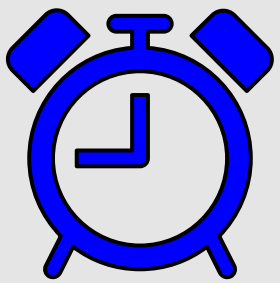
Making Time for Longitudinal Data

BERDC Special Topics Talk 10



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DAKOTA CANCER COLLABORATIVE ON TRANSLATIONAL ACTIVITY

Dr. Mark Williamson

Biostatistics, Epidemiology, and Research Design Core

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Opening

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Goal: Explore and practice the use of **time** in statistical analysis

- Common **experimental designs** that use time
- **Types** of time-based analyses
- **Examples** of time-based analyses
- Dealing with **time as a variable**
- **R practice**
- **SAS practice**
- **Caveats & Concerns**

Before Moving On:

Pre-test: https://und.qualtrics.com/jfe/form/SV_boYcov4TppWktFk

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Experimental Designs

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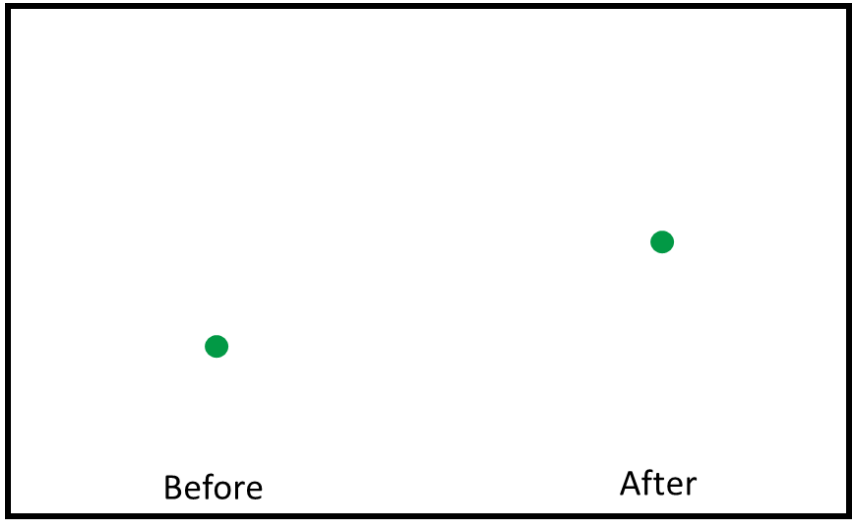
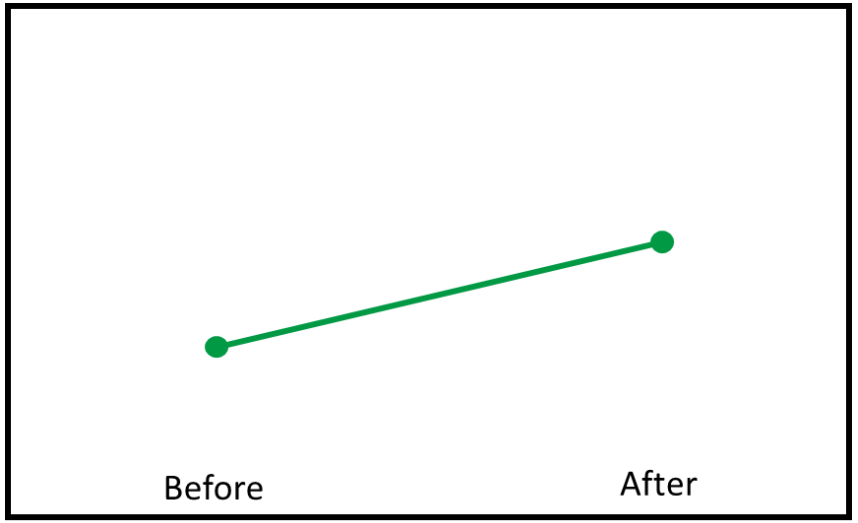
- Pre/post test
  - With or without same individuals
  - With or without control
- Repeated cross-sectional data
- Longitudinal cohort data
- Time Series data





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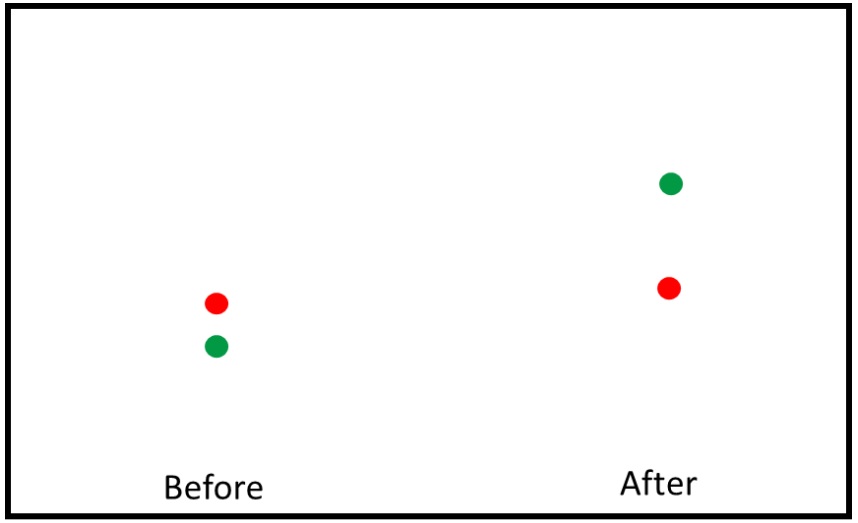

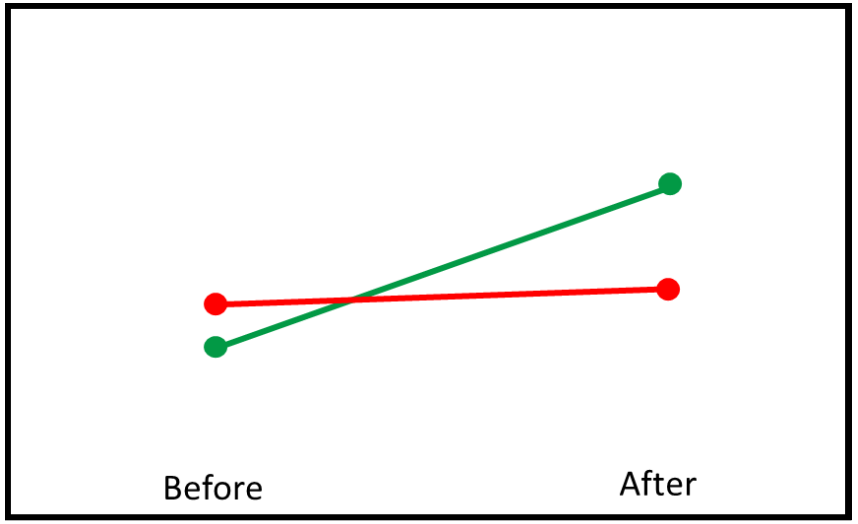

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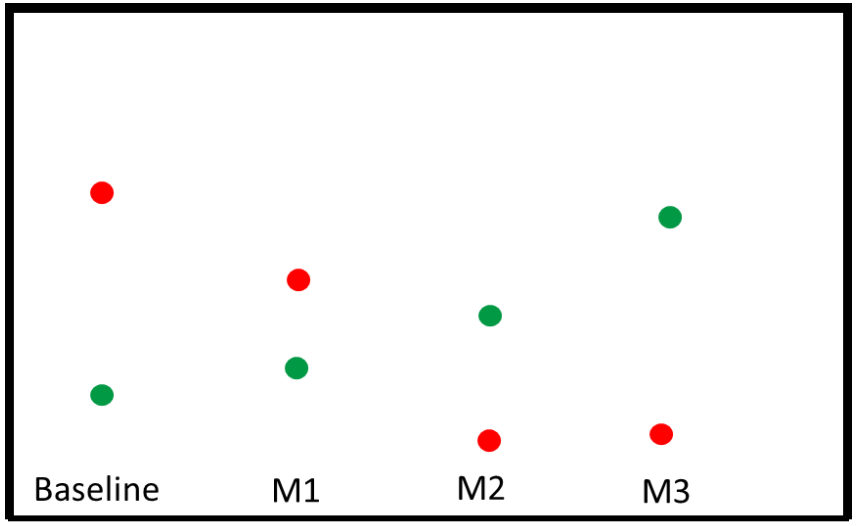

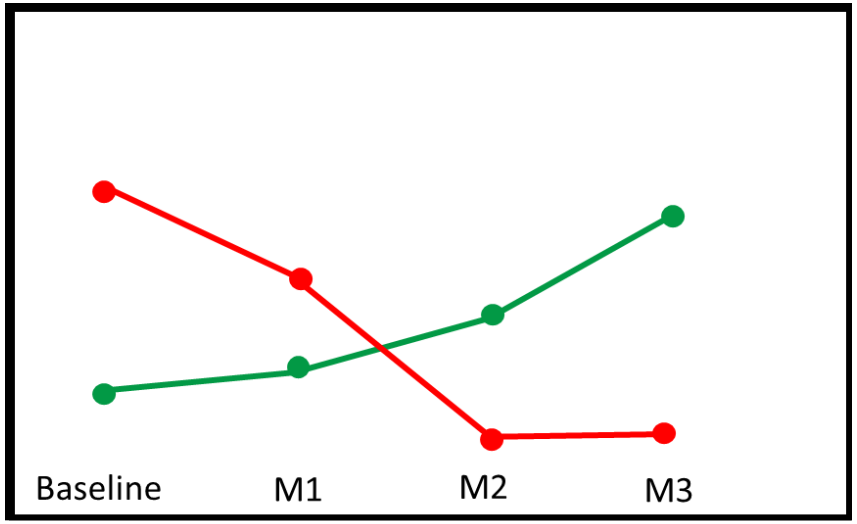

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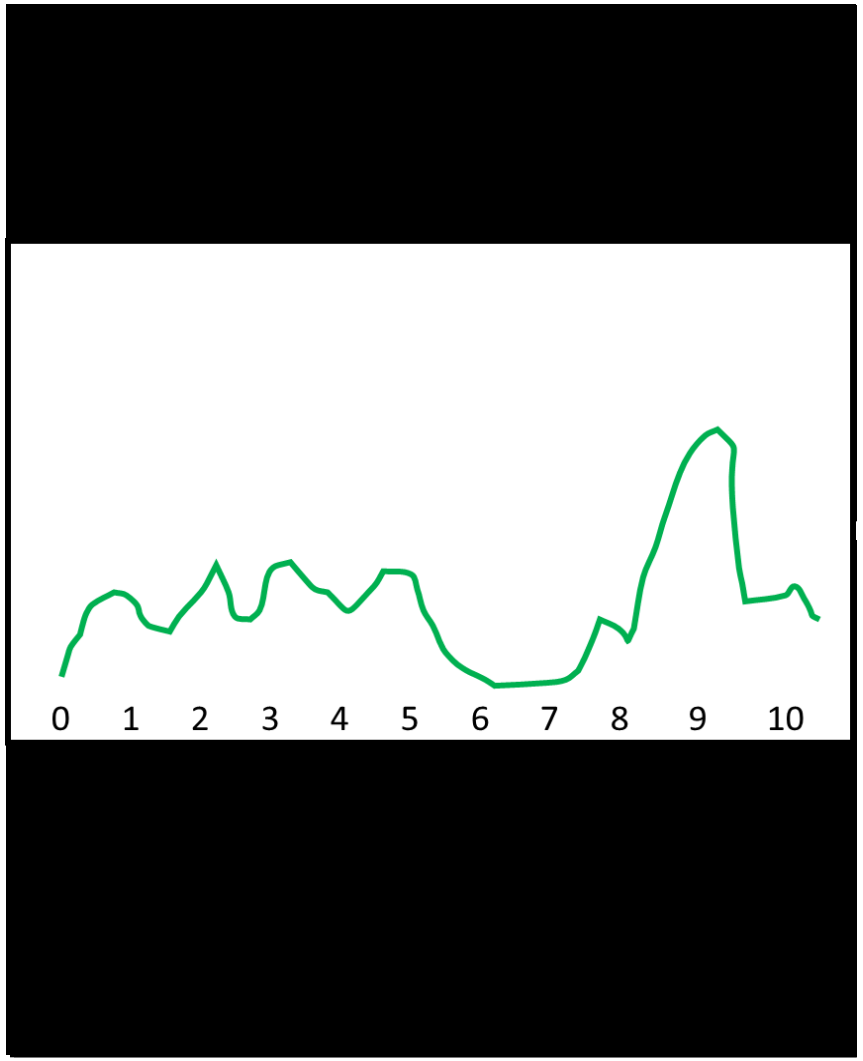

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Statistical Types

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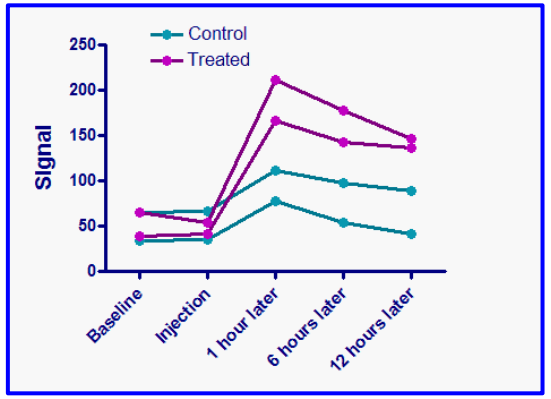
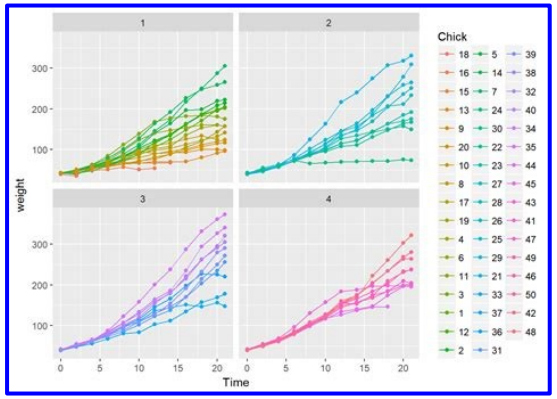
Standard:

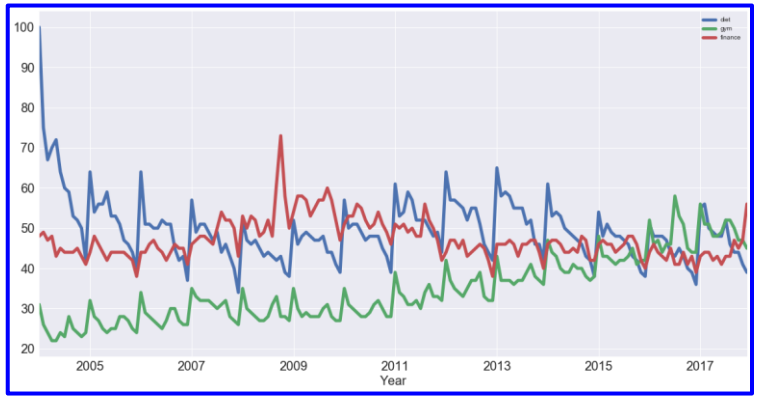
- Repeated Measures ANOVA
- Mixed Models
- Time Series*



https://www.graphpad.com/guides/prism/7/statistics/stat_graphing_tips_repeated_measure.htm



https://terpconnect.umd.edu/~egurarie/teaching/Biol709/Topic3/Lecture16_MixedEffectsModels.html



https://www.datacamp.com/community/tutorials/time-series-analysis-tutorial

Advanced:

- Survival Analysis: ***Survival Analysis Modules I-III***
- Generalized Estimating Equations: ***Linear Regression Module III***
- Multivariate Analysis: ***Multivariate Analysis Module III***

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Examples

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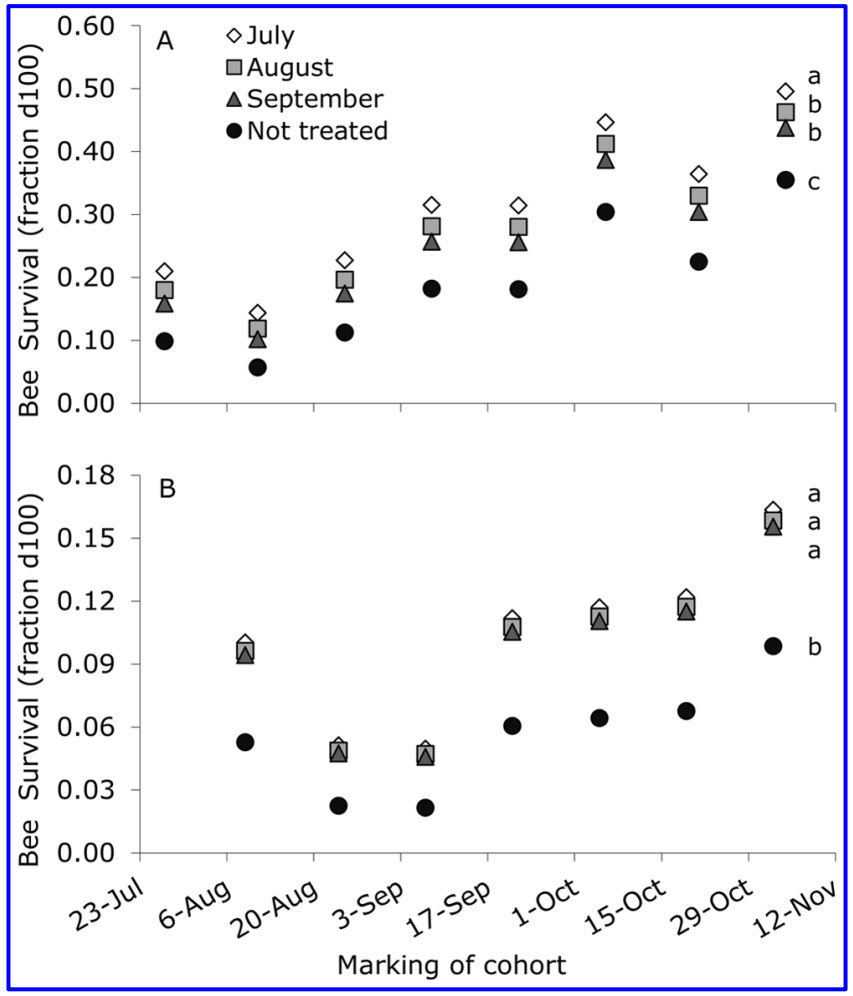
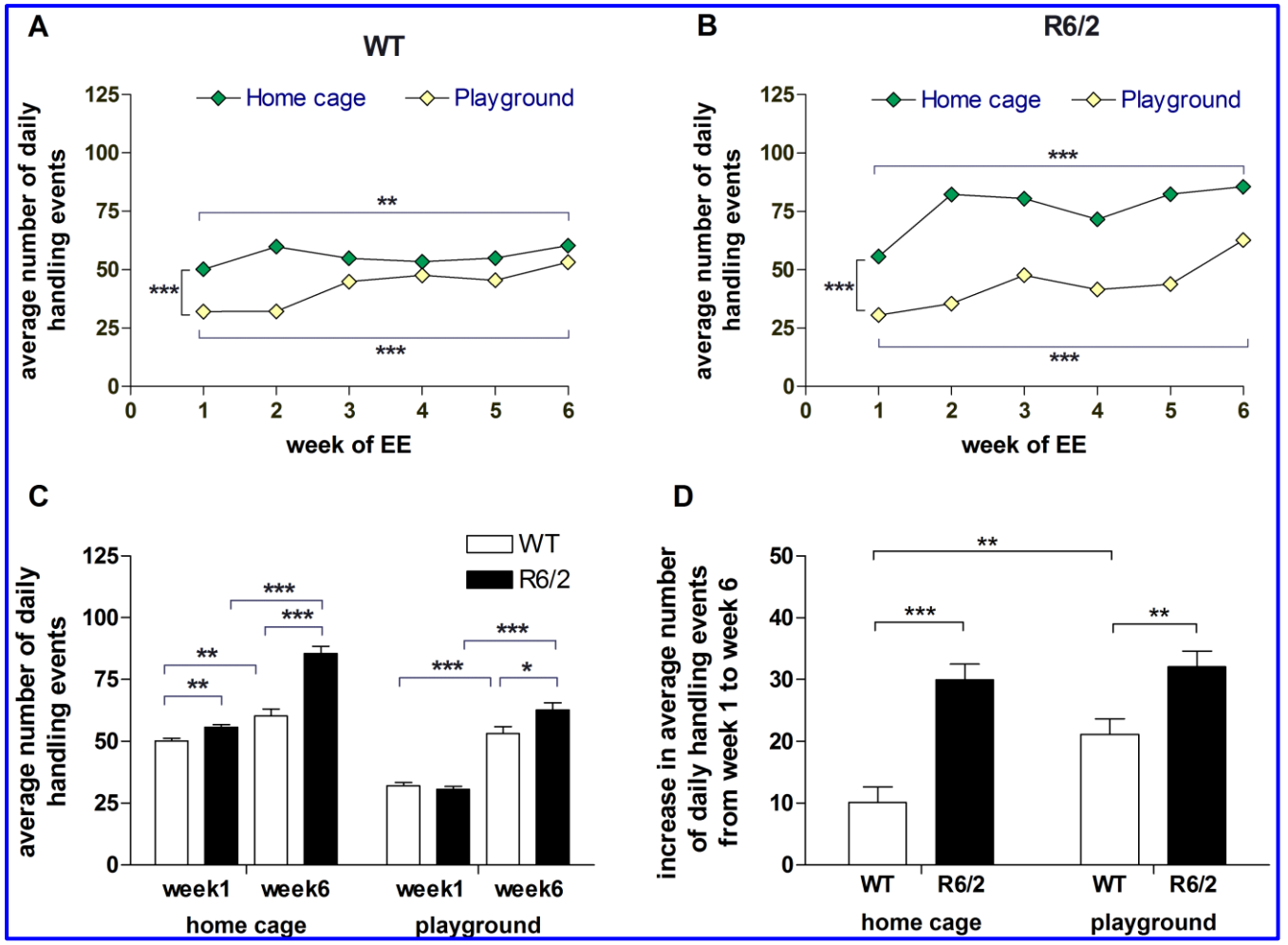


Van Dooremalen et al (2012)



Wood et al (2010)

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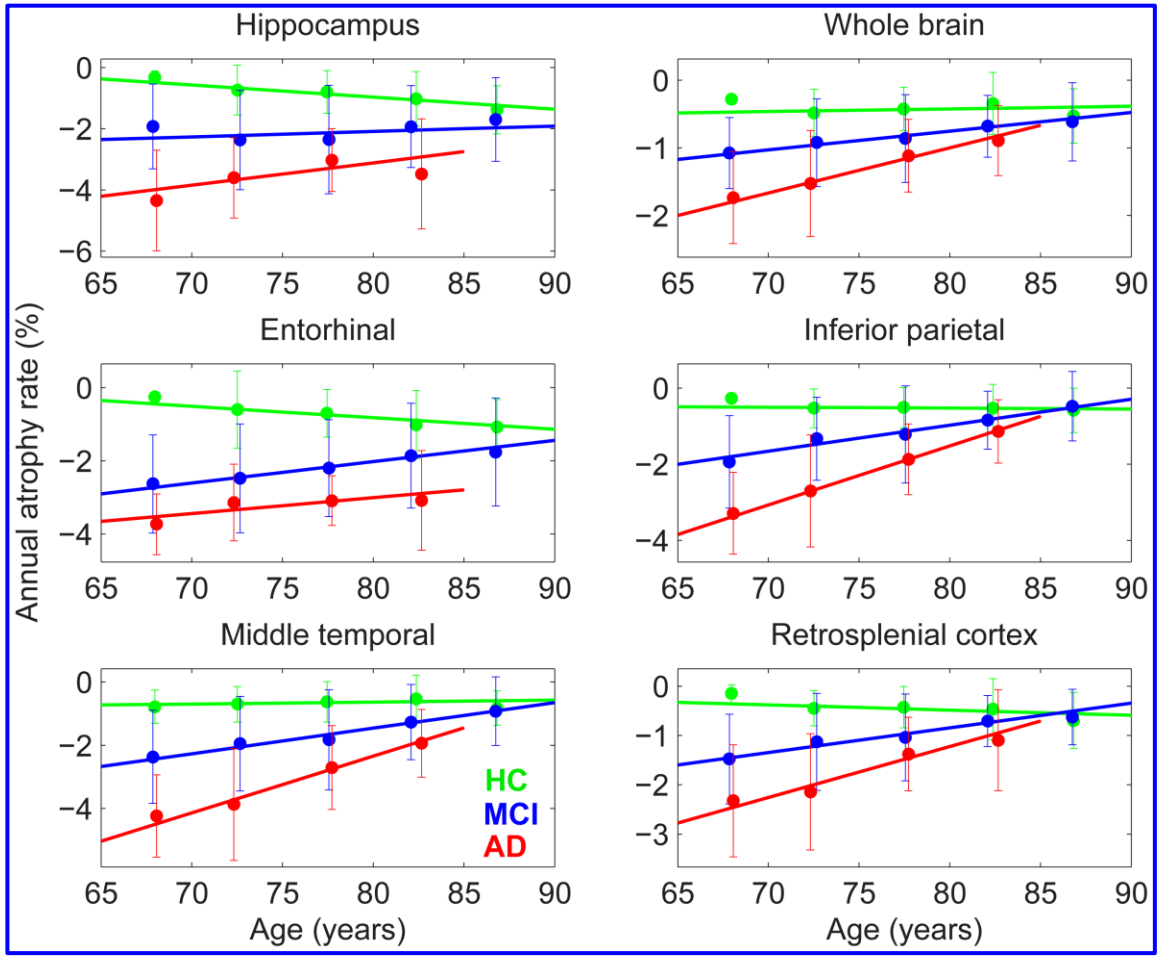
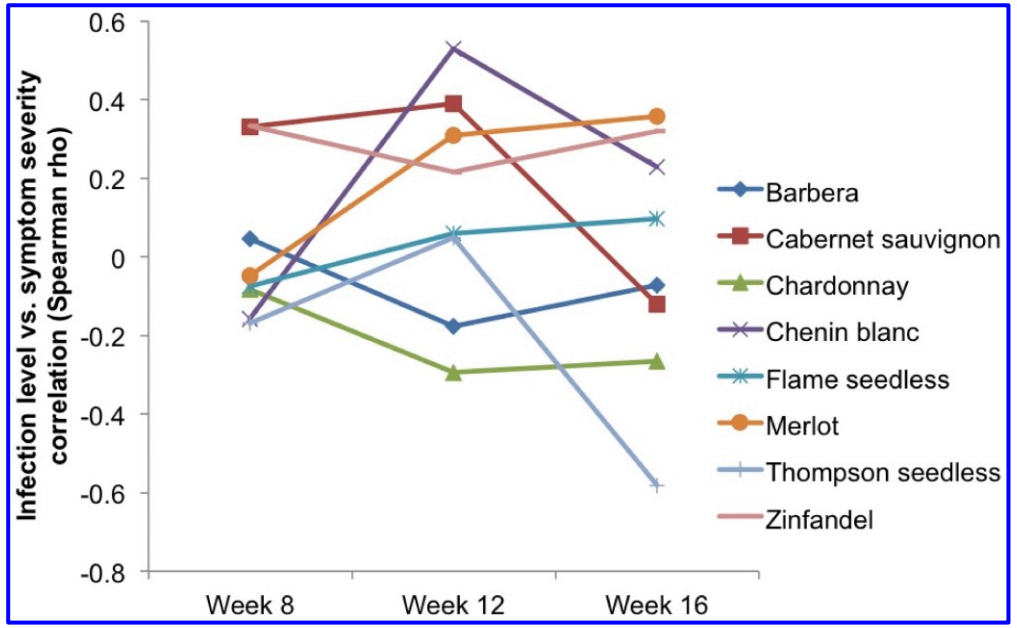
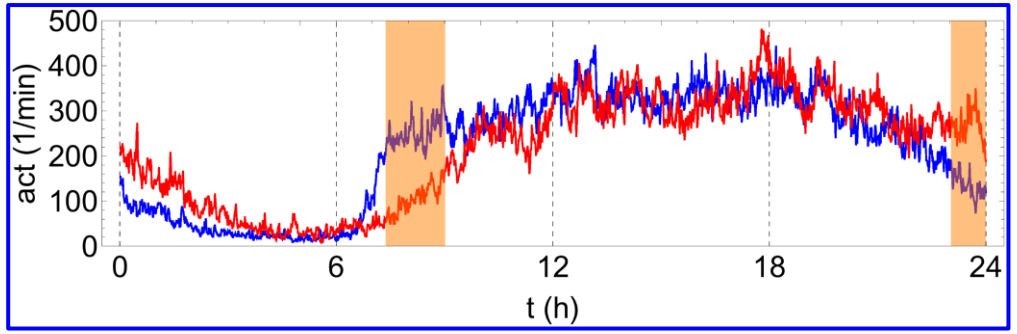
Examples 2



Holland et al (2012)



Rashed et al (2013)



Fossion et al (2017)

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Time as a variable

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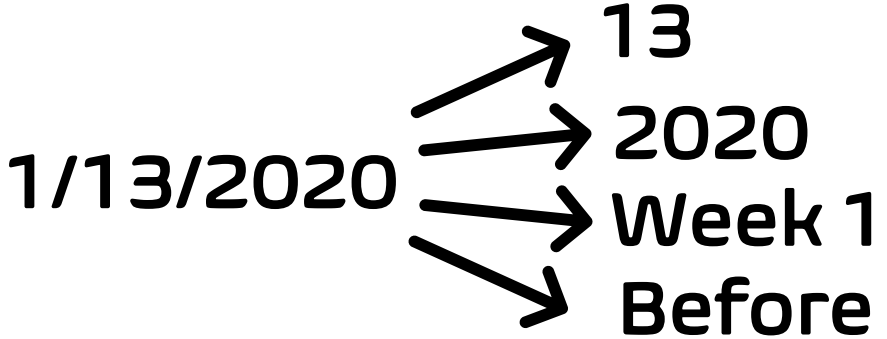
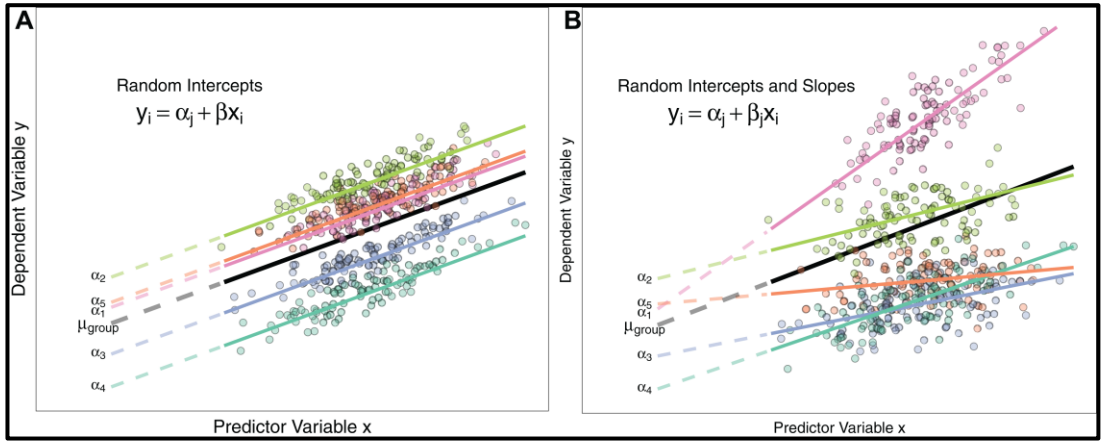
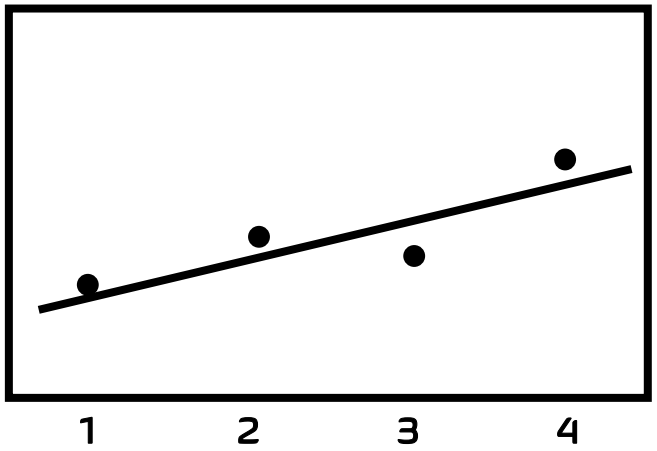
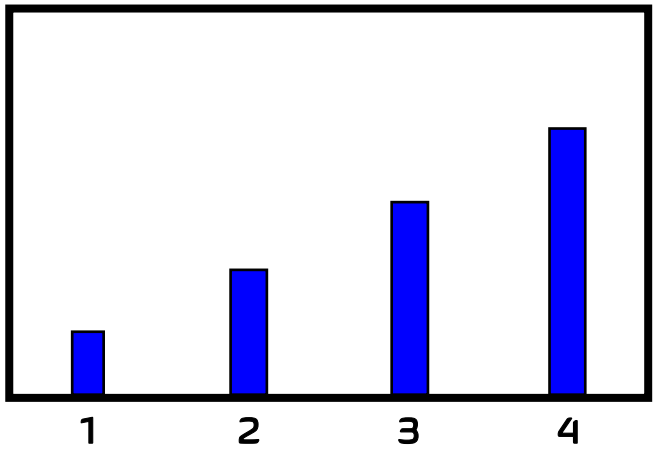
- Conversion of dates
- Numerical or categorical?
- Main feature or controlling factor?
- Fixed or random?



Time1	Time2
1	T1
2	T2
3	T3
4	T4







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R Practice

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Exercises

1. Pre/Post Test
2. Repeated Measures ANOVA
3. Mixed Effects Model

R Code: https://med.und.edu/daccota/_files/docs/berdc_docs/making_time_r_code.txt

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SAS Practice

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Exercises

1. Pre/Post Test
2. Repeated Measures ANOVA
3. Mixed Effects Model

SAS Code: https://med.und.edu/daccota/_files/docs/berdc_docs/making_time_sas_code.txt

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Caveats & Concerns

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- If there are no repeated observations, time can usually be treated as any other type of variable
  - Repeated-Measures ANOVA downgrades to 2-way ANOVA
  - Mixed Model downgrades to Linear Model
- Time categories should be evenly spaced
- Time as a numerical variable is rarely continuous
- Missing data is common in longitudinal datasets

https://www.nathanwpyle.art/

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Conclusions

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- Time can be a tricky subject
- Often rears its head in pre/post tests, longitudinal cohort studies, and repeated cross-sectional studies
- Never fear, repeated measures ANOVA and mixed models are solid tools
- For time series and everything else, you can research deeper

Please take the post-test and survey:

Post-test: https://und.qualtrics.com/jfe/form/SV_1AidW3qbgSehgrQ
Survey: https://und.qualtrics.com/jfe/form/SV_8BrhpWRVIVagWYC

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References

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[1] http://samples.jbpub.com/9781284048308/Chapter5_Sample.pdf

[2] https://bookdown.org/mike/data_analysis/repeated-cross-sections.html

[3] https://sites.globalhealth.duke.edu/rdac/wp-content/uploads/sites/27/2020/08/Core-Guide_Longitudinal-Data-Analysis_10-05-17.pdf

[4] https://health.ucdavis.edu/ctsc/area/Resource_Library/documents/LongitudinalDataAnalysis_12July2017_harvey.pdf

[5] https://www.graphpad.com/guides/prism/7/statistics/stat_graphing_tips_repeated_measure.htm

[6] https://www.datacamp.com/community/tutorials/time-series-analysis-tutorial

[7] https://www.datacamp.com/community/tutorials/time-series-analysis-tutorial

[8] **https://med.und.edu/daccota/berdc-resources.html**

[9] https://mccormickneuro.github.io/uploads/fluxcongress_2021.pdf

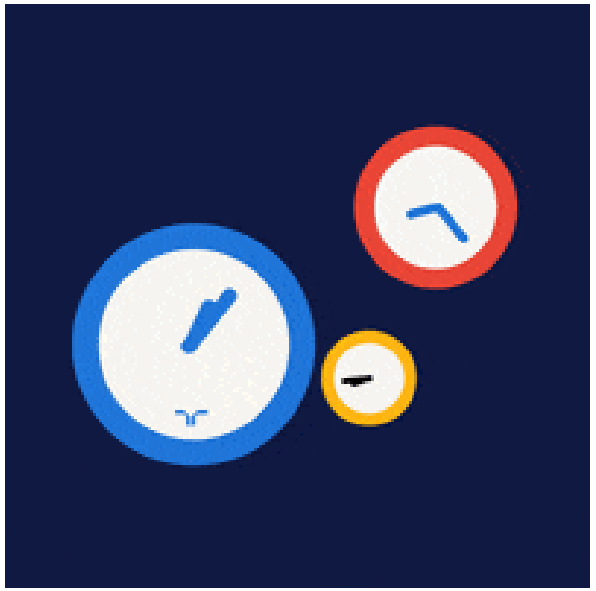
[10] https://doi.org/10.1371/journal.pone.0036285

[11] https://doi.org/10.1371/journal.pone.0009077

[12] https://doi.org/10.1371/journal.pone.0042325

[13] https://doi.org/10.1371/journal.pone.0055326

[14] https://doi.org/10.1371/journal.pone.0181762



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Acknowledgements

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- For the labs that use the Biostatistics, Epidemiology, and Research Design Core in any way, including this Module, please acknowledge us for publications. ***"Research reported in this publication was supported by DaCCoTA (the National Institute of General Medical Sciences of the National Institutes of Health under Award Number U54GM128729)".***

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