PSY 9556B (Jan8) Introduction – Design Issues
Terminology

- Repeated measures (longitudinal vs. non-longitudinal examples)
- Change (two time points; ANOVA, ANCOVA)
- Is change linear? (need more that two time points)
- Interindividual (between s.) vs. intraindividual (within s.) change
- Intraindividual variation across testing occasions

Benefits of Longitudinal Research

- Assessment of change and the form of change
- Stronger causal statement about associations (temporal order)
- Ability to model interindividual vs. intraindividual change
- Ability to model state vs. trait concepts
- Assessment of dynamic (vs. static) associations
    - Change in one variable causing change in another

Challenges in Longitudinal Research

- Appropriate spacing
- Adequate number of time points
- Carry-over effects
- Satisfying assumptions for tests of significance in GLM
- Satisfying measurement invariance across time
- Missing data / attrition (representativeness)
    - Determine why attrition is occurring
- Developing a theory of change (change at the individual and/or group level)
- What are the causes of change (not simply Time; natural, planned, unplanned)
- Assessing mediation with the correct time spacing

Missing Data

- Unplanned vs. planned missingness
- Effects of missing data
- Dealing with missing data
  - Items vs. scale scores
  - Old/traditional ways: listwise, pairwise, single imputation
  - Multiple imputation and Maximum likelihood model estimation
- Missing data properties
  - Missing completely at random (MCAR)
  - Missing at random (MAR)
  - Missing not at random

Defining a Metric of Time

- Polynomials (linear, quadratic, cubic…)
- Orthogonal polynomials
- Time points that depart from a specific trend (e.g., freeing a time point in LGM)
- Piecewise trajectories
- Chronological age, episodic time, experiential time (see Little)
    - Chronological age: can always include as a covariate
    - Episodic time (e.g., puberty, major depressive episode)
        - Can model time before and time after event
    - Experiential time: amount of time in a relationship

Longitudinal Design: Example of a Study

http://www.clsa-elcv.ca/clsa-videos

Longitudinal Design: CLSA

- National, stratified, random sample of 50,000 women and men aged 45 to 85 years
- Repeated waves of data collection at three-year intervals for at least 20 years
- Annual, short questionnaire to maintain contact and minimize losses to follow-up

Longitudinal Design: CLSA

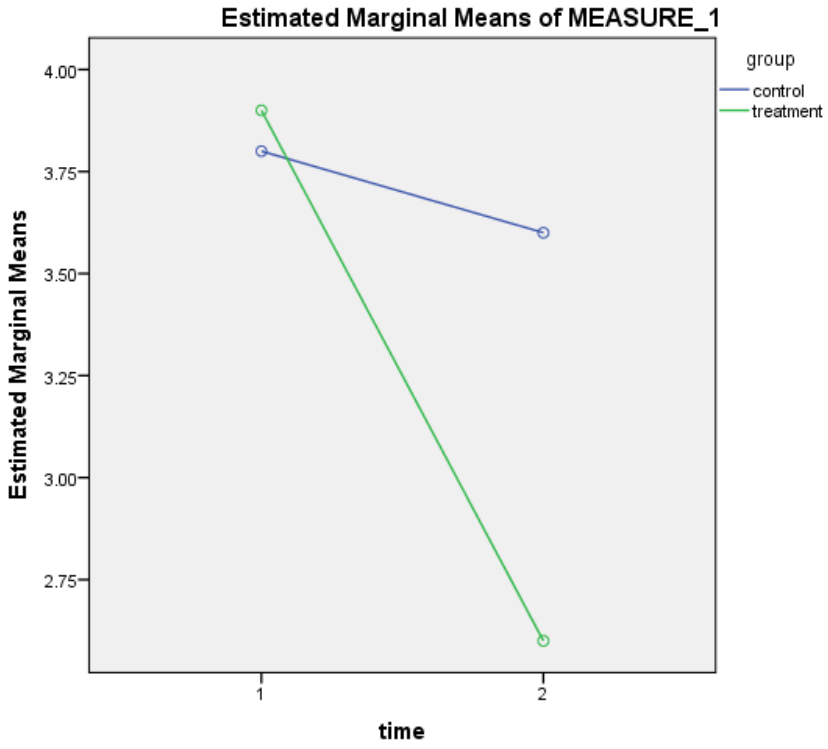
- Cohort
- Cross-sectional design
- Single cohort longitudinal study
- Cross sequential design
- Cohort sequential design
- Time sequential design

Longitudinal Design

	YEAR OF DATA COLLECTION																	
COHOR ▼	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1964	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
1965	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
1966	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
1967	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
1968	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
1969	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
1970	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
1971	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
1972	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
1973	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
1974	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
1975	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
1976	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
1977	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1978	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
1979	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
1980	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1981	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
1982	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1983	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
1984	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1985	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
1986	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
1987	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
1988	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
1989	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
1990	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
1991	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
1992	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1993	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1994	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1995	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1996	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1997	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1998	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1999	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
2000	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Basic Analyses With Two Time Points

	group	dep1	dep2	change
1	1	2	2	0
2	1	3	2	1
3	1	3	0	3
4	1	4	2	2
5	1	6	3	3
6	1	7	5	2
7	1	6	4	2
8	1	5	4	1
9	1	2	2	0
10	1	1	2	-1
11	0	2	3	-1
12	0	4	2	2
13	0	3	5	-2
14	0	6	6	0
15	0	7	5	2
16	0	6	5	1
17	0	5	6	-1
18	0	2	0	2
19	0	2	2	0
20	0	1	2	-1
21				



Basic Analyses With Two Time Points

First analysis is a split plot using GLM repeated measures. We want to see if the interaction is significant and show that the change is significantly larger for the experimental than the control group

```
GLM dep1 dep2 BY group
  /WSFACTOR=time 2 Polynomial
  /METHOD=SSTYPE(3)
  /PLOT=PROFILE(time*group)
  /EMMEANS=TABLES(group)
  /EMMEANS=TABLES(time)
  /EMMEANS=TABLES(group*time)
  /PRINT=DESCRIPTIVE ETASQ OPOWER
  /CRITERIA=ALPHA(.05)
  /WSDESIGN=time
  /DESIGN=group.
```

Descriptive Statistics

	group	Mean	Std. Deviation	N
dep1	control	3.80	2.098	10
	treatment	3.90	2.025	10
	Total	3.85	2.007	20
dep2	control	3.60	2.066	10
	treatment	2.60	1.430	10
	Total	3.10	1.804	20

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
time	Pillai's Trace	.240	5.672[b]	1.000	18.000	.028	.240	5.672	.615
	Wilks' Lambda	.760	5.672[b]	1.000	18.000	.028	.240	5.672	.615
	Hotelling's Trace	.315	5.672[b]	1.000	18.000	.028	.240	5.672	.615
	Roy's Largest Root	.315	5.672[b]	1.000	18.000	.028	.240	5.672	.615
time * group	Pillai's Trace	.145	3.050[b]	1.000	18.000	.098	.145	3.050	.380
	Wilks' Lambda	.855	3.050[b]	1.000	18.000	.098	.145	3.050	.380
	Hotelling's Trace	.169	3.050[b]	1.000	18.000	.098	.145	3.050	.380
	Roy's Largest Root	.169	3.050[b]	1.000	18.000	.098	.145	3.050	.380

a. Design: Intercept + group
Within Subjects Design: time

b. Exact statistic

c. Computed using alpha = .05

Basic Analyses With Two Time Points

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
time	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + group
Within Subjects Design: time

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
time	Sphericity Assumed	5.625	1	5.625	5.672	.028	.240	5.672	.615
	Greenhouse-Geisser	5.625	1.000	5.625	5.672	.028	.240	5.672	.615
	Huynh-Feldt	5.625	1.000	5.625	5.672	.028	.240	5.672	.615
	Lower-bound	5.625	1.000	5.625	5.672	.028	.240	5.672	.615
time * group	Sphericity Assumed	3.025	1	3.025	3.050	.098	.145	3.050	.380
	Greenhouse-Geisser	3.025	1.000	3.025	3.050	.098	.145	3.050	.380
	Huynh-Feldt	3.025	1.000	3.025	3.050	.098	.145	3.050	.380
	Lower-bound	3.025	1.000	3.025	3.050	.098	.145	3.050	.380
Error(time)	Sphericity Assumed	17.850	18	.992					
	Greenhouse-Geisser	17.850	18.000	.992					
	Huynh-Feldt	17.850	18.000	.992					
	Lower-bound	17.850	18.000	.992					

a. Computed using alpha = .05

Basic Analyses With Two Time Points

We can do a similar analysis using an independent t-test to see the effect of group on change. Note that I calculate a change variable. Here we get the same test of significance as we would the interaction term in the split plot ANOVA

```
T-TEST GROUPS=group(1 0)
  /MISSING=ANALYSIS
  /VARIABLES=change
  /CRITERIA=CI(.95).
```

T-Test

```
[DataSet0] C:\Users\ptrembla\Documents\PSY9556_Longitudinal\Lecture1.sav
```

Group Statistics

	group	N	Mean	Std. Deviation	Std. Error Mean
change	treatment	10	1.30	1.337	.423
	control	10	.20	1.476	.467

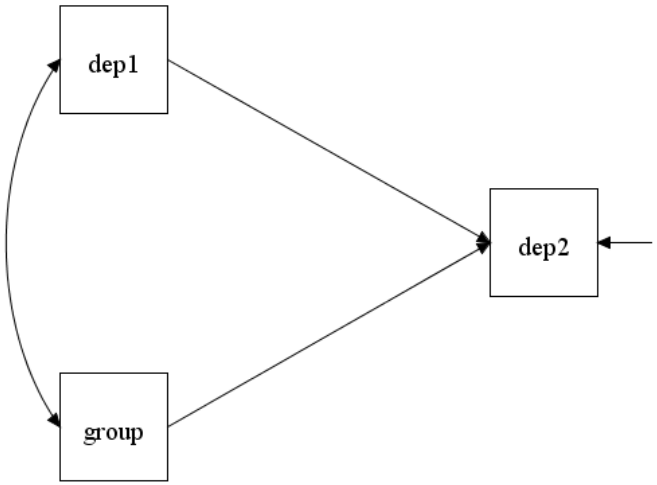
Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
change	Equal variances assumed	.214	.649	1.747	18	.098	1.100	.630	-.223	2.423
	Equal variances not assumed			1.747	17.829	.098	1.100	.630	-.224	2.424

Basic Analyses With Two Time Points

Others use multiple regression to see if the groups differ at Time2 controlling for differences at Time1.

```
REGRESSION
  /MISSING LISTWISE
  /STATISTICS COEFF OUTS R ANOVA ZPP
  /CRITERIA=PIN(.05) POUT(.10)
  /NOORIGIN
  /DEPENDENT dep2
  /METHOD=ENTER group
  /METHOD=ENTER dep1.
```



Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	3.600	.562		6.409	.000			
	group	-1.000	.794	-.284	-1.259	.224	-.284	-.284	-.284
2	(Constant)	1.176	.660		1.781	.093			
	group	-1.064	.550	-.303	-1.935	.070	-.284	-.425	-.302
	dep1	.638	.140	.710	4.540	.000	.702	.740	.710

a. Dependent Variable: dep2

Basic Analyses With Two Time Points

Note that these two analyses differ in their meaning. The change score analysis in split plot ANOVA or (t-test of change scores) determines if the average change is the same for the two groups.

ANCOVA analysis (using MR) tests if the average post-test depression scores are the same across the two groups for subpopulations with the same pre-test depression scores.

Basic Analyses With Two Time Points

$$dep2_i = \beta_0 + \beta_1 Group_i + \beta_2 dep1_i + e_i$$

$H_0 : \beta_0 = 0$ Tests whether the average Dep2 is significantly different from 0 for individuals with a Dep1 score of 0 in the control group (coded as 0)

$H_0 : \beta_1 = 0$ Tests whether the groups differ on Dep2 given same value on pretest

$H_0 : \beta_2 = 0$ Tests whether Dep2 is related to Dep1 , conditional on group.