NRA #NNJ10ZSA003N
Contract #NNX12AB40G

Non-Intrusive Psycho-Social State Detection for Attitudes with Exercise

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SIFT

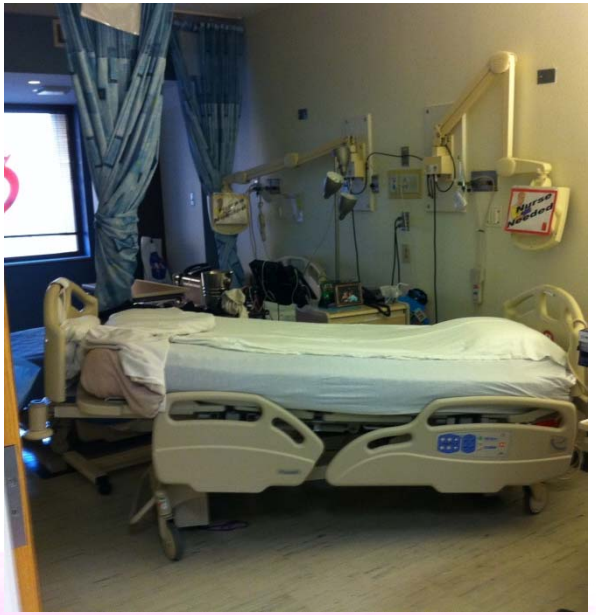
Project Goals and Benefits

- Primarily addressing IRP Gap: Team 1
  - "Risk of performance decrements due to inadequate cooperation, coordination, communications and psychosocial adaptation within a team"
- Developing method(s) to non-intrusively assess team and individual psycho-social states (PSSs)
  - Perform data collection
  - Qualitatively characterize salient factors affecting behavioral health, team cohesion, etc.
- Auxiliary Gaps addressed:
  - BMed1: Stress Inoculation Research
  - BMed2: Detect Indicators of changes in PsychoSocial performance
  - AFT3: Risk of Inadequate Food System; Influencing Mood through Dining

Wide, easy access to psychosocial state data is the essential roadblock to performing the research needed to retire IRP Gap Team 1… and all of its follow on dependents

AD ASTRA-- Approach

- Emphasize Linguistic Analysis Techniques
  - Identified NASA sweet spot of data availability, technique reliability and useful state information
    - Initial literature review → approaches matrix
      - MANY techniques available… text (& potentially speech) analyses most promising
    - Two Broad Data Types
      - Individualized Logs ("Diaries")
      - Interactive Task-Performance Communications ("Task Chat")
- Year 2 Objectives:
  - Validation against survey data
  - Emphasize Journal Data from bed rest
  - Explore what techniques and results can show
  - Illustrate promise of speedy and flexible analyses



AD ASTRA Bed Rest Experiment

- **Daily** journal entries and survey responses: Subjects kept journals and completed surveys “daily”.
  - 943 journal entries with paired survey data
  - Staff provided occasional survey data
- 14 subjects included in this data review
- ~100 days each (counting pre/post and heads down)

- Initial study NOT focused on exercise
  - **Today’s presentation looks at exercise as IV**
  - This request to analyze exercise as an IV provides good test of flexibility and speed of analytic tools



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Analysis Techniques

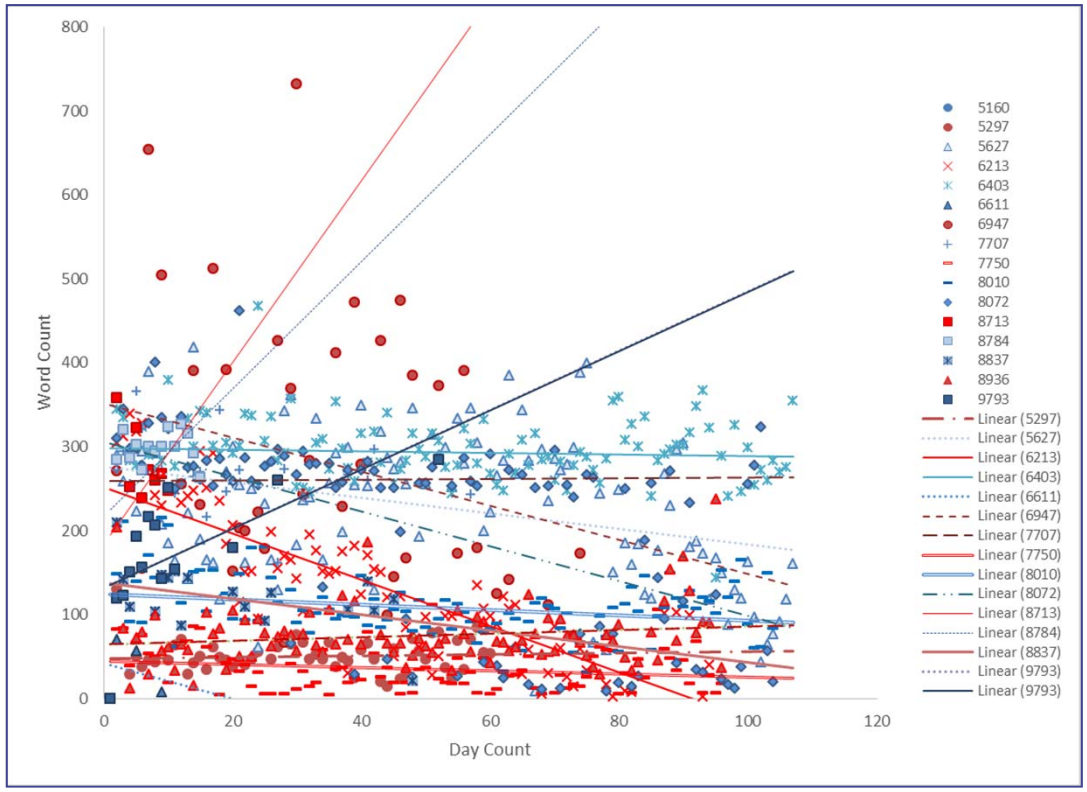
- Linguistic Inquiry Word Count (Pennebaker) – count proportion of words in specific categories
  - E.g., "Study"= {diet, cycle, treadmill, nurse, mri, experiment, research, test, strength, testosterone, etc.}
  - Predictive of personality traits, mood, mental health, etc.
- Latent Semantic Analysis for Valence/Sentiment
  - Uses SVD techniques to evaluate context-based word meaning and estimate emotional intensity/direction of a word set relative to a large dataset of English texts rated for valence[1].
  - Predictive of psychological health, gender stereotypes, pos./neg. attitudes, schemas of self, etc.
- Correlations among the above
- Unusual Word and Topic Identification

[1] Affective Norms for English Words (ANEW) dataset by Margaret M. Bradley, Peter J. Lang from the University of Florida

Variables

- LIWC
  - Word frequency
  - Word Count Positivity: "EMOpositivity" = posemotion / negemotion
  - Time Orientation (Past, Present, Future)
  - Cognitive Mechanism: word categories 'causal words' or 'inhibit' linked to greater health
  - Deception: combination of negemo, exclusion words, pronoun usage, etc.
  - Pronoun usage: "I" vs. "we" usage – in/outgroup affiliation, depression?
- LSA
  - Valence
  - Valence for Keywords & Topics of Interest: attitudes about physical state, food, study, sleep, family, habitat, feelings and thoughts, etc.
  - Big5 Personality Assessment
- Survey responses
  - PANAS (daily)
  - STAI (beginning & end of study)
  - Questions about time orientation, physical state, cognitive mechanisms, etc.
  - Survey Positivity: "PANASpositivity" = PANAS_pos / PANAS_neg

Word Count Frequencies



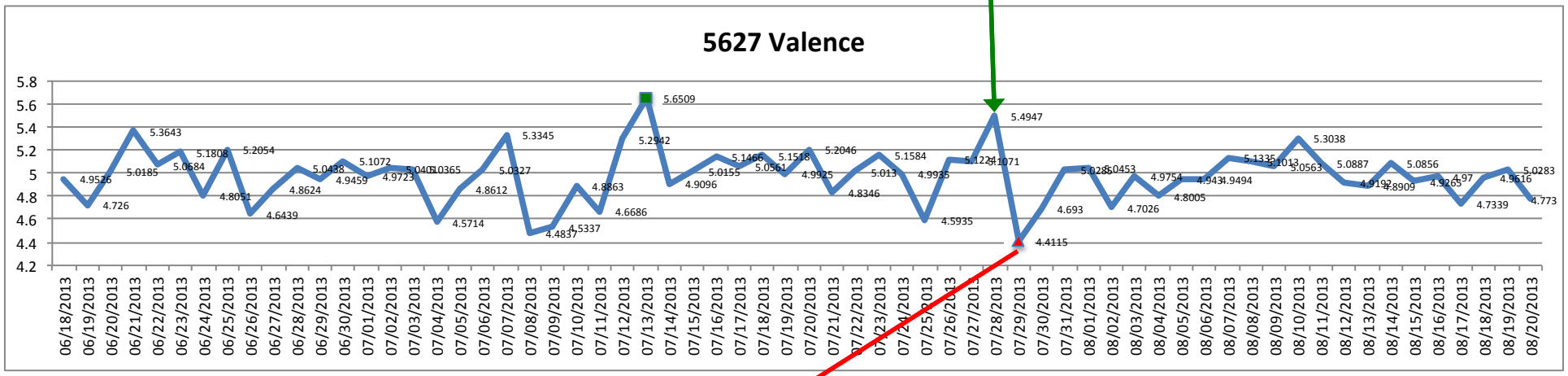
- Overall decline in word count over study days ($p<.001$), but substantial individual differences in word count and trends

Individual Assessment– Valence x Time

LSA Valence used to identify high and low days or periods (with anecdotal validation)

Other highest point

Another Sunday come and gone and another Sunday that did not suck!I spent the day productively studying and doing my best to understand electron transfer up until about 3:30 when I had my massage and then afterwards, me and my room mate followed our Sunday tradition of playing Gears of War until 8:30!I couldn't ask for a better day than that. Especially one that used to depress me so much in the past. Tomorrow is Monday thankfully and it is the 21st day of my bedrest! Again, weekdays go by VERY quickly for which I am most grateful and I am happy to have been able to patch up and regain my strength for this next hectic but welcome week! Morale is high as the expedition continues.



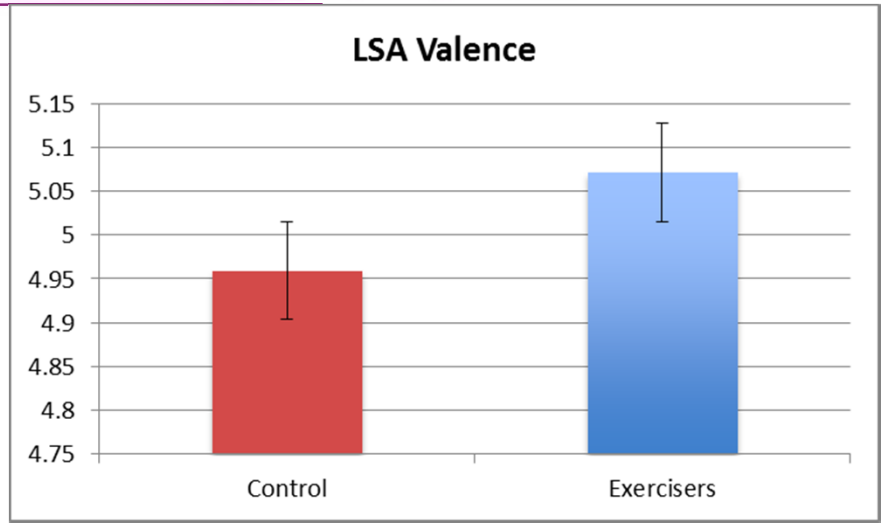
lowest point

I am SO pumped right now it is ridiculous. I am almost 100 percent certain that I am receiving the supplemental testosterone injections. [...] Today was a HEAVY leg day and my legs immediately after were starting to hurt from the intensity of the work out. And then, after icing my legs and resting until the afternoon I had to hit the continuous cycle. I have to admit that it was hard finishing it out today! I had to push myself and grit my teeth and tell my body that it could keep going even when I wanted to rest. But I pushed through and after icing my knees down once again [...] . In some other 'not so positive' news; I think I might have a urinary tract infection, and the hypochondriac within me is freaking out slightly. But a urine sample was taken and it is going to be analyzed so that we can find out the best way to combat it and deal with what is going on [...]
Morale is at an all time high and the expedition continues undaunted as the days tick by! Huzzah!

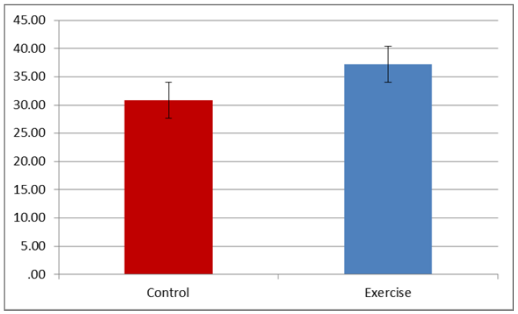
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Exercisers' Mood is Better (and journals show it)

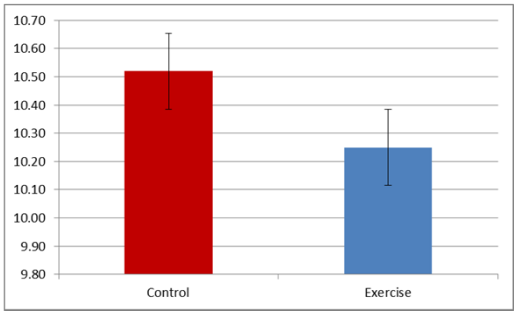
- Overall Valence of entries is higher for Exercisers
  - (using LSA sentiment assessment technique)



Valence of overall journal entries (p=.037)



PANAS positivity survey results (p<.001)

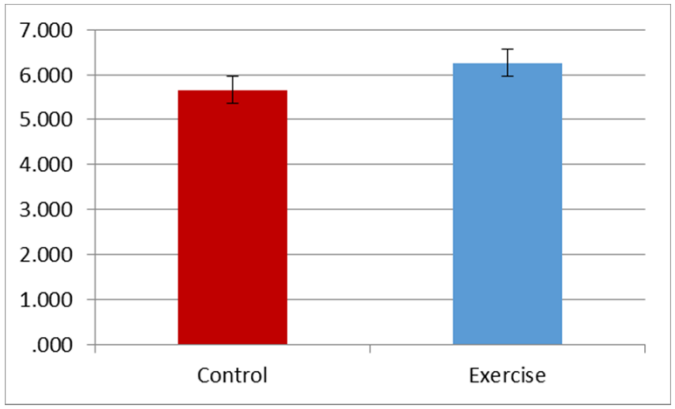


PANAS negativity survey results (p=.002)

- This is similar to an observed effect for PANAS survey scores:
  - PANAS positivity is higher for exercisers
  - PANAS negativity is lower for exercisers

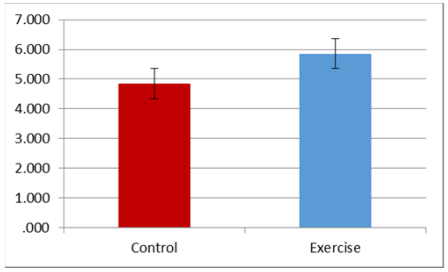
Exercisers' Feel Better (and talk about it)

- Exercisers rate (on surveys) their physical state as higher



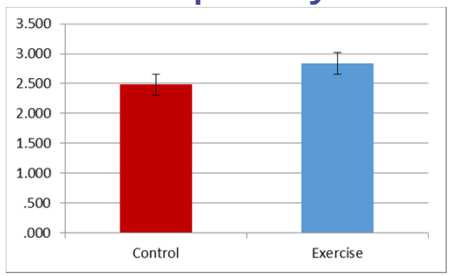
Survey Ratings of Physical State (p<.001)

They use physical/body terms more frequently



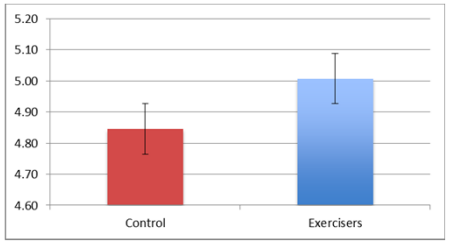
Proportional use of physical state terms (p=.004)

They use biological terms marginally more frequently



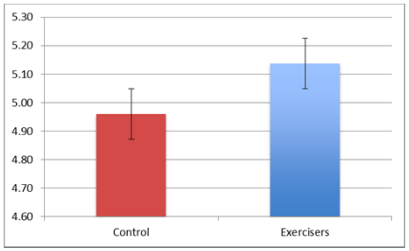
Proportional use of biological terms (p=.057)

Valence for their use of physical state terms is higher



p<.001

Valence for their use of exercise terms is higher



p<.01

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Word Frequencies

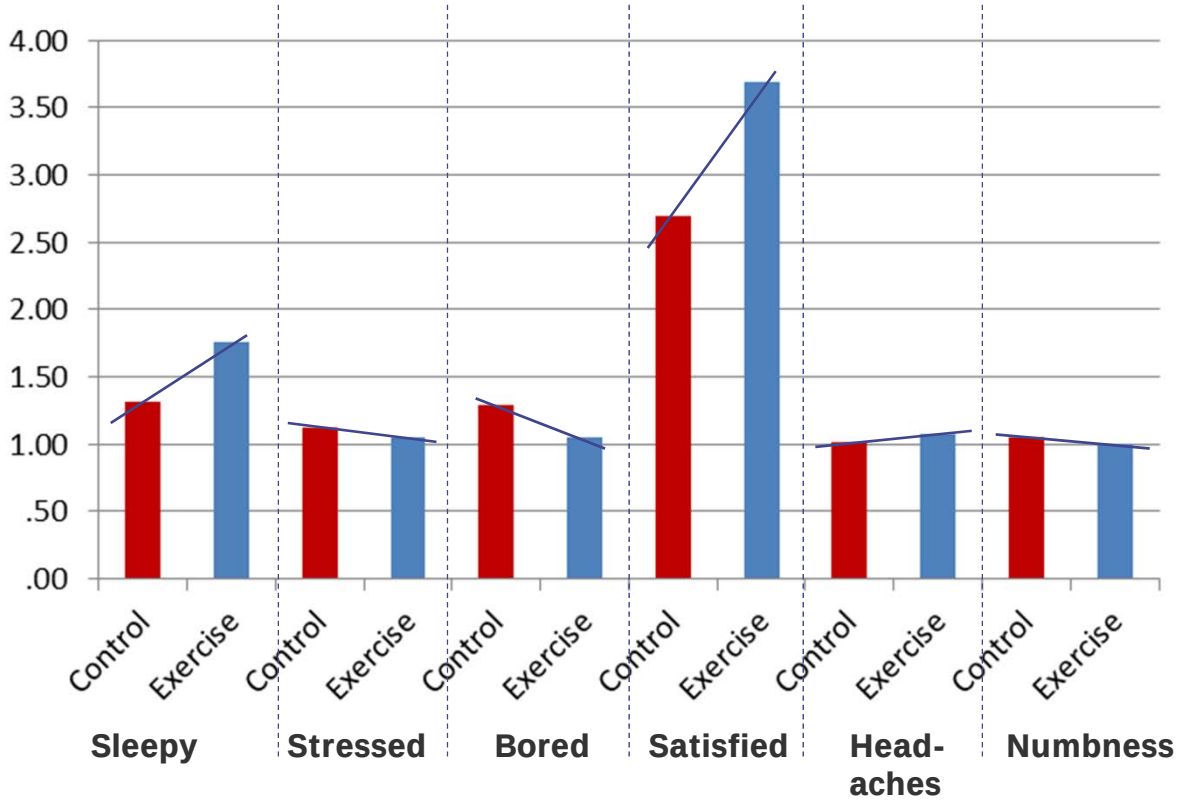
Exercisers used more:	Controls used more:
anger***	positive***
anxiety*	past***
future**	study***
conjunctions***	exclusion***
articles***	negations***
cause***	affect***
I***	relativity***
we***	time***
shehe***	food*
they***	
social***	
motion***	

*p<.05; **p<.01; ***p<.001

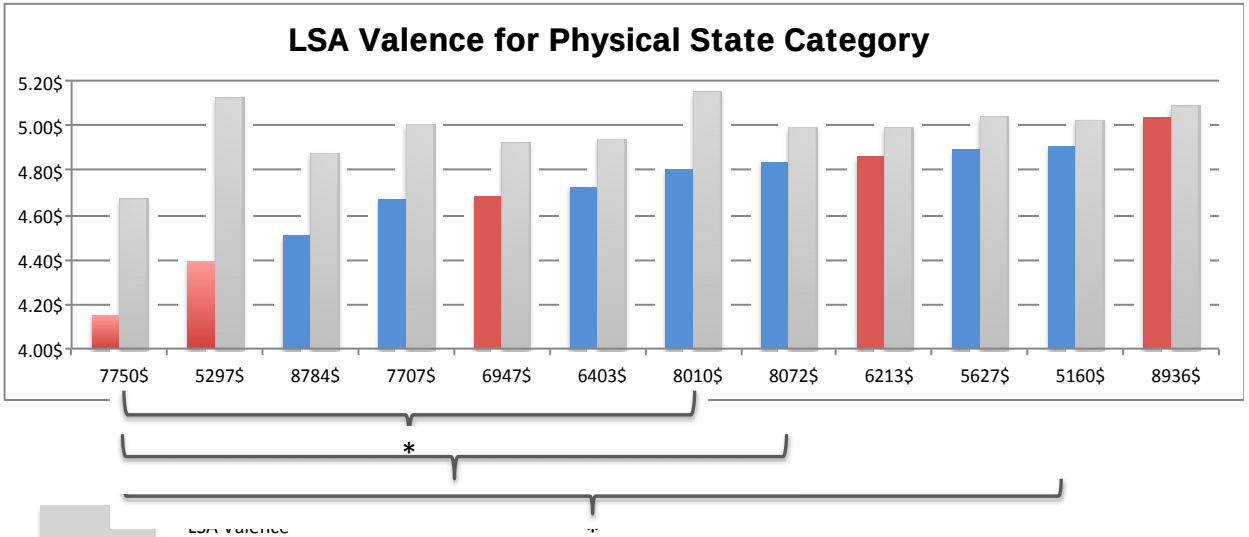
Exercise Survey Results (Extended PANAS)

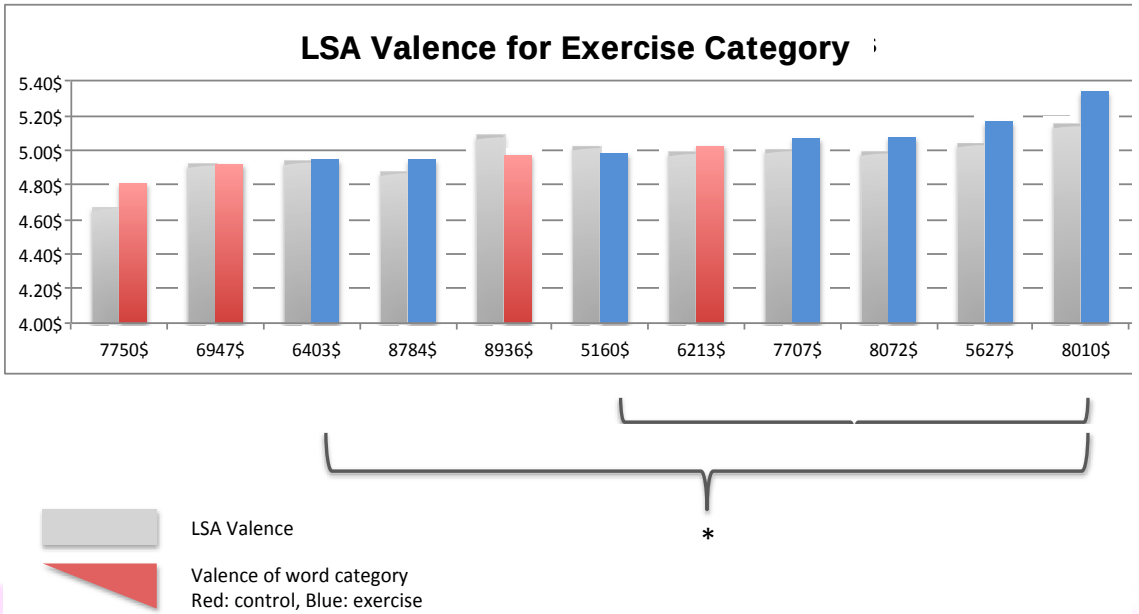
First Pass (~2hrs)

- Survey findings– Exercisers say they are:
  - More Sleepy (p<.001)
  - Less Stressed (p=.006)
  - Less Bored (p<.001)
  - More Satisfied (p<.001)
  - Slightly more pain (p=.054)
  - Have more headaches (p=.001)
  - Have less numbness (p<.001)



Individual Differences in Valence





“Unusual” Words Analysis

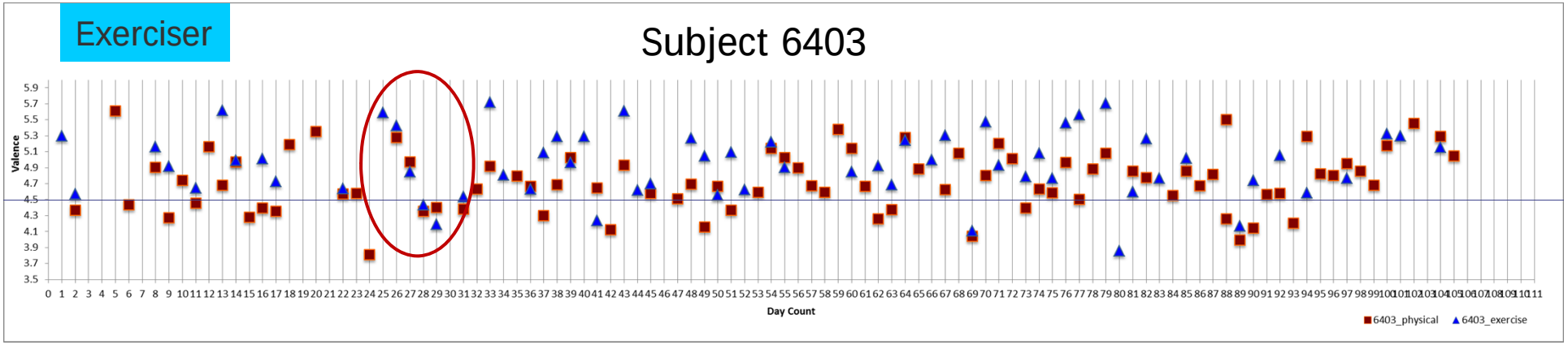
- Simple filter for “usual” words, followed by frequency count
- Identifies “unusual” words
- Can provide clues to topics of interest
- Here, cued us to subject’s painful biopsy

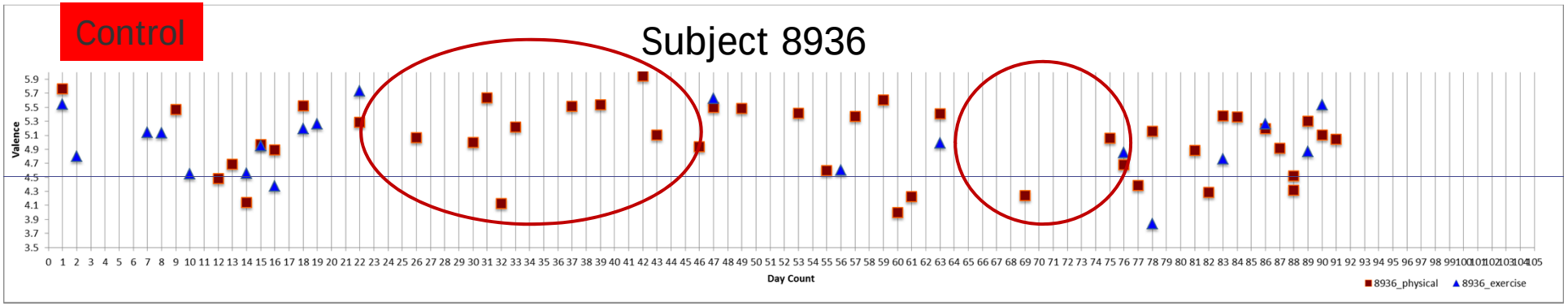
wk11	freq11	wk12	freq12	wk13	freq13
days	10	today	6	today	7
march	9	march	4	april	7
today	7	nerve	3	tile	5
untill	6			minutes	4
stand	6			dinner	4
left	4			time	4
calf	3			art	4
tilt	3			test	4
bedrest	3			morning	4
head	3			rest	3
position	3			massage	3
				worked	3
				legs	3
				met	3
				everythin	3
				Subject: 5160	3



Second Pass 1– (+ ~4 hours analysis time)

- It's possible to track attitudes on a daily basis by word usage and associated valence





Valence for Exercise terms

Valence for Physical terms

Individual Differences in "Drivers" for Attitudes

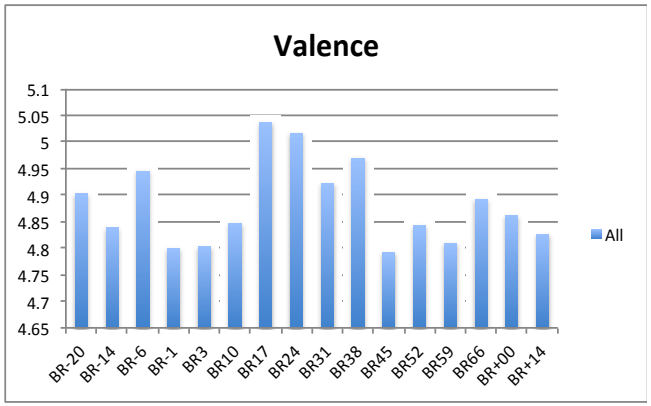
- Correlates between the valence of word group "exercise" and other word groups suggest concurrent thinking and associations = "Drivers"
  - 5627 (E) tends not to mention pain and anger when valence of exercise terms is high
  - 6403 (E) valence of "study", "food", "relations" and use of "home" are high when "exercise" is high.
  - For 8010 (E), when valence for "exercise" is high, mentions of the study decline
  - For 8936 (C), time, sadness and inhibition all increase when valence for "exercise" declines.

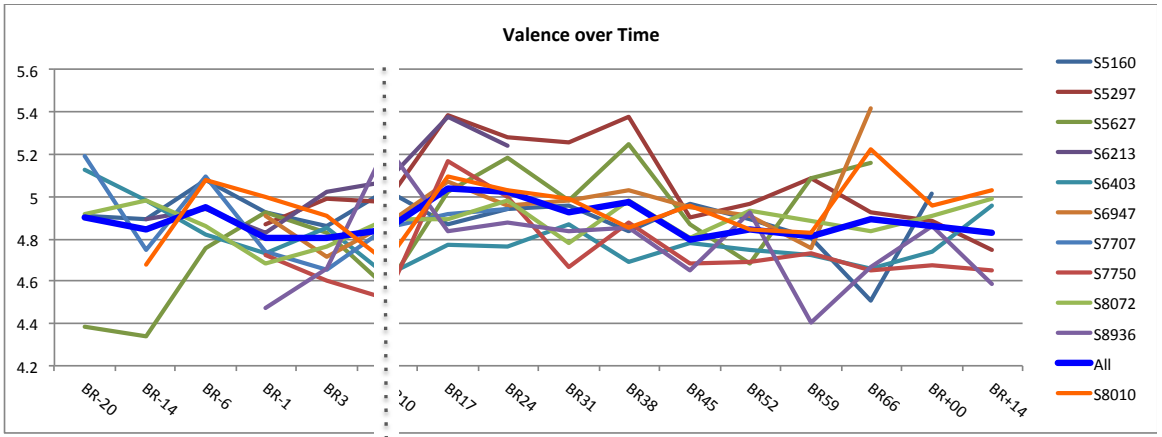
Positive	Negative
Subject 5160	
	physical state :r=.37
Subject 5627	
	pain: r=513
	anger: r=.431
	tentative: r-.444
	exclusion: r=.361
	assent: r=603
Subject 6403	
Val_study: r=.69	
Val_food: r=.418	
Val_Related: r=.523	
home: r=.331	
Subject 6213	
Val_Emo: r=.757	adverb: r=.554
inclusion: r=.565	NegEmo: r=.517
Subject 6947	
	Inclusion: r=.678, p=.05
Subject 7750	
	ipron: .83
Subject 8010	
social: r=.006	study: r=.441
family: r=.464	
PosEmo: r=.4	
Subject 8072	
Val_Emo: r=562	I: r=398
Inclusion: r=.344	PosEmo: r= .302
Leisure: r=.47	Discrepancy: r=.333
habitat: r=.44	
Subject 8936	
	time: r= 592
	sad: r= 561
	inhibit: r=452

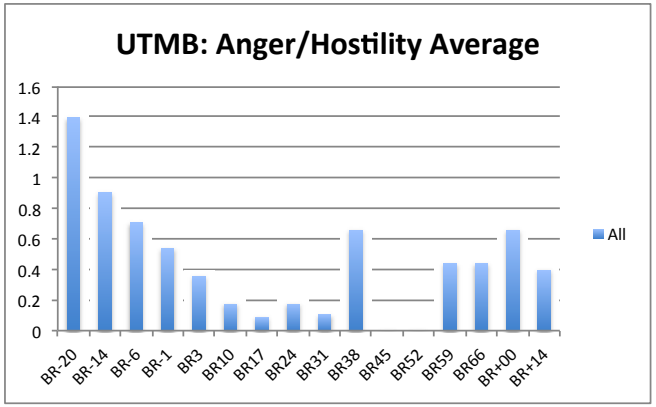
Cross-findings with other investigations

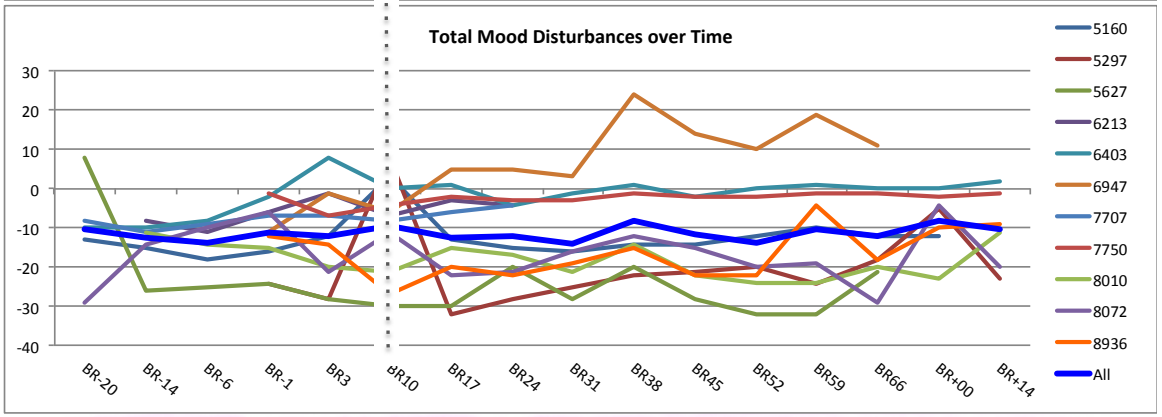
- Correlations between valence and POMS (UTMB)

	Valence*POMS	Valence*Tension/Anxiety	Valence*Anger/Hostility	Valence*Confusion
All Subjects	r= -.18, p=0.03	r= -.221, p=0.007	r= -.231, p=0.005	r= -.363, p=0.001









General Conclusions

- Exercisers exhibit many beneficial attitudes
  - But also some increased pain, anger, anxiety, sleepiness
- Attitudes (in journal writing) about exercise seem positive
- Substantial individual differences in “drivers” for attitudes about exercise
  - Discernible through journal analysis
- Possible to track individual attitudes about exercise (and other topics) over time
- General support for the speed and richness of linguistic analysis (and journals as data sources)

Plans for Publications

- Conference Papers
  - International Astronautical Congress (IAFASTRO)
  - International Academy of Astronautics (IAAWB)
  - Aoerospace Medical Association (AsMA)
  - International Academy, Research and Industry Association (IARIA)
    - International conference on Social Eco-Informatics
- Journal Papers
  - Acta Astronautica