Visual adaptation

Adaptation to faces

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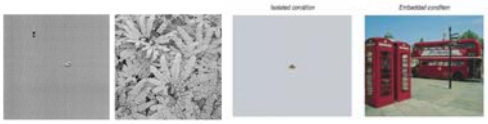
Context

- In everyday life to see an object in isolation from its environment is very unlikely
- Objects mostly appear within their specific context
  - Spatial
  - Temporal

} Both have an impact on object processing



Rolls et al, 2003 Logothethis et al, 2001

An example for the effect of spatial/temporal context

The perceived orientation of a test grating is altered by the presence of a surrounding grating with a different orientation.

Tilt illusion

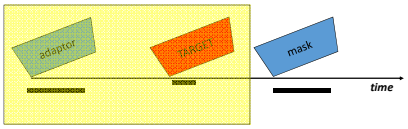
The perceived orientation of the test stimulus is changed after prolonged exposure to another oriented grating.

Tilt after-effect

In both cases the peripherically or previously presented tilted grating biases the perception of the central or subsequent vertical pattern.

Temporal context

- Stimulus BEFORE target (forward masking, priming, adaptation)
  - Decreased/increased/biased perception
- Stimulus AFTER target (backward masking)



Adaptation effect

- occurs at several stages of the visual system
  - from lower-level (retina) to higher-level visual areas (IT)
- for measuring these effects stimuli with different levels of complexity were used
  - one of the most complex, widely used target images: ***human faces***

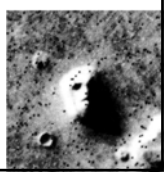
By-pass....

- Why faces?????
- The simple answer: because faces are SPECIAL!
- How? Why?

Human faces …

- 3D visual stimuli convey a multiple of perceptual data
  - Expression/emotion
  - Focus of attention
  - Attractivity
  - Age
  - Gender
  - Race/ethnicity

  Usually effortless, automatic even though very similar structure
- We prone to see faces anywhere…. ☺



The most important question…

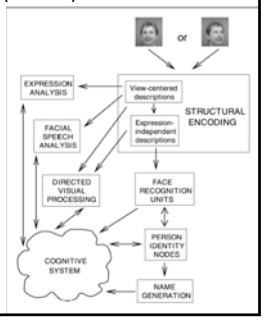
- Are human faces a very special, unique category or they are „only" one object from the others?
- PROs and CONs:
  - Different nature of processing (feature-based versus holistic/configural)
  - Different stages and routes of processing (Bruce and Young model)
  - Different stimulus representation (Valentine's MDFS explanation)
  - Different neural representation (modularity????)
  - Neuropsychology (prosopagnosia)
  - Expertise????

One evidence for holistic processing – Thatcher-illusion
- different processing

It becomes more difficult to detect local feature changes in an inverted face, despite identical changes being obvious in an upright face.

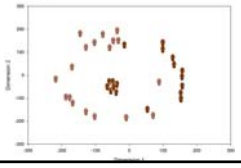
The Bruce and Young model (1986)
- different stages

- A classical box and arrow model
- First stage: structural encoding
  - Based on visual information
  - Viewpoint-dependent
  - Expression-independent
- Second step: parallel processes
- In case of recognition:
  1. Visual analysis
  2. FRU
  3. Other information (name, likes and dislikes)

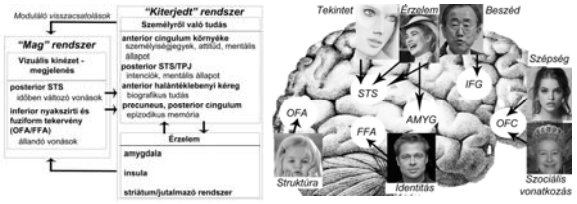


Valentine's MDFS model (1991)
- different representation

- Multidimensional face space
  - Faces are encoded as points in a metaphoric N-dim FS
  - Dimensions: any characteristic which differentiates among faces
  - Origin: average face (Q: from what?)
  - More typical – much closer



Haxby's model (2000)
- different neural representation



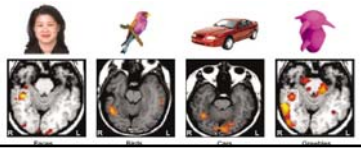
Distributed system for face perception – CORE system: visual analysis, invariant and changeable features separately; EXTENDED system: areas that not primarily visual but play roles in extracting information from faces.

Prosopagnosia
- neuropsychology

- Double dissociation: patient A with impaired face recognition without any problem with other non-face objects versus patient B with the opposite pattern
- Face blindness = prosopagnosia
  - Unable to recognize familiar faces
  - Other visual processes and intellectual functioning remain intact
  - AP vs. DP/CP
    - AP: after brain damage
    - DP/CP: lifelong, without any neurological history
      - Prevalance: ~1.8-2.5%
      - C: congential (???)

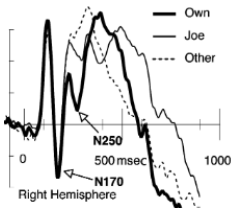
Expertise

- Sceptics: faces vs. Non-face objects – different level of categorization
- Faces: subordinate level (member level)
- Objects: basic level
- Conclusion: we are experts in faces that is why their representation and encoding is so deep and large
- Q: non-face object category experts?



Faces and the brain – Event-related potentials (ERPs)

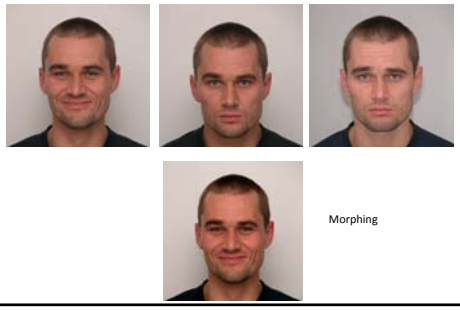
- Right hemisphere dominance
- Posterior OT regions
- P100: early visual encoding
- N170: structural encoding
- P2: ??? A lot …
- N250: identity/familiarity



Faces AND adaptation

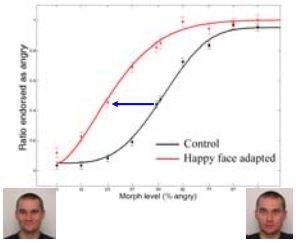
- Behaviourally
  - After-effect (biased perception – biased decisions)
- Neural effect:
  - Altered amplitude values of the face-evoked ERP components

Face after-effect (FAE)



Morphing

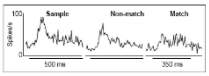
The behavioural effect

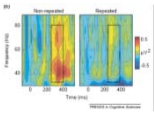


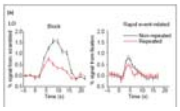
Neural correlates …

Experimental methods of adaptation/RS

- Manifested in decreased activation
- Single cell recording
  (Li et al., 1993)
- EEG/MEG
  (Gruber & Muller, 2005)
  (Kovács et al., 2005)
- fMRI – adaptation
  (Sayres & Grill-Spector, 2006)



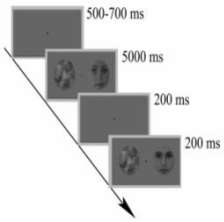




Main questions

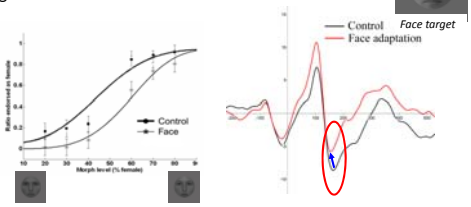
1. Which are the levels of visual processing that face-selective after-effects (FAEs) can be linked to?
2. Is there category specificity in adaptation?
3. How position-invariant FAEs are?
4. Are there hemispheric asymmetries in the strength of the adaptation effect?
5. What role does the duration of adaptation play in shape-selective after-effects?

Methods of the adaptation experiments



- 2AFC discrimination task (gender, distortion, familiarity)
- Central or peripheral stimulus presentation
- ERP recordings /25 or 60 channels, main components: P100, N170, and P2, N250/
- Customary off-line analyses

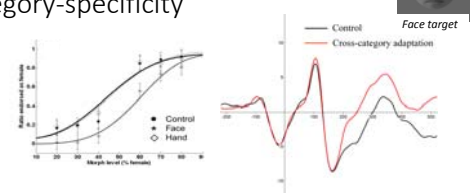
Results



- Significant behavioural and electrophysiological adaptation effect for both face and hand stimuli
- This effect is size- and rotation-invariant

(Kovács, G., Zimmer, M., Bankó, É., Harza, I., Antal, A., Vidnyánszky, Z. (2006) Electrophysiological correlates of visual adaptation to faces and body parts in humans. Cerebral Cortex 16(5):742-753.)

Category-specificity

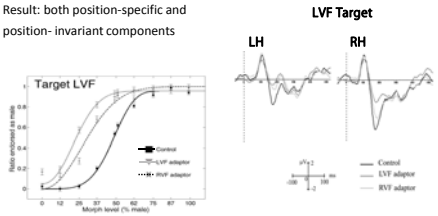


- Human hand/face adaptor does not bias face/hand gender discrimination as compared to the control
- No such cross-category effect on the amplitude and latency of the N170 component

(Kovács, G., Zimmer, M., Bankó, É., Harza, I., Antal, A., Vidnyánszky, Z. (2006) Electrophysiological correlates of visual adaptation to faces and body parts in humans. Cerebral Cortex 16(5):742-753.)

Position-in/variance of the FAEs

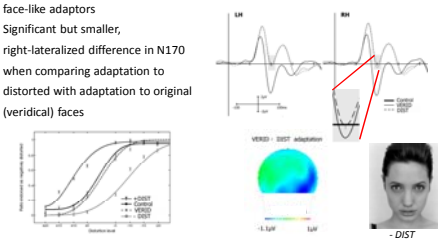
- Aim: to study the position-specificity of adaptation-related FAE
- Peripheral stimulus presentation
- Result: both position-specific and position- invariant components



(Kovács, G., Zimmer, M., Harza, I., Antal, A., Vidnyánszky, Z. (2005) Position-specificity of facial adaptation. NeuroReport 16(5):1945-1949.)

Electrophysiological correlates of face distortion after-effect

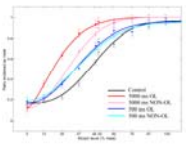
- Large and consistent N170 amplitude reduction for all type of face-like adaptors
- Significant but smaller, right-lateralized difference in N170 when comparing adaptation to distorted with adaptation to original (veridical) faces



(Zimmer, M., Kovács, G.. Electrophysiological correlates of face distortion after-effects. (2011). Quarterly Journal of Experimental Psychology, 64(3): 533-544.)

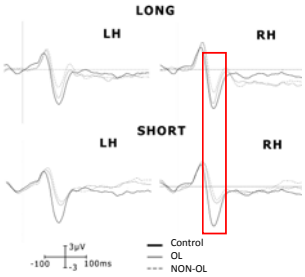
Adaptation duration determines the positional specificity of the FAE

- Duration of the adaptor determines how it will interact with the subsequent target
- Short vs. Long term peripheral adaptation
- Long term presentation of the adaptor (5000 ms) is needed to the adaptation of the position-specific neuronal mechanisms of face processing



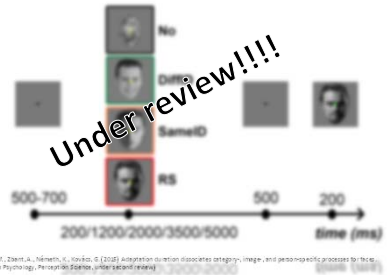
(Kovács, G., Zimmer, M., Harza, I., Vidnyánszky, Z. (2007) Adaptation duration affects the spatial selectivity of facial aftereffects. Vision Research 47(25):3141-3149.)

ERPs



(for a review see Zimmer, M., Kovács, G. (2011) Position specificity of face adaptation after-effects. Philosophical transactions of the Royal Society of London. Series B, Biological Sciences 366(1564): 586-595.)

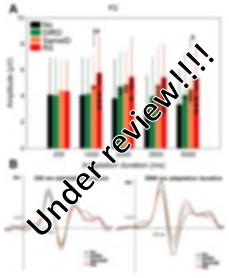
Our current experiment



Results

- Behaviourally - priming

- Electrophysiological correlates



Our model

Clear dissociation among category-, identity-, and image-specific processing steps on N170 and P2 but only in case of longer durations

Results of adaptation studies

1. FAEs are the result of the adaptation of higher-level neuronal processing
2. FAEs are category-specific
3. FAEs have a position-specific and a position-invariant component
4. FAEs show hemispherical asymmetries
5. The duration of adaptation is a key factor in shape-selective after-effects

Thank you for your attention!