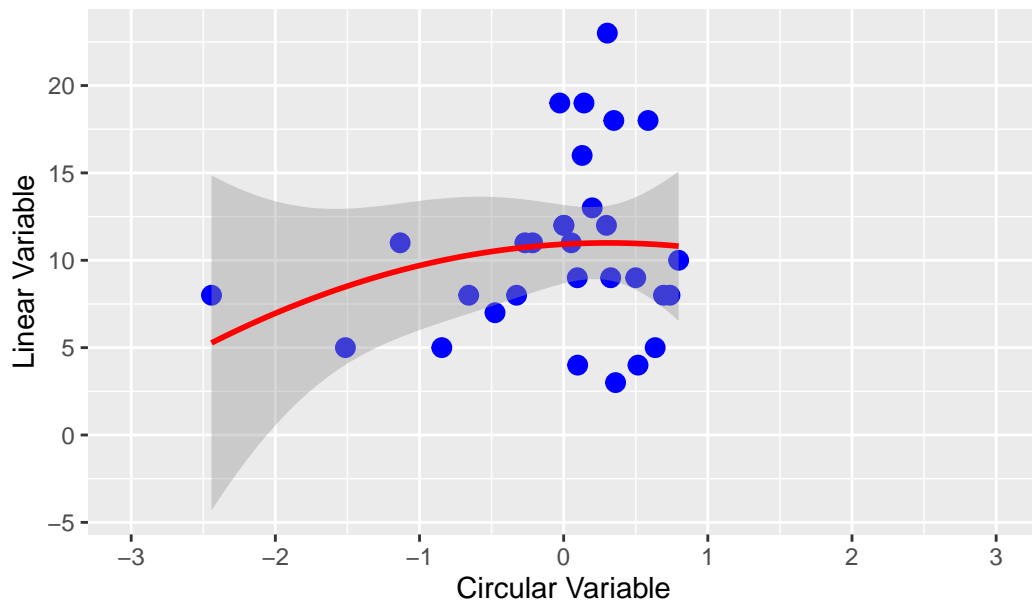
Table 12: Kurz 2023 CP Phase and Memory Circular Linear Correlation Table

	Circlin.R	R.squared
Slow Frontal	0.1322	0.0175
Slow Central	0.4461	0.1990
Slow Parietal	0.1708	0.0292
Fast Frontal	0.2731	0.0746
Fast Central	0.2777	0.0771
Fast Parietal	0.1865	0.0348





Circular–Linear Correlation Scatter Plot with Quadratic Fit



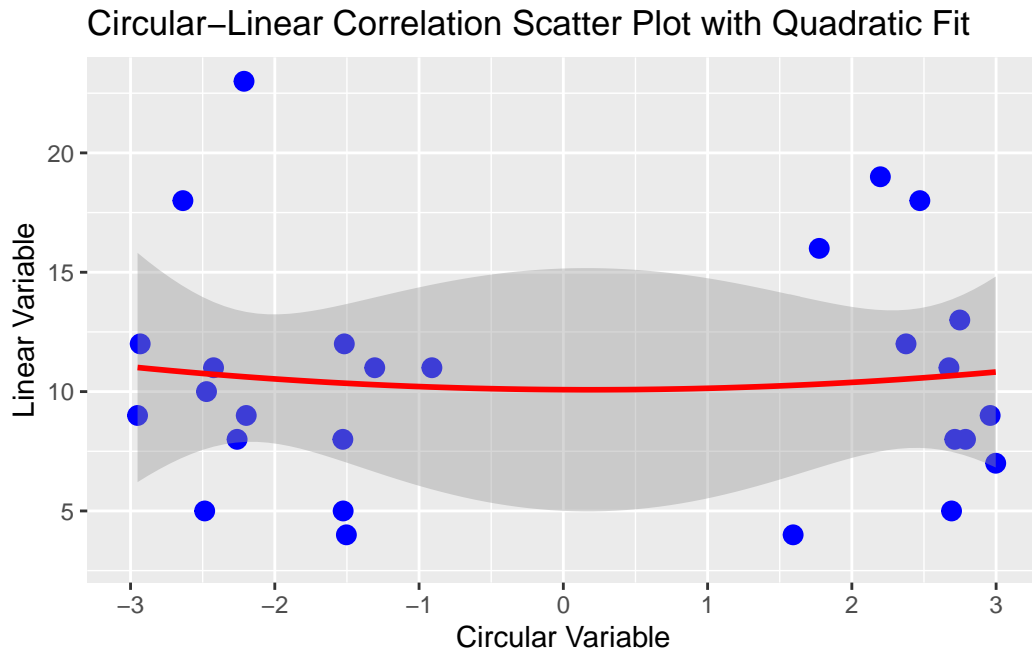


Table 13: Kurz 2023 SP Amplitude and Memory Pearson's  $r$  Correlation Table

	Fast.Spindle	Slow.Spindle
Frontal	0.4792	0.1308
Central	0.5582	0.1738
Parietal	0.5941	0.0830

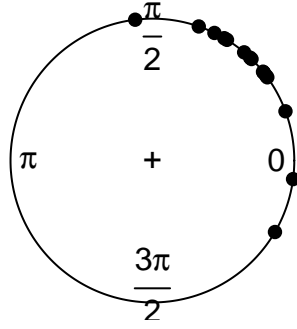
Table 14: Kurz 2023 CP Strength and Memory Pearson's  $r$  Correlation Table

	Fast.Spindle	Slow.Spindle
Frontal	0.2768	-0.0574
Central	0.3140	0.1543
Parietal	0.2721	0.1262

**Donnelly2022**

Table 15: Donnelly 2022 CP Phase and Memory Circular Linear Correlation Table

	Circlin.R	R.squared
Frontal	0.3509	0.1231
Central	0.3510	0.1232
Parietal and Occipital	0.6296	0.3964



Circular–Linear Correlation Scatter Plot with Quadratic Fit

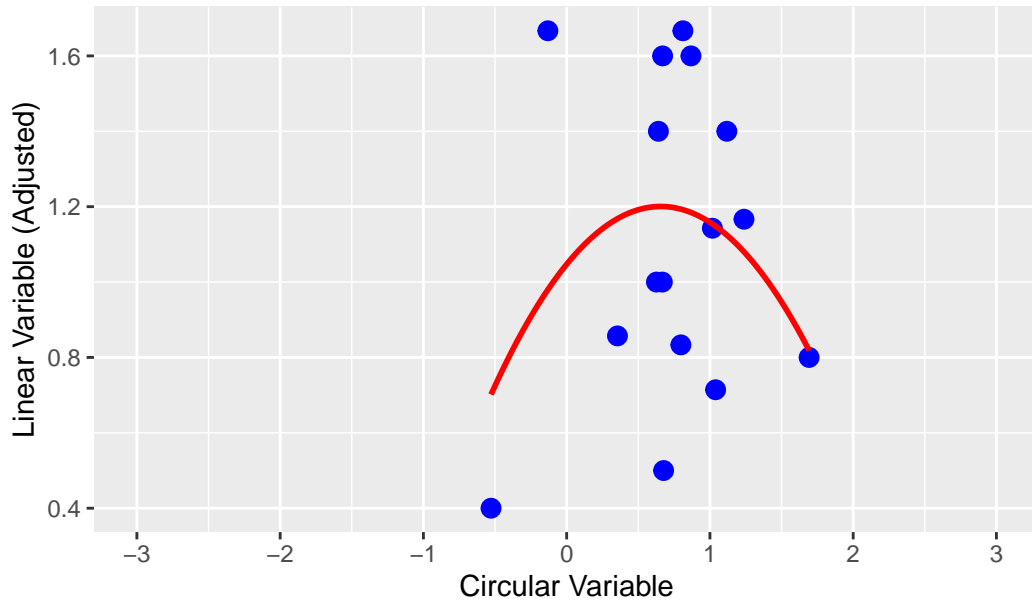


Table 16: Donnelly 2022 SP Amplitude and Memory Pearson's r Correlation Table

	Frontal	Central	Parietal and Occipital
Correlation	0.5232	0.5343	0.3783

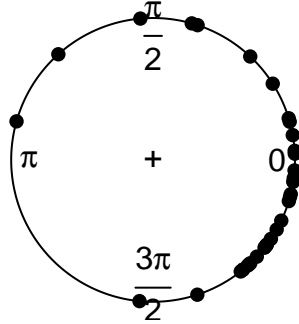
Table 17: Donnelly 2022 CP Strength and Memory Pearson's r Correlation Table

	Frontal	Central	Parietal and Occipital
Correlation	-0.2253	0.0043	0.0886

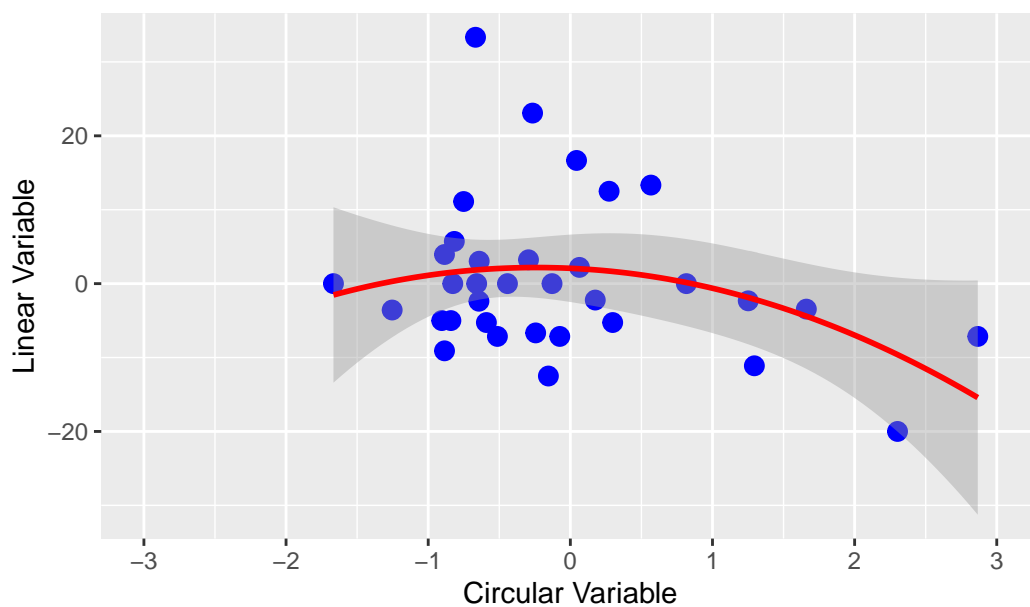
## Denis2022

Table 18: Denis 2022 CP Phase and Memory Circular Linear Correlation Table

	Circlin.R	R.squared
Slow Frontal	0.4076	0.1661
Slow Central	0.3961	0.1569
Slow Parietal and Occipital	0.2586	0.0669
Fast Frontal	0.3818	0.1458
Fast Central	0.2439	0.0595
Fast Parietal and Occipital	0.1751	0.0307



Circular–Linear Correlation Scatter Plot with Quadratic Fit



Circular–Linear Correlation Scatter Plot with Quadratic Fit

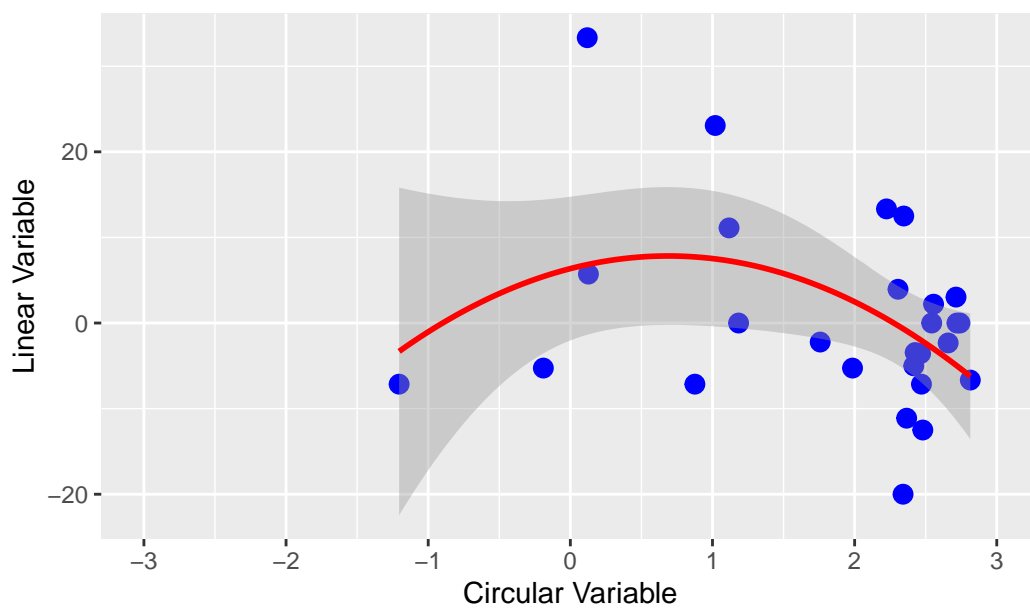


Table 19: Denis 2022 SP Amplitude and Memory Pearson's r Correlation Table

	Fast.Spindle	Slow.Spindle
Frontal	-0.0145	-0.0222
Central	-0.0711	-0.0896
Parietal and Occipital	-0.1847	-0.2770

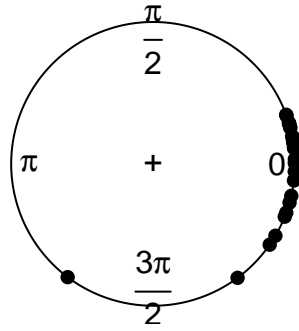
Table 20: Denis 2022 CP Strength and Memory Pearson's r Correlation Table

	Fast.Spindle	Slow.Spindle
Frontal	0.1690	-0.0882
Central	0.1577	-0.1101
Parietal and Occipital	0.1883	-0.0144

Table 21: Denis 2022 CP Percentage and Memory Pearson's r Correlation Table

	Fast.Spindle	Slow.Spindle
Frontal	-0.0619	0.0698
Central	0.0485	0.1087
Parietal and Occipital	0.0591	-0.1029

**Mylonas2020**



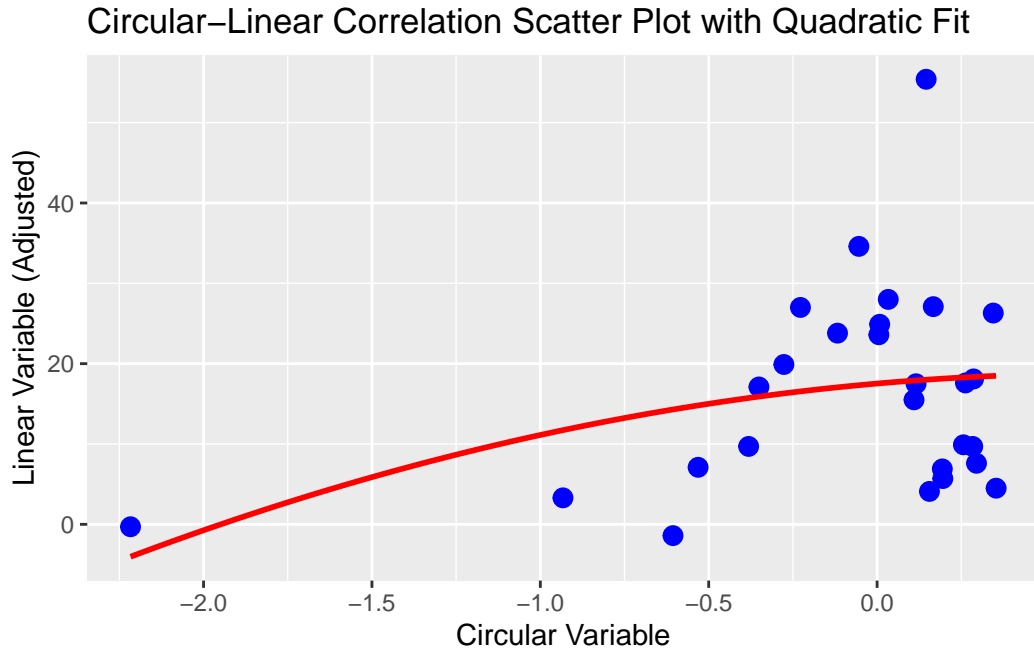


Table 22: Mylonas 2020 Coupling and Memory Correlation Table

Phase.Circlin.R	Phase.R.squared	Amplitude	Strength	SPcSO	SOcSP
0.3801	0.1445	-0.1982	0.0508	-0.0289	0.055

## Hahn2022

Table 23: Hahn 2022 CP Phase and Memory Circular Linear Correlation Table

	Adolescent	Young.Adult
Frontal	0.4950	0.3067
Central	0.2770	0.2908
Parietal and Occipital	0.4205	0.3061

Mylonas2022

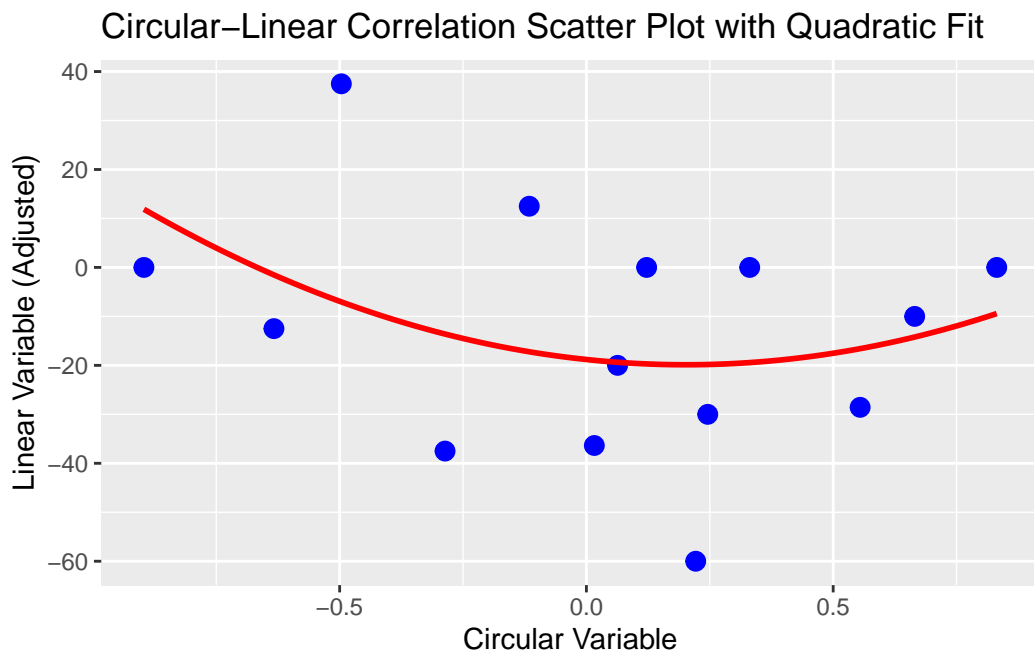
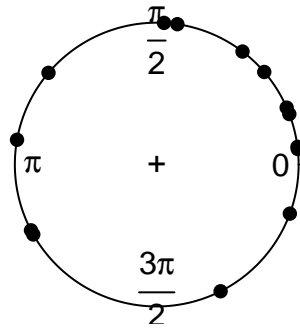


Table 24: Mylonas 2022 Coupling and Memory Correlation Table

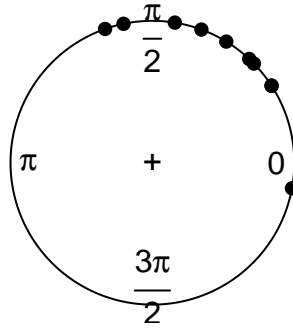
Phase.Circlin.R	Phase.R.squared	Amplitude	Strength	SPcSO
0.3818	0.1458	0.3421	-0.0862	-0.1803

Solano2022

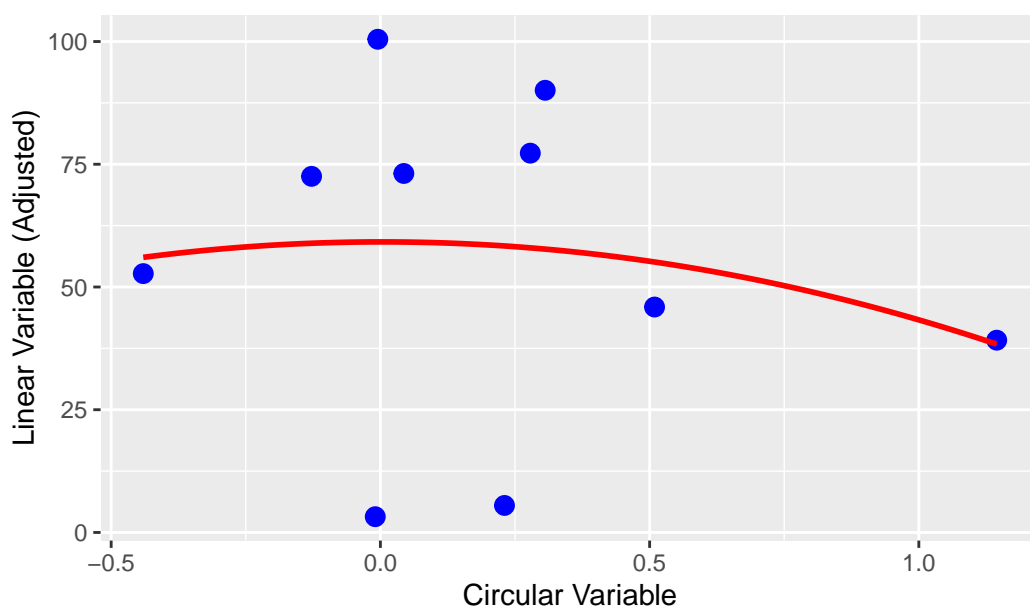


Table 25: Solano 2022 CP Phase and Memory Circular Linear Correlation Table

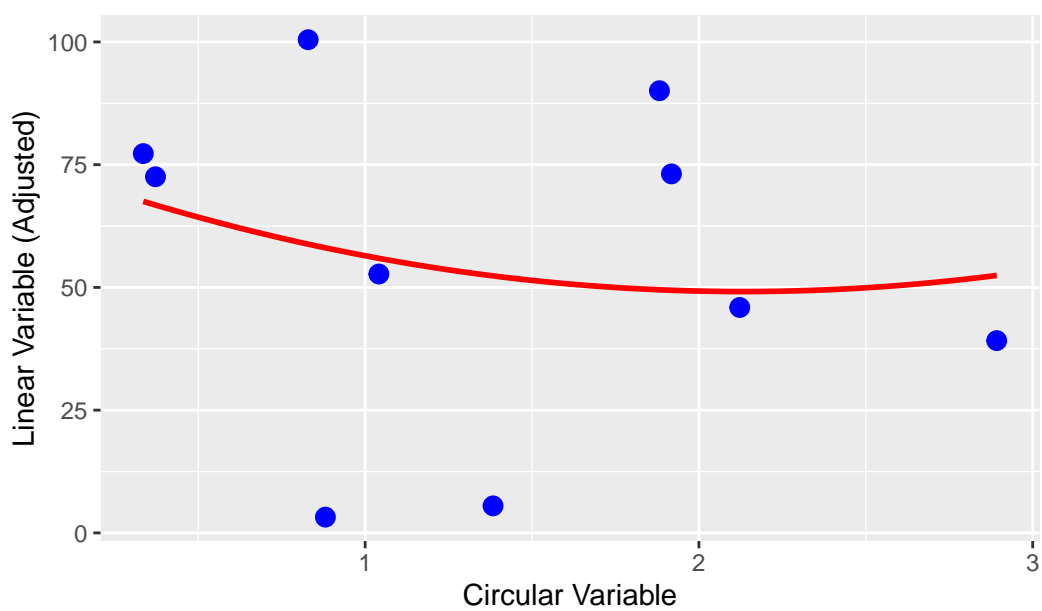
	Circlin.R	R.squared
Fast N2 Frontal	0.8022	0.6436
Fast N2 Central	0.4061	0.1649
Fast N2 Parietal	0.4912	0.2413
Fast N3 Frontal	0.6944	0.4822
Fast N3 Central	0.4623	0.2137
Fast N3 Parietal	0.1923	0.0370
Slow N2 Frontal	0.5664	0.3208
Slow N2 Central	0.2203	0.0485
Slow N2 Parietal	0.2638	0.0696
Slow N3 Frontal	0.1768	0.0313
Slow N3 Central	0.4515	0.2038
Slow N3 Parietal	0.2310	0.0534



Circular–Linear Correlation Scatter Plot with Quadratic Fit



Circular–Linear Correlation Scatter Plot with Quadratic Fit



```
data <- data.frame(Circular = fast2_phase_avg$Favg, Linear = fast2_phase_avg$retention)
plot <- ggplot(data, aes(x = Circular, y = Linear)) +
```

```

geom_point(color = "blue", size = 3) +
geom_smooth(method = "lm", formula = y ~ poly(x, 2), color = "red", se = FALSE)

plot <- plot + labs(x = "Circular Variable", y = "Linear Variable (Adjusted)",
                    title = "Circular-Linear Correlation Scatter Plot with Quadratic Fit")

print(plot)

```

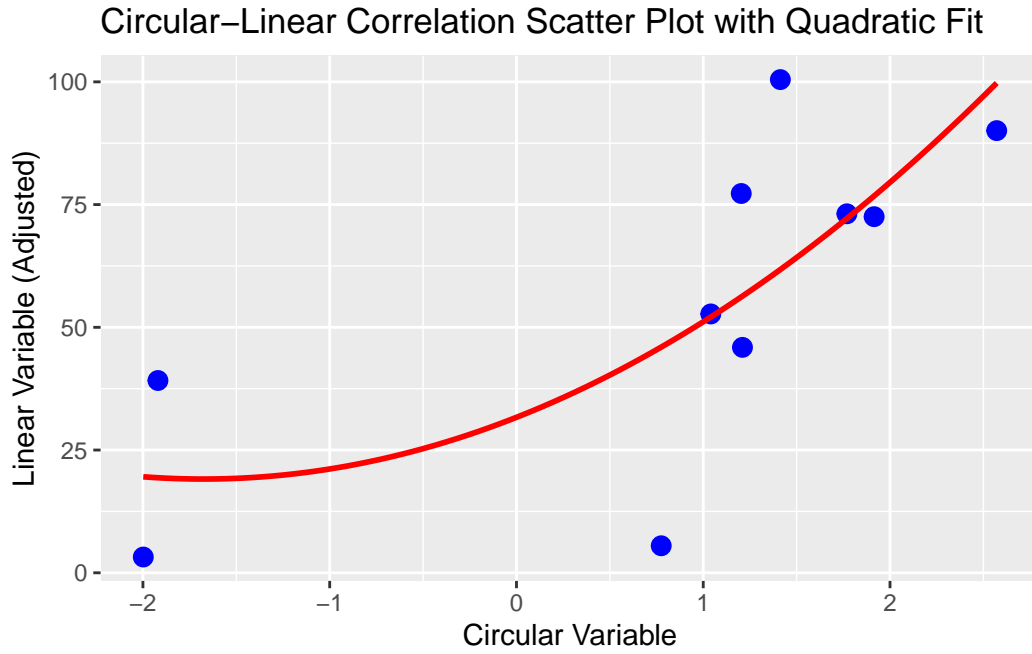


Table 26: Solano 2022 CP Strength and Memory Pearson's r Correlation Table

	Fast.N2	Fast.N3	Slow.N2	Slow.N3
Frontal	-0.2056	0.0946	-0.3233	-0.3958
Central	-0.3257	-0.2465	0.2603	-0.3682
Parietal	-0.4661	-0.5492	0.4755	-0.3698

Table 27: Solano 2022 CP Percentage and Memory Pearson's r Correlation Table

	Fast.N2	Fast.N3	Slow.N2	Slow.N3
Frontal	0.4174	0.3955	0.0969	0.5478
Central	0.3409	0.4175	0.2301	0.2490

	Fast.N2	Fast.N3	Slow.N2	Slow.N3
Parietal	-0.2357	0.1680	-0.3531	0.2353

## IV. References

1. Mardia, K. V. (1976). Linear-Circular Correlation Coefficients and Rhythmometry. *Biometrika*, 63(2), 403–405. <https://doi.org/10.2307/2335637>
2. Posit Team (2023). RStudio: Integrated Development for R. *Posit Software, PBC, Boston, MA*. <http://www.rstudio.com/>.
3. R Core Team (2022). R: A language and environment for statistical computing. *R Foundation for Statistical Computing, Vienna, Austria*. <https://www.R-project.org/>.