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Latent Curve Modeling to Understand Achievement Emotions

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Quant-DARE Methods Showcase

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Source



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- Peterson, E. R., Brown, G. T. L., & Jun, M. C. (2015). Achievement emotions in higher education: A diary study exploring emotions across an assessment event. *Contemporary Educational Psychology, 42*, 82-96.
doi: 10.1016/j.cedpsych.2015.05.002
 - Based on MSc thesis by Miriam Chae Ok JUN supervised by Liz Peterson (Psychology) & Gavin Brown (Education & Social Work)

Problem



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- Understand student emotions about assessment across the process of preparing for, being assessed, and then receiving feedback
- Positive emotions lead to better performance than negative emotions
- Activating emotions help students work better
- How emotions change over time not studied

Achievement Emotions

3 sources
with different
expectations
as to their
effect



Valence & Effect	The AEQ	Kitayama et al. (2006)	Buchtel (2009)
<u>Positive AEs</u>			
Activating/ Engaging	Enjoyment (A)		
	Hope (A)		
	Pride (A)		
Neutral / no direction specified		Close feelings (E)	Close (E) Appreciated (E)
		Friendly feelings (E)	Friendly feelings (E)
		Respect (E)	Respect (E)
		Sympathy (E)	
		Calmness	Calm (N) Competent (N)
Deactivating/ Disengaging		Elation	Elated (N)
		Happy	Happy (N)
		Relaxation	Relaxed (N)
	Relief (De)		
<u>Negative AEs</u>		Pride (D)	Proud (D)
		Respected (D)	Self-respect (D)
		Superior (D)	Superior (D)
		Top of the world (D)	
Activating/ Engaging	Anger (A)		
	Anxiety (A)		
	Shame (A)		
Neutral / no direction specified		Ashamed (E)	Ashamed (E)
		Fear (E)	
		Guilt (E)	Guilty (E)
		Indebted (E)	
		Boredom	Bored (N)
		Depression	
		Disgust	Disgusted (N)
	Unhappy	Unhappy (N)	
Deactivating/ Disengaging		Sadness	
		Frustration (D)	Annoyed (N) Frustrated (D)
	Hopelessness (De)		
		Sulky feelings (D)	Sulky feelings (D)
		Angry (D)	Angry (D)
	Boredom (De)		

Research Goals



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- Understand structure of AEs when drawn from multiple inventories
- Dynamic effect of assessment processes on AEs
- Relationship of AEs to Test performance and to Prior GPA

Participants



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- 166/395 students in Educ121
 - Completed learning log within 24 hours of being prompted,
 - Completed >6 of 9 learning logs,
 - Did 2 or more logs before the test and all 4 after the test, and
 - Gave consent to access their GPA.

Difference to non-Participants



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- Equivalent
 - age group ($\chi^2_{(2)}=1.00$, Cramer's $V=.06$, $p=.61$),
 - ethnicity ($\chi^2_{(5)}=9.47$, Cramer's $V=.17$, $p=.09$),
 - English spoken at home ($\chi^2_{(1)}=0.25$, Cramer's $V=.03$, $p=.62$),
 - birth in New Zealand ($\chi^2_{(1)}=0.56$, Cramer's $V=.04$, $p=.46$),
 - number of courses completed ($\chi^2_{(3)}=6.36$, Cramer's $V=.14$, $p=.10$), and
 - years attending university ($\chi^2_{(5)}=8.91$, Cramer's $V=.16$, $p=.11$).

Difference to non-



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Participants

- Non-Equivalence: fewer among participants
 - females ($\chi^2_{(1)}=7.95$, Cramer's $V=.15$, $p<.01$)
 - first in the family to go to university ($\chi^2_{(1)}=8.03$, Cramer's $V=.15$, $p<.01$)
 - But Cramer's V in the small range so relatively inconsequential.
- Non-Equivalence: higher among participants
 - cumulative GPA ($F_{(1,273)}=24.21$, $p<.001$, $d=.60$)
 - mid-term test ($F_{(1,273)}=21.68$, $p<.001$, $d=.56$)
 - results reflect more academically able students.

Data Collection



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- Diary Study
 - Structured, repeated-measures technique to capture self-reports as event is experienced
 - addresses questions concerning process and change and reduces the possibility of using an aggregated response to reconstructed events and the chance of participants' current state influencing their recall
 - used a closed-format rating scale completed within 24 hours of the end of the 2-hour course lecture

Timing of Data



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Diary	1	2	3	4	5	6	7	8	9
Days elapsed	0	2	4	7	9	12	22	25	27
Assessment Process	Study Week			Test Week Test day			Feedback week		

Analysis: AE structure



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- Confirmatory Factor Analysis for existing models:
 - Model 1: positive vs. negative structure of AEs for (a) Pekrun, (b) Kitayama, and (c) Buchtel frameworks,
 - Model 2: positive vs. negative structure of all AEs aggregated across three frameworks, and
 - Model 3: positive vs. negative structure with subordinate effect (i.e., engaging, neutral, and disengaging) factors for (a) Kitayama and (b) Buchtel frameworks.

Analysis: AE structure



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- Exploratory Factor Analysis
 - Dimensionality analysis (Courtney 2013)
 - FA oblimin, ml estimation (Costello & Osborne, 2005)
 - Items with factor loadings $> .40$ were kept, while items with cross loadings on another factor $> .30$ were excluded
 - Followed by CFA to test EFA solution fit to data

Analysis:

Invariance



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- Testing the stability of the factor structure across each time of administration
 - Nested multi-group CFA
 - equivalent regression weights (metric),
 - equivalent factor intercepts (scalar),
 - equivalent item residuals (strict).
 - Difference in CFI $\leq .01$ = equivalent models.
 - McArdle (2007) metric equivalence sufficient to compare factor means in longitudinal conditions.

Analysis:

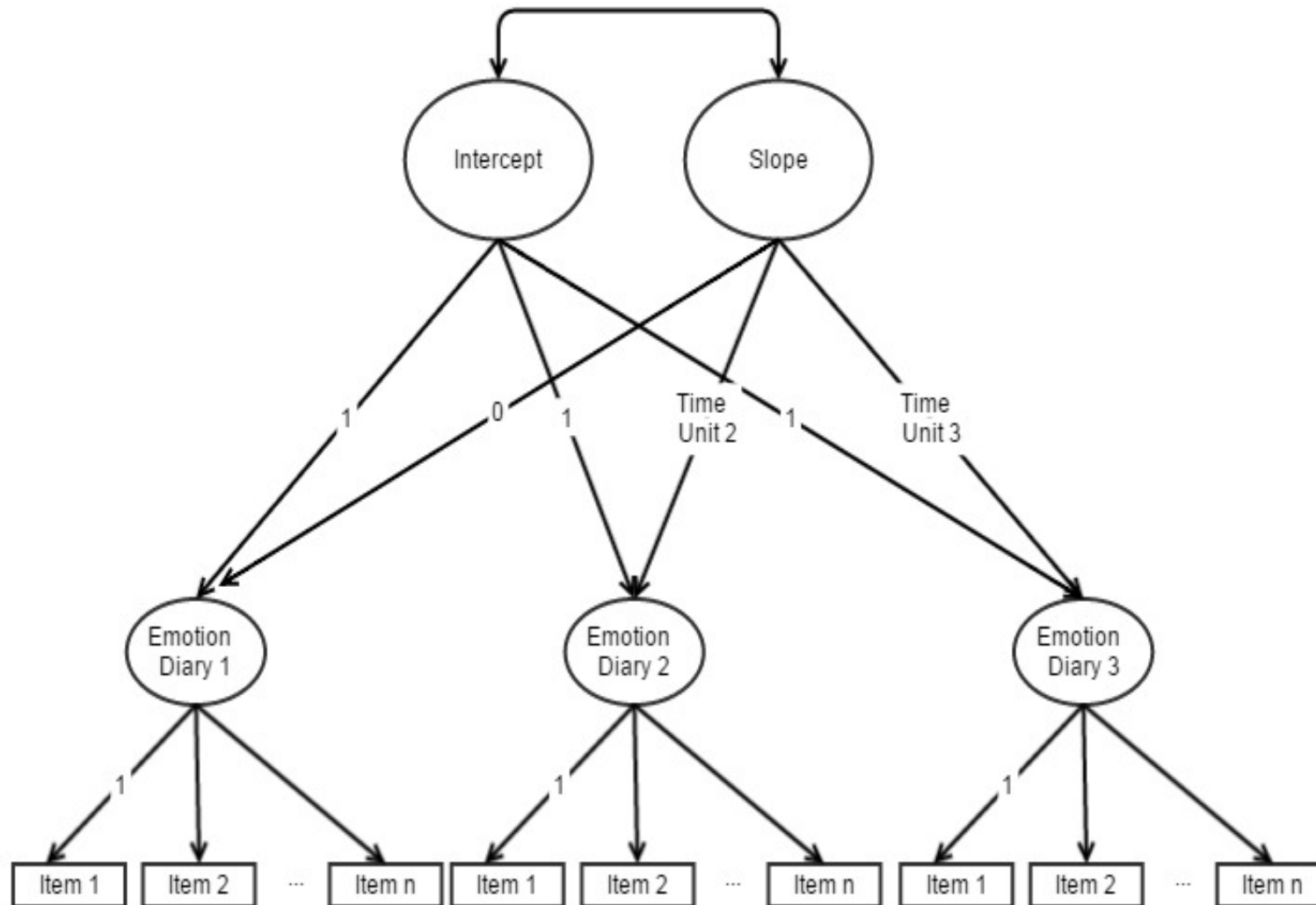
Longitudinal

- Latent curve modeling
 - presumes linear relationship over time between starting (i.e., intercept) and tendency to change (i.e., slope) values
 - Two inter-correlated latent traits used to explain variation in responding over time



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LCM structure



Analysis: Model Fit



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- Non-rejection when multiple indices meet conventional standards

Statistic	Acceptable	Ideal
χ^2/df ratio	<3.83	<3.00
Gamma Hat/ Comparative Fit Index	$\geq .90$	$\geq .95$
Root-Mean Square Error of Approximation (RMSEA)	$\leq .05$	$\leq .08$
Standardized Root-Mean Residual (SRMR)	$\leq .06$	$\leq .08$

Results: Factor Analysis



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Model	Description	Stats	Commentary
Nine day administration models			
1a. Pekrun's AEQ	MGCFA invariance 9 days ($k=81$)	$\chi^2=983.80$; $df=386$; $\chi^2/df=2.55$; RMSEA=.032; CFI=.896; SRMR=.064; gamma hat=.96	Strong invariance; metric & scalar
1b. Kitayama	MGCFA invariance 9 days ($k=207$)	$\chi^2=6025.89$; $df=2229$; $\chi^2/df=2.70$; RMSEA=.034; CFI=.841; SRMR=.082; gamma hat=.98	Weak invariance; metric only (one error variance corrected to .005)
1c. Buchtel	MGCFA invariance 9 days ($k=189$)	$\chi^2=5513.12$; $df=1844$; $\chi^2/df=3.13$; RMSEA=.037; CFI=.839; SRMR=.079; gamma hat=.97	Weak invariance; metric only
2. All positive- negative	MGCFA invariance 9 days ($k=279$)	$\chi^2=11044.71$; $df=3897$; $\chi^2/df=2.76$; RMSEA=.032; CFI=.805; SRMR=.080; gamma hat=.97	Weak invariance; metric only
3a. Kitayama	Engage-disengage-neutral, MGCFA invariance 9 days ($k=207$)	$\chi^2=5675.90$; $df=2178$; $\chi^2/df=2.61$; RMSEA=.034; CFI=.854; SRMR=.073; gamma hat=.98	Weak invariance; metric only
3b. Buchtel	Engage-disengage-neutral, MGCFA invariance 9 days ($k=189$)	Negative error variance Negative Disengage CR=2.432	Inadmissible

Results: Invariance Across Time with Academic Measures



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Three week models (study, test and feedback week)			
4a. AEQ Model 1a only	LCM Week 1 + GPA & test	positive-negative correlation covariance not positive definite in Day 3	Inadmissible
4b. Kitayama Model 1b only	LCM Week 1 + GPA & test	positive-negative correlation covariance not positive definite in Day 1 and Day 3	Inadmissible
4.c Buchtel Model 1c only	LCM Week 1 + GPA & test	positive-negative correlation covariance not positive definite in Day 1 and Day 3	Inadmissible
4d. All Model 2	LCM Week 1 + GPA & test (k=98)	$\chi^2=10324.65$; $df=4650$; $\chi^2/df=2.22$; RMSEA=.086; CFI=.610; SRMR=.191; gamma hat=.59	Reject fit ; no statistically significant paths to GPA or Test score
4.e All Model 2	LCM Week 2 + GPA & test (k=98)	$\chi^2=11101.49$; $df=4650$; $\chi^2/df=2.39$; RMSEA=.092; CFI=.629; SRMR=.193; gamma hat=.55	Reject fit ; no statistically significant paths to GPA or Test score
4f. All Model 2	LCM Week 3 + GPA & test (k=98)	$\chi^2=12699.35$; $df=4650$; $\chi^2/df=2.73$; RMSEA=.102; CFI=.602; SRMR=.266; gamma hat=.50	Reject fit ; no statistically significant paths to GPA or Test score

So...reject this approach and try EFA

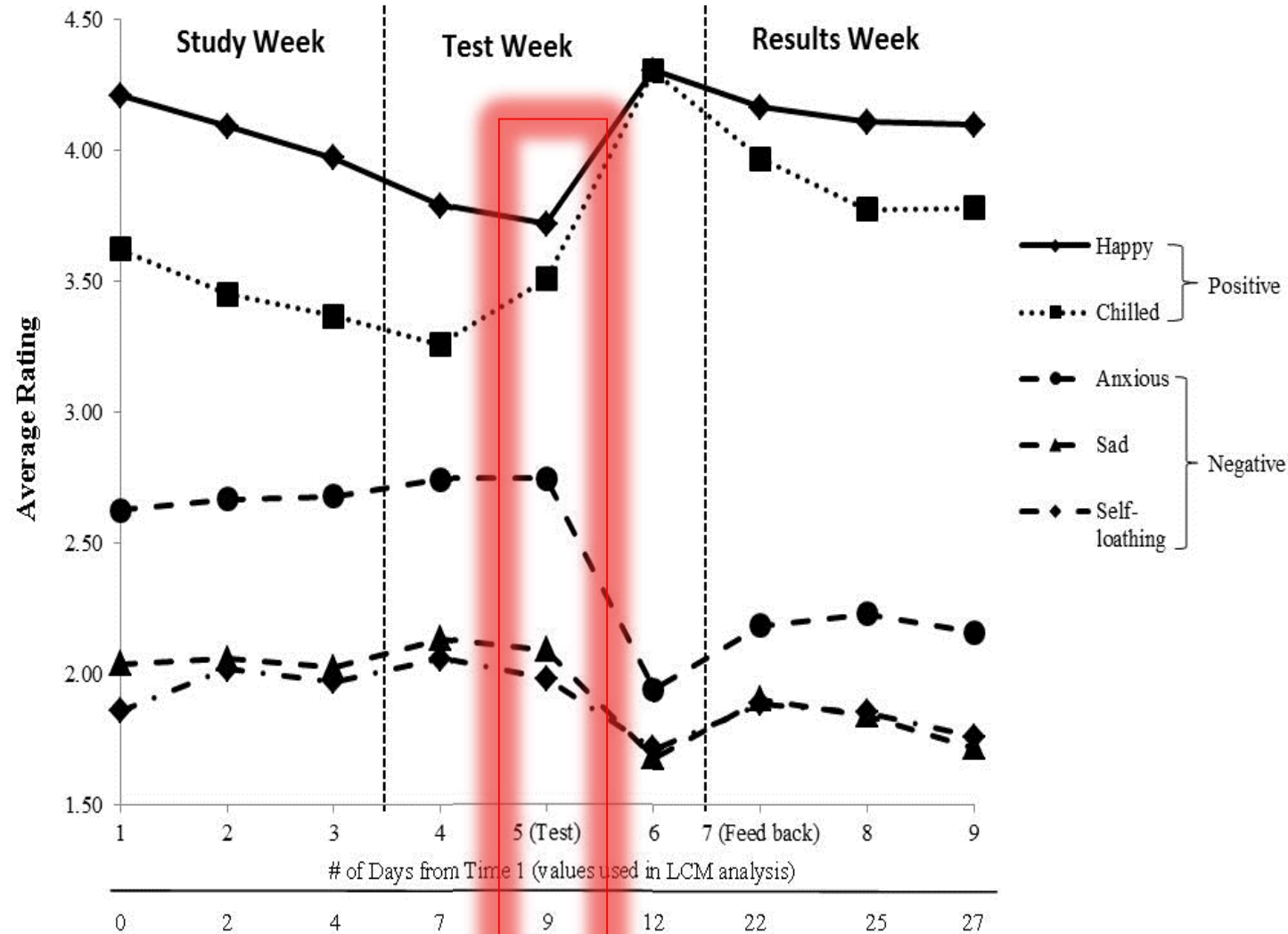
Results: EFA



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Positive Emotion Items	Factor Pattern Matrix		Factor Pattern Matrix			
	Happy	Chilled	Negative Emotion Items	Sad	Anxious	Self-loathing
I felt happy.* [#]	.96	-.07	I felt sad.* [#]	.87	-.11	-.09
I experienced enjoyment.* [#]	.92	-.12	I was unhappy.* [#]	.84	-.04	-.08
I felt friendly feelings.* [#]	.90	-.08	I felt depressed.* [#]	.75	.07	-.04
I felt appreciated.* [#]	.69	.08	I felt sulky feelings.* [#]	.71	.16	-.01
I felt like I was respected.* [#]	.59	.20	I felt like I was indebted.	.33	.26	-.07
I felt competent.*	.43	.25	I felt frustrated.* [#]	.13	.71	-.03
I felt elated.	.54	.33	I felt anxious.* [#]	.30	.55	.07
I felt hopeful.	.50	.36	I was fearful.* [#]	.19	.47	-.22
I felt close feelings.	.40	.21	I was bored.*	-.07	.41	-.02
I felt superior.*	-.16	.90	I felt annoyed.	.03	.47	-.35
I felt relieved.*	.05	.77[#]	I felt ashamed.* [#]	-.09	.03	-.87
I felt like I was on the top of the world.*	.30	.50	I felt disgusted.* [#]	.21	-.16	-.74
I felt relaxed.*	.29	.48[#]	I felt angry.* [#]	.04	.06	-.64
I felt sympathetic.*	.03	.47	I felt guilty.* [#]	.11	.17	-.51
I felt calm.*	.21	.46[#]	I felt hopeless.	.31	.23	-.38
I felt proud.	.43	.46				
I felt self-respect.	.39	.44				
Factor inter-correlations			Factor inter-correlations			
Happy		.70	Sad		.50	-.69
			Anxious			-.53

EFA Means by Process



EFA Invariance fit



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Emotion	Unconstrained	<u>CFI</u>			<u>ΔCFI</u>		
		Metric	Scalar	Residual	Metric	Scalar	Residual
<i>Positive</i>							
Chilled	1.000	0.998	0.893	0.891	0.002	0.105	0.002
Happy	0.972	0.972	0.961	0.961	0.000	0.011	0.000
<i>Negative</i>							
Anxious	1.000	0.999	0.912	0.909	0.001	0.087	0.003
Self-loathing	0.989	0.975	0.959	0.955	0.014	0.016	0.004
Sad	0.998	0.989	0.980	0.979	0.009	0.009	0.001

Impact on Test Score



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Emotion	Week in Assessment Process					
	<u>Study Week</u>		<u>Test Week</u>		<u>Feedback Week</u>	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
<i>Positive</i>						
Happy	0.06	0.23	0.12	0.24	0.26 **	-0.14
Chilled	0.05	0.28	0.07	0.19	0.34 *	-0.24
<i>Negative</i>						
Anxious	0.10	-0.11	0.10	-0.46	—	—
Sad	-0.11	-0.25	0.03	0.05	-0.21 *	-0.05
Self-loathing	-0.11	-0.11	-0.31	-0.35	-0.24 **	0.01

Impact of Prior GPA



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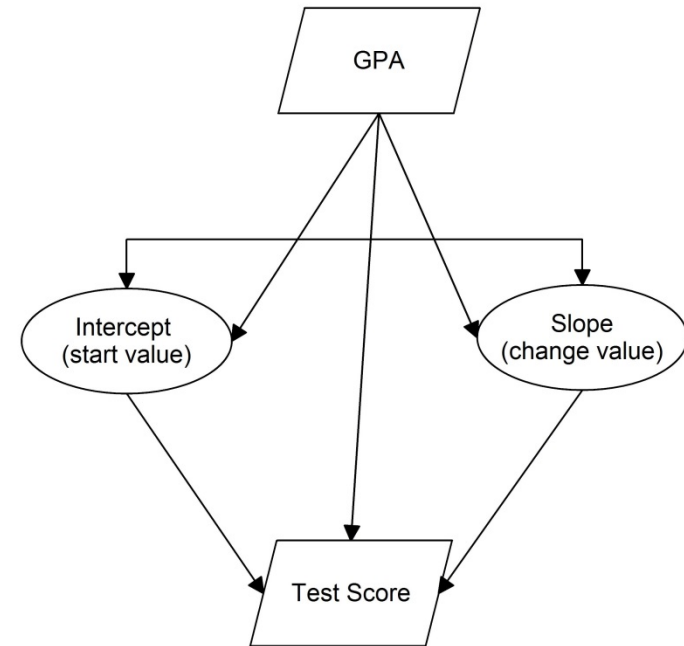
Emotion	Week in Assessment Process					
	<u>Study Week</u>		<u>Test Week</u>		<u>Feedback Week</u>	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
<i>Positive</i>						
Happy	-0.02	0.04	0.06	0.14	0.21*	-0.14
Chilled	-0.02	0.09	0.01	0.02	0.22*	-0.21
<i>Negative</i>						
Anxious	0.05	-0.13	0.15	-0.48	—	—
Sad	-0.01	-0.07	-0.02	0.15	-- 0.18 *	0.06
Self-loathing	-0.08	0.02	-0.09	-0.05	-0.20*	-0.03

LCM SEM Feedback Week



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*The power of being a high achiever?
More positive, less negative feelings around achievement*



Standardised Regression Weights and Effects

Feedback Week Emotions	GPA on Test (β)	GPA on Intercept (β)	GPA on Slope (β)	Intercept on Test (β)	Slope on Test (β)	Test SMC
<i>Positive Emotion</i>						
Happy	.54***	.17*	ns	.18 *	ns	.36
Chilled	.55***	ns	ns	.20**	ns	.35
<i>Negative Emotion</i>						
Sad	.57***	-.15*	ns	ns	ns	.33
Self-loathing	.57***	-.21**	ns	ns	ns	.33

Discussion



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1. Identified five conceptually meaningful AE factors
 - integration of Pekrun et al.'s (2007) AEQ research with Kitayama et al. (2006) and Buchtel (2009)
2. AEs tend to vary according to moment in the assessment process
3. Feedback on tested performance “once results are known” crystallises relationship of emotions to academic performance