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

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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
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
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
Overall decline in word count over study days ($p < .001$), but substantial individual differences in word count and trends.
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 high as the expedition continues.

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!! 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.
Overall Valence of entries is higher for Exercisers

(using LSA sentiment assessment technique)

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

They use physical/body terms more frequently

They use biological terms marginally more frequently

Valence for their use of physical state terms is higher

Valence for their use of exercise terms is higher

Survey Ratings of Physical State (p<.001)
## Word Frequencies

<table>
<thead>
<tr>
<th>Exercisers used more:</th>
<th>Controls used more:</th>
</tr>
</thead>
<tbody>
<tr>
<td>anger***</td>
<td>positive***</td>
</tr>
<tr>
<td>anxiety*</td>
<td>past***</td>
</tr>
<tr>
<td>future**</td>
<td>study***</td>
</tr>
<tr>
<td>conjunctions***</td>
<td>exclusion***</td>
</tr>
<tr>
<td>articles***</td>
<td>negations***</td>
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<td>affect***</td>
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<td>l***</td>
<td>relativity***</td>
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<tr>
<td>we***</td>
<td>time***</td>
</tr>
<tr>
<td>shehe***</td>
<td>food*</td>
</tr>
<tr>
<td>they***</td>
<td></td>
</tr>
<tr>
<td>social***</td>
<td></td>
</tr>
<tr>
<td>motion***</td>
<td></td>
</tr>
</tbody>
</table>

*p<.05; **p<.01; ***p<.001
Exercise Survey Results (Extended PANAS)

- 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

LSA Valence for Physical State Category

LSA Valence for Exercise Category

Valence of word category
Red: control, Blue: exercise

LSA Valence

Valence of word category
Red: control, Blue: exercise

4.00 4.20 4.40 4.60 4.80 5.00 5.20 5.40

7750 5297 8784 8010 8072 5160 8936

4.00$ 4.20$ 4.40$ 4.60$ 4.80$ 5.00$ 5.20$ 5.40$

7750$ 5297$ 8784$ 8010$ 8072$ 5160$ 8936$
“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
It’s possible to track attitudes on a daily basis by word usage and associated valence.

Exerciser

Subject 6403

Control

Subject 8936

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.
Cross-findings with other investigations

- Correlations between valence and POMS (UTMB)

<table>
<thead>
<tr>
<th></th>
<th>Valence*POMS</th>
<th>Valence*Tension/Anxiety</th>
<th>Valence*Anger/Hostility</th>
<th>Valence*Confusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Subjects</td>
<td>r = -.18, p=0.03</td>
<td>r = -.221, p=0.007</td>
<td>r = -.231, p=0.005</td>
<td>r = -.363, p=0.001</td>
</tr>
</tbody>
</table>

Valence

Valence over Time

Total Mood Disturbances over Time

UTMB: Anger/Hostility Average
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

Conférence 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