Expression Analysis with FaceReader

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6 December 2017

Noldus

FACEREADER

PRESENTATION OVERVIEW

- Introduction Noldus
- What is FaceReader?
  - How does it work?
  - Analysis
  - Applications
  - Advantages
  - Validation
  - Restrictions
- Demo
- FaceReader Online
- Future developments
- Q/A

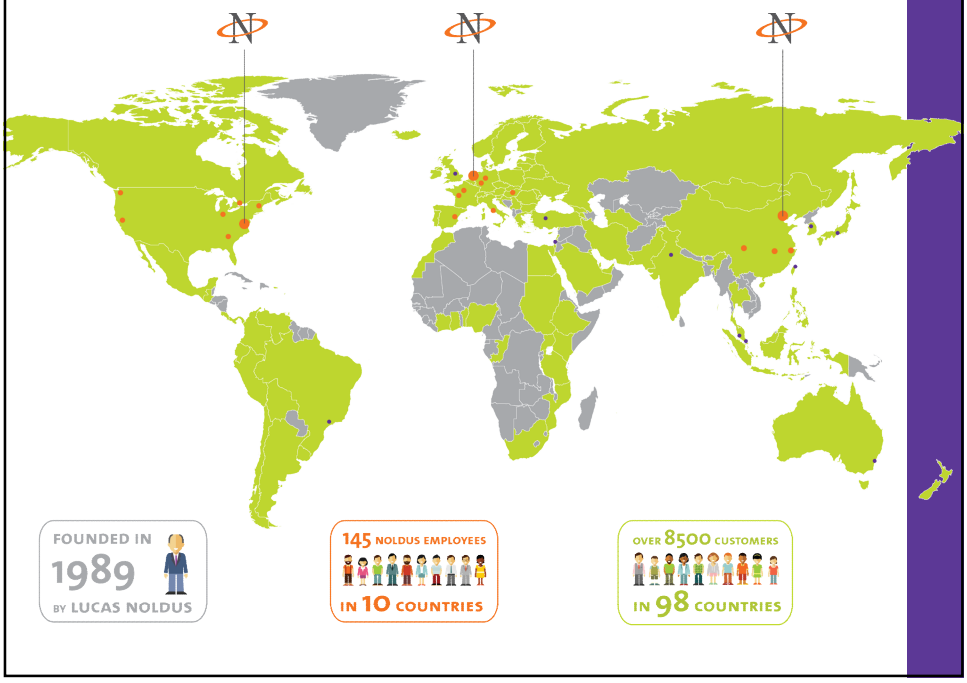
THE COMPANY

WHO WE ARE...

BENEFIT FROM 25 years OF INNOVATION

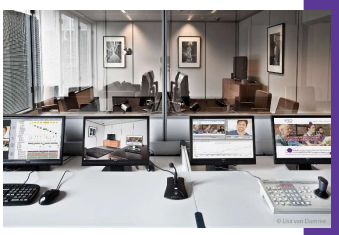
Developer of professional software, hardware, and integrated solutions for behavioral research

"We wish to contribute to a world where technology applied to understanding behavior enables people to make better products and to increase quality of life."

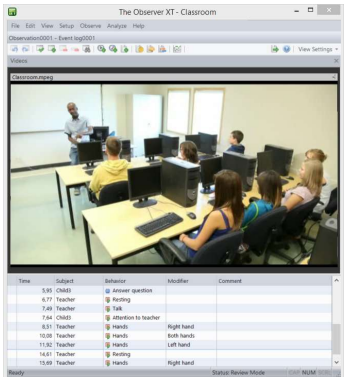


THE COMPANY

CORE ACTIVITIES



System integration



Product development

Services

OUR CUSTOMERS

ACADEMIC CLIENTS AND APPLICATIONS

Customers

- The world's top 25 universities
- > 6.000 research groups
- > 96 countries

Scientific track record

> 10.000 publications

Application areas

Psychology
Medicine
Zoology
Human Factors
Neuroscience
Consumer Science
Sports

OUR CUSTOMERS

CORPORATE CLIENTS
> 700 companies

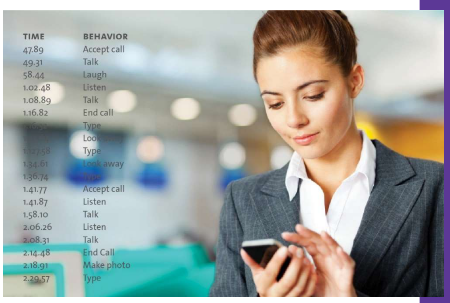
symantec.
MERCK Animal Health
Microsoft
Pfizer
YAHOO!
gsk GlaxoSmithKline
PHILIPS
intel
hp
BOSE
IBM
LG Life's Good
NASA
BOEING
KLM
T-Mobile
HUAWEI
Sony Ericsson
NISSAN
VOLVO
BMW
FIAT
TOYOTA
LAND ROVER
DOWJONES
Rabobank
AEGON
VISA
Nestlé
Unilever
nutreco
DANONE

OUR SOLUTIONS

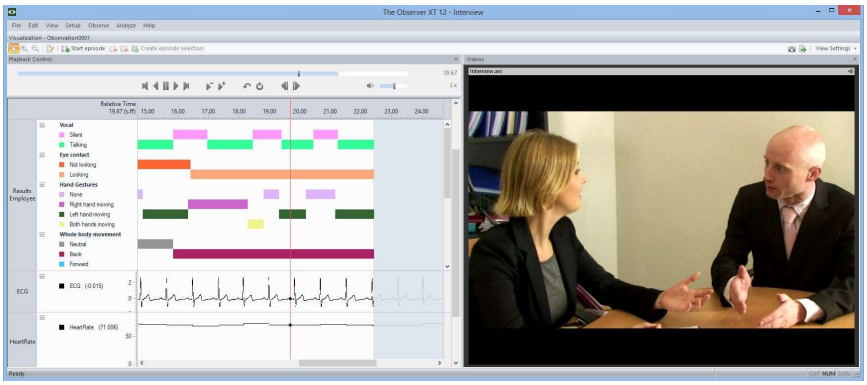
THE OBSERVER XT

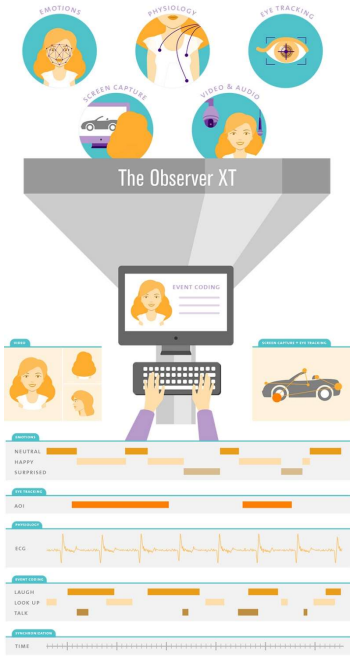
Behavioral coding and analysis software

- Code behaviors live or from video
- Collect, integrate, analyze, and manage data
- Calculate descriptive statistics and assess reliability
- Code on-the-go and share the work



OUR SOLUTIONS – THE OBSERVER XT

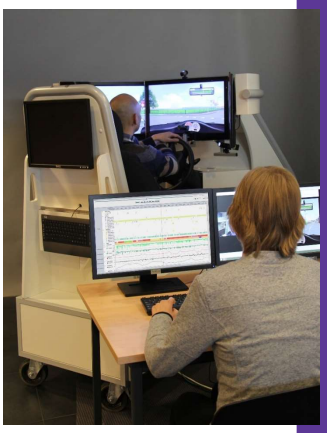




Multimodal Data Integration in The Observer XT

OUR SOLUTIONS

SIMULATION LABS
DriveLab



- Integration of multiple modalities (physiological data, eye tracking, facial expressions)
- Assessment of workload
- Application examples:
  - Analyze effects of drugs on driver behavior
  - Evaluation of driving support systems
  - Influence of age differences on driving performance
  - Impact of text messaging on driving performance and safety

FACEREADER

WHAT IS FACEREADER?

FaceReader automatically detects facial expressions

Classification of the basic emotions

- Happy
- Sad
- Angry
- Surprised
- Disgusted
- Scared
- Contempt
- Plus a 'neutral' state

FACEREADER

Classical view on emotions

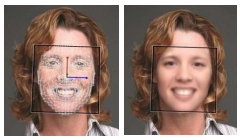
- Cartoon-ish

  Inside Out (2015, Pixar Animation Studios)

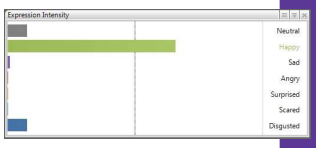
FACEREADER

HOW DOES IT WORK
3 steps

1. Find the position of the face



2. Create a face model *(Active Appearance Model)*

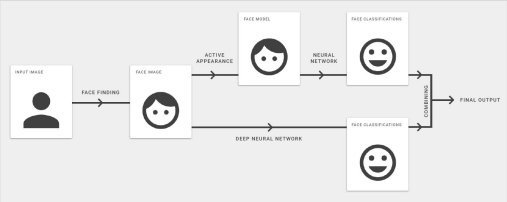


3. Classification of the emotion

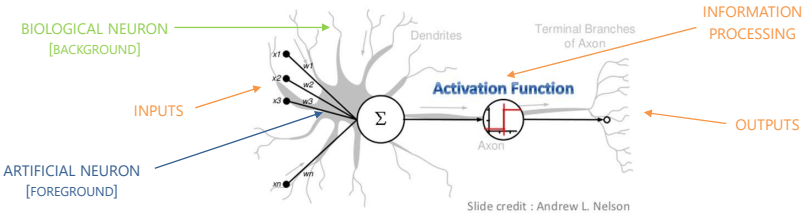
HOW DOES IT WORK

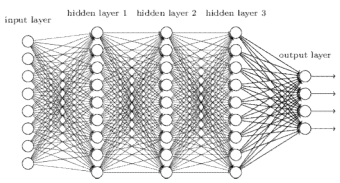
DEEP FACE MODEL

- Works in parallel with Active Appearance Model and continues in some cases if AAM can't model the face
- Deep learning: able to make sense of large amounts of complex data (like images incl. low resolution / bad quality images)

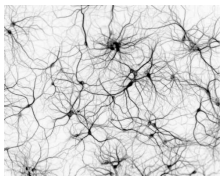


HOW DOES IT WORK - **DEEP FACE MODEL – ARTIFICIAL NEURAL NETWORKS**



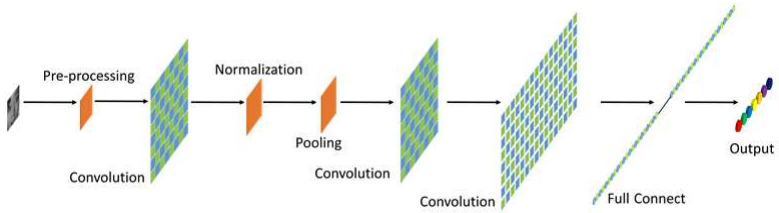


ARTIFICIAL DEEP NEURAL NETWORK



BIOLOGICAL NEURAL NETWORK

HOW DOES IT WORK - **DEEP FACE MODEL – A SIMPLIFIED ILLUSTRATION**

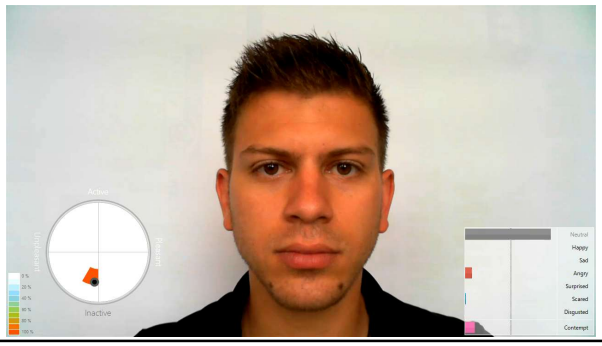


Face image	**Low-level concepts** *(edges & corner)*	**Mid-level concepts** *(eye, nose)*	**High-level concepts** *(smiles, wrinkles)*	**Output** *(expressions, AUs, etc.)*

ANALYSIS

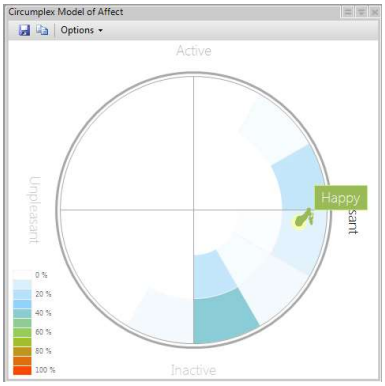
INPUT OPTIONS

- Video
- Live via webcam or IP
- Images



ANALYSIS

CIRCUMPLEX MODEL



The circumplex model is a graphical representation of valence and arousal

ANALYSIS

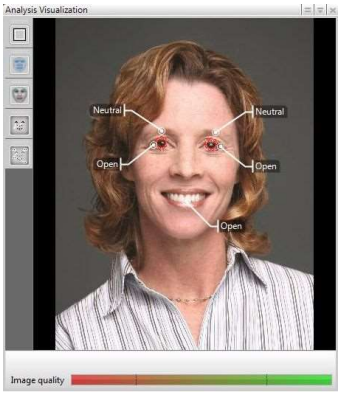
PROPERTIES

Subject Characteristics

Category	Result	Amount	Certainty
Gender (fixed)	Female		100%
Age (fixed)	25 - 35		
Beard	None	0%	
Moustache	None	13%	
Glasses	No		100%
Ethnicity	Caucasian		97%

ANALYSIS

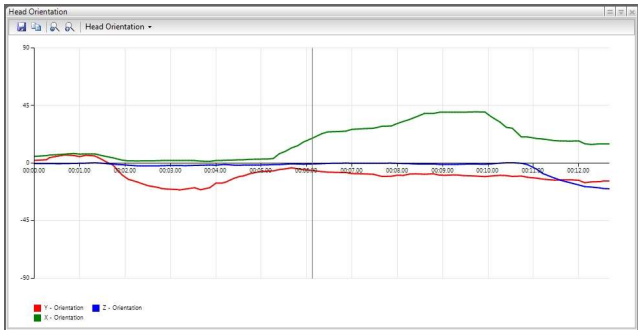
FACIAL STATES



- Left and right eye opened or closed
- Mouth open or closed
- Left and right eyebrow raised, neutral or lowered

ANALYSIS

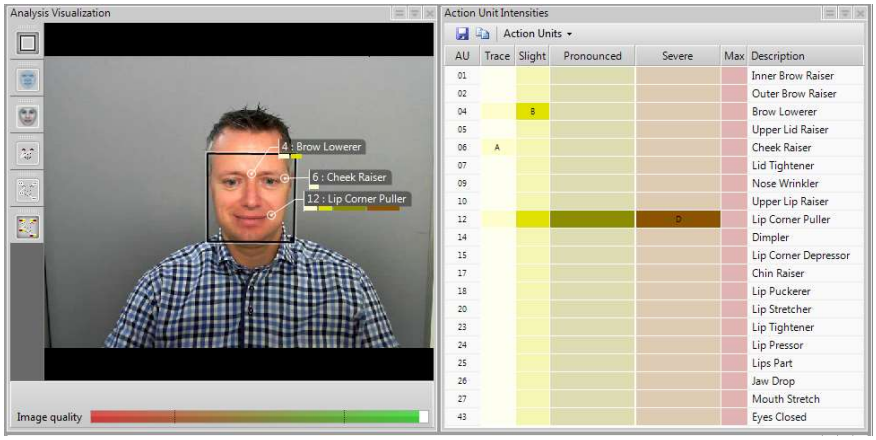
ADDITIONAL CLASSIFIERS



Track Head orientation / Global gaze direction

ANALYSIS

Action Units (Optional)



ANALYSIS

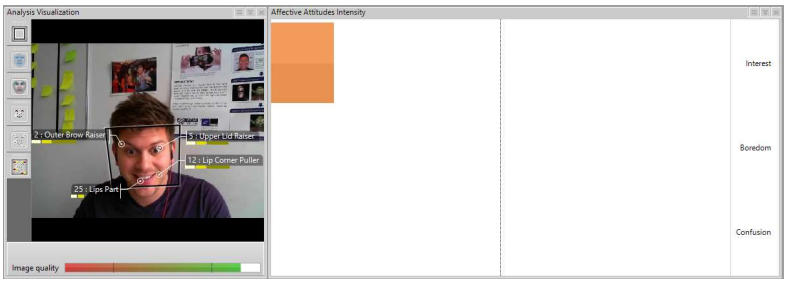
AFFECTIVE ATTITUDES

- Temporal affects that are expressed over a period of time:
  - Interest (2 sec)
  - Boredom (5 sec)
  - Confusion (2 sec)
- Based on sets of Action Units plus nodding or head shaking
- In 7.1 available on experimental basis
  - Visualization and data export possible
  - No temporal / numerical analysis

ANALYSIS

AFFECTIVE ATTITUDES: Interest

- The parameters for the computation of interest as an affective attitude are as follows:
  1. **Time window duration**: 2 seconds
  2. **Trigger condition:** Trace activation of either AU1 or AU2
  3. **Set of contributors:** 1×AU1 + 1×AU2 + 1×AU5 + 1×AU7 – 1×AU20 – 1×AU26



ANALYSIS

AFFECTIVE ATTITUDES: Confusion

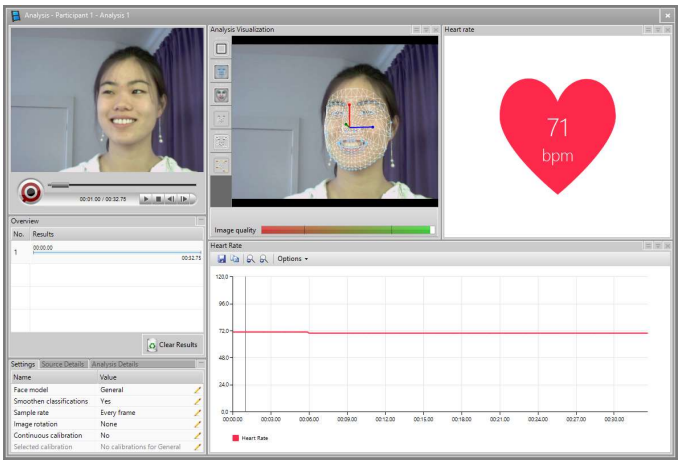
- The parameters for the computation of confusion as an affective attitude are as follows:
  1. **Time window duration**: 2 seconds
  2. **Trigger condition:** Trace activation of either AU4 or AU7
  3. **Set of contributors:** 1×AU4 + 1×AU7 + 1×AU15 + 1×AU17 + 1×AU23

ANALYSIS

AFFECTIVE ATTITUDES: Boredom

- The parameters for the computation of boredom as an affective attitude are as follows:
  1. **Time window duration**: 5 seconds
  2. **Trigger condition:** at least 0.5 Neutral expression, and less than 0.25 arousal, and less than 0.05 interest and confusion
  3. **Set of contributors:** 0.5×Neutral + 0.5×(1-Arousal) + 1×AU14 + 1×AU23 + 1×AU24 + 1×AU43 - 1×AU1 - 1×AU2 - 1×AU4 - 1×AU6 - 1×AU7 - 1×AU12 - 1×Interest

ANALYSIS – **REMOTE PPG**



RPPG is a method based on the fact that changes in blood volume due to the pressure pulses cause small changes in the reflectance of the skin.

What is FaceReader?

APPLICATION EXAMPLES

- User experience research
- Affective computing
- Game research
- Consumer behavior research
- Interaction with patients
- Interaction of children with toys or computers
- Testing advertisements/commercials
- Emotions of schizophrenics patients
- Classroom interactions

What is FaceReader?

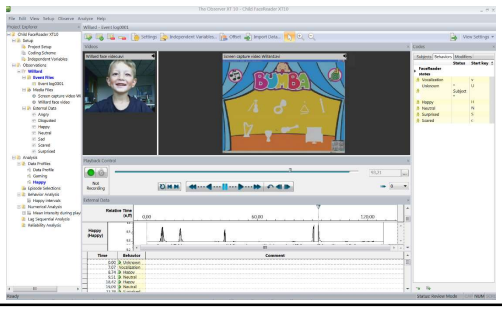
PUBLICATIONS

- **Dys, S.P.; Malti, T.** (2016). It's a two-way street: Automatic and controlled processes in children's emotional responses to moral transgressions. *Journal of Experimental Child Psychology*, **152**, 31-40. doi: 10.1016/j.jecp.2016.06.011
- **He, W.; Boesveldt, S.; Graaf, de, C.; Wijk, R.A. de** (2014). Dynamics of autonomic nervous system responses and facial expressions to odors. *Frontiers in Psychology, doi: 10.3389/fpsyg.2014.00110.*
- **Lewinski, P.; Fransen, M. L.; Tan, E.S.H.** (2014). Predicting advertising effectiveness by facial expressions in response to amusing persuasive stimuli. *Journal of Neuroscience, Psychology, and Economics, doi: 10.1037/npe0000012.*
- **Harley, J.M.; Bouchet, F.; Sazzad Hussain, M.; Azevedo, R.; Calvo, R.** (2015). A multi-componential analysis of emotions during complex learning with an intelligent mulit-agent system. *Computers in Human Behavior*, **48**, 615-625
- **More:** *http://www.noldus.com/facereader/selected-publications*

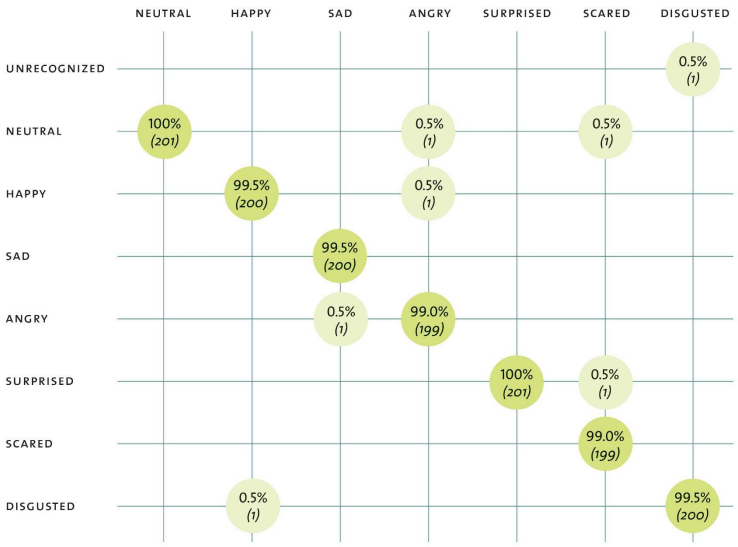
What is FaceReader?

ADVANTAGES

- Objective & accurate analysis
- Save time/resources
- Integration with The Observer XT



What is FaceReader: VALIDATION



What is FaceReader?

RESTRICTIONS AND PERFORMANCE

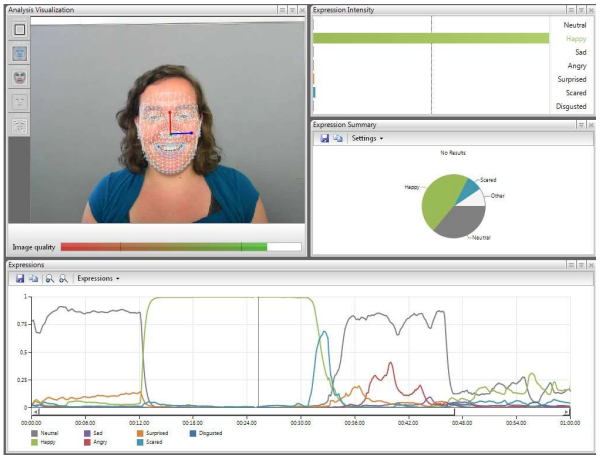
Limitation in FaceReader 7.1

- Test persons should be over 3 years old
- Spectacles may hinder categorization

Increase performance

- Create good light conditions (diffuse frontal lighting)
- Minimize movement and rotation of test participants as much as possible
- Make sure the eyes are visible

Demo

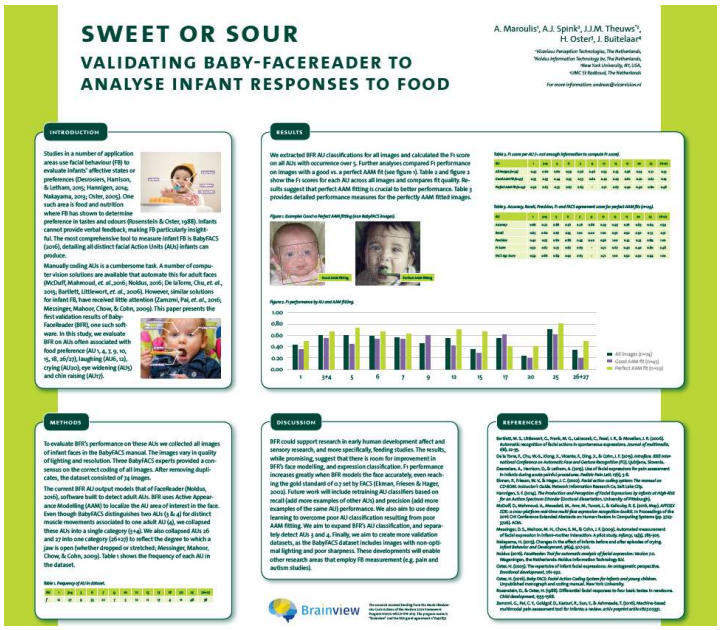


FaceReader Online

- Scalable, cloud based analysis through Windows Azure
- Remote research with large numbers of participants as they watch videos
- Record webcam streams around the world
- For use in combination with surveys
- Technique for gaining consumer insight: compare responses between stimuli and groups
- http://www.noldus.com/facereader/facereader-online

FaceReader Online

Future Developments – Baby FaceReader



SWEET OR SOUR

VALIDATING BABY-FACEREADER TO ANALYSE INFANT RESPONSES TO FOOD

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INTRODUCTION

Studies in a number of application areas use facial behaviour (FB) to evaluate infants' affective states or preferences (Desrosiers, Harrison, & Letham, 2015; Hannigan, 2014; Nakayama, 2013; Oster, 2005). One such area is food and nutrition where FB has shown to determine preference in tastes and odours (Rosenstein & Oster, 1988). Infants cannot provide verbal feedback, making FB particularly insightful. The most comprehensive tool to measure infant FB is BabyFACS (2016), detailing all distinct facial Action Units (AUs) infants can produce.

Manually coding AUs is a cumbersome task. A number of computer vision solutions are available that automate this for adult faces (McDuff, Mahmoud, et. al., 2016; Noldus, 2016; De la Torre, Chu, et. al., 2015; Bartlett, Littlewort, et. al., 2006). However, similar solutions for infant FB, have received little attention (Zamzmi, Pai, et. al., 2016; Messinger, Mahoor, Chow, & Cohn, 2009). This paper presents the first validation results of Baby-FaceReader (BFR), one such software. In this study, we evaluate BFR on AUs often associated with food preference (AU 1, 4, 7, 9, 10, 15, 18, 26/27), laughing (AU6, 12), crying (AU20), eye widening (AU5) and chin raising (AU17).

RESULTS

We extracted BFR AU classifications for all images and calculated the F1 score on all AUs with occurrence over 5. Further analyses compared F1 performance on images with a good vs. a perfect AAM fit (see figure 1). Table 2 and figure 2 show the F1 scores for each AU across all images and compares fit quality. Results suggest that perfect AAM fitting is crucial to better performance. Table 3 provides detailed performance measures for the perfectly AAM fitted images.

METHODS

To evaluate BFR's performance on these AUs we collected all images of infant faces in the BabyFACS manual. The images vary in quality of lighting and resolution. Three BabyFACS experts provided a consensus on the correct coding of all images. After removing duplicates, the dataset consisted of 74 images.

The current BFR AU output models that of FaceReader (Noldus, 2016), software built to detect adult AUs. BFR uses Active Appearance Modelling (AAM) to localize the AU area of interest in the face. Even though BabyFACS distinguishes two AUs (5 & 4) for distinct muscle movements associated to one adult AU (4), we collapsed these AUs into a single category (5+4). We also collapsed AUs 26 and 27 into one category (26+27) to reflect the degree to which a jaw is open (whether dropped or stretched; Messinger, Mahoor, Chow, & Cohn, 2009). Table 1 shows the frequency of each AU in the dataset.

DISCUSSION

BFR could support research in early human development affect and sensory research, and more specifically, feeding studies. The results, while promising, suggest that there is room for improvement in BFR's face modelling, and expression classification. F1 performance increases greatly when BFR models the face accurately, even reaching the gold standard of 0.7 set by FACS (Ekman, Friesen & Hager, 2002). Future work will include retraining AU classifiers based on recall (add more examples of other AUs) and precision (add more examples of the same AU) performance. We also aim to use deep learning to overcome poor AU classification resulting from poor AAM fitting. We aim to expand BFR's AU classification, and separately detect AUs 3 and 4. Finally, we aim to create more validation datasets, as the BabyFACS dataset includes images with non-optimal lighting and poor sharpness. These developments will enable other research areas that employ FB measurement (e.g. pain and autism studies).

Brainview

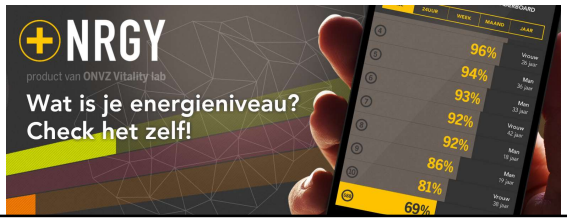
REFERENCES

Future Developments

OEM Versions

Examples:

- Customer Support Centers
- Tutoring systems
- Gaming
- Driver behavior
- Assessment
- Emotional energy (NRGY app ONVZ)

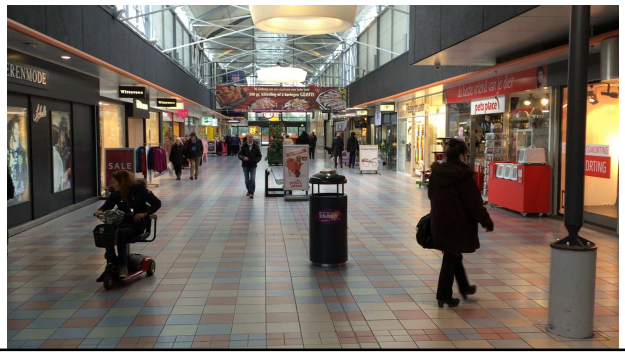


Future Developments

OEM Versions

Examples:

- Digital signage



THANK YOU
Any questions?

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