

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

Matej Cigale, Mitja Luštrek

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Department of intelligent systems, Jožef Stefan Institute, Ljubljana

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Section 2: Sources of knowledge

Section 3: Overview of the solutions

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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**



Problem definition



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A: I can see her **smiling**

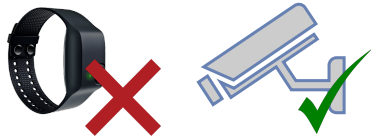


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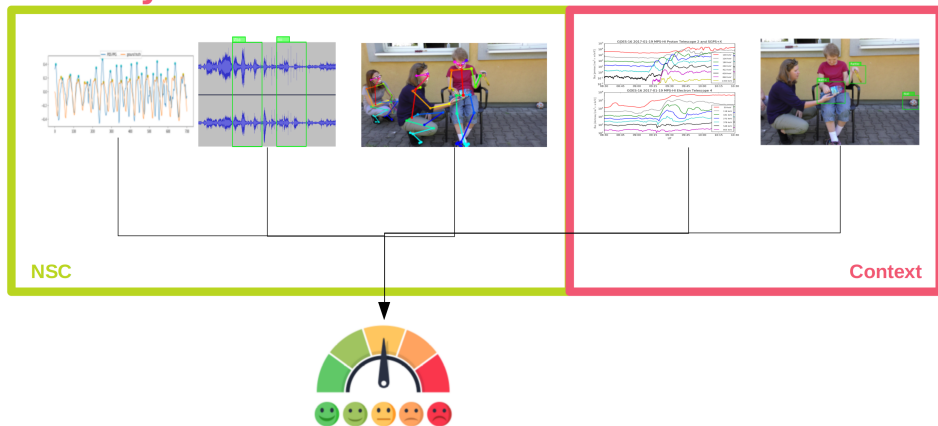
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Non-symbolic communication and Context



Data collection

- Annotated data
- Expert knowledge from caregivers

2.3-corners of mou [1]	because of screaming	
3.11-Specific Move [1]	showing teeth	
5.2-female caregiv [1]		
5.5-End-user acts [1]		
5.8-Other noises [2]	bottle sizzling	bottle sizzling
A.1 Comment [0]		
A.2 Demand [0]		
A.3 Protest [1]		
B.1 Pleasure [0]		
B.2 Displeasure [1]		

2.2.	Appearance of Eyes	Appearance of Pleasure		
Cross the words that best describe the appearance of eyes	<input checked="" type="checkbox"/> good eye contact	<input type="checkbox"/> little eye contact	<input type="checkbox"/> avoiding eye contact	
	<input type="checkbox"/> closed eyes	<input checked="" type="checkbox"/> staring	<input type="checkbox"/> sleepy eyes	
	<input checked="" type="checkbox"/> "smiling"	<input type="checkbox"/> winking	<input type="checkbox"/> vacant	
			<input checked="" type="checkbox"/> eyebrow	

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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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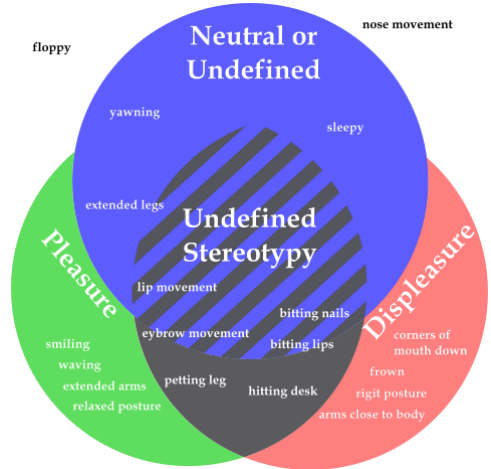
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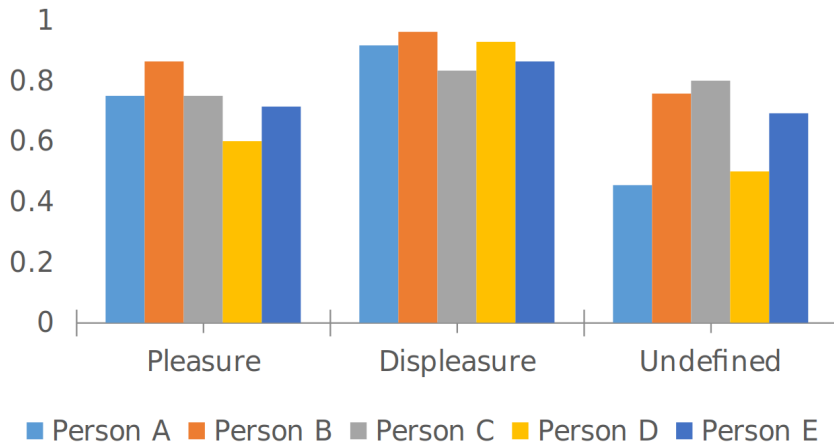
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Unique non-symbolic communication

- 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

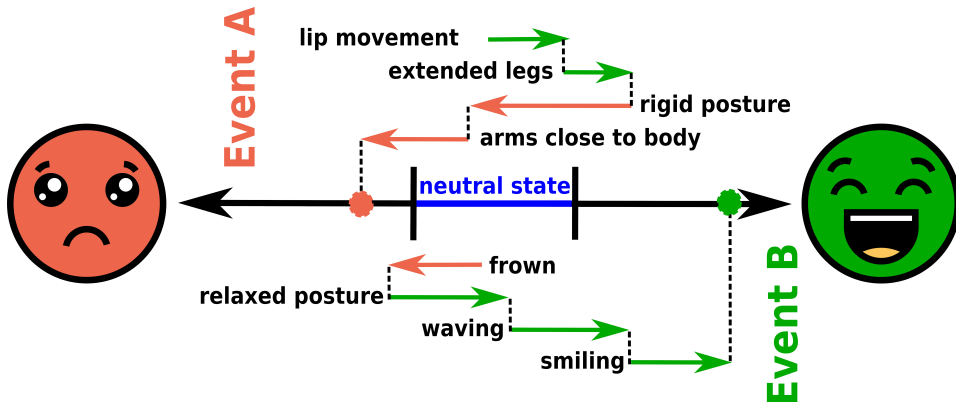


The Unique Non Verbal Signals Method

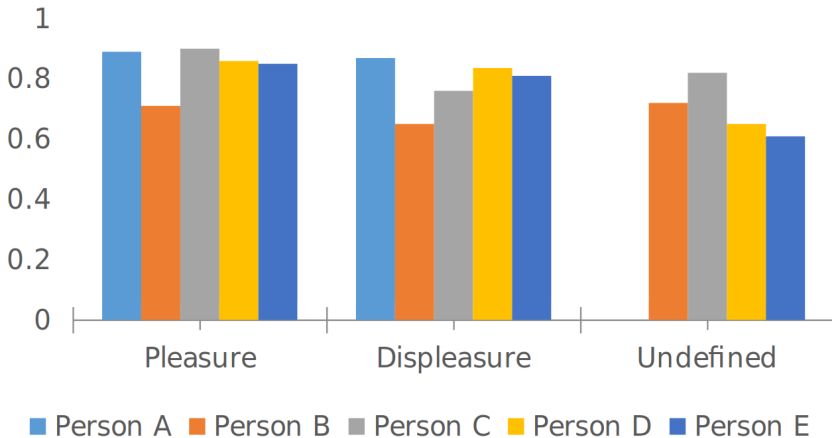


Valence method

- 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