Emotions are to Personality as Weather is to Climate

Analogical reasoning as a tool for scientific investigation

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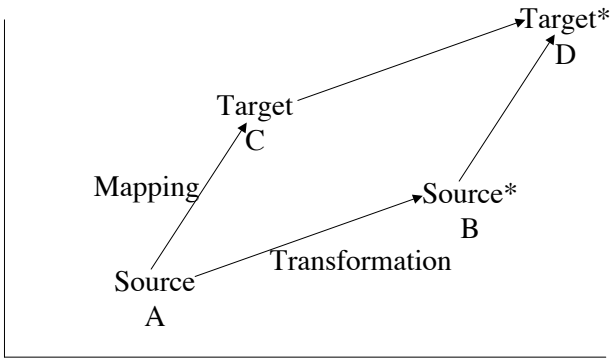
Thinking analogically as a scientific exercise

- Analogy as a tool for scientific investigation
- Mapping Sources to Targets
  - Superficial Feature mapping
  - Structural Relationship mapping

- Gentner, D., K. J. Holyoak and B. N. Kokinov. (Eds.) 2001. The analogical mind : perspectives from cognitive science. Cambridge, Mass.: MIT Press.
- Gentner, D., Brem, S., Ferguson, R. W., Markman, A. B., Levidow, B. B., Wolff, P., & Forbus, K. D. (1997). Analogical reasoning and conceptual change: A case study of Johannes Kepler. *The Journal of the Learning Sciences, 6*(1), 3-40.

The process of analogy A:B::C:D



Thinking analogically as a scientific exercise

- Many dynamic systems may be represented by the same simple linear differential equations
  - Consider damped harmonic motion and
    - Pendulums
    - Springs
    - Oscillating electrical circuits
  - Knowing how one system operates allows for predicting how the others operate.
    - Mapping is structural (identical differential equations) rather than surface
- Similar models for motivation and emotion

Mood, emotion motivation as dynamic systems

- Atkinson and Birch (1970): dynamics of action
  - Motivational forces and action tendencies have inertial properties as analogous to classical physics ("an action tendency at rest will remain at rest …")
    - Physical Force:Velocity::
    - Psychological force:Action Tendency
  - Revelle and Michaels (1976); Kuhl and Blankenship (1978): achievement motivation as dynamic system
  - Revelle (1986, 1995) : Stable personality traits are the rates of change of emotional states
    - Mass:Acceleration:: Trait: State

Dynamic systems

- Basic concepts of dynamics
  - States have values at particular time
  - States change over time
  - Time is a fundamental variable
    - Frequency
    - Latency
    - Persistence
- Simple linear systems
  - e.g. damped harmonic motion
  - Rates of change and changes in rates of change
    (1st and 2nd derivatives of states)

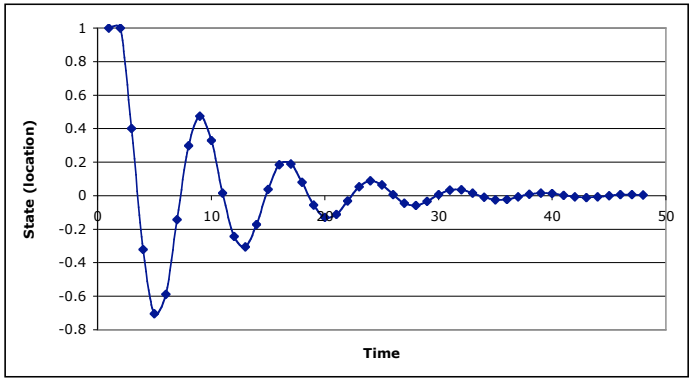
Application of inertial models to mood and emotion

- Boker (2001) : mood as a externally forced, damped harmonic oscillator
  - Self-regulation of Mental Health
  - Dynamic models of mood disorders
  - Mood as analogous to a pendulum
    - Shocks lead to diversion from steady state
    - Damped recovery to baseline

Dynamic systems

- Simple linear systems (e.g., a damped pendulum)

$$d^2x = b_1dx + b_2x + e$$

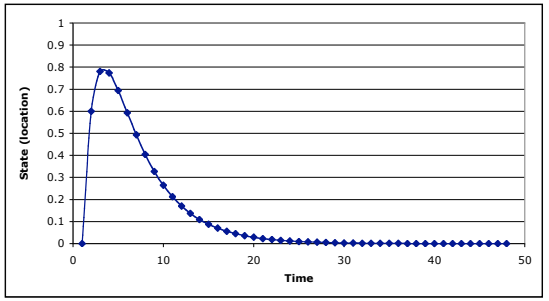


Emotion as a dynamic system

- Simple linear systems (e.g., anxiety as reaction to stress with damped recovery)

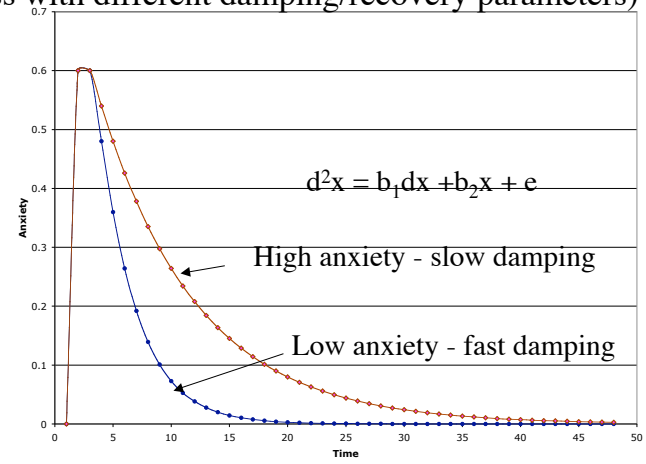
$$d^2x = b_1dx + b_2x + e$$

Gilboa and Revelle (1994) examined speed of recovery of emotional Stroop following mood induction



Individual differences in dynamic systems

Simple linear systems (e.g., anxiety as reaction to stress with different damping/recovery parameters)



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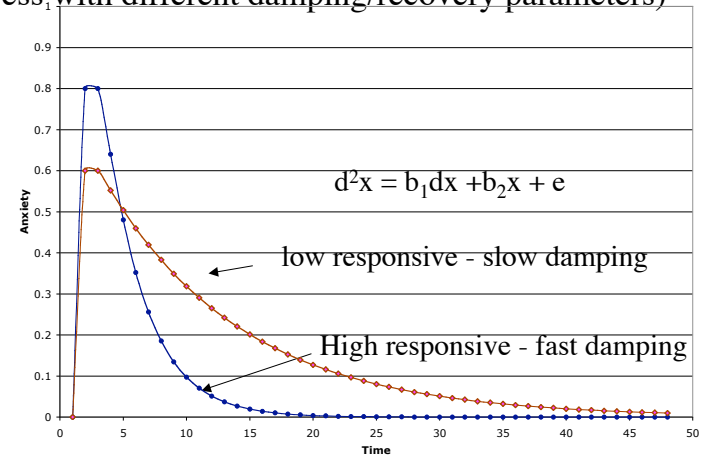


Linear vs.. non linear systems

- Unfortunately, most real systems are not linear
- Non linear dynamic systems are much more complicated
  - Turbulence (ocean swells break into surf)
  - Chaos (small differences in initial conditions lead to drastically different outcomes)
- Use non-linear physical systems as analogy for non-linear psychological system

Emotions are to Personality as Weather is to Climate: a surface feature mapping

- Weather
  - Lasts for hours to 10s of hours
- Weather systems
  - Hours to days
- Climate
  - Characteristics of weather over years

- Emotions
  - Last for seconds to 10s of seconds
- Mood
  - 10s of seconds to 1000s of seconds
- Personality
  - Characteristics of emotions across years

Why use an analogy?

- To use tools developed for one field for another
- To apply modeling techniques from one field to the other
- To evaluate effectiveness of modeling techniques
- To suggest unappreciated structural and functional properties of target based upon properties of the source

Weather as short term, local effects

- air temperature (current, daily high/low)
- pressure
- humidity (relative)
- cloud cover
- precipitation (amount, intensity)
- visibility
- wind (direction, velocity, variability)

Are there "dimensions" of weather?

- What happens when we apply the techniques that have traditionally been used in Psychology to analyze the dimensions of weather and climate?
- Conceptual dimensions of weather:
  - Warm - Cold
  - Dry - Wet
  - Stable - variable

Structure of affect:Structure of weather

- What are the appropriate ways to measure differences in affect?
  - Affect (positive vs. negative) and Arousal or
  - Positive Affect and Negative Affect
  - Usually discussed in terms of factor analyses and rotations of affect data
- What happens when we measure temperature
  - High and Low vs.
  - Average and Variability
  - Consider what happens when we factor temperature data

Temperature correlations

	H1	L1	H2	L2	H3	L3	H4	L4	H5	L5	H6	L6
H1	1.00	0.88	0.82	0.90	0.81	0.79	0.76	0.75	0.73	0.72	0.84	0.80
L1	0.88	1.00	0.78	0.90	0.85	0.87	0.66	0.72	0.74	0.76	0.82	0.82
H2	0.82	0.78	1.00	0.87	0.83	0.88	0.84	0.82	0.85	0.86	0.75	0.80
L2	0.90	0.90	0.87	1.00	0.81	0.89	0.77	0.80	0.74	0.79	0.80	0.82
H3	0.81	0.85	0.83	0.81	1.00	0.91	0.70	0.71	0.85	0.82	0.85	0.87
L3	0.79	0.87	0.88	0.89	0.91	1.00	0.76	0.79	0.83	0.84	0.77	0.83
H4	0.76	0.66	0.84	0.77	0.70	0.76	1.00	0.93	0.81	0.80	0.70	0.72
L4	0.75	0.72	0.82	0.80	0.71	0.79	0.93	1.00	0.81	0.87	0.71	0.80
H5	0.73	0.74	0.85	0.74	0.85	0.83	0.81	0.81	1.00	0.94	0.78	0.84
L5	0.72	0.76	0.86	0.79	0.82	0.84	0.80	0.87	0.94	1.00	0.78	0.89
H6	0.84	0.82	0.75	0.80	0.85	0.77	0.70	0.71	0.78	0.78	1.00	0.93
L6	0.80	0.82	0.80	0.82	0.87	0.83	0.72	0.80	0.84	0.89	0.93	1.00

Data based upon observed highs and lows for 250 cities
October 31 - Nov 5

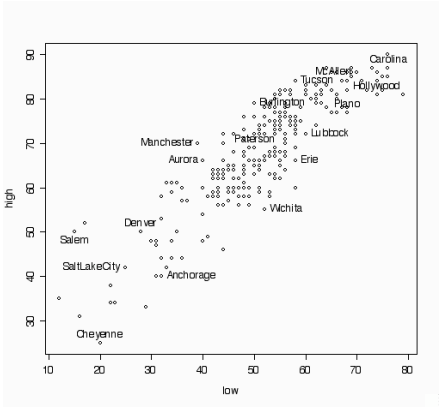
How many factors of Temperature?

- Screen test clearly implies 1 factor

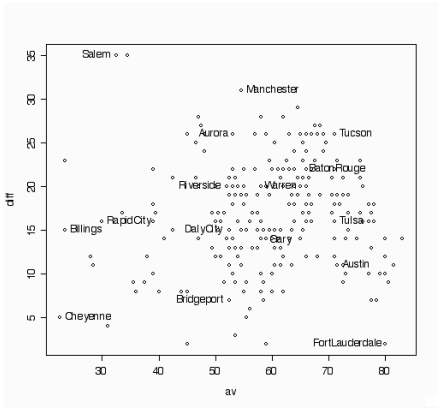
	Factor1	Factor2	Factor3	Factor4	Factor5
SS loadings	9.591	0.615	0.575	0.290	0.181

- Chi Square implies at least 5 factors!
  - Test of the hypothesis that 5 factors are sufficient.
  - The chi square statistic is 252.36 on 16 degrees of freedom.
  - The p-value is 1.7e-44
- Common sense suggests 2

Daily High vs. Low Temperature



Daily Average vs. range of temperature



What about dimensions of affect?

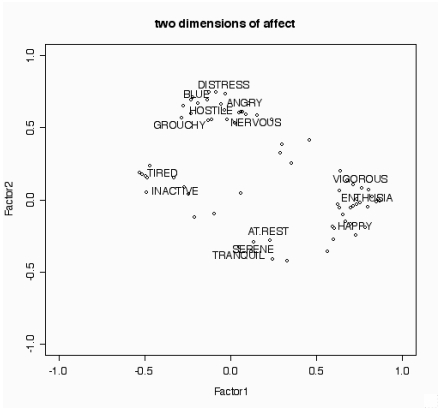
- Roughly 3000 NU undergraduates filled out a mood questionnaire before participating in a number of studies. 70-72 item questionnaire (Mood State Questionnaire and MSQ Revised) with items taken from Watson & Clark, Larsen and Diener, Thayer
- Response scale 0-3
  - (not at all … very much)

- Supported in part by a contract from ARI to W. Revelle and K.J. Anderson

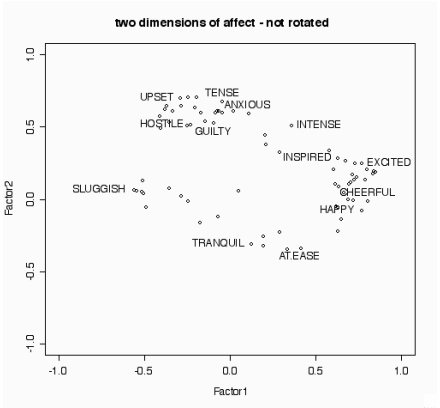
How many factors?

- Scree test?
- Maximum Likelihood > 8 factors
- Very Simple Structure Test 2 factors
- Interpretability
  - 2 broad bipolar factors or
  - 4 correlated unipolar factors

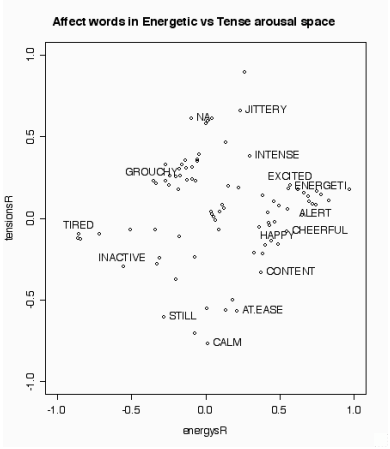
Dimensions of Affect
Affect and Arousal



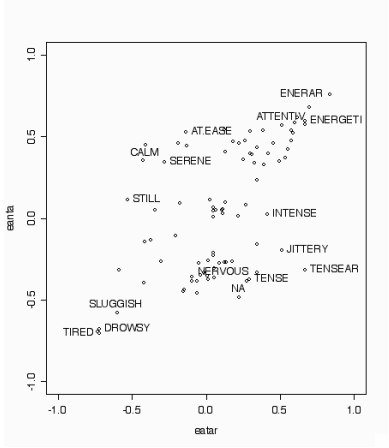
Dimensions of Affect



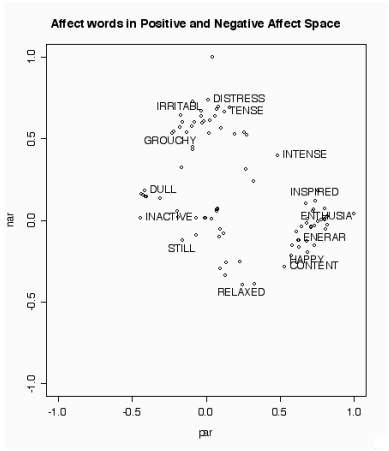
Affect in arousal space



Affect in rotated arousal space



Affect words in Affect Space



Dimensions of Weather, Dimensions of Affect

- Psychometric answer
  - 1 factor of temperature cold vs. hot
  - 1 factor of affect sad vs. happy
- Practical answer
  - 2 dimensions of temperature
    - Average temperature, variability of temperature
  - 2 dimensions of affect
    - Negative, Positive

Experimental Studies of Mood

- Film Clips to induce positive and negative affect

  Frontline (concentration camp)

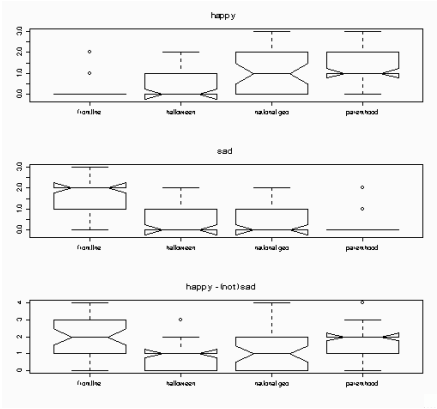
  National Geographic (African Veldt)

  Parenthood (birthday party scene)

  Halloween (threat sequence)

Measured response on “happy” and “sad” (as well as full set of items)

Experimental study of mood



Experimental study of mood

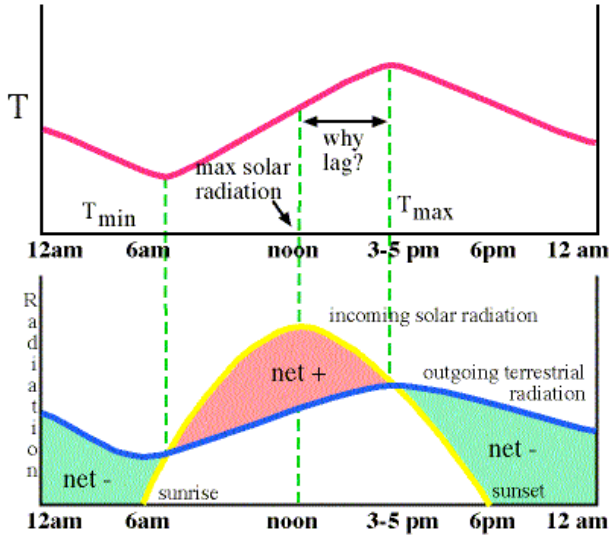
- Mood induction through short video clips
  - Parenthood (high happy, low sad)
  - National Geographic (neutral)
  - Frontline (low happy, high sad)
  - Halloween (low happy, low sad)
- Experimental results suggest sad ≠ -happy

- Data collected by Gregory Rogers and Steve Sutton and supported in part by a contract from ARI

Within subject variation

- Weather
- Daily variation in temperature
  - Lagged measure of solar flux
- Daily variation in solar radiation at surface
- Emotion
- Body temperature
  - leading measure of alertness
- Diary studies of emotion

Temperature vs. solar radiation

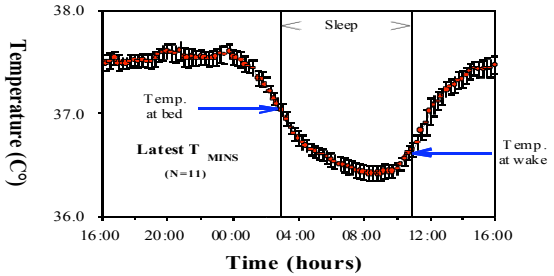


Body temperature as leading indicator of alertness

- Body temperature as a measure of arousal?
  - Core body temperature collected for ≈ 2 weeks
  - Data taken by aggregating subjects from multiple studies conducted by Eastman and Baehr on phase shifting by light and exercise
  - (Baehr, Revelle and Eastman, 2000)
  - Pooled across all subjects
  - Divided by "morning" and "evening" people

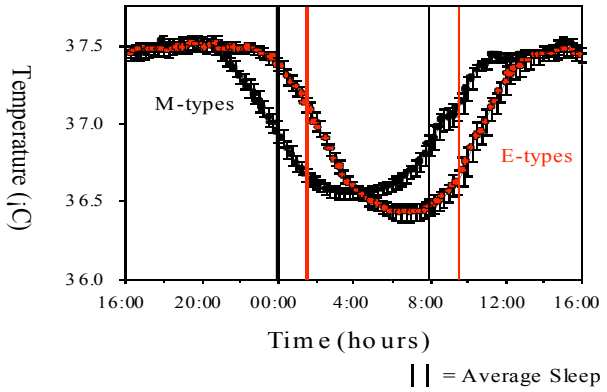
Body Temperature as f(time of day)

(Baehr, Revelle & Eastman, 2000)



Morningness/Eveningness and BT

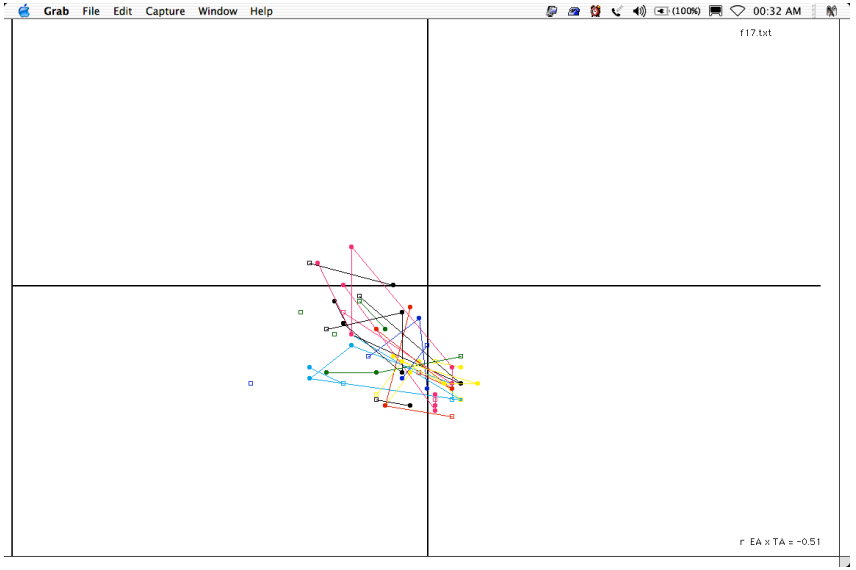
(Baehr, Revelle and Eastman, 2000)



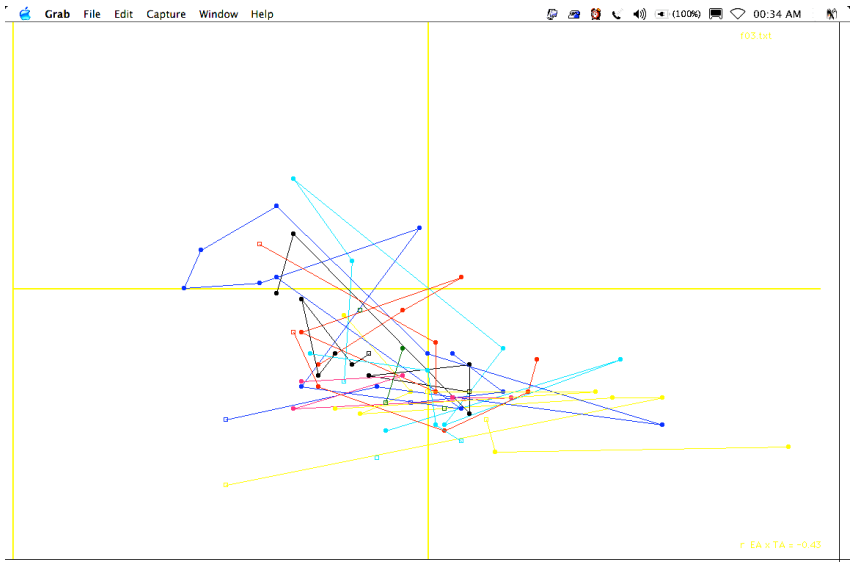
Measuring the dynamics of personality

- How do people differ in their experience of emotion?
- Measurements taken every 3 hours during waking day (palm pilots or diaries)
- We can observe within subject change in positive and negative affect over a day, replicated each day
- Note that while people differ in their pattern, within each person, the pattern is consistent
- (data from Eshkol Rafaeli and from Gregory Rogers)

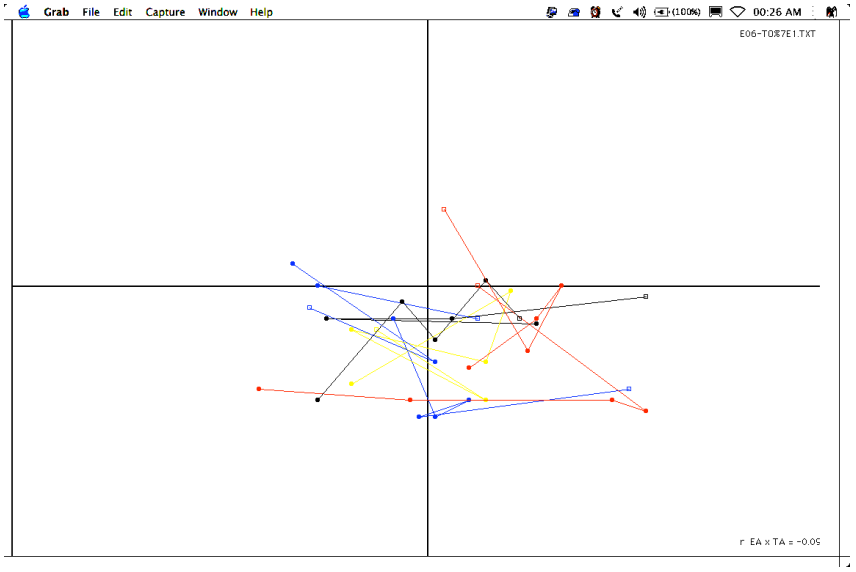
Within subject dynamics (r = -.51)



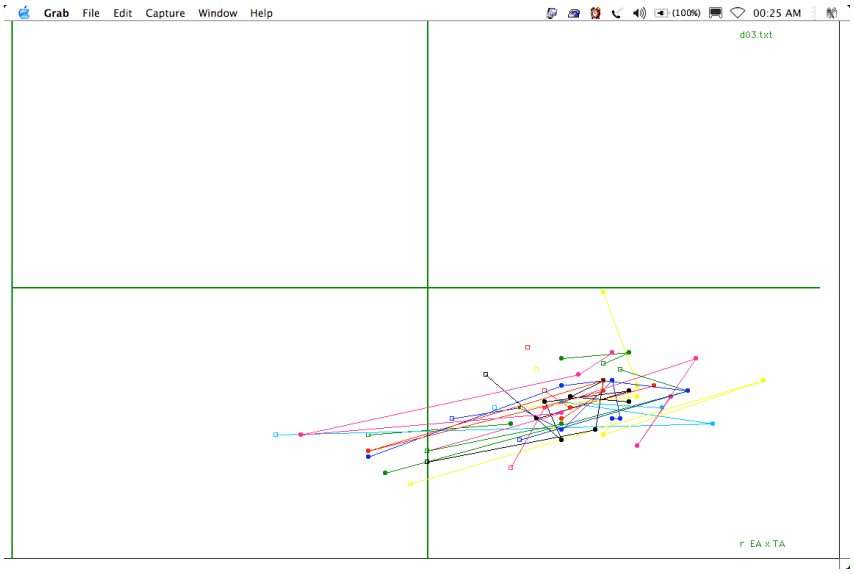
Within subject dynamics (r = -.43)



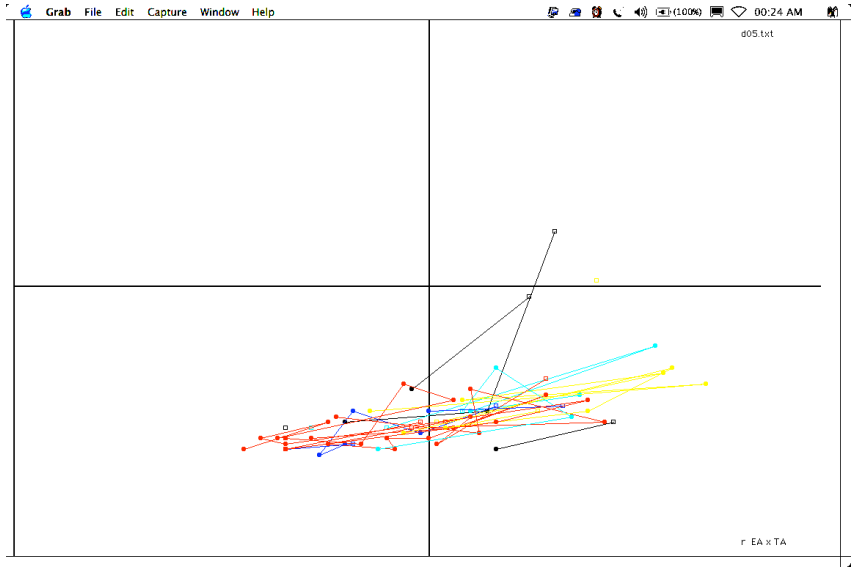
Within subject dynamics (r = -.05)



Within subject dynamics (r = .55)



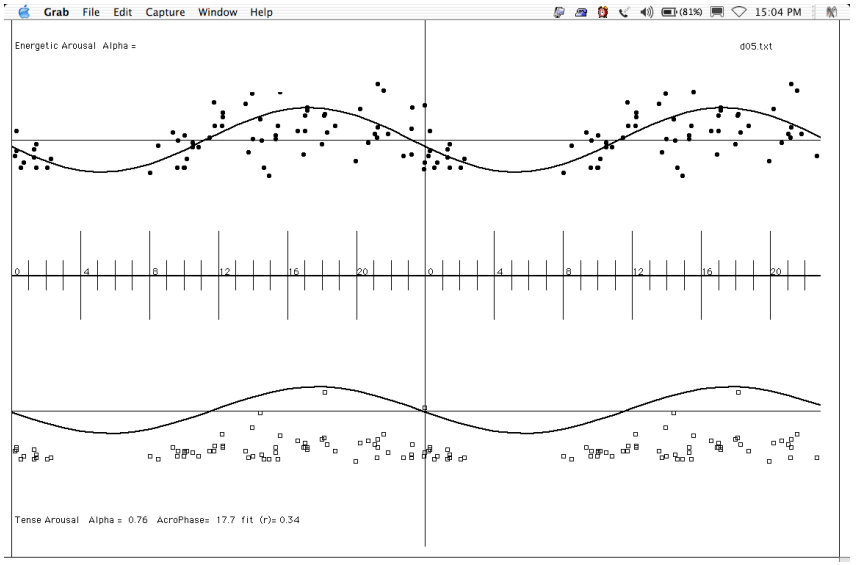
Within subject dynamics (r=.59)



Daily variation in mood: Is it systematic?

- Body temperature shows systematic diurnal effect. What about positive and negative affect (or energetic and tense arousal)?
- Fit cosine curves (period = 24, best fitted phase) to self report measures
- "double plot" to highlight circadian variation
- Circadian fits are much better for Positive Affect/Energetic Arousal than for Negative Affect/Tense Arousal

Fitting affect within subjects



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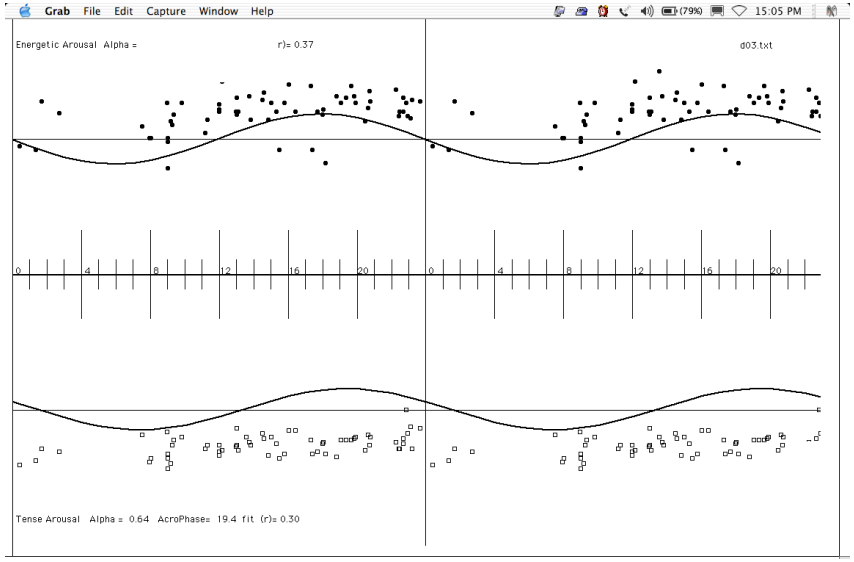

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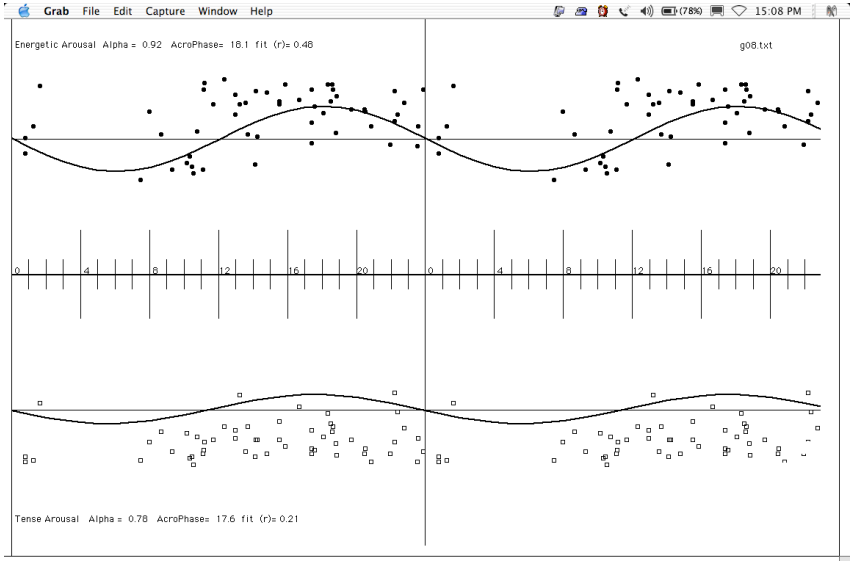

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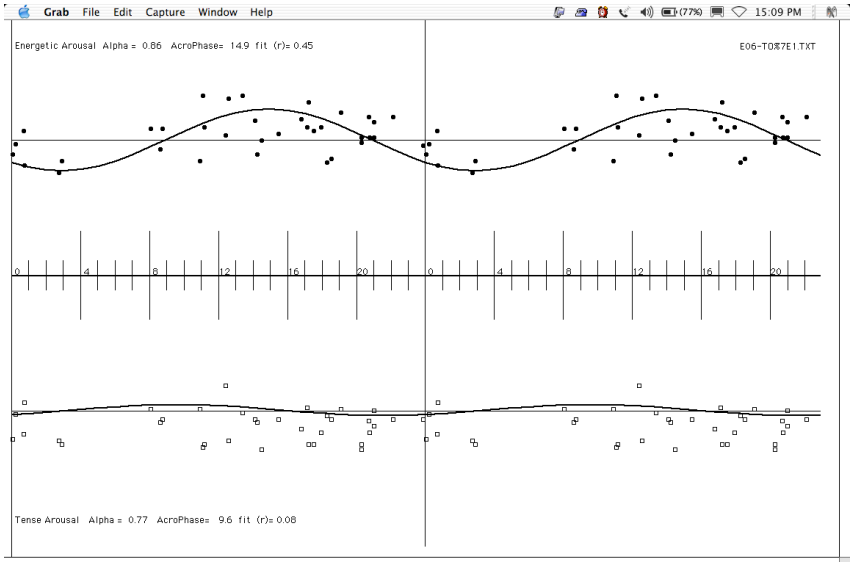

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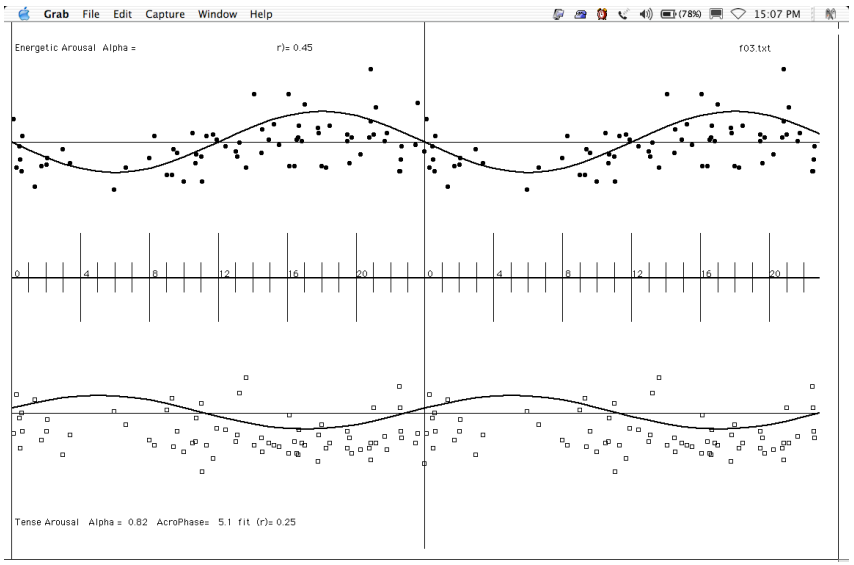

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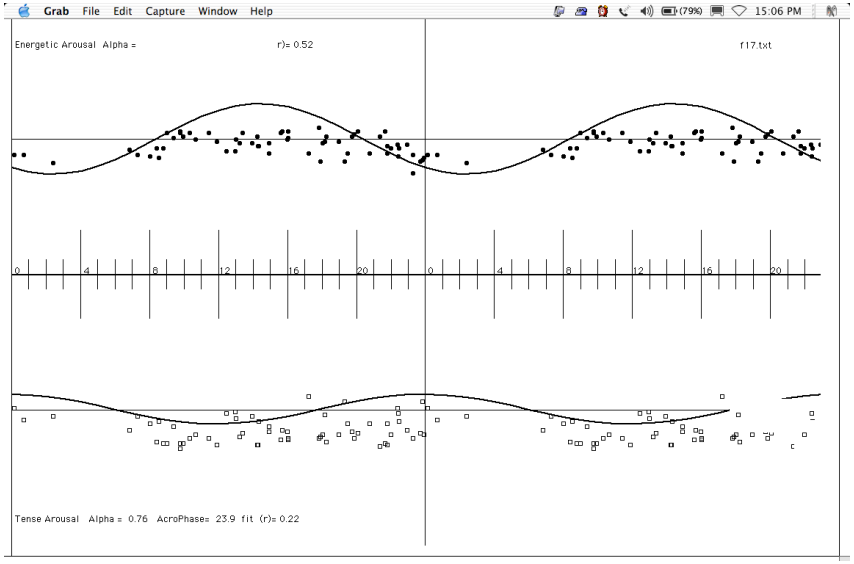
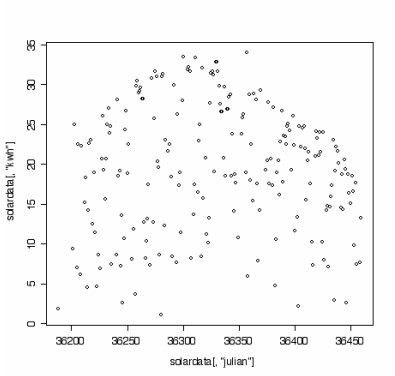


Weather reflects solar input
Solar input varies over time

- Amount of solar energy received at the ground varies from hour to hour and day to day.
- Are there systematic effects that can be detected from observing daily solar energy received?

Solar input over 6 months

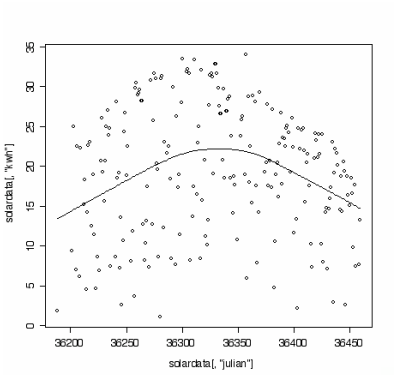


Data=observed PV output of a solar house in Evanston, Illinois

Running averages as smoothes of data

- Smoothing removes daily signal but detects longer term effects
- Smoothed daily solar input shows seasonal effects
- When emotional state is measured daily, smoothed data show more consistency of individual differences than do daily data.
  - (Epstein)

Solar input over 6 months (smoothed)



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Within subject variation

- Weather
- Daily variation in temperature
  - Lagged measure of solar flux
- Daily variation in solar radiation at surface
- Seasonal effects

- Emotion
- Body temperature
  - leading measure of alertness
- Diary studies of emotion
- Situational effects

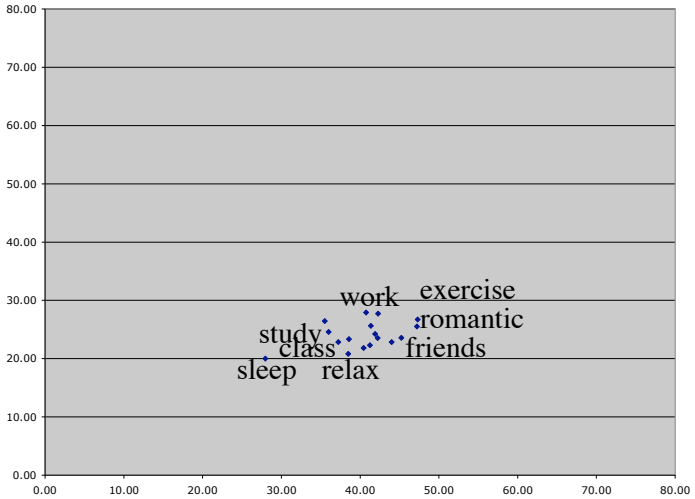
Affect varies by situation

- A small effect of situation on affect, but a much larger individual difference in experience of affect by situation
- Is the affect a function of the situation, or is the situation a function of prior affect?
- Individuals differ in their choice of situation, as well as the affect they experience in the situation

Individual affect depends upon person in the situation

- Situations were defined using Dan Ozer's categorization of typical student activities
- Aggregate the affect ratings by situations to examine the effect of situation on individuals.
- Note the variation between subject in the effect of situations

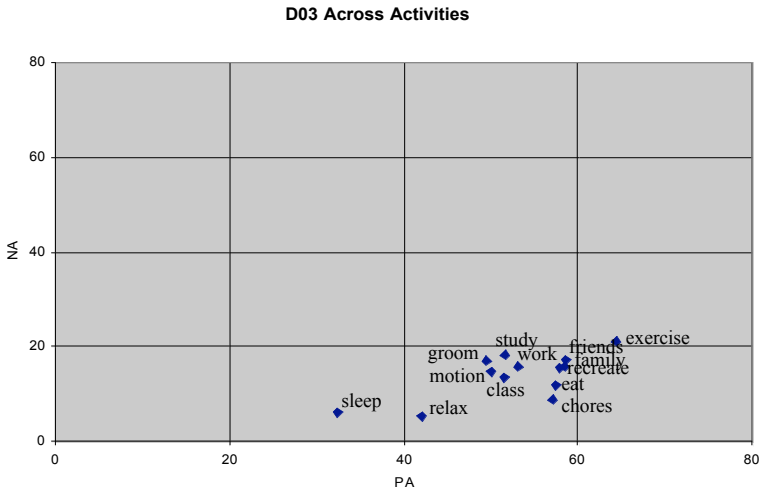
A small effect of situations on positive and negative affect



Individual differences in response to situations (or situational choice)

- Mood measurements taken every 3 hours
- Situations reported at the same time
- Plot situations in the affect space (Positive and Negative Affect)
- Plot each individual pattern across situations in the affect space

r = .695



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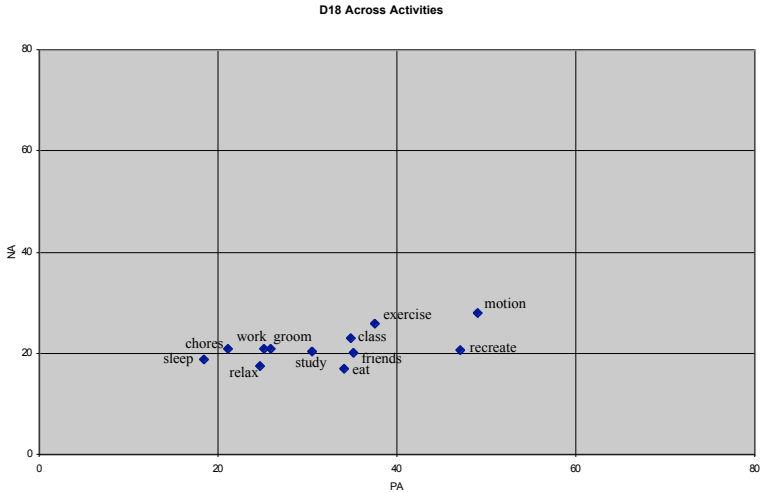

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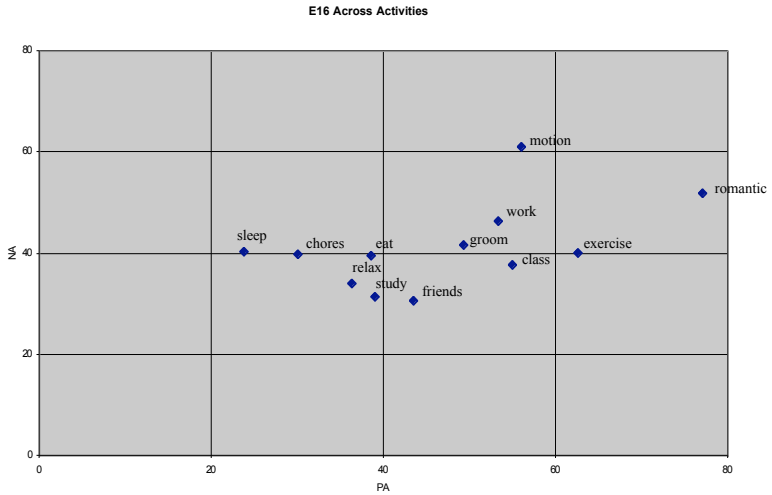

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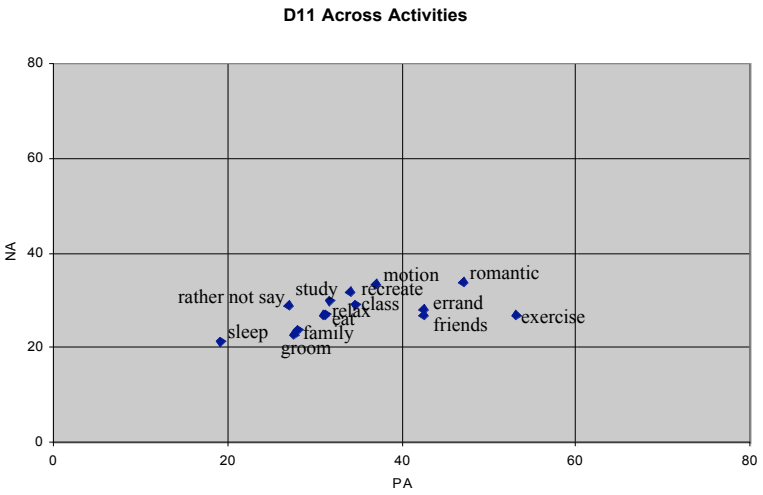

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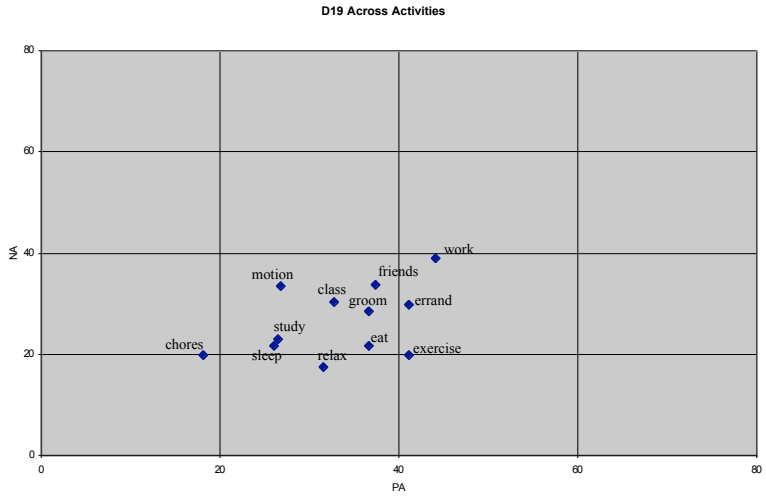
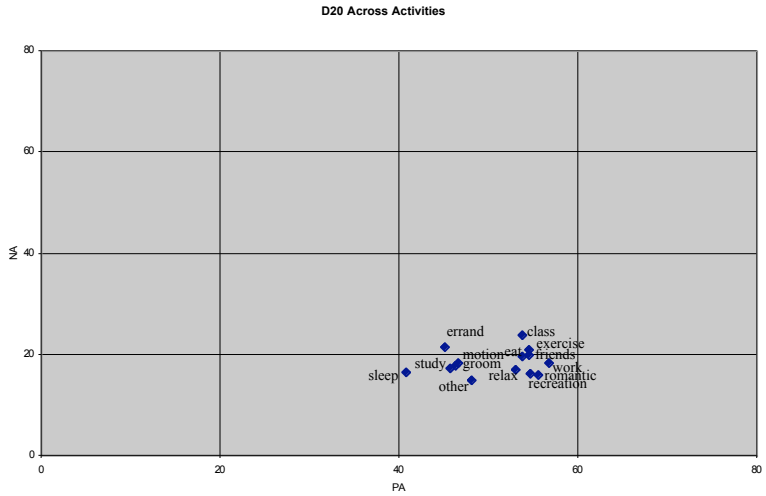
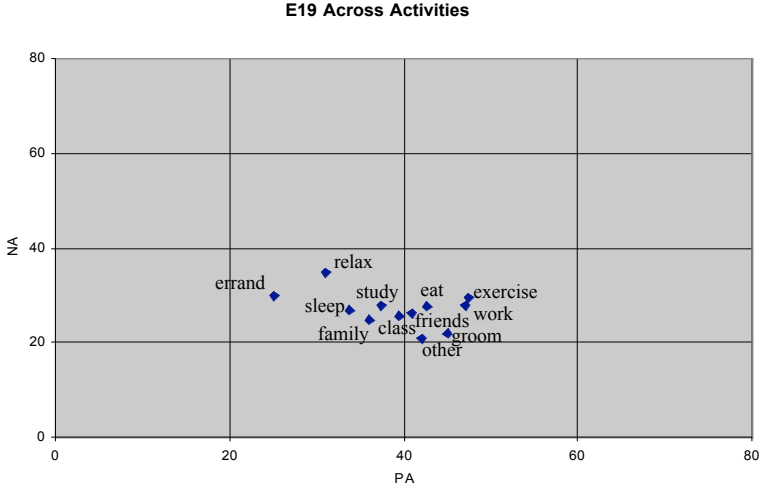


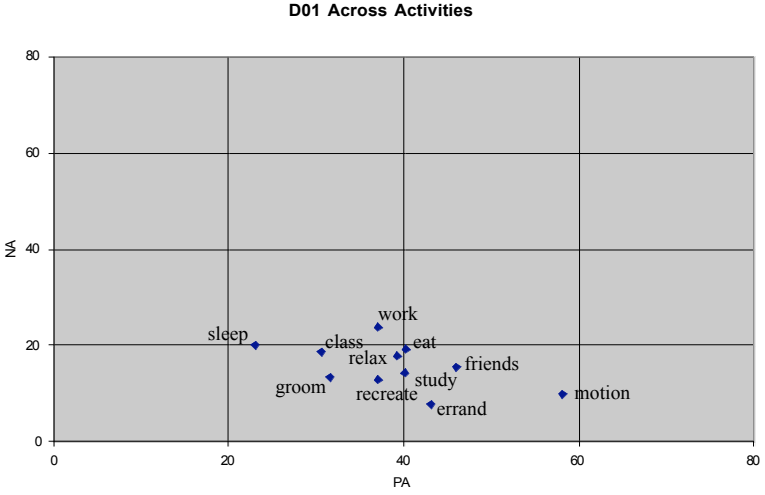
r = .191



r = -.433



r = -.539



Within subject variation

- Weather
- Daily variation in temperature
  - Lagged measure of solar flux
- Daily variation in solar radiation at surface

- Emotion
- Body temperature
  - leading measure of alertness
- Diary studies of emotion

Emotions are to Personality as Weather is to Climate: structural mapping

- Weather
  - Mean and variability
- Weather systems
  - Hours to days
- Climate
  - Average of weather over multiple years
  - Variability of weather across seasons

- Emotions
  - Mean and variability within situations
- Mood
  - 10s of seconds to 1000s of seconds
- Personality
  - Average of emotions across years
  - Variability over time

Correlations of Monthly Averages 250 American cities

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	1.00	0.99	0.96	0.89	0.80	0.68	0.60	0.69	0.84	0.92	0.96	0.99
Feb	0.99	1.00	0.98	0.92	0.84	0.72	0.65	0.74	0.87	0.94	0.96	0.98
Mar	0.96	0.98	1.00	0.98	0.92	0.82	0.76	0.83	0.93	0.97	0.98	0.97
Apr	0.89	0.92	0.98	1.00	0.98	0.92	0.86	0.91	0.97	0.98	0.95	0.92
May	0.80	0.84	0.92	0.98	1.00	0.98	0.93	0.96	0.98	0.95	0.89	0.84
Jun	0.68	0.72	0.82	0.92	0.98	1.00	0.98	0.98	0.96	0.88	0.80	0.72
Jul	0.60	0.65	0.76	0.86	0.93	0.98	1.00	0.99	0.92	0.83	0.73	0.64
Aug	0.69	0.74	0.83	0.91	0.96	0.98	0.99	1.00	0.96	0.89	0.81	0.73
Sep	0.84	0.87	0.93	0.97	0.98	0.96	0.92	0.96	1.00	0.97	0.93	0.87
Oct	0.92	0.94	0.97	0.98	0.95	0.88	0.83	0.89	0.97	1.00	0.98	0.95
Nov	0.96	0.96	0.98	0.95	0.89	0.80	0.73	0.81	0.93	0.98	1.00	0.98
Dec	0.99	0.98	0.97	0.92	0.84	0.72	0.64	0.73	0.87	0.95	0.98	1.00

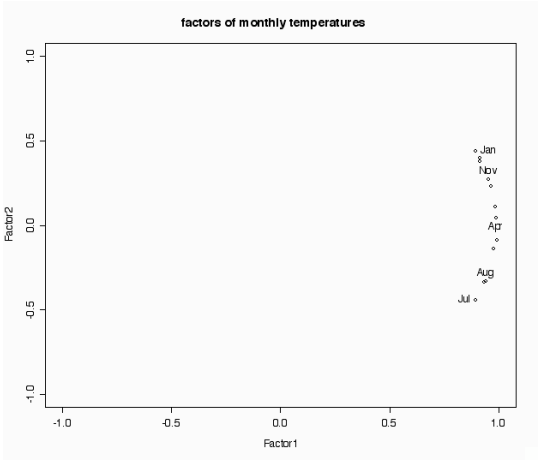
Factors of monthly temperatures

- Scree test (1 or 2)

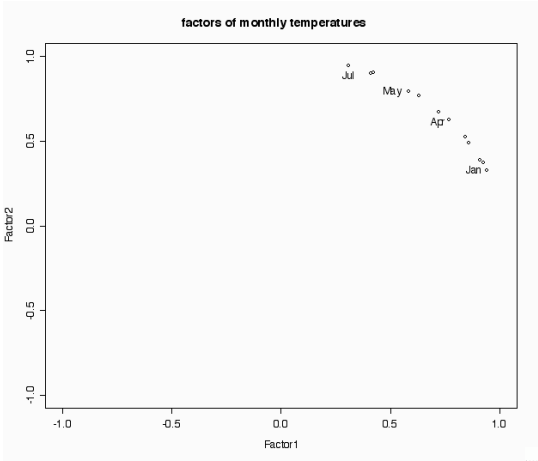
	Factor1	Factor2	Factor3	Factor4
SS loadings	10.783	1.070	0.048	0.043
Proportion Var	0.899	0.089	0.004	0.004
Cumulative Var	0.899	0.988	0.992	0.995

- Chi square > 4
- Theory and interpretability = 2
  - Mean and variability of temperature
  - Circumplex structure ?

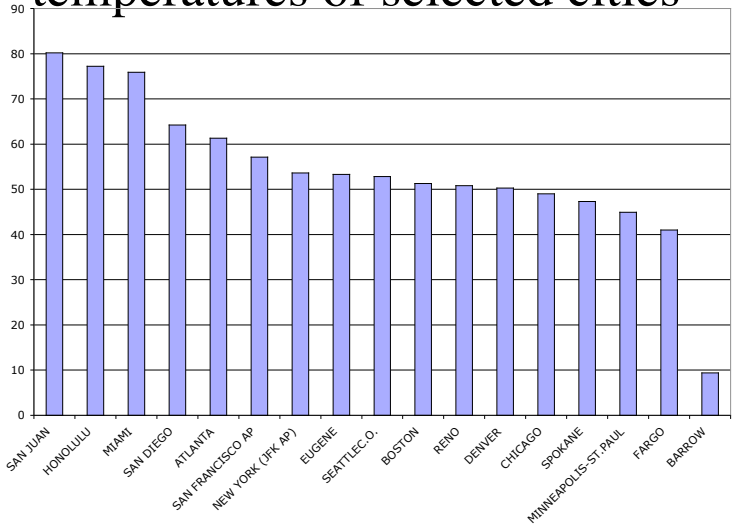
Unrotated factors of average monthly temperature



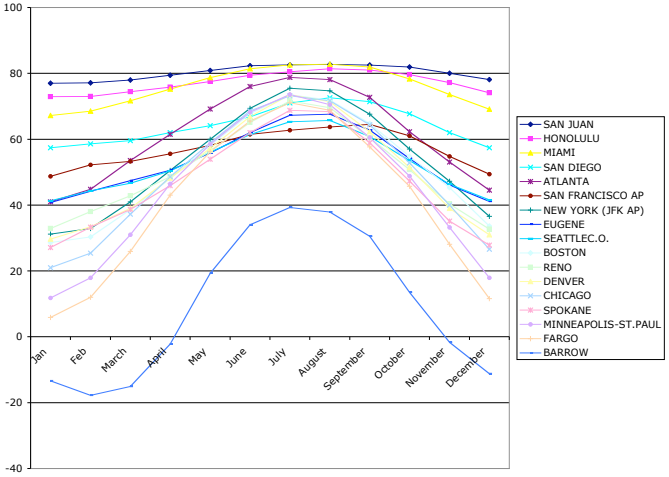
Rotated dimensions of average monthly temperature



Individual differences in Mean temperatures of selected cities



Individual (city) differences in seasonal variation of temperature



Climate: the Big 2

- Cities differ in
  - Average temperature
  - Variation in average temperature
- Causal theories of the big 2?
  - Latitude (average solar flux)
  - Heat capacity (proximity to large body of water)

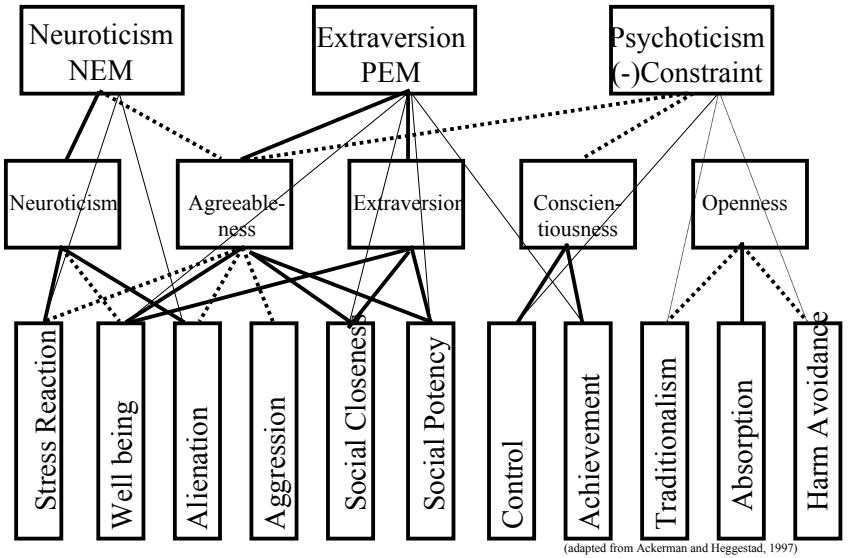
Personality: the Giant 2

- People can be described in terms of
  - Extraversion
  - Neuroticism
- Causal theories of the Giant 2
  - Extraversion as a sensitivity to cues for reward, sensitivity to reward, strong behavioral activation system, and results in typically Positive Emotion
  - Neuroticism as a sensitivity to cues for punishment, sensitivity to punishment, strong behavioral inhibition system, and results in typically Negative Emotion

Personality and Climate mean and variability

- Personality
  - Affect
    - Average positive and negative affect
    - Variability in affect
    - Daily
    - Over the year
  - Behavior
    - Approach
    - Inhibition
  - Cognition
  - Desires (goals)
- Climate
  - Temperature
    - Daily range
    - Yearly range
  - Humidity
  - Air quality

The Giant 3, Big 5, Small 11



(adapted from Ackerman and Heggestad, 1997)

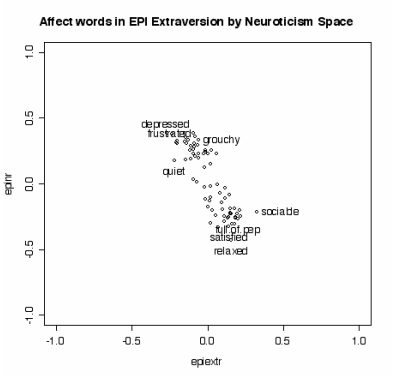
Poor fit between inventories?

	epiE	epiS	epiImp	epilie	epiNeur	bfagree	bfcon	bfext	bfneur	bfopen
epiE	1	0.85	0.8	-0.22	-0.18	0.18	-0.11	0.54	-0.09	0.14
epiS	0.85	1	0.43	-0.05	-0.22	0.2	0.05	0.58	-0.07	0.15
epiImp	0.8	0.43	1	-0.24	-0.07	0.08	-0.24	0.35	-0.09	0.07
epilie	-0.22	-0.05	-0.24	1	-0.25	0.17	0.23	-0.04	-0.22	-0.03
epiNeur	-0.18	-0.22	-0.07	-0.25	1	-0.08	-0.13	-0.17	0.63	0.09
bfagree	0.18	0.2	0.08	0.17	-0.08	1	0.45	0.48	-0.04	0.39
bfcon	-0.11	0.05	-0.24	0.23	-0.13	0.45	1	0.27	0.04	0.31
bfext	**0.54**	0.58	0.35	-0.04	-0.17	0.48	0.27	1	0.04	0.46
bfneur	-0.09	-0.07	-0.09	-0.22	**0.63**	-0.04	0.04	0.04	1	0.29
bfopen	0.14	0.15	0.07	-0.03	0.09	0.39	0.31	0.46	0.29	1

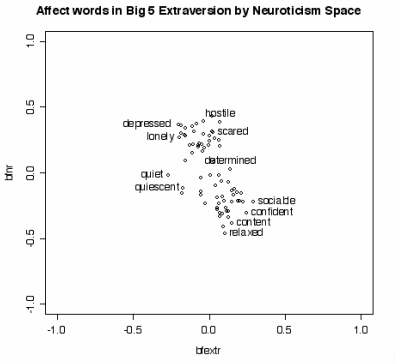
Relating Personality to Emotion

- Conventional interpretation
  - Extraversion = ∑ positive affect = Positive Emotionality
  - Neuroticism = ∑ negative affect = Negative Emotionality
- But, are all measures of E and N the same?
  - EPI, EPQ
  - NEO
  - BFI
  - IPIP

Affect in EPI space



Affect in Big Five space



Personality is more than ∑(affect)

Just as temperature is an inadequate measure of weather, and average temperature an inadequate measure of climate, so is average affect an incomplete measure of personality

Personality is the integrated pattern of Affect, Behavior, Cognition, and Desires.

Personality and ABCs

- Personality as the integrated pattern of Affect, Behavior, Cognition, and Goals
- Integration across all domains of functioning and levels of processing
- Ortony, Norman, and Revelle (in press)

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