ANOVA & Linear Model:

Summary

"If you're going through hell, keep going."
Winston Churchill

Review of ANOVAs vs. Linear Regression

ANOVA

- Tests effects of variables through "main effect" terms
- Then tests level differences with post hoc analyses

Linear Regression

- Tests effects of variables through dummy coding

Review of ANOVAs vs. Linear Regression (cont.)

ANOVA

- Uses overall tests as a safeguard against doing too many significance tests

Linear Regression

- Has no safeguard against conducting too many tests

Review of ANOVAs vs. Linear Regression (cont.)

ANOVA

- Used to test which variables are significant

Linear Regression

- Can be used to test which variables are significant
- But can also test overall model

Review of ANOVAs vs. Linear Regression (cont.)

- In both ANOVA & linear regression:
  - Adding a variable to a model partials out its effect from the other terms in the model
  - But in ANOVAs, one doesn't add a term *just* to partial it out
    - Adding a variable to an ANOVA is done as an explicit test of that term

Review of ANOVAs vs. Linear Regression (cont.)

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Review of ANOVAs vs. Linear Regression (cont.)

- In linear regression:
  - We have more flexibility
    - Can test differences between variable levels right there
    - Can tweak how the variables are tested
      - E.g., can test non-normal data
    - Can also test "model fit"...

Model Fit

- "Model fit" is how well a given statistical model explains a given set of data
  - How well it "fits" the data
  - Misfit means there is a big difference between what the model predicts the data are like
    - And what the data are actually like

Model Fit (cont.)

- Why focus on the overall model instead of individual variables?
  - Since predictors are often correlated themselves
    - And even non-significant correlations—and non-significant predictors—

      can effect results
  - For theory! E.g., to find the best combination of predictors

Interpreting an ANOVA: Variable Summary

Between-Subjects Factors			
		Value Label	N
Gender	0	Male	92
	1	Female	67
Spec_Ed	0	No Diagnosed Disability	79
	1	Has Diagnosed Disability	80

Interpreting an ANOVA: Source Table...

Tests of Between-Subjects Effects

Dependent Variable: ELA_Grade

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent Para-meter	Observd Power[b]
Corrected Model	21.690[a]	3	7.230	12.49	.000	.195	37.479	1.000
Intercept	1146.48	1	1146.48	1981	.000	.927	1981.03	1.000
Gender	2.276	1	2.276	3.934	.049	.025	3.934	.504
Spec_Ed	13.229	1	13.229	22.86	.000	.129	22.858	.997
Gender * Spec_Ed	3.169	1	3.169	5.476	.021	.034	5.476	.643
Error	89.703	155	.579					
Total	1265.81	159						
Corrected Total	111.393	158						

a. R Squared = .195 (Adjusted R Squared = .179)

b. Computed using alpha = .05

Multilevel Models

Capturing the Unknown

- Those cared for in the same hospital have similar experiences
  - Those cared for in the same *unit* within a hospital have similar experience
  - Even if we can't measure completely why

Which People Make a Personality?

- Traditionally, studies of personality development compare "nature" vs. "nurture"
- E.g., Minesota Twin Studies
  - Mono- & dizygotic twins reared together & separately
  - Thus shared & unshared genes & environment

Which People Make a Personality? (cont.)

- Looking further at "nurture"
  - Home environment accounts for more variance than non-home
    - E.g., children "nested" in the same family share variance in personality
    - Knew this even before we knew the sources of this variance
    - Whence, research on parenting styles

Which People Make a Personality? (cont.)

- But even the home environment can be further sub-divided
  - Children have their own "microenvironment"
  - I.e., variance in personality can be further nested to effects within a given child

Which People Make a Personality? (cont.)

- E.g., birth order can matter
  - Those born first have different relationships with parents than later-born children
  - I.e., labeling each child by birth order may account for a significant amount of the within-family variance
- In fact, unshared variance at home may matter more than shared variance

Levels of Variance

- So, research into effects of "nurturance" on personality
  - Has non-genetic variance
    - Some of that shared within a home
      - Some of that shared within first-borns
        - Some of that in an other "microenvironmental" level

Levels of Variance (cont.)

- So, any model of "nurturance" benefits from having multiple levels
  - And variance unique to that level
    - *Both shared and unshared variance*
      - I.e., both explicitly measured
      - And from sources unknown, but common to that level

Capturing the Unknown: Nesting Variance

- Statistical models often partial out variance into signal & noise
  - Outcome = Signal + Noise
  - *E.g.,:*
    - $Y = X + e$
    - $Y = X_1 + X_2 + e$

Capturing the Unknown: Nesting Variance (cont.)

- Statistical models often partial out variance into signal & noise
  - Outcome = Signal + Noise
  - *E.g.,:*
    - $Y = X + e$
    - $Y = X_1 + X_2 + e_1 + e_2$

Multilevel Models

of Change

"If you change the way you look at things,
the things you look at change."
Wayne Dyer

Examples of Longitudinal Studies

- Framingham Heart Study (Dawler, Kannel, & Lyell, 1963)
- Health Behaviors of Nursing Students: A Longitudinal Study (Clement et al., 2002)

What Do These Studies All Share?

- They all:
  - Track change in outcomes over time
  - Test what predicts different types of changes
    - E.g., different rates of change between groups

Questions about Change

1. How does the outcome change over time?
2. Can we predict differences in these changes?

- These two question are addressed through two, different pieces of our analyses

Questions about Change (cont.)

1. How does the outcome change over time?
   - Can be a descriptive question—not necessarily inferential
     - Is change linear? Logarithmic?
     - Does it always change the same way?
   - Addressed through looking at the pattern of the outcome *within* each participant
   - Level 1 analysis (Singer & Willet, 2003):
     - Describe the shape / rate of the change

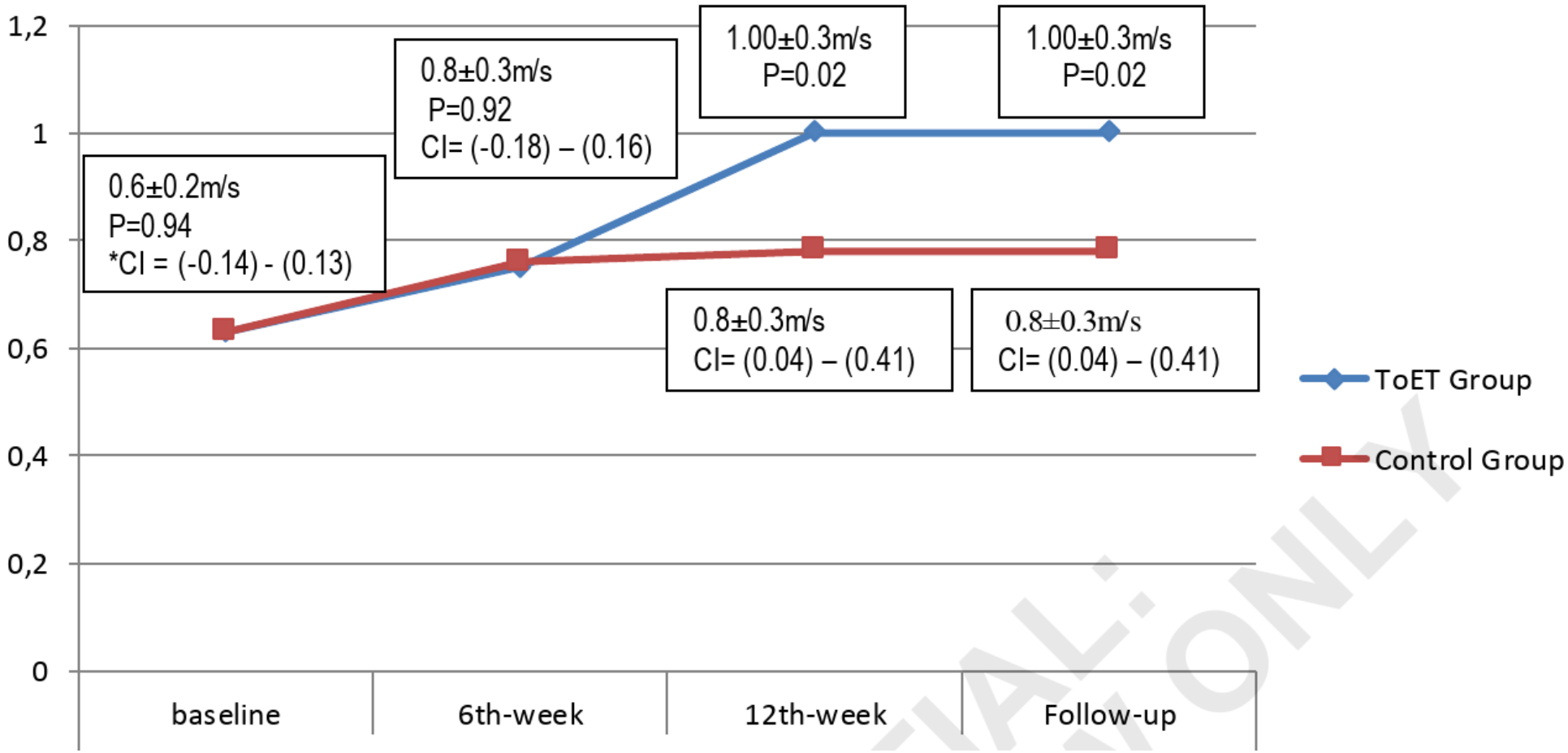
Questions about Change (cont.)

2. Can we predict differences in these changes?
   - An inferential question
   - Do groups differ in how they change?
     - Do other predictors correlate with rates of change?
   - Addressed through looking at differences *between* participants
     - From different groups, with different characteristics, etc.
   - Level 2 analysis (Singer & Willet, 2003):
     - Can we predict the shape / rate of change

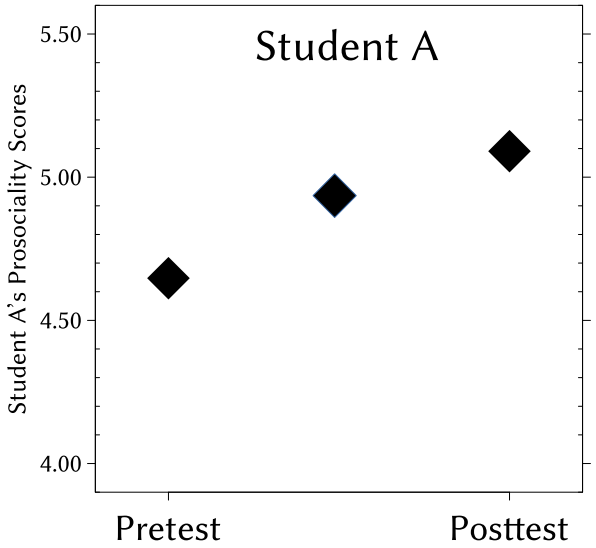
Ways to Test Longitudinal Data

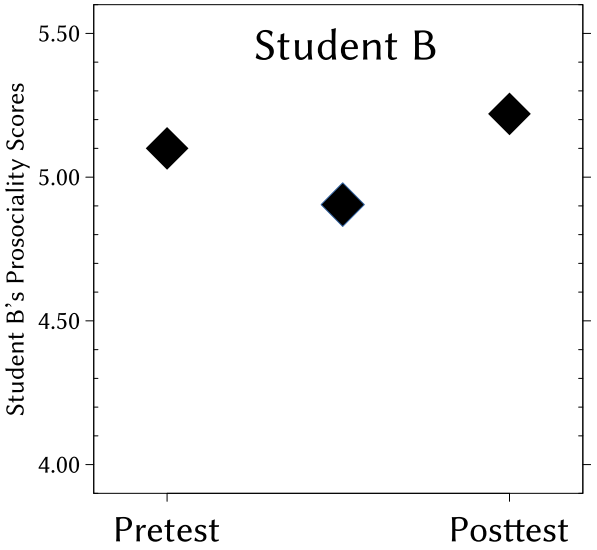
- Compute a pre-post difference score
  - The compare groups' difference scores
- Control for pretest score
  - Then compare groups' posttest scores (e.g., ANCOVA with pretest as covariate)
- Create a *nominal* factor for time
  - Then test for mean differences between levels of time (e.g., repeated measures ANOVA)

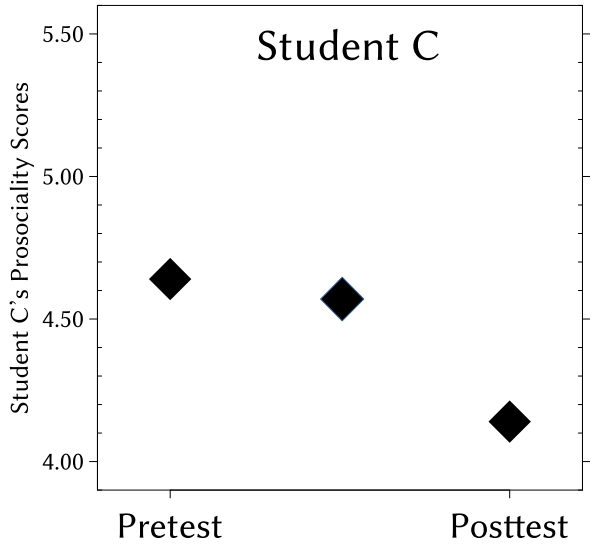
Repeated Measures ANOVA

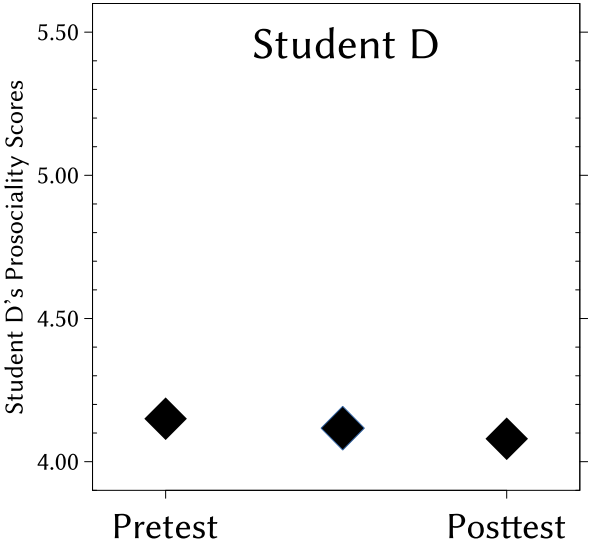


An Alternative Method

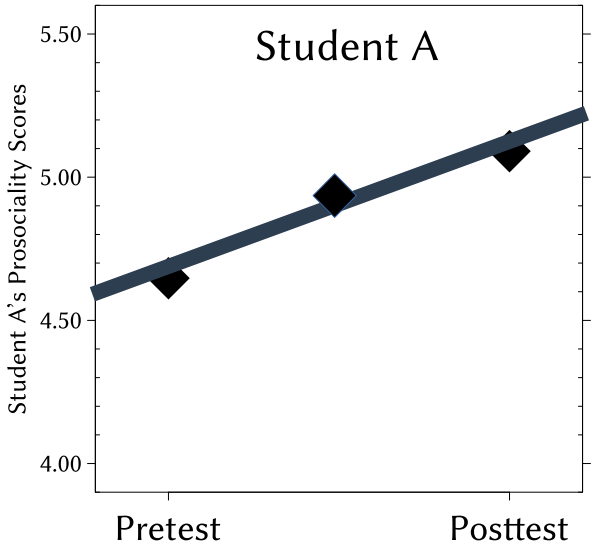


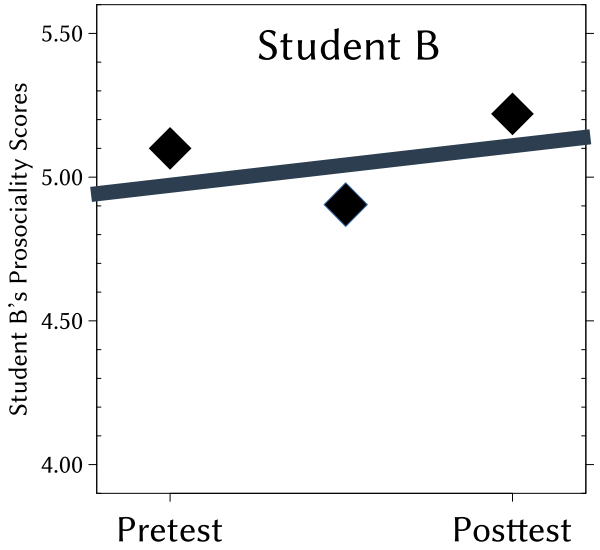


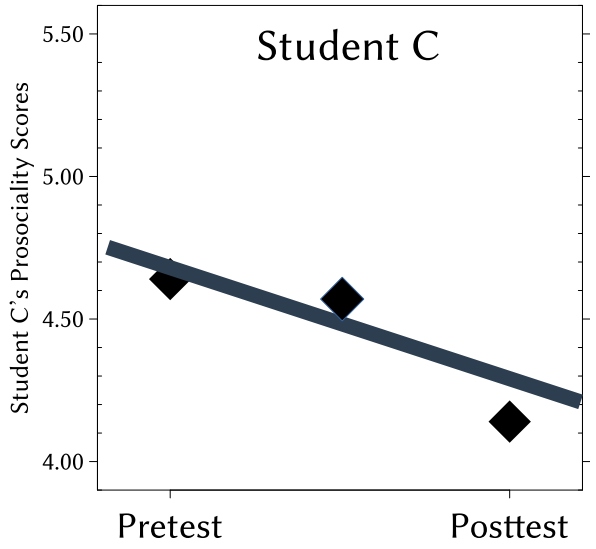


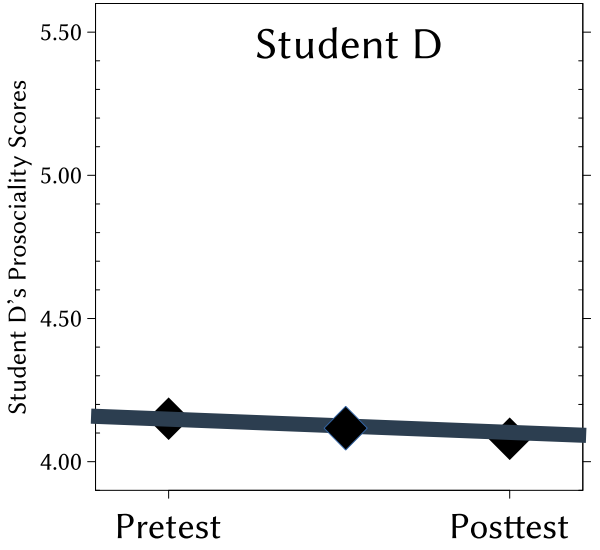


An Alternative Method (cont.)









An Alternative Method (cont.)

- Alternative method (Singer & Willet, 2003):
  - Using the time-varying scores,
    - Compute intercept & slope *for each participant*
    - Then include terms for the intercept & slope in the model
  - Also parse our error into nested levels

An Alternative Method: MLM

- We therefore "nest" time-changing data within each participant
  - Just as we would nest, e.g., patients in a hospital unit
    - And hospitals in city, city in state, etc.
- Called multilevel models of change (MLMs)
    - Also called hierarchical linear models

An Alternative Method (cont.)

- Including *slope* in model:
  - Allows time to be treated more flexibly
  - Models within-participant variance more accurately
  - Uses information in data set more efficiently
    - Requiring less data than other methods

An Alternative Method (cont.)

- Including *intercept* in model:
  - Can control for effect of initial values
    - (I.e., remove its effect from other comparisons)
  - Or can test if initial values affect later development
    - (E.g., floor or ceiling effects)

Prerequisites to Analyzing Change Through MLMs

1. Longitudinal data
2. Three or more “waves” of data
3. A time-varying outcome
4. A sensible metric for time

Prerequisites to Analyzing Change Through MLMs (cont.)

1. Longitudinal data
   - Measuring the same case over time
     - i.e., not cross-sectional
   - In which we measure different cases that are at different points of development

Prerequisites to Analyzing Change Through MLMs (cont.)

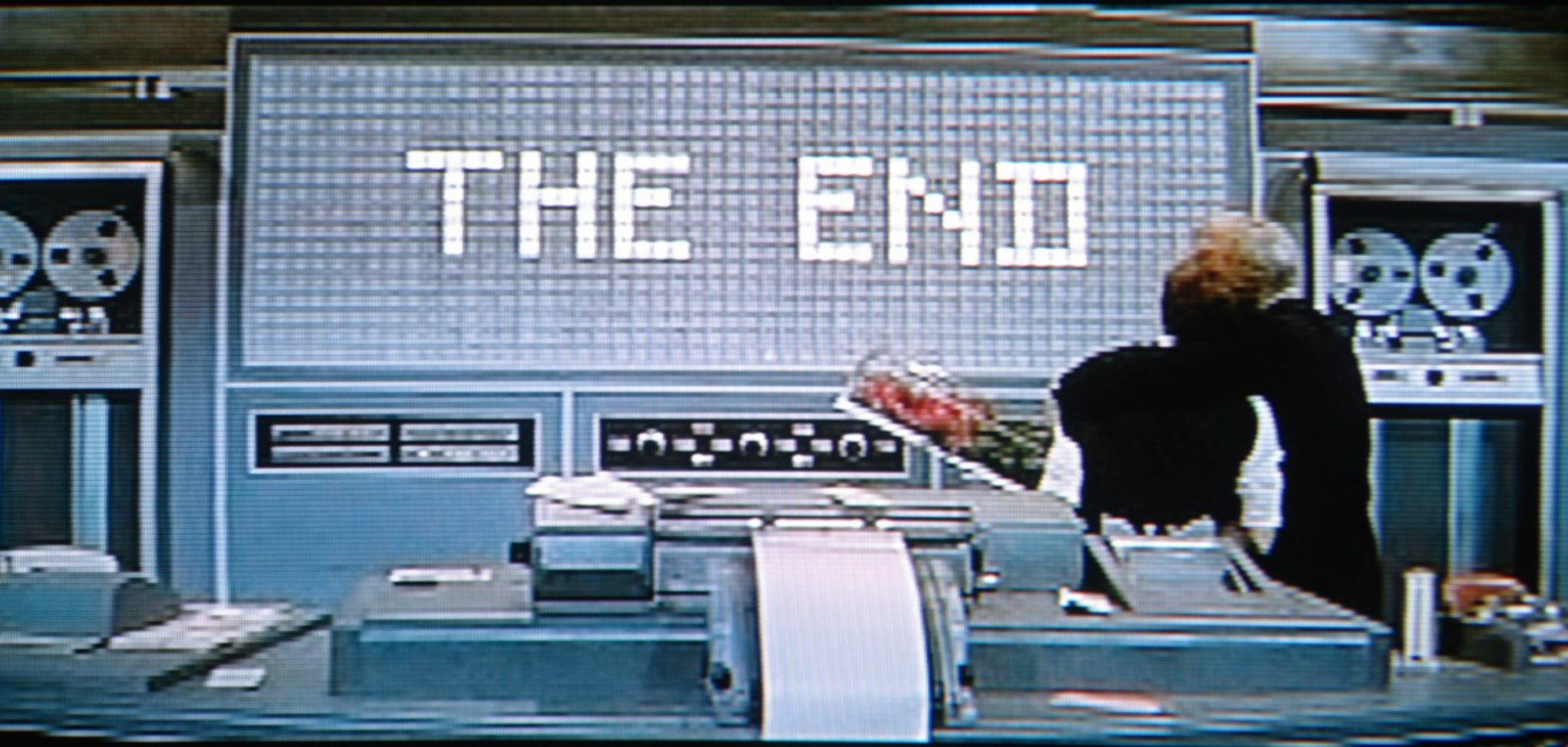
2. Three or more "waves" of data
   - 2 waves cannot:
     - Determine shape of change
     - Or how much is due to error / chance
   - More waves produce more precise measures
     - And reduces measurement error

Prerequisites to Analyzing Change Through MLMs (cont.)

3. A time-varying outcome
   - That remains valid & reliable at different times
   - MLMs need continuous data

Prerequisites to Analyzing Change Through MLMs (cont.)

4. A sensible & precise metric for time
   - Sensible
     - Useful for the decisions to make / research questions to answer
     - Appropriate spacing of measurement
   - Precise
     - Better decisions come with more information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