

# Multiple knowledge categorising behavioural states and communication attempts in people with profound intellectual and multiple disabilities.

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# People with PIMD

- Profound intellectual and multiple disabilities
- Other possible disabilities such as motor or sensorial impairments
- Often coupled with other health issues
- Heavily reliant on caregivers
- Each individual is unique with different abilities and signals



- Allow people with PIMD to access digital services to enrich their life
- Use non-symbolic communication(NSC) signals to detect:
  - inner states
  - communication attempts
- Use with context to propose actions that improve mental state
  - Liked and disliked people
  - Suggest adding or removing an
  - Change the environment to suit the needs of the person

# Problem definition



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Q: How does she feel?

A: I can see her **smiling**



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Section 1: Introduction, motivation and problem definition

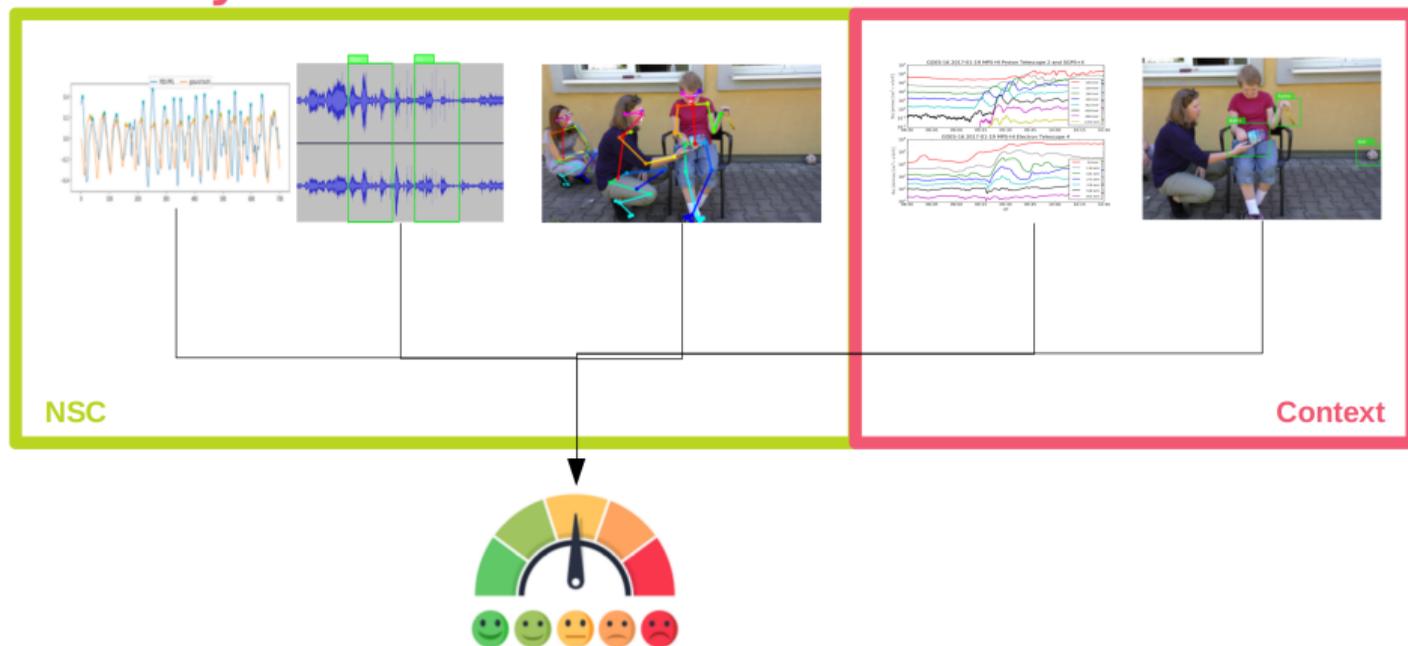
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# Non-symbolic communication and Context



# Data collection

- Annotated data
- Expert knowledge from caregivers

|                           |   |  |   |
|---------------------------|---|--|---|
| 2.3-corners of mou<br>[1] |   | because of screaming                                 |   |
| 3.11-Specific Move<br>[1] |   | showing teeth  |   |
| 5.2-female caregiv<br>[1] |   |  |   |
| 5.5-End-user acts<br>[1]  |   |  |   |
| 5.8-Other noises<br>[2]   |   | bottle sizzling                                      | bottle sizzling                               |
| A.1 Comment<br>[0]        |   |  |   |
| A.2 Demand<br>[0]         |   |  |   |
| A.3 Protest<br>[1]        |   |  |   |
| B.1 Pleasure<br>[0]       |   |  |   |
| B.2 Displeasure<br>[1]    |   |  |   |
| 2.2.                      | Appearance of Eyes  | Appearance of Pleasure                               |   |
|                           |   | <input checked="" type="checkbox"/> good eye contact | <input type="checkbox"/> little eye contact   |
|                           |   | <input type="checkbox"/> closed eyes                 | <input checked="" type="checkbox"/> staring   |
|                           |   | <input checked="" type="checkbox"/> "smiling"        | <input type="checkbox"/> winking              |
|                           |   |  | <input type="checkbox"/> avoiding eye contact |
|                           |   |  | <input type="checkbox"/> sleepy eyes          |
|                           |   |  | <input type="checkbox"/> vacant               |
|                           |   |  | <input checked="" type="checkbox"/> eyebrow   |
|                           | Cross the words that best describe the appearance of eyes |  |   |

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- Up till now we evaluated several different possible approaches:
  - Several standard ML approaches
  - Unique non-symbolic communication signals model
  - Valence derived inner state model
  - Decision support system based on expert knowledge
- Augmenting ML with expert knowledge

- Several methods were tested
  - nearest neighbors, linear SVM, RBF SVM, Gaussian process, decision tree, random forest, neural net, AdaBoost, naive Bayes, QDA
- The decision trees provide the best results
- We would like to make use of expert knowledge and perhaps even have access to the model and tweak it if the experts say that it does not make sense

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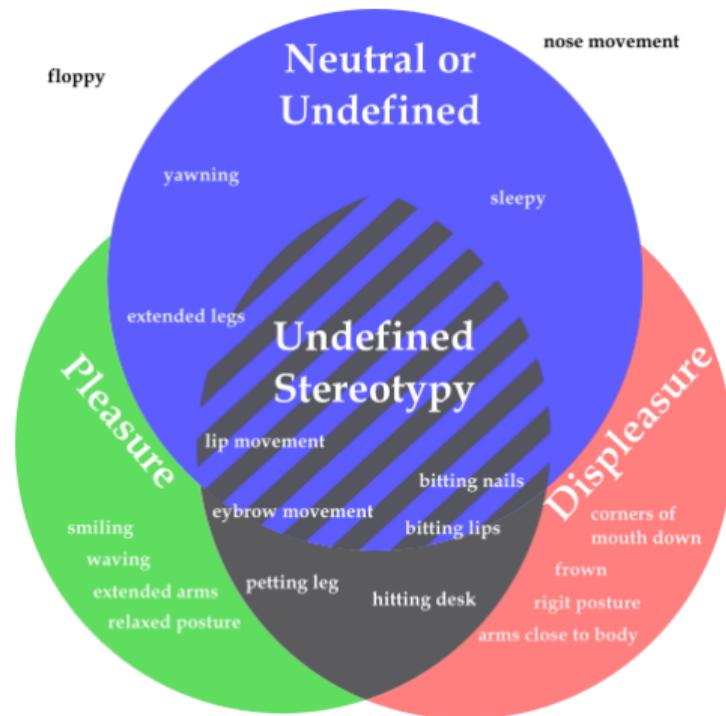
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# Unique non-symbolic communication

- Try to extract the NSC that is unique to each inner state and does not happen in any other situation
- To decide pleasure we check if any there exists a NSC that is defined as pleasure and is detected

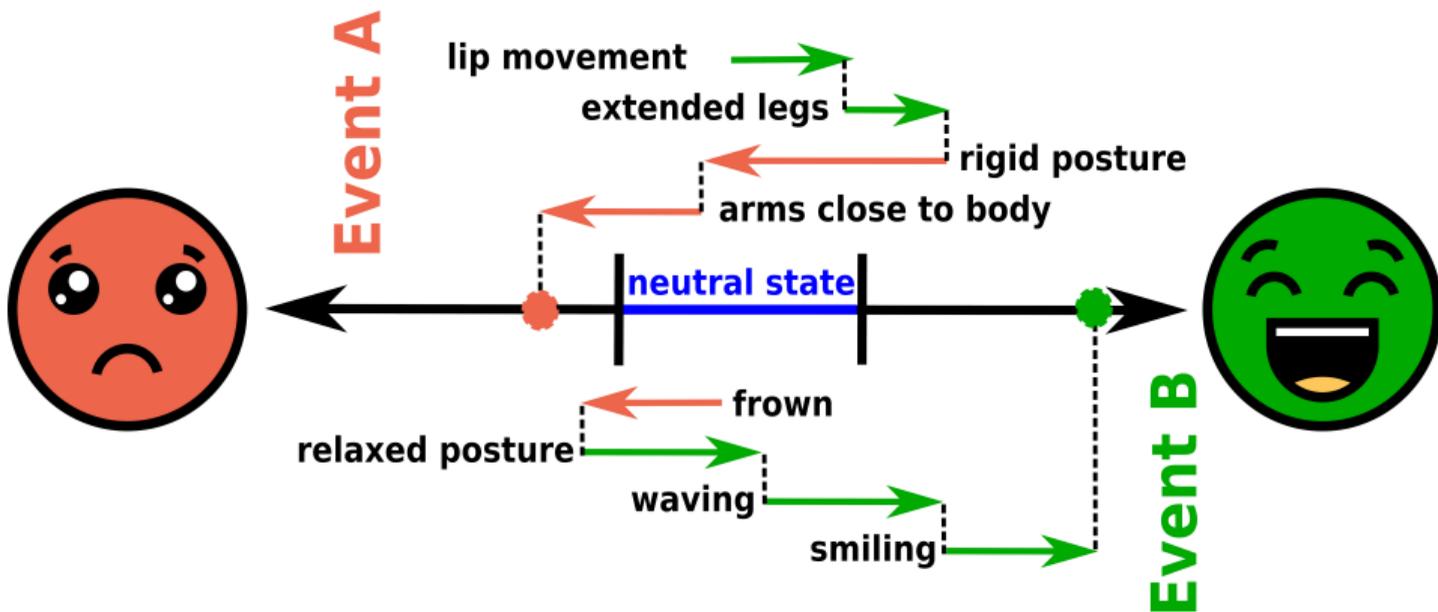


## The Unique Non Verbal Signals Method

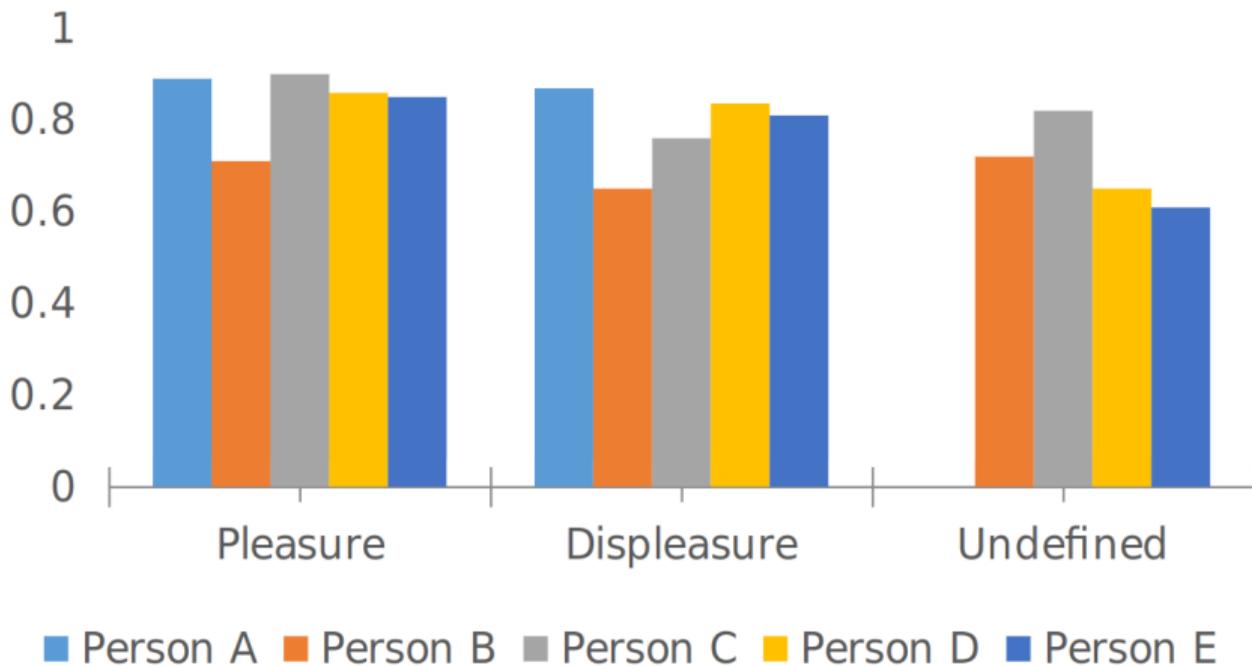


## Valence method

- Calculate the valence score of a NSC, then decide based on the sum of expressed NSC what inner state is most
- This method is expected to perform better with more observations



## The Valence Method



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- People and objects can be good indicators of inner state
  - The dataset at this time small
  - Some objects/people are session specific
  - Hard to argue causality
- The system might perform better if historical information is taken into account
- Working with the data from the recognizers needs to be validated
- Specialised ontology to aid reasoning about context in development