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Personalized intelligent platform enabling interaction with digital services to individuals with profound and multiple learning disabilities



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

PARTNERS:



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Employing Advanced ICT for the Inclusion of People with Profound Intellectual and Multiple Disabilities

Michał Kosiedowski, Torsten Krämer, Christin Kupitz



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*IT IS ENTIRELY POSSIBLE THAT BEHIND THE PERCEPTION OF OUR
SENSES, WORLDS ARE HIDDEN OF WHICH WE ARE UNAWARE*

Albert Einstein



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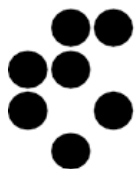
The INSENSION project

- Financing: EU-Project supported by the Horizon 2020 program
- Period: 01/2018 – 06/2021
- Consortium: International & interdisciplinary
- Objectives: Design and develop an ICT platform that enables persons with PIMD to use digital applications and services that:
 - ▶ can enhance the quality of their life
 - ▶ increase their ability to self-determination
 - ▶ enrich their life

Technological partners



**Future Internet,
eInclusion technologies**



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Artificial intelligence



Computer vision

Domain partners



Intellectual disability,
special education

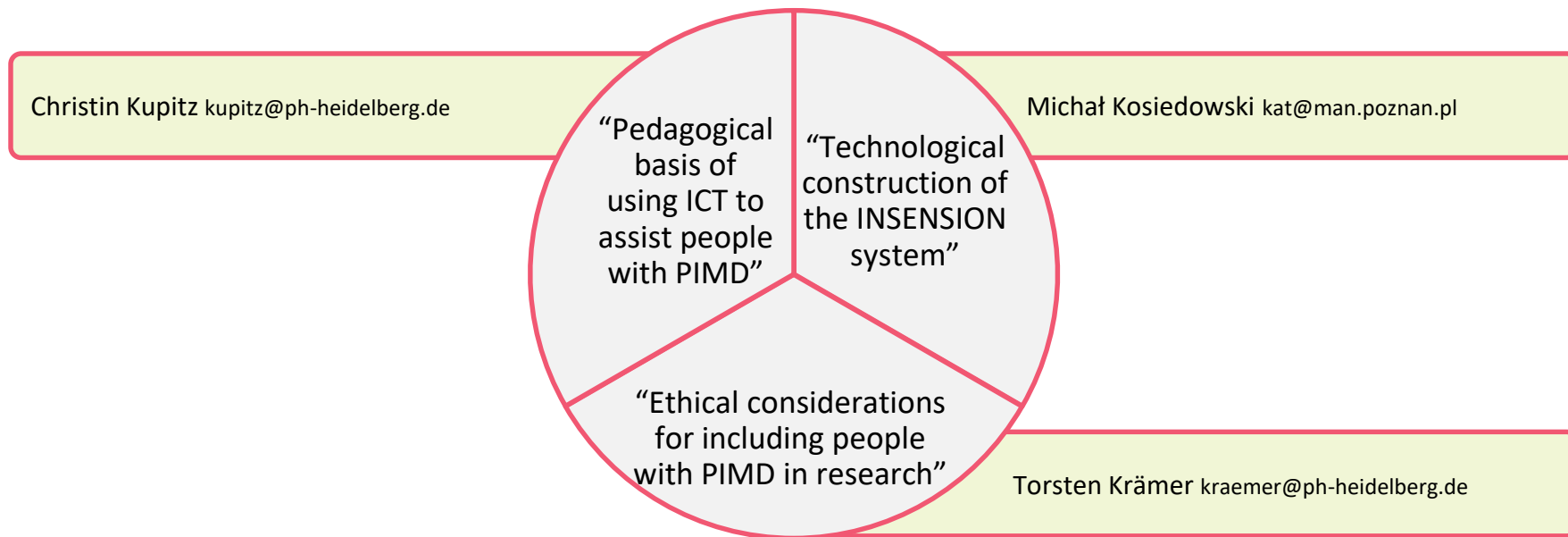


Care provision to people
with intellectual disability

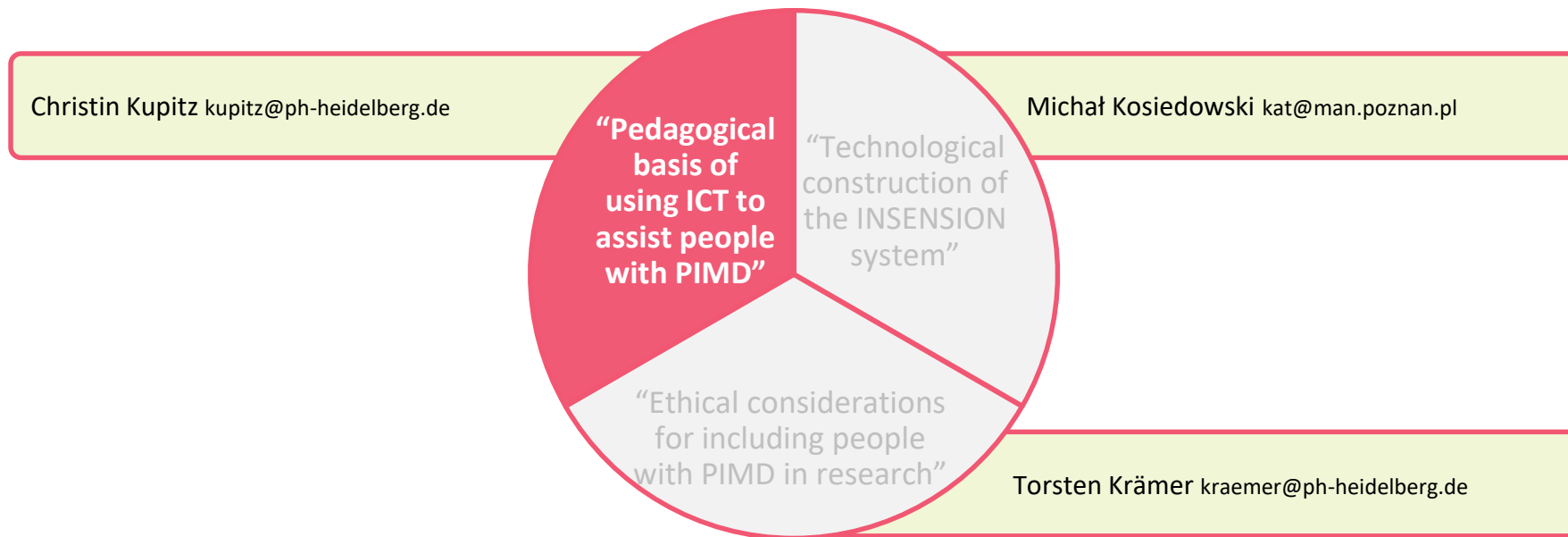


Creation and distribution
of assistive technologies

Different perspectives on the INSENSION project



Different perspectives on the INSENSION project



The goal

Design and develop an ICT platform that enables persons with profound intellectual and multiple disabilities to interact with their surroundings and, as a result, increase the ability to self-determination.

Target Group

People with profound intellectual and multiple disabilities (PIMD)*:

- Profound intellectual disability
- Adaptive behavior clearly below average

In addition:

- Motor impairment
- Sensory impairment
- Medical problems (e.g. epilepsy)

* also referred to as PMLD – profound and multiple learning disabilities

Pre-verbal Communication Development

Communication:

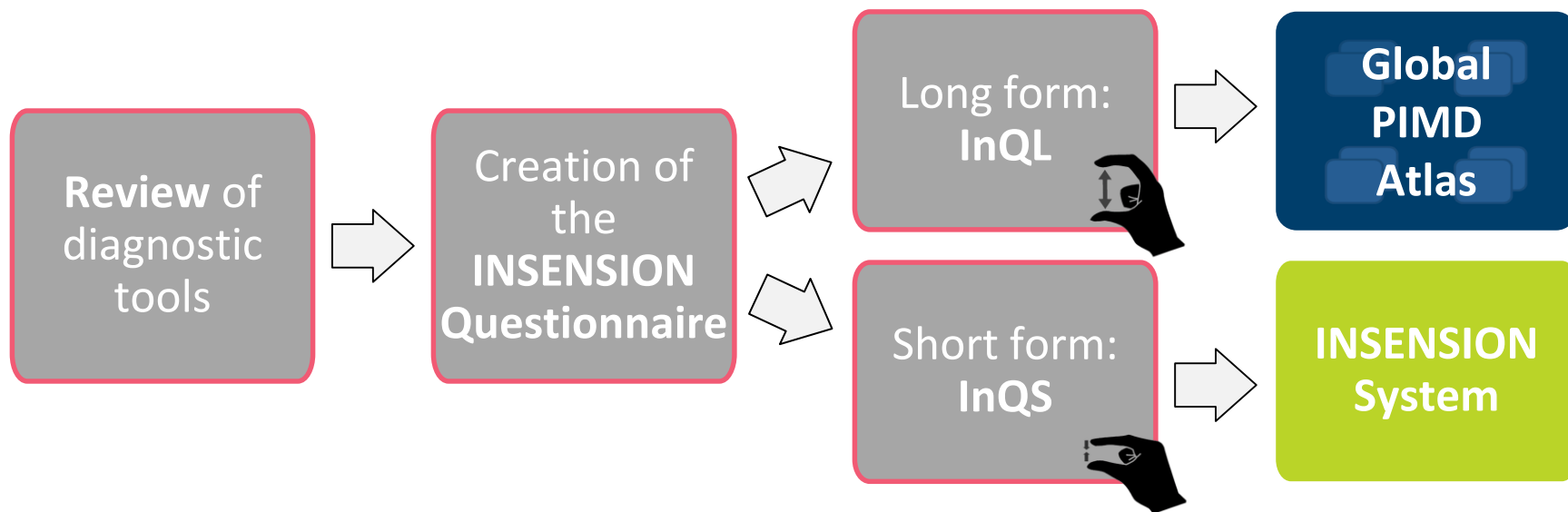
- Usually no verbal language
- Often on a pre-symbolic level
- Use of individual and unconventional behavior signals

(Axelsson et al., 2014; Nakken & Vlaskamp, 2007)



(Kane, 1992; Rowland, 2013)

Assessment of Communication and Inner States in People with PIMD



The *INSENSION* Questionnaire – Longform (InQL)

Hall et al. (2008) & Vos et al. (2012)

Preverbal Communication Schedule (PVCS)

by KIERNAN and REID (1987)

Aberrant Behavior Checklist (ABC)

by AMAN & SINGH (2017)

Mood & Anxiety Semi-structured Interview (MASS)

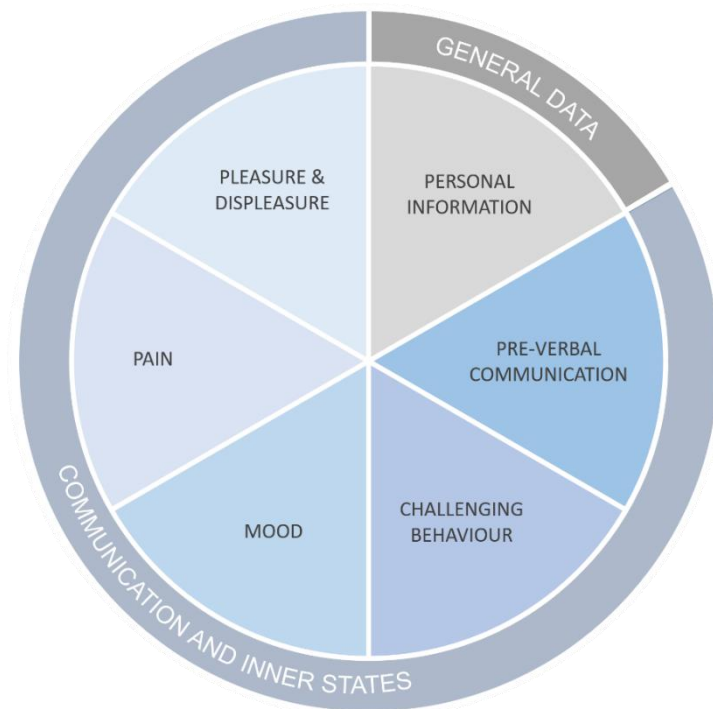
by CHARLOT et al. (2007)

Non-communicating Adult Pain Scale (NCAPS)

by LOTAN et al. (2009)

Disability Distress Assessment Tool (DisDat)

by REGNARD et al. (2007) complemented by Roemer et al. (2017)



Evaluation of the InQL

- Difficulties in implementation:
 - Assessment of pain and stress situations
 - Assessment of behavior during the night
- Advantages & benefits of the INSESION questionnaire:
 - Attention also to the knowledge of the relatives
 - New perspectives
 - Impulse for reflection and conscious analysis

Further Information



Engelhardt, M., Krämer, T., Marzini, M., Sansour, T. & Zentel, P. (2020). Communication assessment in people with PIMD. Evaluating the use of the INSENSION Questionnaire – Longform (InQL). *Psychoeducational Assessment, Intervention and Rehabilitation*, 2(1), 1–14.
<https://doi.org/10.30436/PAIR20-01>

Kosiedowski, M., Engelhardt, M., Krämer, T. & Urbanski, J. (2019). Global Atlas of people with profound intellectual and multiple disabilities. *Journal on Technology and Persons with Disabilities*, 7, 106–119.

The *INSENSION* Questionnaire – Shortform (InQS)

Hall et al. (2008) & Vos et al. (2012)

Preverbal Communication Schedule (PVCS)

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Aberrant Behavior Checklist (ABC)

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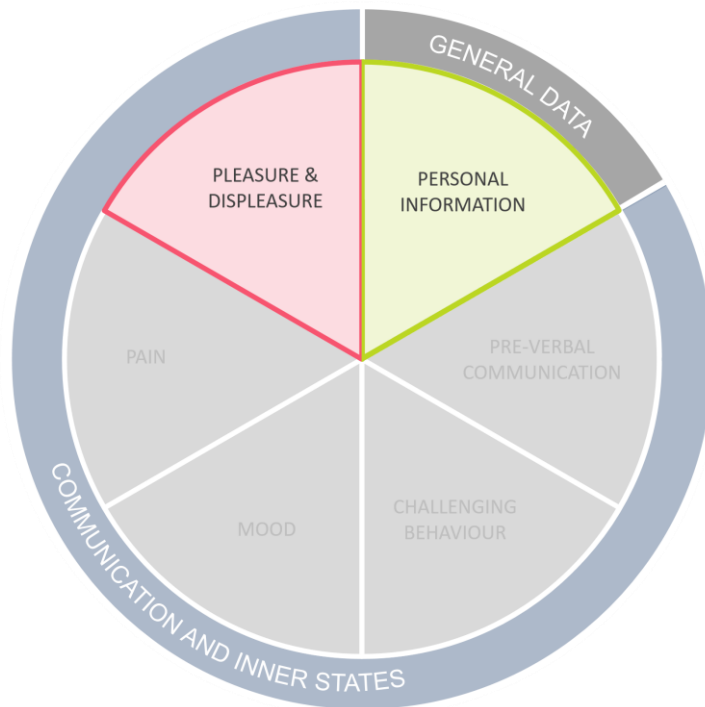
by CHARLOT et al. (2007)

Non-communicating Adult Pain Scale (NCAPS)

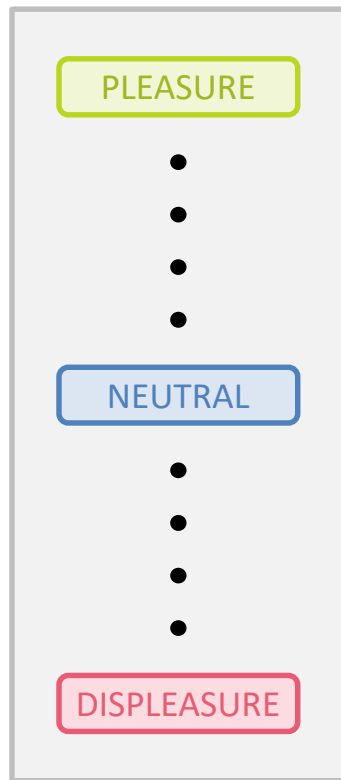
by LOTAN et al. (2009)

Disability Distress Assessment Tool (DisDat)

by REGNARD et al. (2007) complemented by Roemer et al. (2017)



Meaningful Behavior Signals



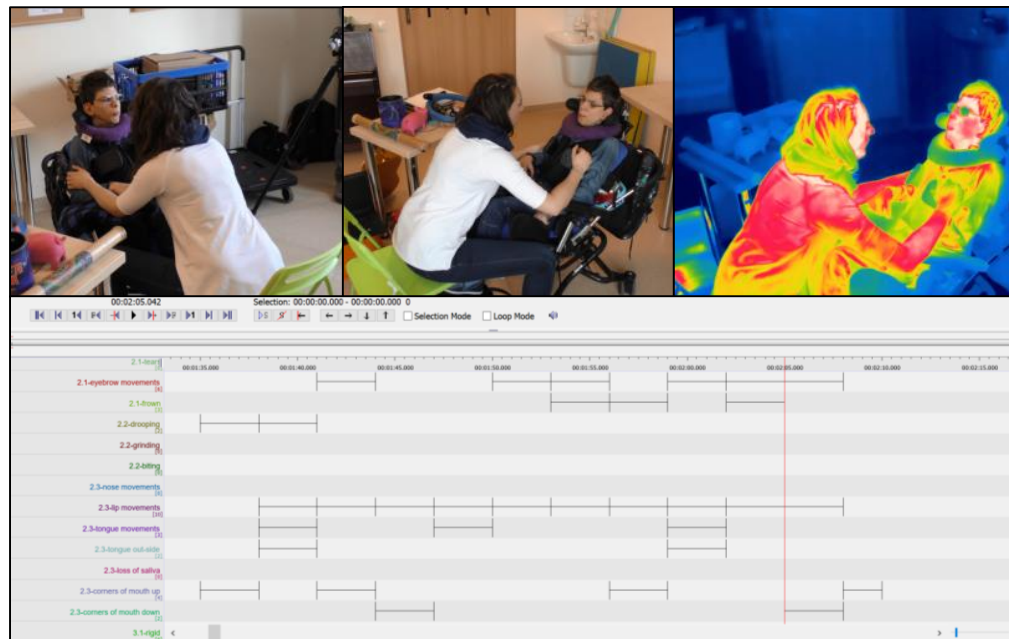
Corners of mouth up
Jerky body
Special vocalisation

Raising arm(s)
Floppy body

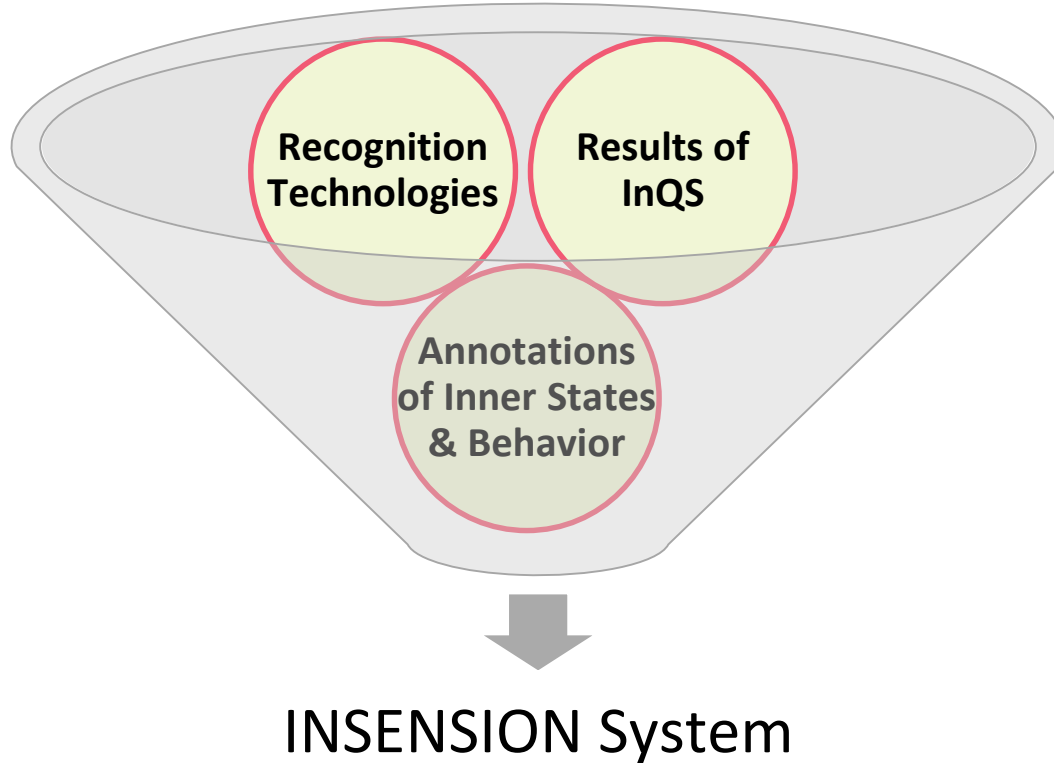
Frown
Closed eyes
Special vocalisation

Annotation Process

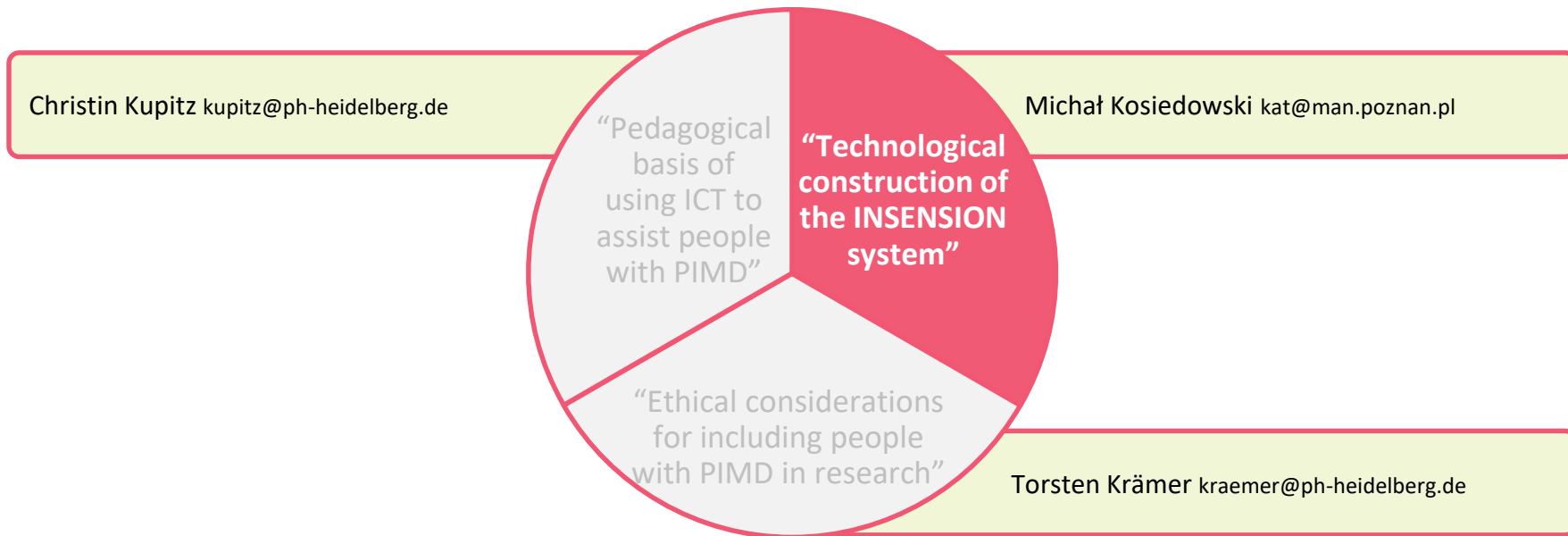
- Based on the individual annotation guideline
- Annotation of selected videos regarding
 - different behavioral signals and
 - different inner states
- Over 20 h of annotated recordings



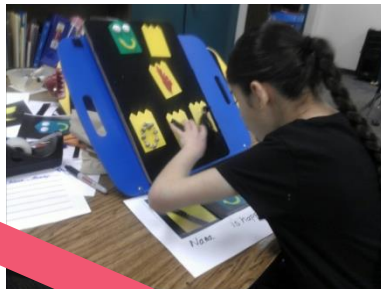
Further Procedure



Different perspectives on the INSENSION project



Non-symbolic interaction (1)



Request an item



Receive the item



**AUGMENTATIVE AND ALTERNATIVE
COMMUNICATION**

Non-symbolic interaction (2)

- Reactions to the happenings around through:
 - gestures
 - facial expressions
 - vocalizations
 - gaze
- These signals are highly individual!

Non-symbolic interaction (3)

ACCEPT

(I WANT IT)



Inner state

PLEASURE



NEUTRAL

DISAPPROVE

(I DON'T WANT IT)



DISPLEASURE



The system



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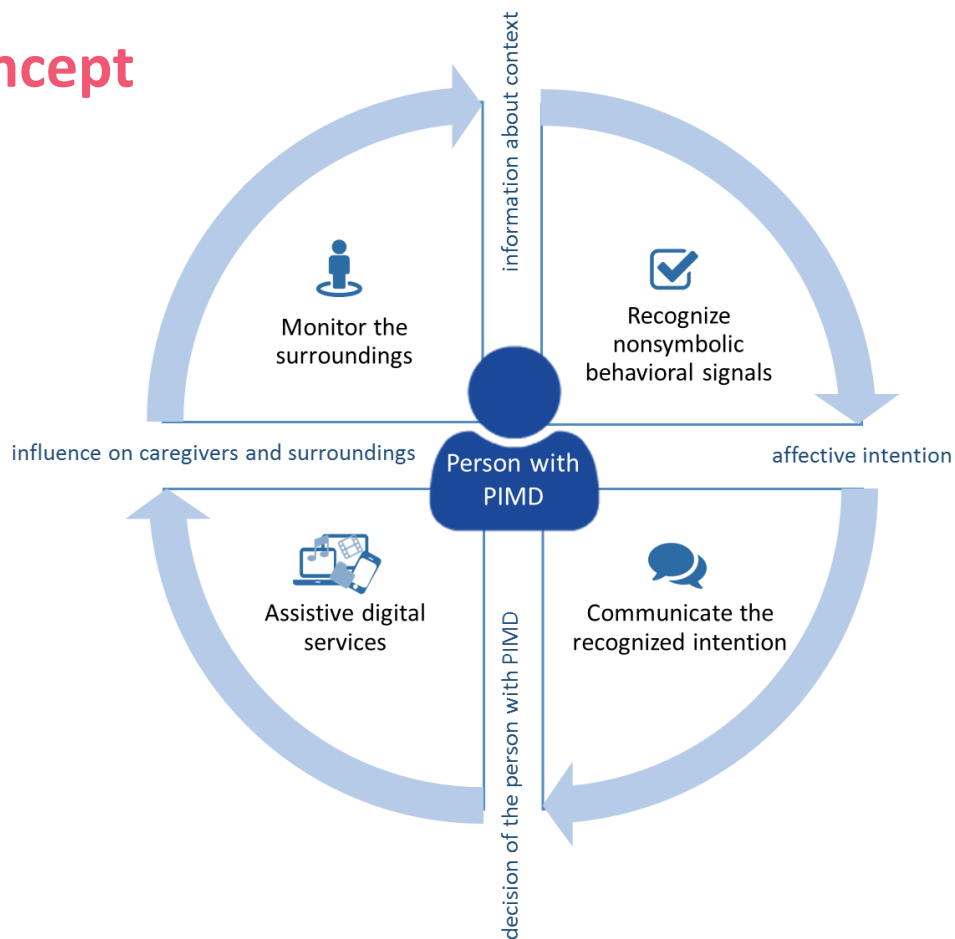
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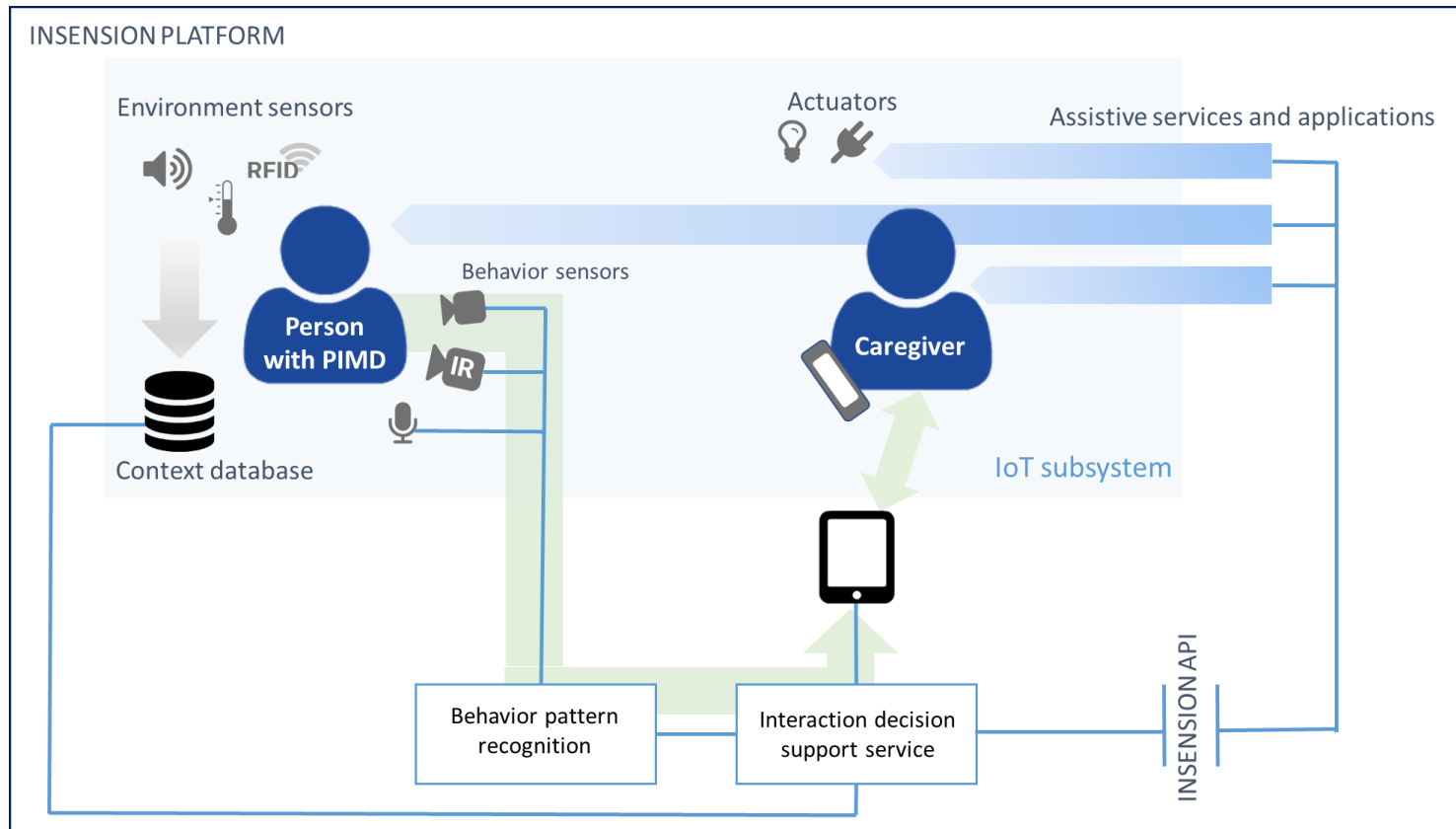
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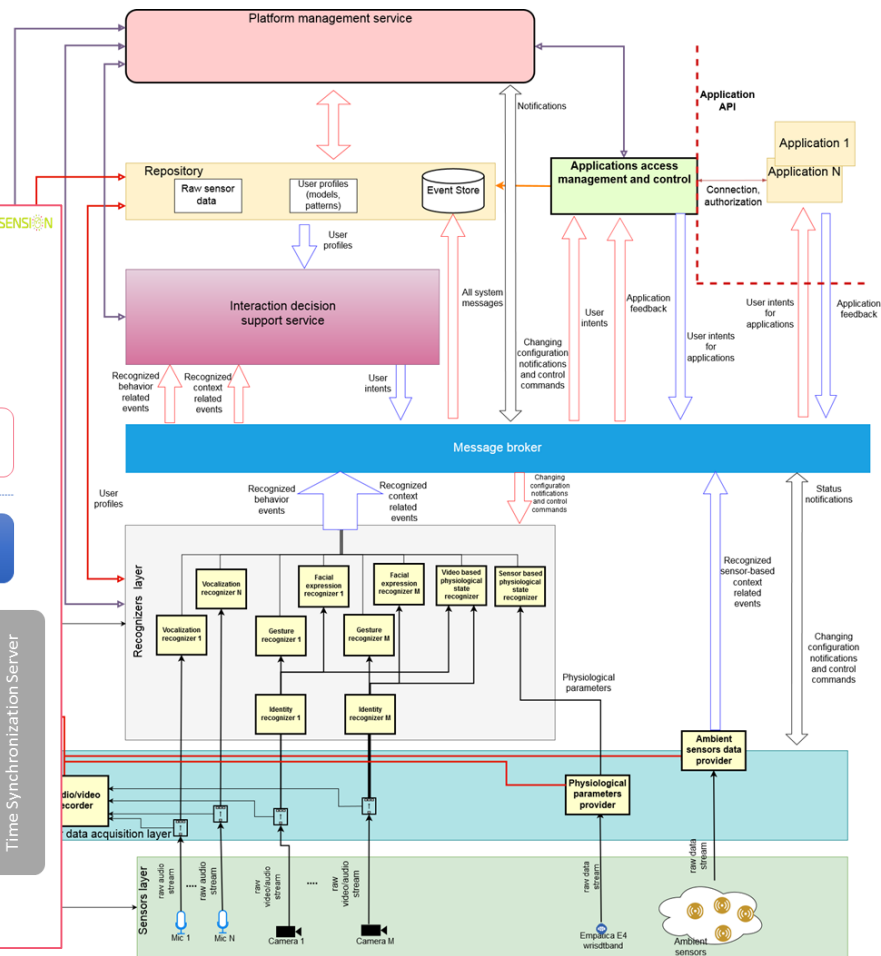
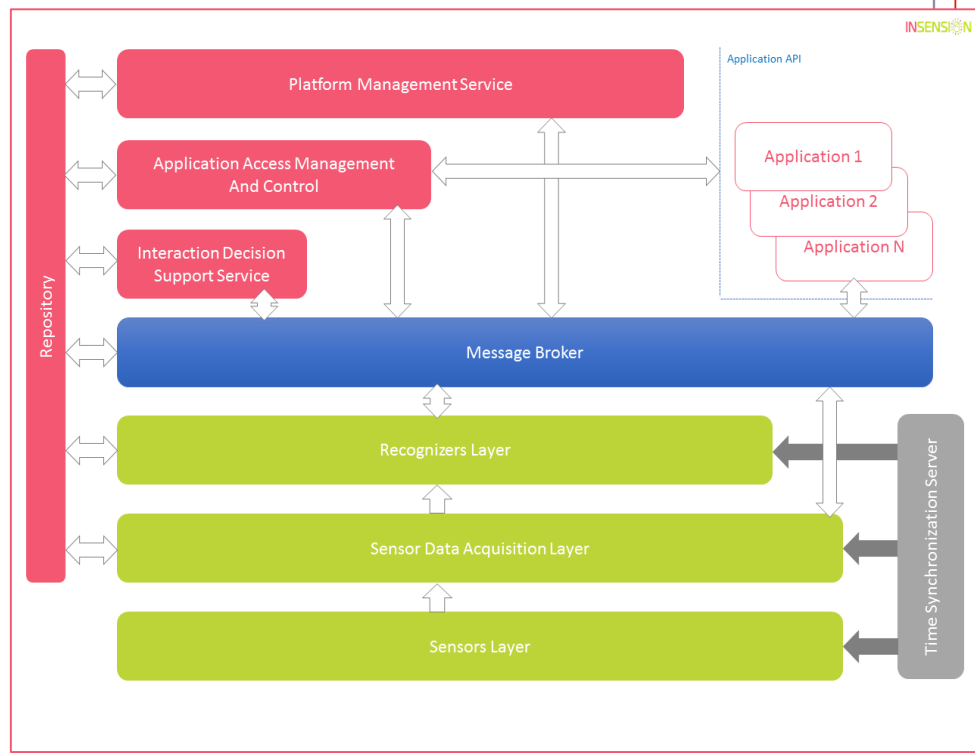
General concept



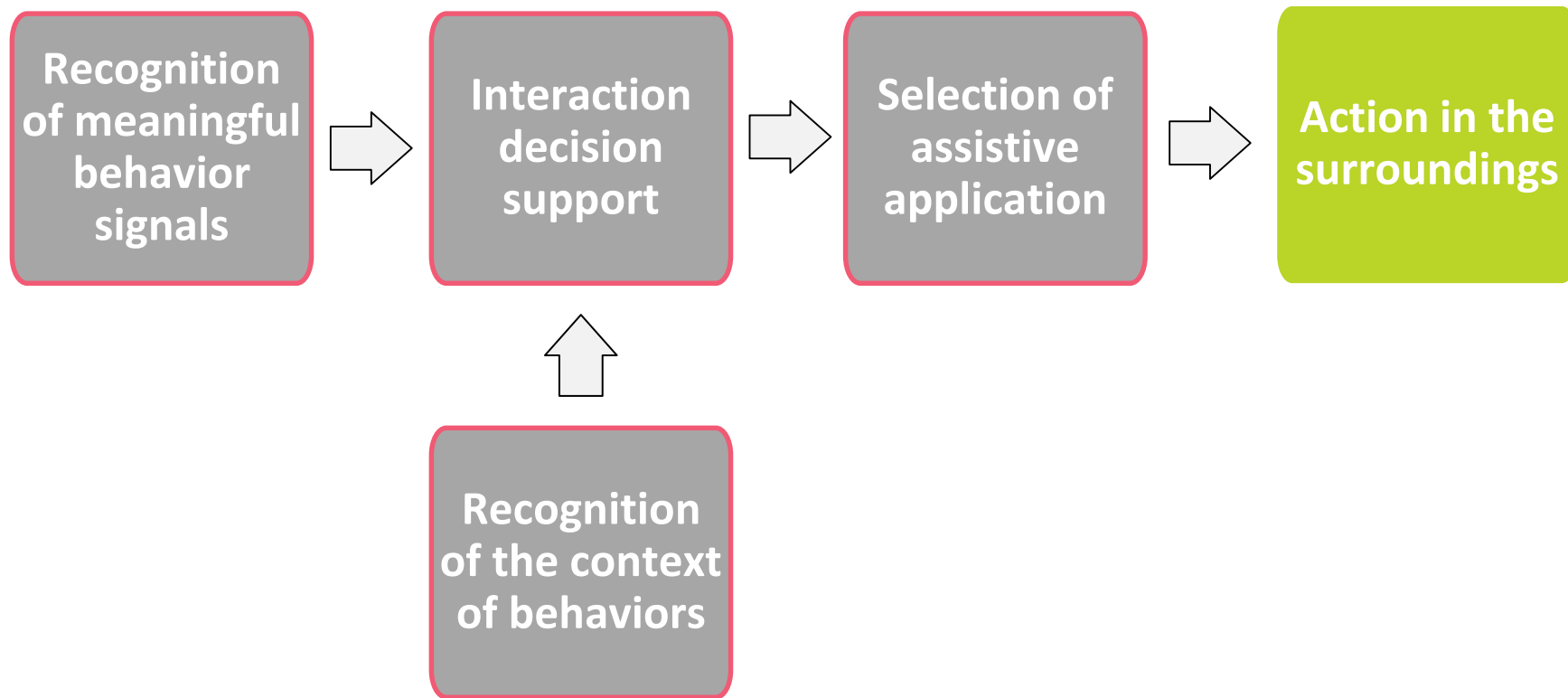
Insension platform



Platform complexity



The process of supporting user's interaction with surroundings





1. Recognition of behavior signals



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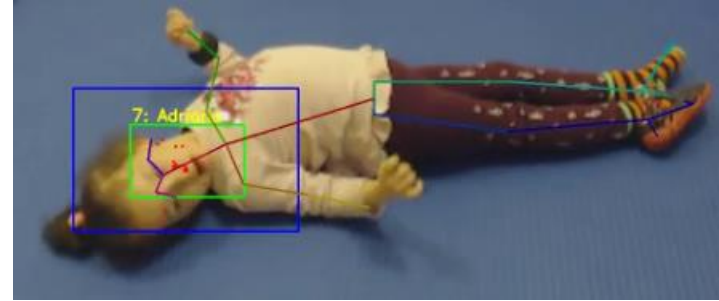
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Recognizers of behavior signals



*Facial expression
recognizer*



Gesture recognizer



Vocalization recognizer



2. Recognition of the context



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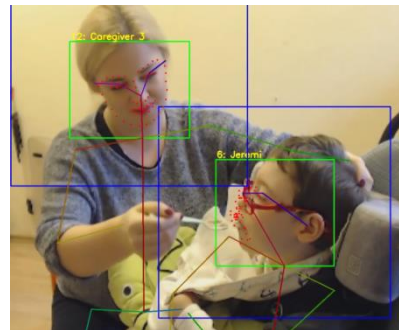
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Context recognizers



Ambient sounds recognizer



Identity recognizer



Ambient sensors

Feedback
from
assistive
applications



Object recognizer



3. Interaction decision support



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Interaction decision support

- Objective: interpret the data collected by recognizers as *user intents* using machine learning techniques
 - A *user intent* contains:
 - inner state of the user (PLEASURE/DISPLEASURE/NEUTRAL)
- plus
- potential causes of the behavior related to the current user intent



4. Selection of the assistive application to act



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Selection of the application to act (1)


Administration
Language
Account

Record
Persons
Previous Events
Platform Management
Users Accounts
Applications
About Insension

Home / Persons / Ad R / Applications

Applications sets

Create new set

Do nothing
Default order set
More
Edit
Delete

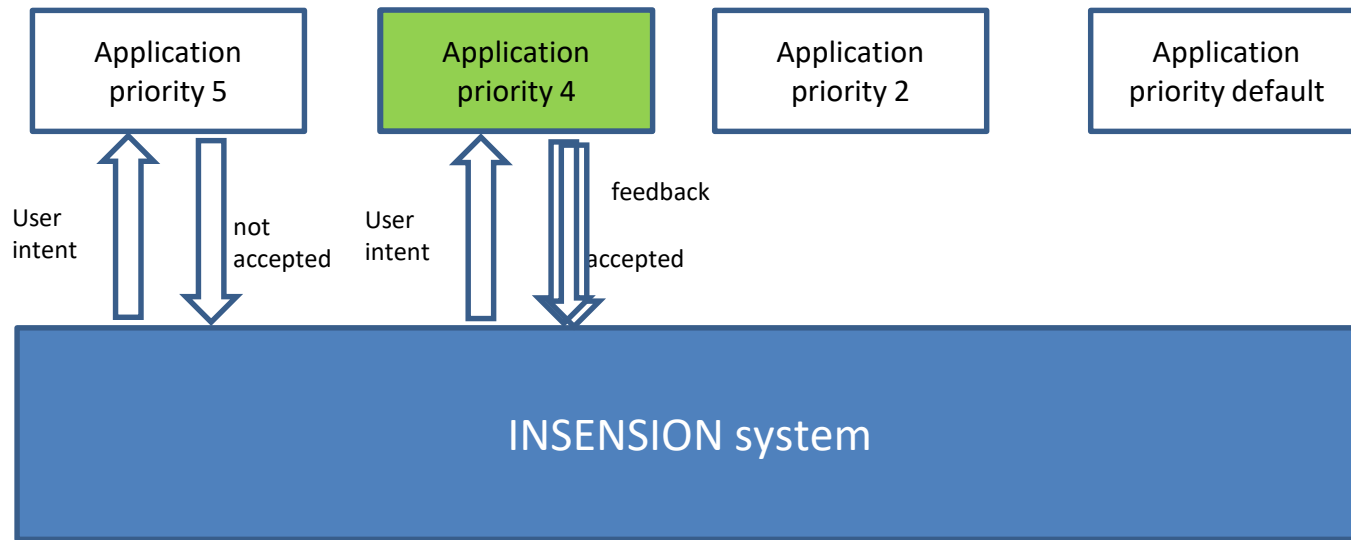
daytime
More
Set as default
Edit
Delete

Available applications
Run as first Smart Room
Run as last Media Player (Default)

nighttime
More
Set as default
Edit
Delete

Available applications
Run as first Media Player
Run as last Communicator (Default)

Application has to confirm it will take action





5. Action in the surroundings of the person with PIMD



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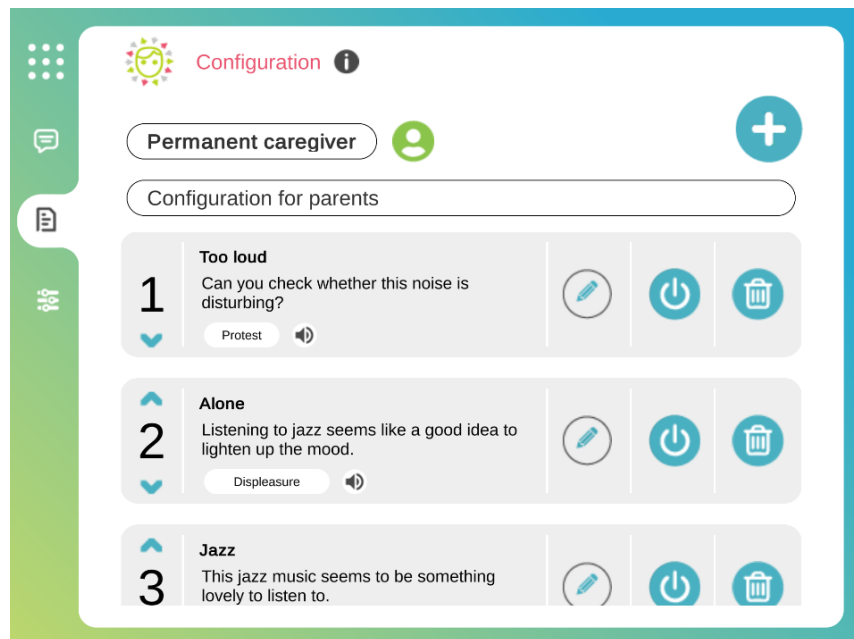


Assistive applications

- **Goal of the INSENSION platform:** provide information on the current need of the end user to external applications which are capable of acting on behalf of the end user
- **Example (pilot) applications:**



Applications must be configured to know what to do when



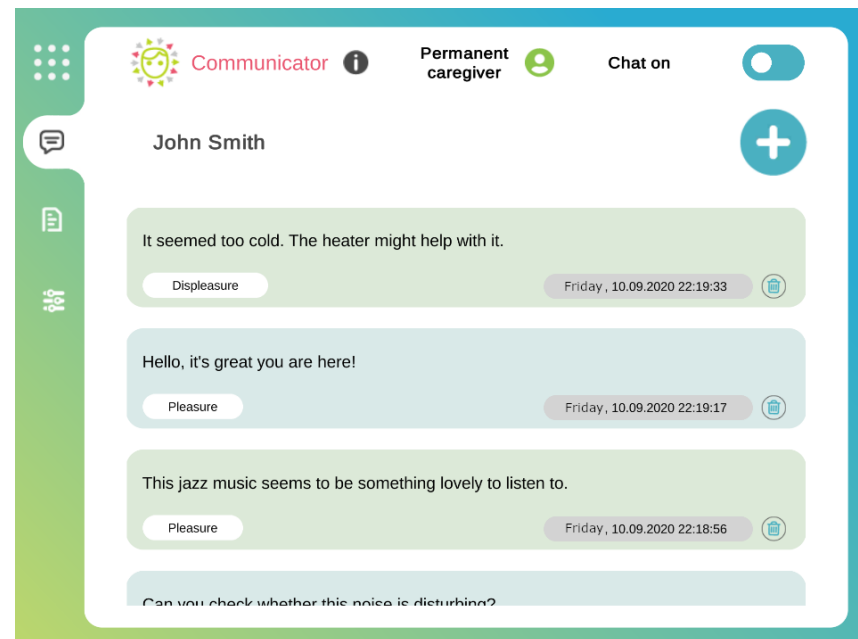
Configuration ⓘ

Permanent caregiver ⓘ

Configuration for parents

1	Too loud Can you check whether this noise is disturbing?			
	Protest			
2	Alone Listening to jazz seems like a good idea to lighten up the mood.			
	Displeasure			
3	Jazz This jazz music seems to be something lovely to listen to.			

Rules

Communicator ⓘ

Permanent caregiver ⓘ Chat on ☒

John Smith ⓘ

It seemed too cold. The heater might help with it.

Displeasure Friday, 10.09.2020 22:19:33

Hello, it's great you are here!

Pleasure Friday, 10.09.2020 22:19:17

This jazz music seems to be something lovely to listen to.

Pleasure Friday, 10.09.2020 22:18:56

Can you check whether this noise is disturbing?

Actions

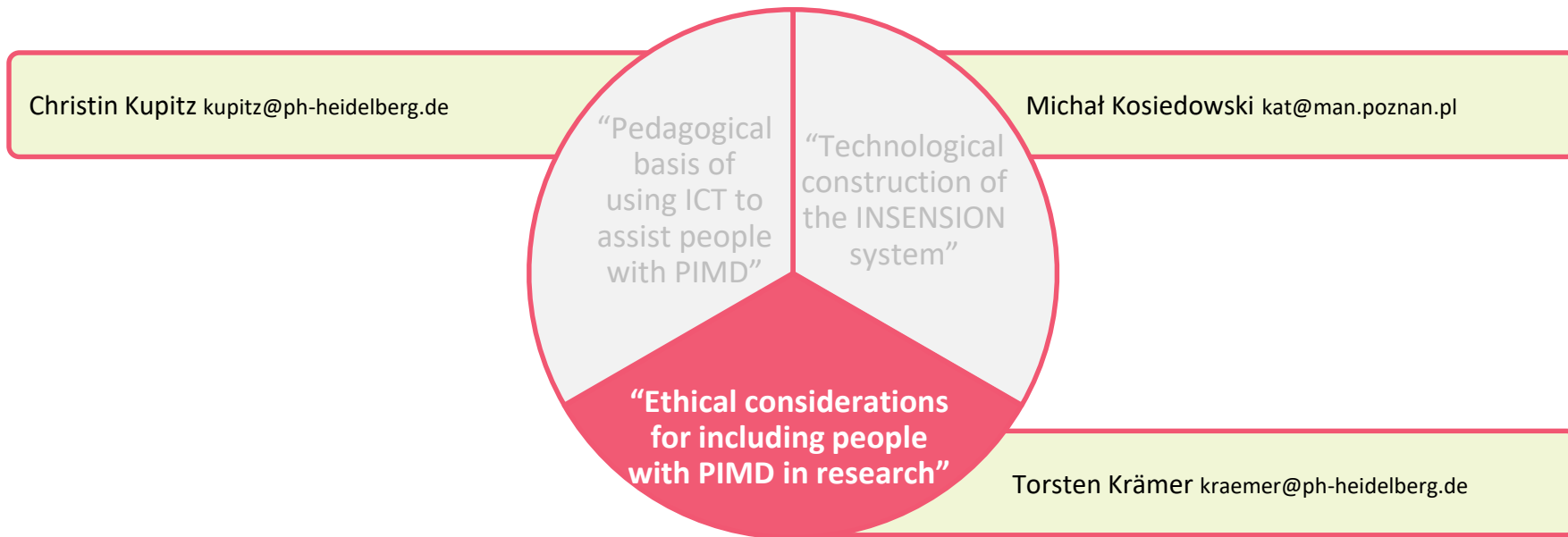
Further Information



Kosiedowski, M., Radziuk, A., Szymaniak, P., Kapsa, W., Rajtar, T., Stroinski, M., Campomanes-Alvarez, C., Campomanes-Alvarez, B., Lustrek, M., Cigale, M., Dovgan, E., Slapnicar, G. (2019). On Applying Ambient Intelligence to Assist People with Profound Intellectual and Multiple Disabilities. In: Bi Y., Bhatia R., Kapoor S. (eds) Intelligent Systems and Applications. IntelliSys 2019. Advances in Intelligent Systems and Computing, vol 1038, 895-914. Springer, Cham.
https://doi.org/10.1007/978-3-030-29513-4_66

C. Campomanes-Álvarez, B. R. Campomanes-Álvarez and P. Quirós (2019). Person Identification System in a Platform for Enabling Interaction with Individuals Affected by Profound and Multiple Learning Disabilities. 2019 IEEE 18th International Conference on Cognitive Informatics & Cognitive Computing (ICCI*CC), 2019, 166-173. <https://doi.org/10.1109/ICCICC46617.2019.9146032>

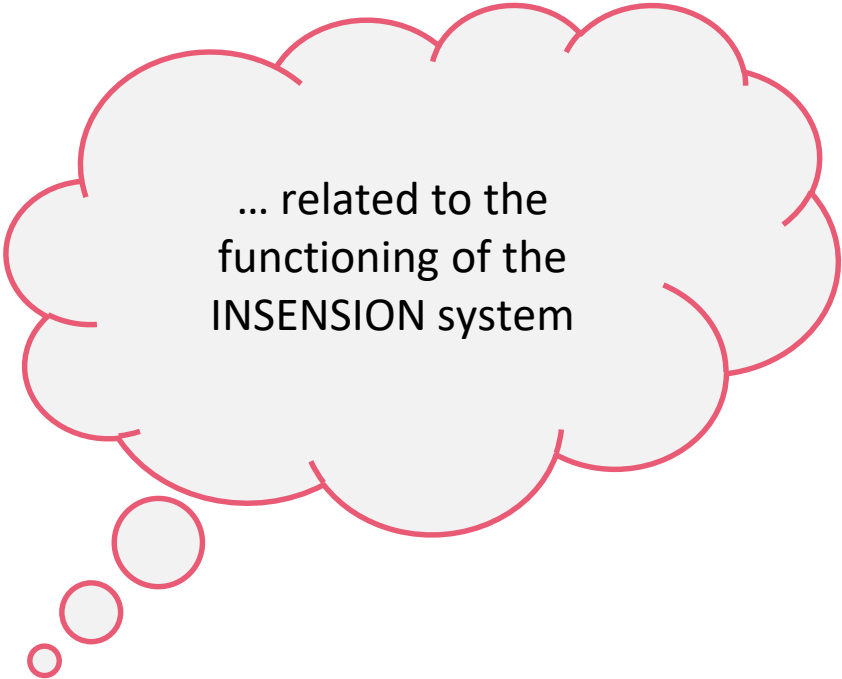
Different perspectives on the INSENSION project



Ethical considerations



... related to involving
people with PIMD in
research



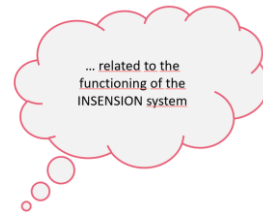
... related to the
functioning of the
INSENSION system

Permanent monitoring through artificial intelligence?

Taking pre-intentional
behavior as a reference
point for our
communicative actions
(Hennig 2011)

Acknowledging and
respecting
communicative downtime
(Klauß 2002)

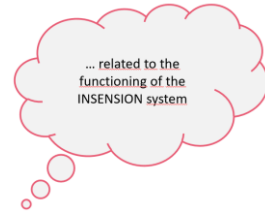
*balance between necessary caring, attentive
accompaniment and paternalistic supervision*



Concerns about technology in care?

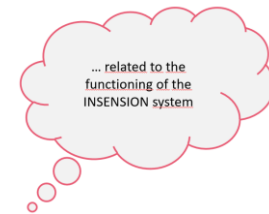
- **little concern** about cleaning robots or technical aids such as electric beds or wheelchairs that are able to avoid obstacles
- **medium concerns** about prostheses, the use of which will be made safer by sensors, service robots that can handle transport routes
- **major concerns** about so-called care robots, which interact directly with people in need of care, providing them with medication and food

(Butter et al. 2008)



Dehumanization through artificial intelligence?

- Addressing technical aids in the care of vulnerable people goes to the heart of what it means to be human
- Increasing humanization of robots and artificial intelligence leading to dehumanization of care



Dehumanization through artificial intelligence?

Our approach:

- Increase the independency and self-efficacy of people with PIMD
- Support for the caregivers (assistance in decision-making)
- More quality-time for human interactions!



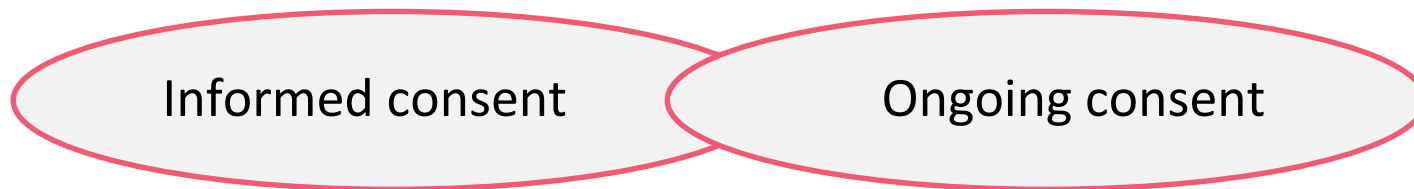
Involving people with PIMD in research?

- Participation despite lack of consent of the persons with PIMD themselves
 - Permanent monitoring
 - Collection of personal data
 - Unclear long-term effects on participants with PIMD and caregivers



Involving people with PIMD in research?

Our approach:



- Informed consent at the beginning including close caregivers (professionals and relatives)
- Substitute 'consent' by legal guardians
- Focusing the benefits for the persons with PIMD

- Ongoing consent during the whole research process including all persons involved
- Monitoring the behavior of the persons with PIMD
- Permanent and transparent reflection with optional readjustment

(Calveley, 2012; Coons & Watson, 2013; Mietola et al., 2017)

Further Information



Engelhardt, M., Kosiedowski, M., Krämer, T., & Tyrakowska, J. (2019). Should Artificial Intelligence be Used to Empower People with Profound Intellectual Disabilities? Proceedings of the STS Conference Graz 2019, 84–104. <https://doi.org/10.3217/978-3-85125-668-0-06>

Krämer, T., & Zentel, P. (2020). Expression of Emotions of People with Profound Intellectual and Multiple Disabilities. A Single-Case Design Including Physiological Data. Psychoeducational Assessment, Intervention and Rehabilitation, 2(1), 15–29. <https://doi.org/10.30436/PAIR20-02>



Additional study



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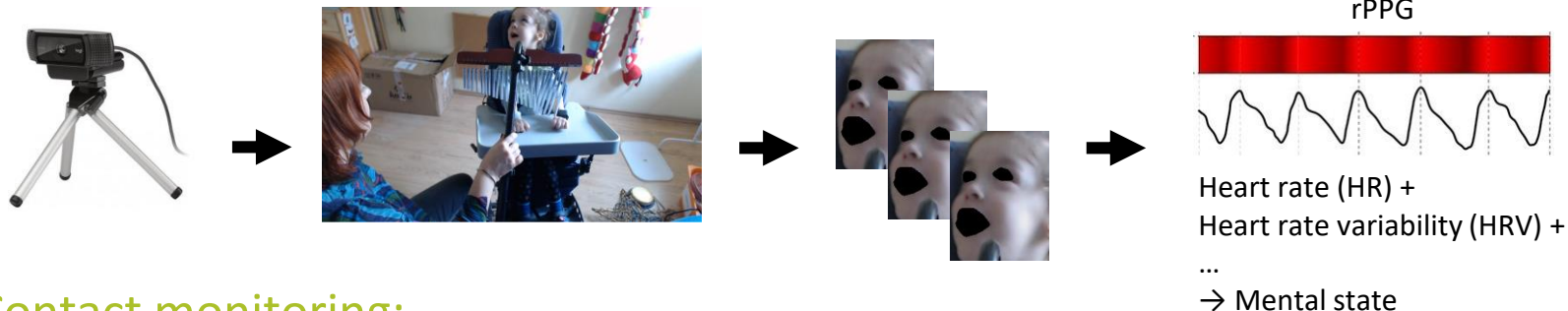
Additional study: influence of monitoring physiological response on the platform accuracy

Literature has suggested that including information on physiological response of people with PIMD might help to interpret their behaviors:

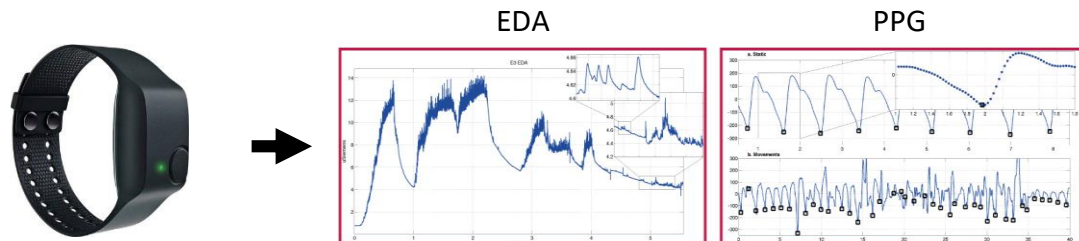
- *„heart rate and skin temperature can give information about the emotions of persons with severe and profound ID”* [Vos et al. 2012]
- *„frequent consistent physiological reactions”* to stimuli [Lima et al. 2013]
- *„a shallow, fast breathing pattern, used less thoracic breathing, had a higher skin conductance and had less RSA when experiencing positive emotions than when experiencing negative emotions”* [Vos et al. 2010]

Physiological parameters monitoring

- Contact-free monitoring:



- Contact monitoring:





Summary



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Summary

- Providing technological means to (successfully) support people with PIMD in interacting with others and surroundings is challenging
- The research leading to creation of the prototype of such technology is complex and requires integration of expertise from several disciplines
- The system must be verified with the participation of the target end users – people with PIMD (and their caregivers)
- While the system extensively uses AI, it does not aim to remove the human caregiver
- An AI-based system to support people with PIMD is a must: not applying Artificial Intelligence on people with PIMD due to their incapability of consenting to it would refuse them the possibility to benefit from the potential of achieving a (higher) level of independence



Thank you for your attention!

Further information: www.insension.eu
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