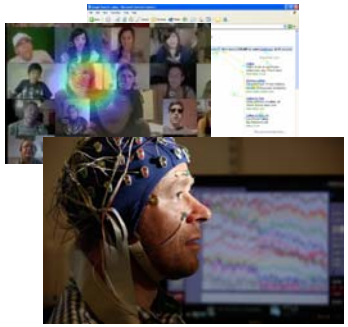
case studies in design informatics

Lecture 12: Biophysical Measurement



design informatics

NRlabs neuropolitics research

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Some background

- Zeng, Z. H., Pantic, M., Roisman, G. I., & Huang, T. S. (2009). A survey of affect recognition methods: audio, visual, and spontaneous expressions. [Review]. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 31(1), 39-58. doi: 10.1109/tpami.2008.52.*
- Vinciarelli, A., Pantic, M., & Bourlard, H. (2009). Social signal processing: Survey of an emerging domain. [Review]. *Image and Vision Computing, 27(12), 1743-1759. doi: 10.1016/j.imavis.2008.11.007.*
- Gatica-Perez, Daniel (2009). Automatic nonverbal analysis of social interaction in small groups: A review. *Image and Vision Computing, 27(12), 1775-1787. doi: http://dx.doi.org/10.1016/j.imavis.2009.01.004.*

Affect monitoring (Zeng et al. 2009)

- Ubiquitous computing needs to move beyond current HCI designs:
  - keyboard + mouse
  - transmission of explicit messages
- Currently "ignoring implicit information about the user, such as changes in the affective state.
- Yet, a change in the user's affective state is a fundamental component of human-human communication.
- Some affective states motivate human actions, and others enrich the meaning of human communication."
- A system should be able to:
  - detect subtle changes in user (affective) behaviour
  - initiate interactions based on this (rather than waiting for commands)

Applications (Zeng et al. 2009)

- Customer services
- Call centers
  - make an appropriate response or pass control over to human operators
- Intelligent automobile systems
  - monitor the vigilance of the driver and apply an appropriate action to avoid accidents
- Game and entertainment industries.
- Affect-related research
  - improve the quality of the research by improving the reliability of measurements and speeding up the currently tedious manual task of processing data
- Personal wellness and assistive technologies
  - automated detectors of affective states and moods, including fatigue, depression, and anxiety

Databases of spontaneous affect
(Zeng et al. 2009)

- Human-human conversation
  - Interviews; phone conversations; meetings
- HCI
  - Wizard of Oz; dialogue systems
- Video kiosk
  - Affective video reactions

Universal (visible) emotions

Paul Ekman (1960s, early 70s)
Facial Action Coding System (FACS)

1. Happiness
2. Surprise
3. Anger
4. Sadness
5. Fear
6. Disgust
7. [Contempt] – added in the 1990s; not uncontroversial.

aps
ASSOCIATION FOR PSYCHOLOGICAL SCIENCE

What Scientists Who Study Emotion Agree About

Paul Ekman
University of California, San Francisco and Paul Ekman Group, LLC

Perspectives on Psychological Science
2016, Vol. 11(1) 31–34
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Emotions and Decisions: Beyond Conceptual Vagueness and the Rationality Muddle

Perspectives on Psychological Science
2016, Vol. 11(1) 101–116
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Kirsten G. Volz[1] and Ralph Hertwig[2]

Opens: For centuries, decision scholars paid little attention to emotions: Decisions were modelled in normative and descriptive frameworks with little regard for affective processes. Recently, however, an "emotions revolution" has taken place, particularly in the neuroscientific study of decision making, putting emotional processes on an equal footing with cognitive ones.

Maintain good practice


Impact of research

Why people fall for pseudoscience (and how academics can fight back)

Sian Townson

Ingrained cognitive biases play a role, as does inverted snobbery about educational privilege. But we must battle on, says this scientist

Contact author

Tuesday 26 January 2016 07:00 GMT

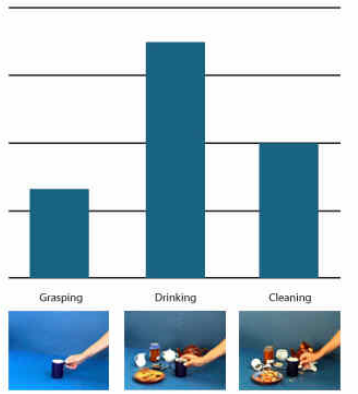
Shares 13,445 Comments 688

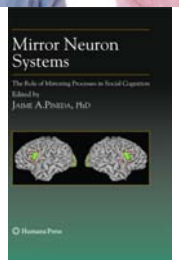
Save for later

Scientists have a duty to call out dubious research, says Sian Townson. Photograph: Alamy

Neurostuff = mind control or mind reading!!!

Mirror neurons





Hardwired empathy

- Observing the same action in different contexts elicits different levels of mirror neuron activity.
  - Suggests that the mirror neuron system does more than code the observed action ("that's a grasp"). It also codes the intention behind the action ("that's a grasp to drink" or "that's a grasp to clear the table"). [UCLA School of Medicine.]
- Instrumental for interpreting the facial expressions and actions of others.

Physiognomy

- System for identifying personality types (incl. criminals) from facial characteristics.
- Aristotle: "noses with thick, bulbous ends belong to persons who are insensitive, swinish".
- Too extreme! Debunked by science.

Illustration from a 19th-century book on physiognomy. [Encyclopaedia Britannica]

Automatic facial expression analysis software

Can automatically detect:

- Valence (positive, negative or neutral responses).
- Emotions (joy, anger, surprise, fear, sadness, disgust, contempt, frustration and confusion).
- Facial landmarks (e.g. corners of mouth)
- Various set actions/behaviours.
- Head pose.

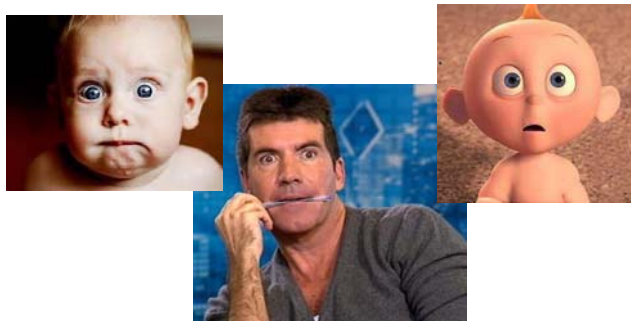
Goldberg, Joseph H. (2012). Relating perceived web page complexity to emotional valence and eye movement metrics. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 56(1), 501-505.

Universal emotions (Ekman)

Tim Roth in "Lie to Me"

Interocular Trauma Test (IoTT)

Some things just hit you between the eyes when you see them.



Some reactions obvious

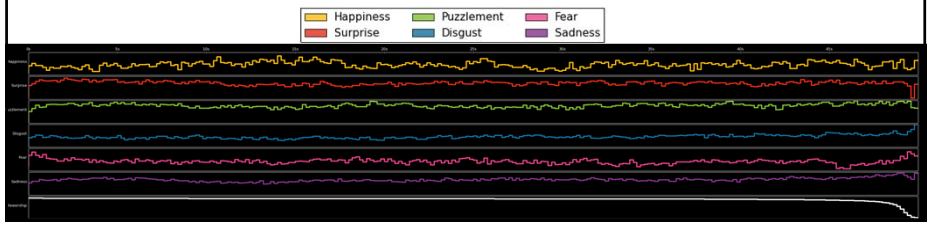
Microexpressions

- Brief, involuntary facial expressions:
  - Difficult to conceal or fake.
  - Can last as little as 0.04 seconds (video typically runs at 23 or 25 fps).
  - Computer vision techniques can give precise measurements.

Neuropolitics experiment

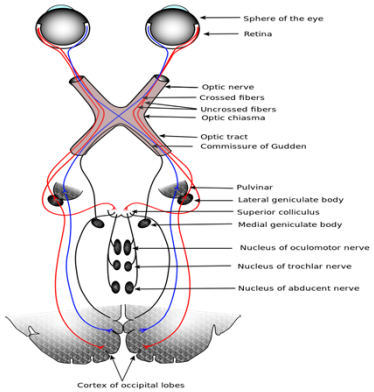
- 1200+ online participants
- 140 laboratory-based participants
- Questionnaire data:
  Demographics; political bias; moral foundations; personality traits
- Facial coding of affective response to 10 video clips
  - Debates, interviews, documentaries, infographics

Some example output



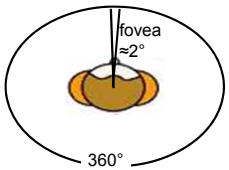
Human visual system

Brain hungry
&
complex



Human vision is very focused

We only see a small portion of the world in detail at any one moment!



Implication

1. Large proportion of the brain dedicated to visual processing.

\+ 2. Limited momentary input.

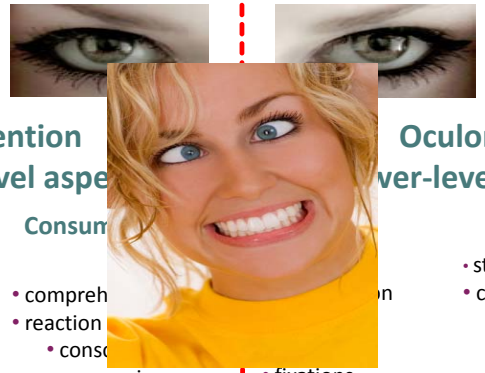
= 3. Where you are looking ***now*** is very important and highly informative.

Eye movements

- Eyes have the most active muscles in the body
- Movements even when asleep (REM sleep)
- Fixations (stable, typically about 3 or 4 per second)
- Saccades (ballistic jumps – visual suppression)
- Smooth pursuit (tracking moving objects)
- Pupillometry (pupil dilation as an indication of emotional arousal and cognitive load – not just a reaction to light)

Cognitive processing

- Eye-movement data are a good moment-to-moment indicator of visual-cognitive processing.
- Strong Eye-Mind Hypothesis. (Just & Carpenter, 1980)
- *Where?* (spatial)
  - Eye movements as indicators of overt visual attention: **where** we currently **look at** (e.g., word in a sentence, object in a scene) is **where** we currently **attend to.**
- *When?* (temporal)
  - Fixation durations: increased processing difficulties show in longer fixation times.



Intention
(higher-level aspe

Production

- planning
- input device

Consum

- compreh
- reaction
  - cons
  - unconscious
- anticipation
- social cue
- pupil dilation

Oculomotor
ver-level aspects?)

- fixations
  - location
  - duration
- smooth pursuit
- mono/binocular

Stimuli

- static / dynamic
- contingent change

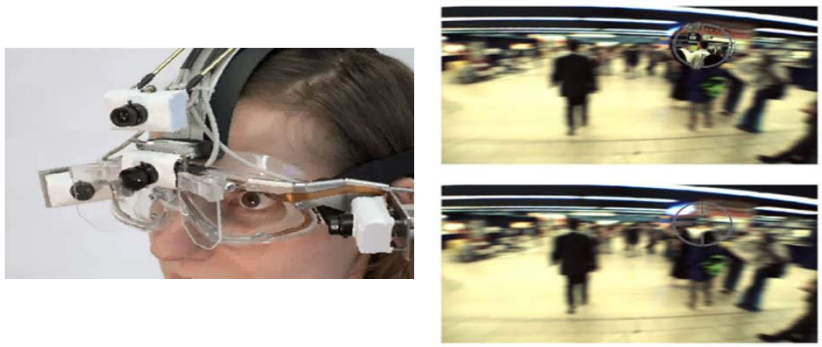
Eye-tracking equipment

Eye point-of-view

Top: gaze camera

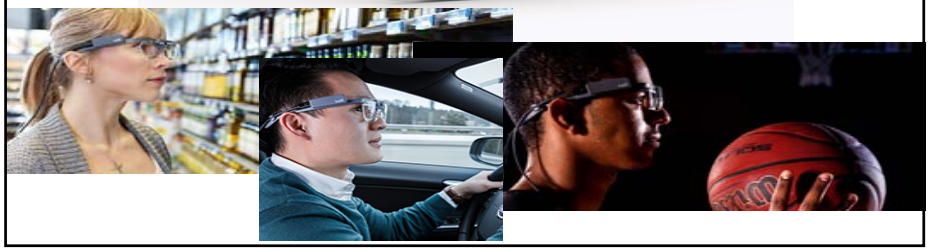
Bottom: head camera

Eye Tracking in the Real World



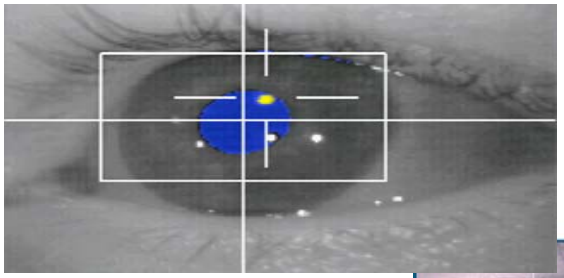
"EyeSeeCam" (LMU Munich; Schneider *et al.*, 2009)

New mobile tech

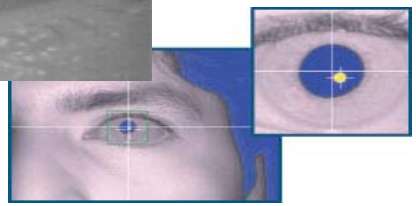


EyeLink (made by SR Research)

Infra-red video monitoring



Pupil tracking
+
Corneal reflection



Consumer and industry: all hype?

Gaming market

Gaming market

Realistic gaming functions: Armed with new knowledge about your presence, eye movement and corresponding head movement, Tobii eye-tracking enhanced games, including Tom Clancy's The Division, Watchdogs II and Deus Ex: Mankind Divided, allow you to input commands that are more in-tune to real life. Aim at where you look, signal teammates with a glance and navigate a cockpit freely.

System intelligence: Armed with more information about you, including your attention and position in front of the notebook, your machine can now optimize power usage and even trigger more advanced security profiles. A groundbreaking new feature exclusive to Alienware machines.

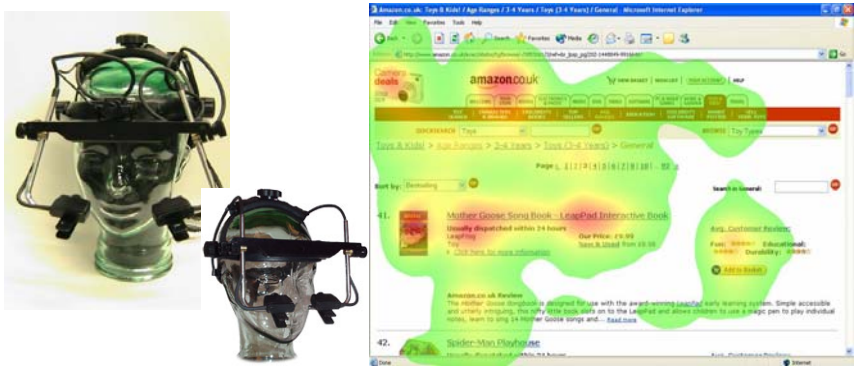
Game coaching: With new exclusive Overwolf apps, replay your gaze pattern and see where you went wrong. Learn from your mistakes, find new opportunities and crush the competition.

Windows Hello: A revolutionary HD resolution camera with an IR sensor and facial recognition technology allows you to log in with just a look.

[http://www.dell.com/en-us/shop/productdetails/alienware-17-laptop/]

Integrated laptop

Eye-tracking



Viewing behaviour:
Individual differences & group consensus

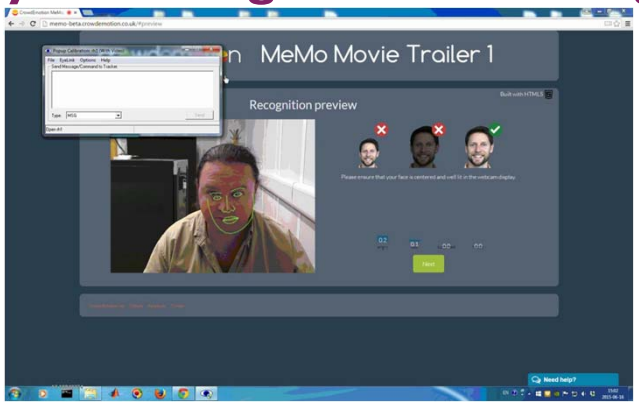
Implicit knowledge (PigGate)

Pupillometry

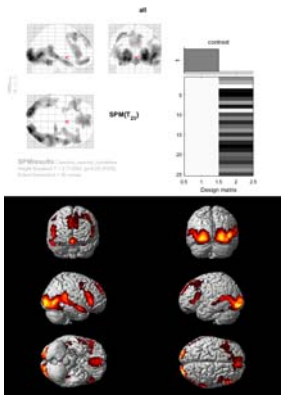
- Changes in pupil dilation due to psychological processes.
- Dilation is not just a reflex to light.
- Reaction to arousal or emotions (positive or negative).
- Evidence of task demand (cognitive load).

Partala, T., & Surakka, V. (2003). Pupil size variation as an indication of affective processing. *International Journal of Human-Computer Studies*, 59(1-2), 185-198.
Granholm, Eric, & Steinhauer, Stuart R. (2004). Pupillometric measures of cognitive and emotional processes. *International Journal of Psychophysiology*, 52(1), 1-6.
Scheepers, Christoph, Mohr, Sibylle, Fischer, Martin H., & Roberts, Andrew M. (2013). Listening to limericks: A pupillometry investigation of perceivers' expectancy. *PLoS ONE*, 8(9), e74986.

Eye Tracking + Facial Coding

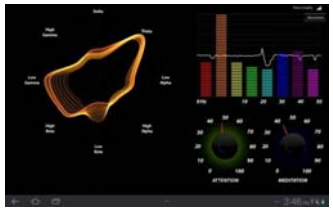


Brain imaging



- Difficult to conduct under normal conditions:
  - fMRI – major hospital facilities;
  - EEG – becoming more portable (lab-based still much more accurate).

Gaming / personal development

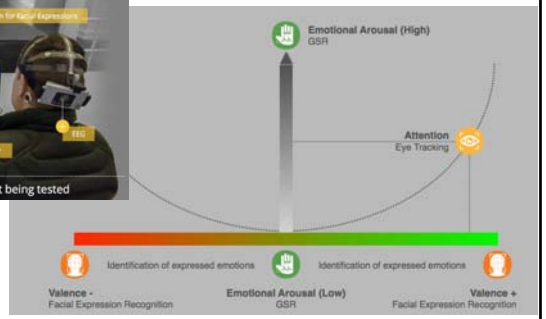


Biometric pros & cons

Measures	Reveals	Pros	Cons
Galvanic Skin Response (GSR or EDA)			
Conductivity of skin (sweat glands)	• Level of physiological arousal (indicator of emotional intensity)	• Easy setup • Inexpensive • easily understood	• Response lags stimulus • Sensitive to fitment, motion • Requires baseline • Data processing
Electroencephalography (EEG)			
Electrical brain activity at the scalp	• Mental effort, processing • Engagement, excitement	• Good temporal resolution • Relates to cognition, workload • Access wide array of emotions	• Sensitive to fitment, motion • Data filtration, metric extraction • Requires expertise, training
Pupil Dilation			
Change in pupil diameter	• Level of physiological arousal • Cognitive load	• Non-contact, stealthy • Built into Tobii Pro eye trackers (sync'd data)	• Must control brightness of room, test stimuli • Requires baseline
Facial Electromyography (fEMG)			
Facial muscle activity	• Emotional valence • Emotional intensity	• Sensitive to subtle signals • Strong research basis	• Sensitive to electrode placement • Facial hair may interfere • Requires data filtration, processing
Heart Rate (HRV, ECG, plethysmograph)			
Pulse rate	• Level of physiological arousal	• Easy to set up and use, often included with GSR systems • Inexpensive	• Sensitive to electrode placement
Facial Expression Coding			
Visible expressions	• Emotional valence • Emotional intensity	• Non-contact • Easy to set up • Easily understood	• Glasses may interfere • Sensitive to lighting, movement • Some emotions not expressed • People may express differently

www.tobiipro.com

Multiple measures approach?



imotions.com

Neuromarketing

http://www.smivision.com

Social sensing (and honest signals)

Schmid Mast, Marianne, Gatica-Perez, Daniel, Frauendorfer, Denise, Nguyen, Laurent, & Choudhury, Tanzeem (2015). Social sensing for psychology: automated interpersonal behavior assessment. *Current Directions in Psychological Science, 24(2), 154-160. doi: 10.1177/0963721414560811.*

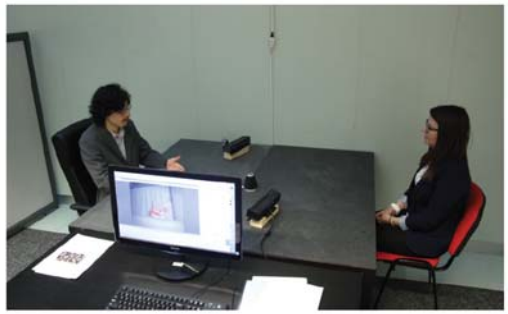


Fig. 1. Stationary social sensing of a dyadic interaction via Microsoft Kinect (for video and depth recording; shown to the front and left of each interaction partner) and Dev-Audio Microcone (for voice recording; shown at center of table).

Table 1. Validated Behavior-Extraction Methods

Extracted cues	Sensing devices	Key words for describing the algorithms	Examples of nonverbal behaviors extracted	References
Arm and body postures	Video; Kinect	Hand likelihood map extraction (optical flow, face detection, edges, skin segmentation); hand tracking; 3D torso-pose extraction	Self-touch, gestures	Marcos-Ramiro, Pizarro-Perez, Marron-Romera, Nguyen, and Gatica-Perez, 2013
Head pose (as proxy for gaze)	Video	Dynamic Bayesian Network; contextual prior models; observations: speaking proportion, visual head pose based on exemplars	Gazing	Ba and Odobez, 2011
Eye gaze	Video; Kinect	3D head-pose tracking from depth data; eye gaze direction tracking from pose-corrected eye appearance	Gazing	Funes and Odobez, 2012
Face location and motion		Frame-based classification between nodding and not-nodding; Fourier representation of face-region optical flow	Nodding	Nguyen, Odobez, and Gatica-Perez, 2012
Facial-feature localization and FACS-based classification of facial expressions	Video	Face detection; facial-feature detection (eye corners and center, tip of the nose, mouth corners and center); feature extraction (using Gabor filters); action-unit recognition; expression intensity and dynamics	Smiling and FACS codes	Littlewort et al., 2011
Face detection and geometric analysis	Video	Upper-body detection, head detection inside upper-body areas, head-pose estimation, looking-at-each-other scoring between pairs of heads	Eye contact	Marin, Zisserman, Eichner, and Ferrari, 2014
Full-body pose	Video; Kinect	Body-part representation; depth image feature extraction; randomized decision-forest body part classification	Arms on hips, arms crossed	Shotton et al., 2011
Speech qualities	Close talk microphone, microphone array, smartphone mic	Speech qualities: voiced/non-voiced classification using hidden Markov models, pitch tracking; speaker segmentation: filter-sum beamforming using an array of microphones	Voice energy, pitch, speaking rate	Basu, 2002; Boersma and Weenink, 2013; Kiran et al., 2010; Lu et al., 2012

Note: FACS = Facial Action Coding System (Ekman & Friesen, 1978).

Schmid Mast, et al (2015)

Finished! Happy or sad?