CONNECTING MENTAL STATES AND BODILY EVENTS:
Measuring autonomic nervous system activity

Anu Karvonen

NIRE seminar 11.6.2015, Oxford
Themes

1. Why study the body? What ANS?
2. Relational Mind project
3. Electrodermal activity (EDA)
4. Heart rate variability (HRV)
5. Other methods in our study
6. Ideas for education
Why include the body?

- Basic assumption in psychophysiology: behavioral, cognitive, emotional and social happenings are visible in physiological processes
- Bi-directionality between our bodily feelings and cognitive thoughts
Autonomic nervous system (ANS)

- Also called the involuntary nervous system, because it functions largely below the level of consciousness.
- Maintains internal homeostasis
  - The sympathetic nervous system (SNS) prepares the organism to take action in states of emergency ("fight-or-flight")
  - The parasympathetic nervous system (PNS) is connected to relaxation and recovery ("rest-and-digest")
Relational Mind project

- Funded by the Academy of Finland (2013-2016), belongs to the Human Mind research programme
- Coordinated in Finland, University of Jyväskylä
  - PI Prof. Jaakko Seikkula, Virpi-Liisa Kykyri, Anu Karvonen, other researchers...
- European partners in Germany, Greece, Czech Republic, Spain and Great Britain


11.6.2015 Anu Karvonen
Relational Mind project

- The mind is **embodied** and takes place in **relationships**
- We use couple therapy as a "natural laboratory" to study attunement of clients and therapists in:
  - Dialogue (social aspects)
  - Inner dialogue (psychological aspects)
  - ANS activity and body movement (embodiment)
Design

- Faces (4 cameras)
- Whole setting, split screen (2 cameras)

Session 1

SESSION 2

Session 3, 4, 5

SESSION 6

Session 7, 8...

ANS measuring

Stimulated Recall Interviews

"What thoughts, feelings or bodily sensations did you have at that time of the session?"
ANS measures in the session

Electrodermal activity

Respiration

Heart rate monitor

Finger pulse volume

+ in the SR interviews also:

Neck microphone

11.6.2015 Anu Karvonen
Electrodermal activity (EDA) / skin conductance (SC)

- Measure of the electrical conductance of the skin, which varies depending on the amount of sweat-induced moisture on the skin.
- Sweat is controlled by the **sympathetic nervous system**, so skin conductance is used as an indication of psychological or physiological **arousal**.
- Almost all **emotions** produce increases in EDA (Kreibig, 2010)
  - Exceptions e.g. relief…
- EDA synchrony has been connected to (primitive) **empathy** (Marci & Orr, 2006; Marci et al. 2007; Messina et al. 2013) and **emotional reactivity** (Slovák et al. 2014).
- Tonic and phasic changes. Responses start about 1-2 seconds after a stimulus, reaching a peak at about 4 seconds. Return to 50% of baseline in 1-15 seconds, most often in 4-8 seconds.
T2: what would you answer to her (Lasse’s late grandmother) if she was here talking to you?
Lasse: (wiping tears - 6 seconds of silence)
probably not anything else than hug her
T2: mh … mh (nodding) … yes …
T2: yes
T1: Heli what is going on in your mind while you’ve been listening to what Lasse is saying .. his words?
Heli: yea … hard to say .. you do kind of wish that somehow … somehow that .. well I can’t say, I was thinking that ..
Lasse is after all like a grown up man and a father … even though his, his his .. kind of what which fam-, what family is it then .. childhood family or that so - - -
EDA concordance index
Modified from: Marci & Orr, 2006; Marci et al. 2007; Messina et al. 2013

Karvonen et al. Sympathetic nervous system synchrony during couple therapy
(submitted)

Respective color narrow lines represent chance level concordances
(Monte Carlo shuffling to other signal)
Pros of SC measuring

- Easy to use and implement to different research designs
- Equipment is cheap
- The most popular method for investigating human psychophysiological phenomena
  - Has been used for over a 100 years, and still on the increase in clinical applications
- Quite straightforward to interpret*
  - When SC rises, the person is more alert. When it decreases, the person is less alert.

*but....
What to consider in SC measuring

- SC is dependent on, and reacts to, many factors
  - Age and sex of the participant
  - Room temperature and humidity
  - Circadian rhythm and time of day
  - Medication, caffeine, nicotine, prior physical exercise...

- People have an individual SC level, which has to be taken into account if one does *between subjects* SCL comparisons rather than *within subjects* comparisons

- Does not tell the specific emotion: both happy excitement as well as anxiety can increase EDA

- While studying emotions we usually don’t wish for startled or orienting responses
  - Difficult to sometimes interpret e.g. whether "X" causes the reaction or the "newness of X"

- Participants have to stay quite still

11.6.2015 Anu Karvonen
Heart rate and its variability

- Heart is innervated by both sympathetic (accelerans nerve) and parasympathetic (vagus nerve) branches
  - In rest mostly vagal influence
- Heart rate variability (HRV) describes variation in the time interval between heartbeats
  - High HRV connected to good e.g. good physical fitness, relaxation and recovery
  - Lowered HRV in e.g. stress, anxiety and exertion (increases mortality risk also in healthy people)
  - The body does not really differentiate between physical stress and psychological stress!
- The most widely used methods are time-domain and frequency-domain methods. In the future non-linear methods?
Client’s highest stress peak during a therapy session
(1 client, 1 therapist and 1 psychology student)

The client did not later remember what was discussed during the highest stress peak!

Stimulated Recall Interview:
I: what do you think .. how similar was the feeling now (while watching the clip) compared to there during the session?
C: easier
I: this was easier?
C: yes .. from that (points to screen while shaking her head) I remember nothing .. but now that I see it .. I remember I was crying but I don’t remember what happened there
I: yes
C: yes
I: yea .. but there was something that felt easier now?
C: yes .. much easier (shaking her head) - - - I didn’t remember this situation, I just remembered that I was crying and someone gave me the tissue - - -
Pros of HRV measuring

- A very popular measure, has been extensively studied in numerous fields
  - Sport sciences, medicine and cardiology, occupational health, psychological phenomena, relaxation techniques...

- Especially useful when studying stress, emotional strain, anxiety, quality and the amount of recovery, resilience to outside demands etc...

- A sensitive measure: changes in stress can be seen even when other physiological variables (e.g. blood pressure) are stable

- Wireless devices are cheap, unobtrusive and the participants can move freely
What to consider in HRV measuring

- How to synchronize data to e.g. video with popular wireless devices
  - Monitor’s own clock can differ seconds or even minutes
- How accurately you want to connect HRV to phenomena
  - For HRV calculation you need at least a 30 second period; most often 1 minute or 5 minutes is used
  - Frequencies like HF can be calculated for every second
- When comparing *between subjects*, one has to take into account e.g. age, physical fitness level, medication etc…
- Lowered HRV may be a result of either decreased parasympathetic activation or increased sympathetic activation
Other methods we use

- FaceReader program, which detects basic emotions automatically from a video recording
  - Over 10,000 manually annotated images used for training the software, modeling of the face using 500 key points
  - Emotions: Happy, sad, angry, surprised, scared, disgusted, contempt and neutral
Other methods we use

Joystick method
Main value of ANS measuring
(in my opinion)

- It makes visible those reactions and experiences, which are **not talked about** and/or which **cannot be observed** from behavior or facial expressions
  - Participants can either be unaware of them or hide them on purpose
Ideas for education

- Cognitive side has been dominant in educational research (rationality, goal setting…) – how is the emotional experience connected to the educational experience?
- Connecting ANS information to e.g. learning disabilities, achievement emotions and academic emotions, motivation, temperament, performance in school……
  - Comparing the subjective feeling of doing tasks to ”objective” ANS data: are feelings similar or different?
- Monitoring well-being of students and teachers by using heart rate measuring devices (stress, recovery)
- Stimulated Recall Interview has been used with teachers (interactive decision-making), but it could also be useful with students
  - New information about decision-making, thoughts and feelings during tasks
  - Learning disabilities may be connected to reflective abilities?
  - ”Outside observer” perspective often brings new realizations and enhances reflection
Ideas for education

- Training teachers to better observe students’ arousal levels and increase/decrease arousal in the class to enhance learning?

![Diagram showing optimal arousal range for learning](https://notesoncrazy.com)

- Peak learning level for high arousal bias
- Peak learning level for low arousal bias

---

11.6.2015 Anu Karvonen
STAIRWAY research project in University of Jyväskylä

- Study of individual- and environment-related factors that promote learning, school well-being and successful transition from primary school to lower secondary school.

- Longitudinal data collected 2014-2016 (n = 800). A subsample of students (n ~ 180) participates in an experiment, which provides real-time information on emotional and motivational processes. -> ANS measuring


11.6.2015 Anu Karvonen
Thank you!

anu.karvonen@jyu.fi
