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Disclosure of speaker's interests

No conflict of interests



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AMSTERDAM 6 - 8 JULY 2021



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 780819.



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# Emotions in daily life of people with PIMD

## Analyzing the influence of physiological changes

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PARTNERS:



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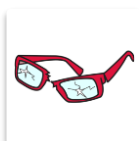


## Background



**Empirical research in this field**

(e.g. Lima et al., 2011; Vandesande et al., 2020; Vos et al., 2012; Vos et al., 2013)



**Highly individual behaviour signals are often hard to read**

(e.g. Hennig 2011; Petry & Maes 2006)



**Support of communication development & interaction**

(e.g. Petry & Maes 2006)



**Self-reports are often not possible**

(e.g. Luxen 2003; Vos et al. 2012)



**Possible reduction of dependence by emotion recognition**

(e.g. Adams & Oliver; Helm 2000; Ross & Oliver 2003)



**Improving services & activities**

(e.g. Marteau et al. 2014; Petry & Maes 2006)

## Research Questions

- I. How can the emotional expression of people with PIMD be distinguished?
- II. Are the emotional states related to physiological changes in heart rate (variability)?

## Participants

- Two participants:
  - (1) 8 years; male
  - (2) 6.5 years; female
- Living at with their families & daily attending a kindergarten (later school)
- Profound intellectual disability (reported, not tested)
- Severe motor impairments
- Communication:
  - Preverbal
  - Primarily communicated by using intentional and unconventional behaviors
- Other diagnoses:
  - cerebral palsy (both), epilepsy & visual impairment (1)

## Method

### Preparation

- Assessment (InQS)
- Technical setup

### Data Collection

- Recordings of everyday activities
- physiological measurement

### Analysis I

- Emotional Profiles
- Annotations with valence scale

### Analysis II

- Data Processing
- Statistical methods
- Machine learning tools

## Data Collection

- Setting: known environment in kindergarten
- Video recordings from two perspectives
- Physiological data with a focus on heart rate (variability)  
→ measured by the Empatica E4 wristband (non-invasive)
- Start in November 2019
- Total period of 7.7 months
- Over 15 h of recordings:
  - (1) approx. 7.8 h collected on 18 measurement days
  - (2) approx. 7.3 h collected on 14 measurement days



## Data Collection

	(1)	(2)
<b>In total</b>	7h 49min	7h 19 min
<b>A-Phase</b>	9 %	12 %
<b>B-Phase</b>	89 %	77 %
▶ Eating and drinking	36 %	10 %
▶ Physically oriented activities	23 %	40 %
▶ Audiovisual activities	24 %	37 %
▶ Care	2 %	-
▶ Transfer / position change	6 %	4 %
▶ Little/moderate interaction	9 %	9 %

(oriented towards van der Putten & Vlaskamp, 2011)



# Emotional Profiles

- Triangulated proxy reporting (Lyons et al., 2017)
  - InQS – questionnaire for DSPs
  - Annotations of DSPs based on a valence scale oriented to the Circumplex model (Russell, 1980)
  - Validation of specific behavior signals

➔ Emotional profiles were created and used for further annotations by the researchers

➔ Cohen's Kappa:

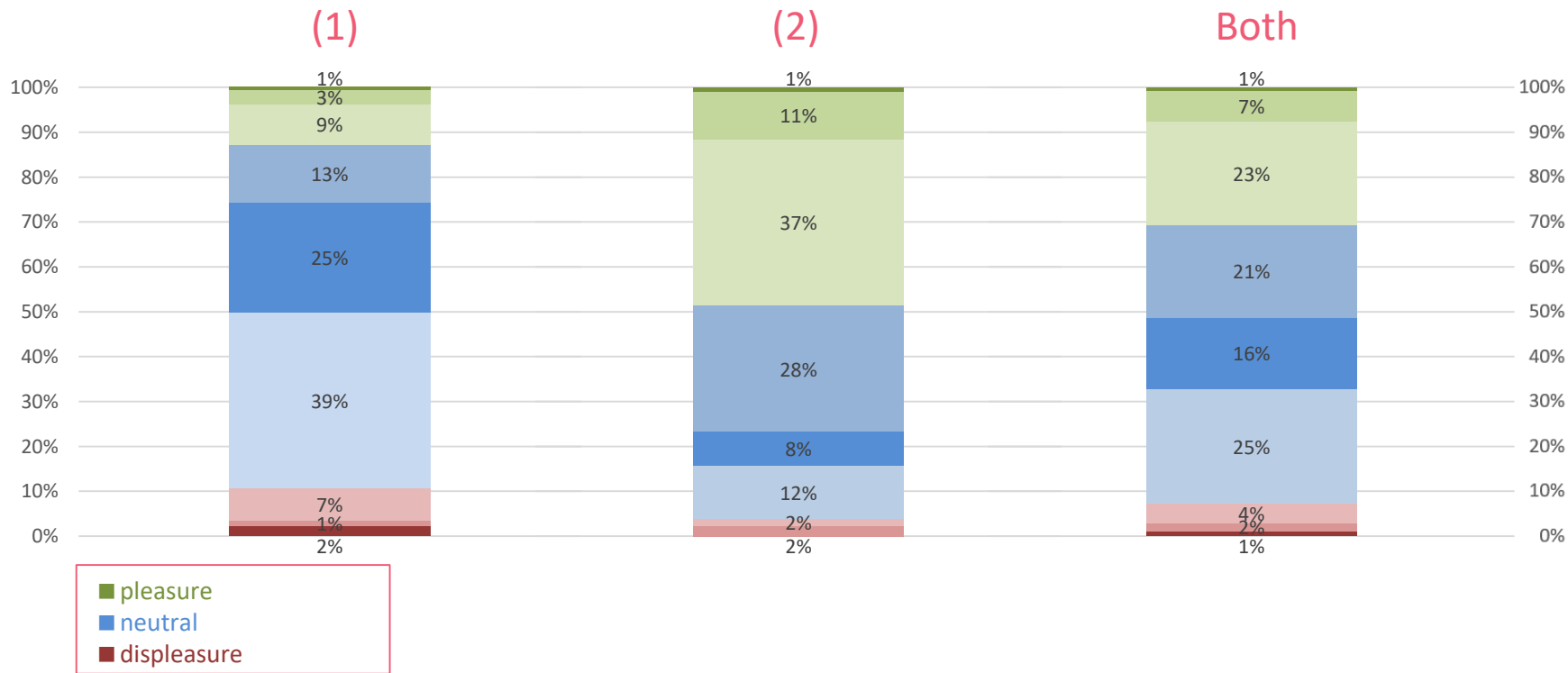
(1) 0.73

(2) 0.71

Table 1. Emotional Profile of (1)

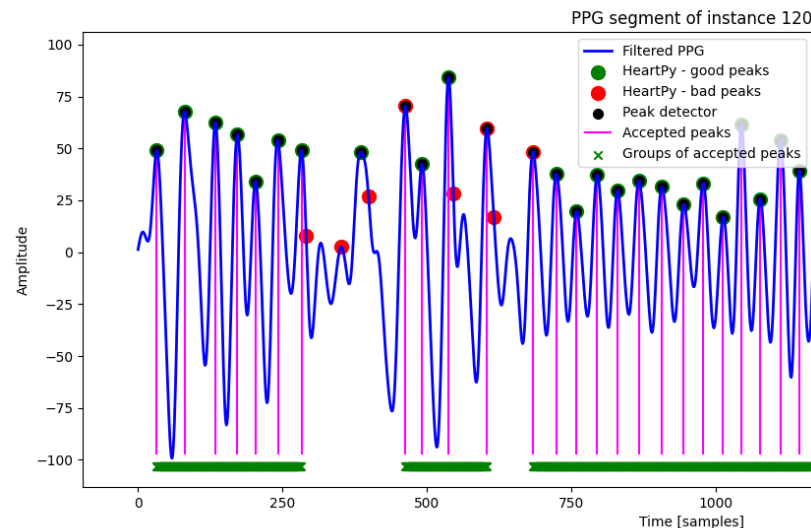
Valence Scale	Behavior Description
9	He smiles widely and vocalizes or even shouts for a long duration at a high volume. Mostly his body, arms and legs move jerkily in a recurring manner and he overstretches his head backwards (due to increased muscle tone).
8	He smiles widely or vocalizes for a medium duration at a medium volume. Mostly, his body, arms and legs move jerky for a short duration (due to increased muscle tone).
7	He smiles slightly or vocalizes for a short duration at a low volume.
6	He looks around with open eyes and partly opened mouth. Sometimes, he moves his arms and legs a little bit as well.
5	He is calm and moves very little and slowly with the whole body. Mainly, he has semi-closed eyes.
4	He still does not move a lot, but acts passive or even a bit rejecting. In most cases, he makes a snoring sound while breathing.
3	He hits his head backwards against the headrest and breathes more heavily.
	He chokes (e.g. while eating) and has to cough briefly, which leads to slight tightening and tensing of arms and legs.
	He shows disapproval of the current activity (usually eating) by turning his head away, widening his eyes a lot and, in the case of eating, not opening his mouth.
2	He rubs his legs together while his arms are slightly outstretched but not raised (due to slightly increased muscle tone), he shows a staring gaze with widened eyes and his head tosses slightly from left to right.
	He chokes (e.g. when eating) and has to cough several times, which leads to a strong tightening and cramping of the arms and legs, accompanied by intensively narrowed eyes and a strong frown.
1	He rubs his legs together quickly and intensely, while his arms are slightly stretched out and raised (due to increased muscle tone) and shaking strongly. At the same time, he shows a staring gaze with widened eyes and his head tosses slightly from left to right.
	He continuously cries or even screams at high volume accompanied by narrowed eyes, a wide-open mouth and tensely bent arms.

## Annotation Results – Emotional States



## Data Processing

- Peak detection within a 30s window of PPG:
  - Using heartpy library & custom peak detector
  - Rejecting peaks that not meet the requirements
  - Single group contains at least 3 peaks
- 15 features were extracted from PPG:
  - HRmean, RMSSD, LFnorm, HFnorm, LFdHF, HR\_estimate1, HRmedian, IBImedian, SDNN, SDSD, SDbonus1, SDbonus2, VLF, LF, HF



# Preliminary Results – Predicting Potential Emotional Differences

## Analysis [1]

- All emotional states (i.e., 2 – 9)
- Pleasure **vs.** displeasure **vs.** neutral  
→ valence

## Analysis [2]

- Removing bordering emotional states (i.e., 3, 4, 6, 7)
- Pleasure & displeasure **vs.** neutral  
→ arousal

Using machine learning models & 5-fold stratified cross validation

	Baseline	kNN	Tree	RF	SVM	AdaBoost	XGB
[1]	59 %	65 %	62 %	61 %	59 %	62 %	65 %
[2]	63 %	65 %	66 %	66 %	65 %	70 %	69 %

## Summary

- Assessment of emotional expression of people with PIMD is challenging
  - Lack of proof that the annotated behaviors actually match the emotional states
  - Situations in everyday life vs. laboratory settings
- Recordings of everyday life does not provide perfect data
  - Imbalanced data regarding phases & emotional states
  - More movement/noise in (dis)pleasure moments → required rejecting of valuable data
- Results support the findings that physiological data can broaden the insight into the emotional well-being of people with PIMD

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**Thank you for your attention!**

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