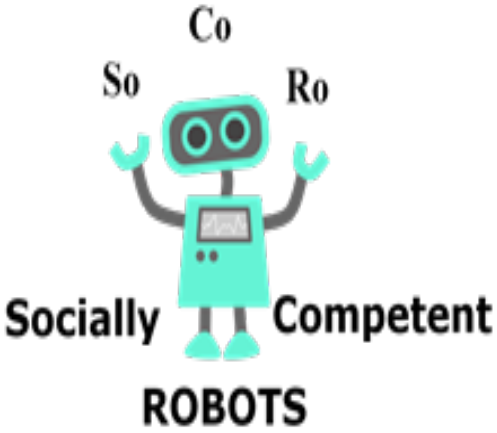
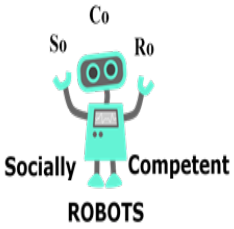


EPSRC
Engineering and Physical Sciences Research Council

Cultural Social Signal Interplay with an Expressive Robot

Ruth Aylett



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Overview

- Autism and SoCoRo
- Piloting facial expressions
- Using the Autism Quotient questionnaire
- Culturally-mediated interpretations

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Introduction..

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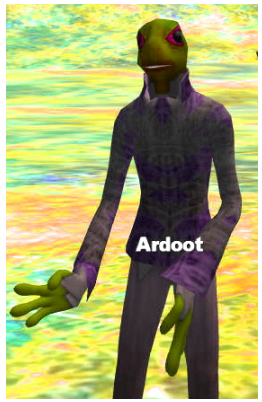

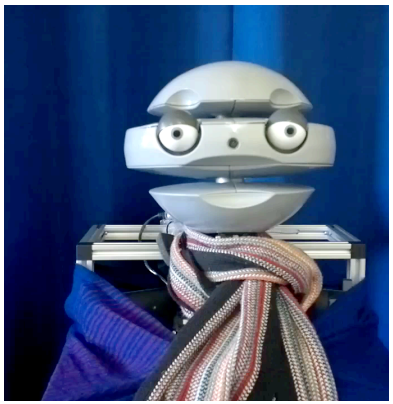

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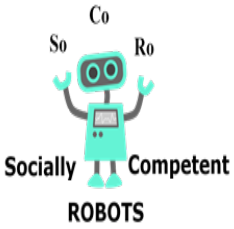
Project aim

Work towards a socially competent robot to deliver social skills therapy to high-functioning autistic adults



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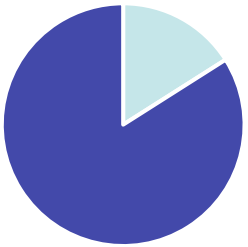
Lifespan of high-functioning adults with an ASD

KASPAR the robot

FTE of adults with ASD in UK



Infancy

Primary education

Secondary education

Unemployment

Employment

Higher education

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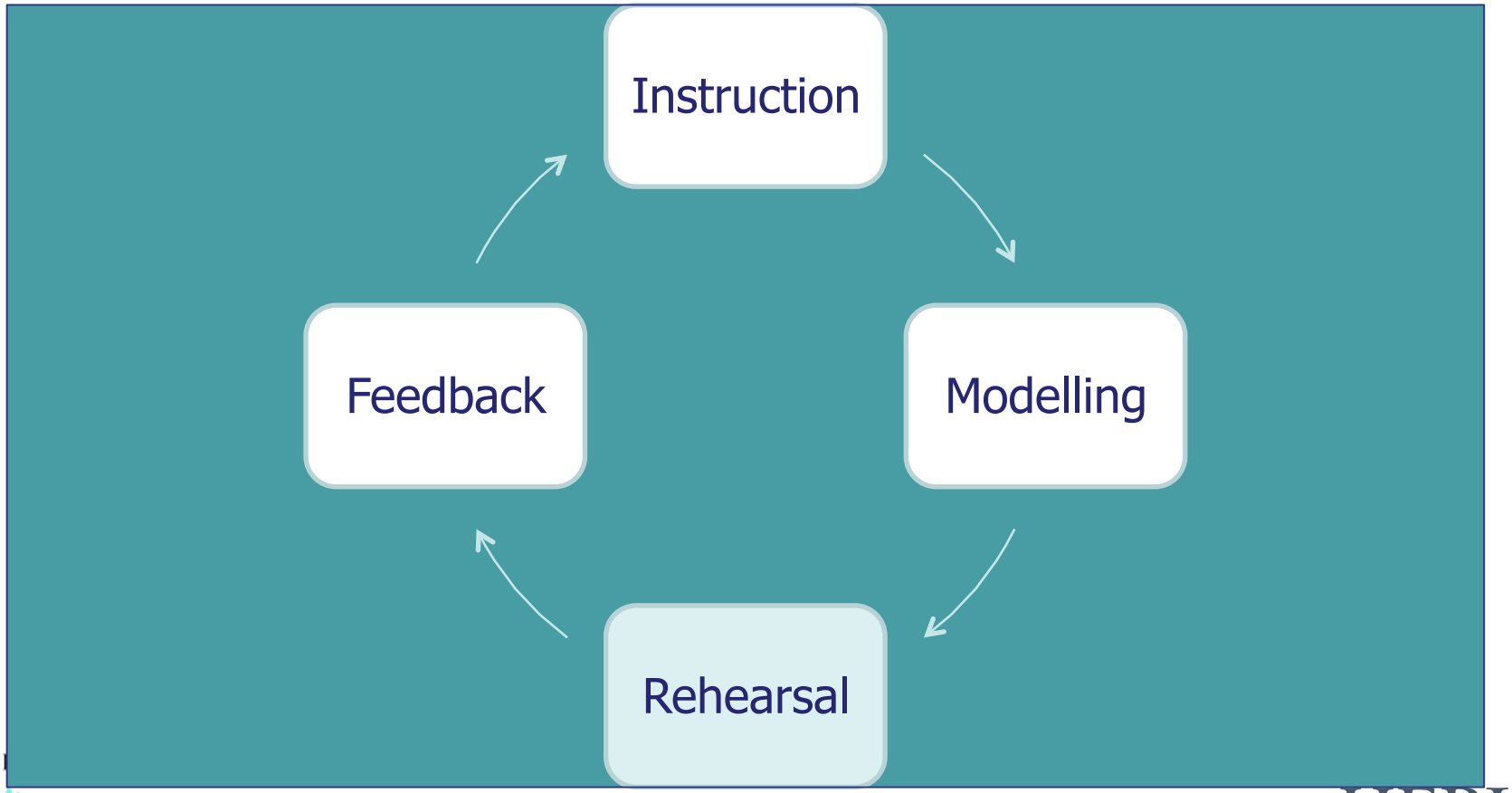
Therapy: Behavioural skills training (BST)



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Feasible workplace social skills of interest

- Interpreting facial expressions
- Coping with interruptions/ transitions
- Completing time-sensitive tasks
- Dealing with feedback

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Why robots?

Signal-to-noise ratio

Facial Action Coding System

- A smile: AU12
  - Change in the nasolabial furrow
  - Change in the infraorbital triangle
  - Change in the lip corners

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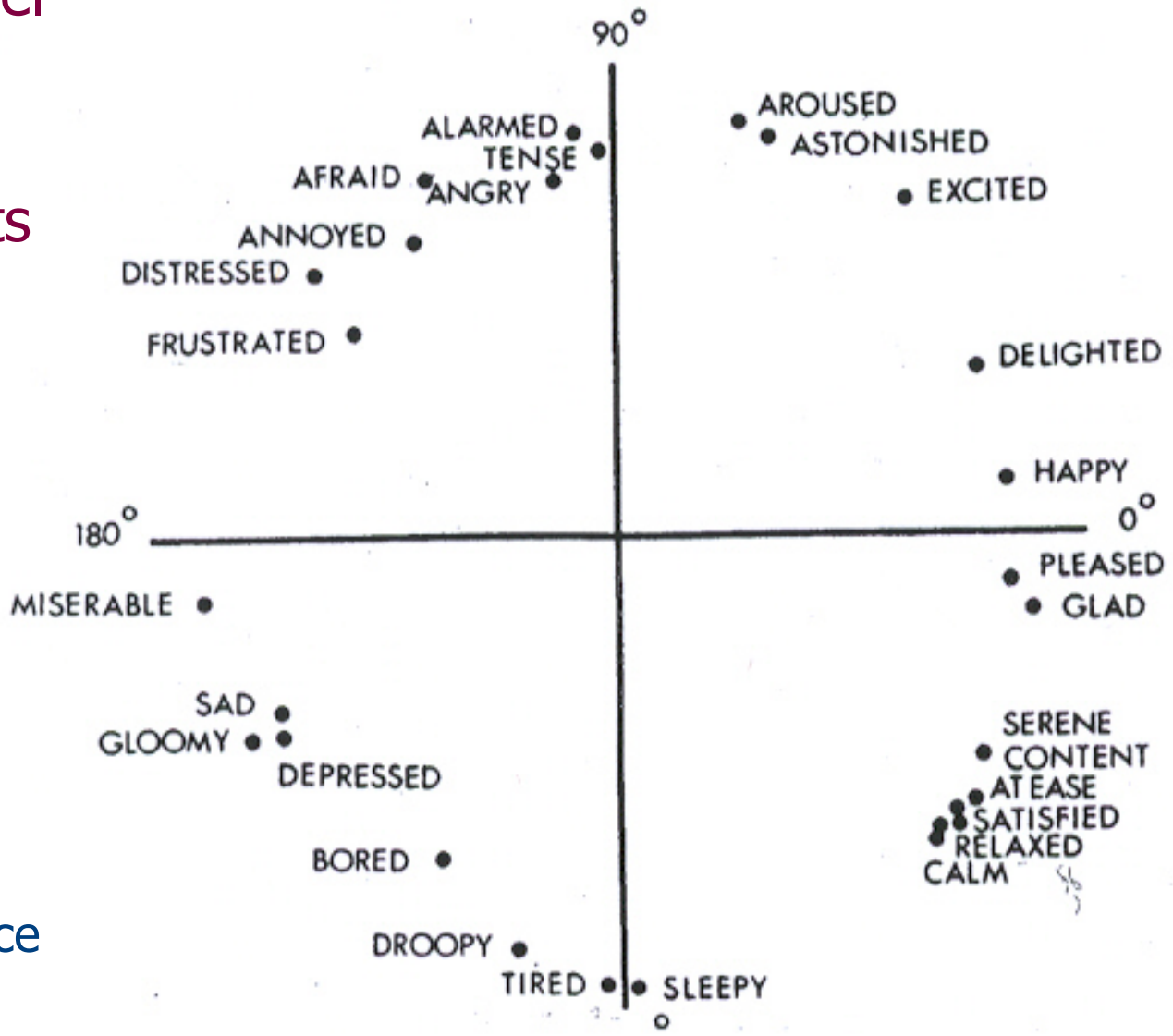
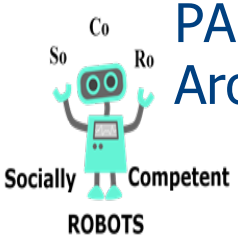
Static v dynamic

- AUs alone more useful for static expressions
  - When is an AU invoked?
  - With what dynamics?
- What can be used to dynamically drive facial expressions?

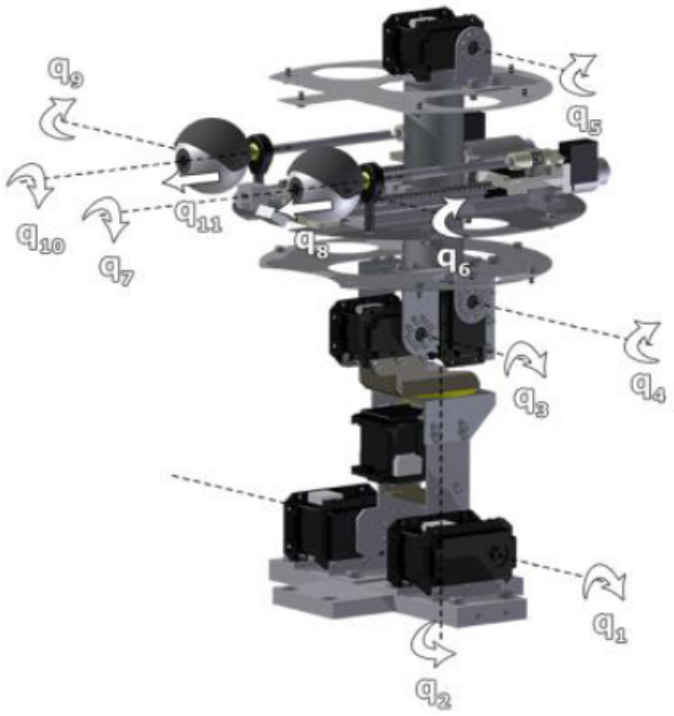
Russell's classification

- Circumplex Model of Affect
  - Russell 1980
- Two components
  - (1) pleasure-displeasure VALANCE
  - (2) arousal-sleep AROUSAL
- Adding a third:
  - Dominance
    - To split anger and fear
  - PAD: Pleasure, Arousal, Dominance





Controlling the Emys head



Joint	Joint name
q1	Neck pitch (rotation)
q2	Head yaw (rotation)
q3	Head pitch (rotation)
q4	Lower disc (rotation)
q5	Upper disc (rotation)
q6	Left eyelid (rotation)
q7	Left eyebrow (rotation)
q8	Left eye (translation)
q9	Right eyelid (rotation)
q10	Right eyebrow (rotation)
q11	Right eye (translation)

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Designing expressions

- Emys DOFs -> feasible AUs
  - Example:
    - Eyebrows: AU1, AU2, AU4
- Literature mapping AUs to PAD values
  - Hadar 2015
  - Boukricha et al 2009
  - Grammer & Oberzaucher 2006
  - Snodgrass 1992

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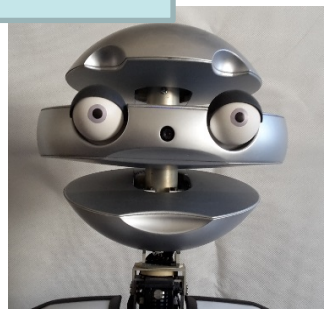
Experimental work: Expressive behaviour

Approval

1: Head up, jaw drop

2: Outer brow raiser, lips part

3: Wink, head left



4: Upper lid raiser, jaw drop

Disapproval

5: Inner brow raiser, lower lip depressor

6: Chin raise, head down

7: Brow lowerer, chin raise

8: Eyes closed, head down

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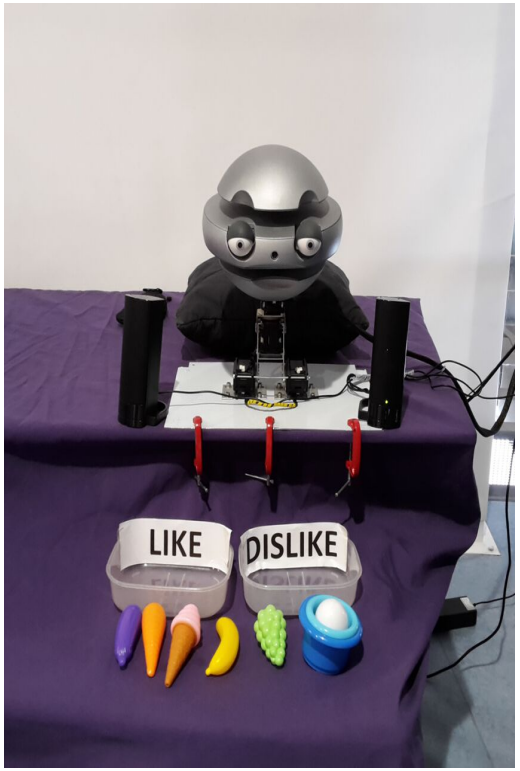
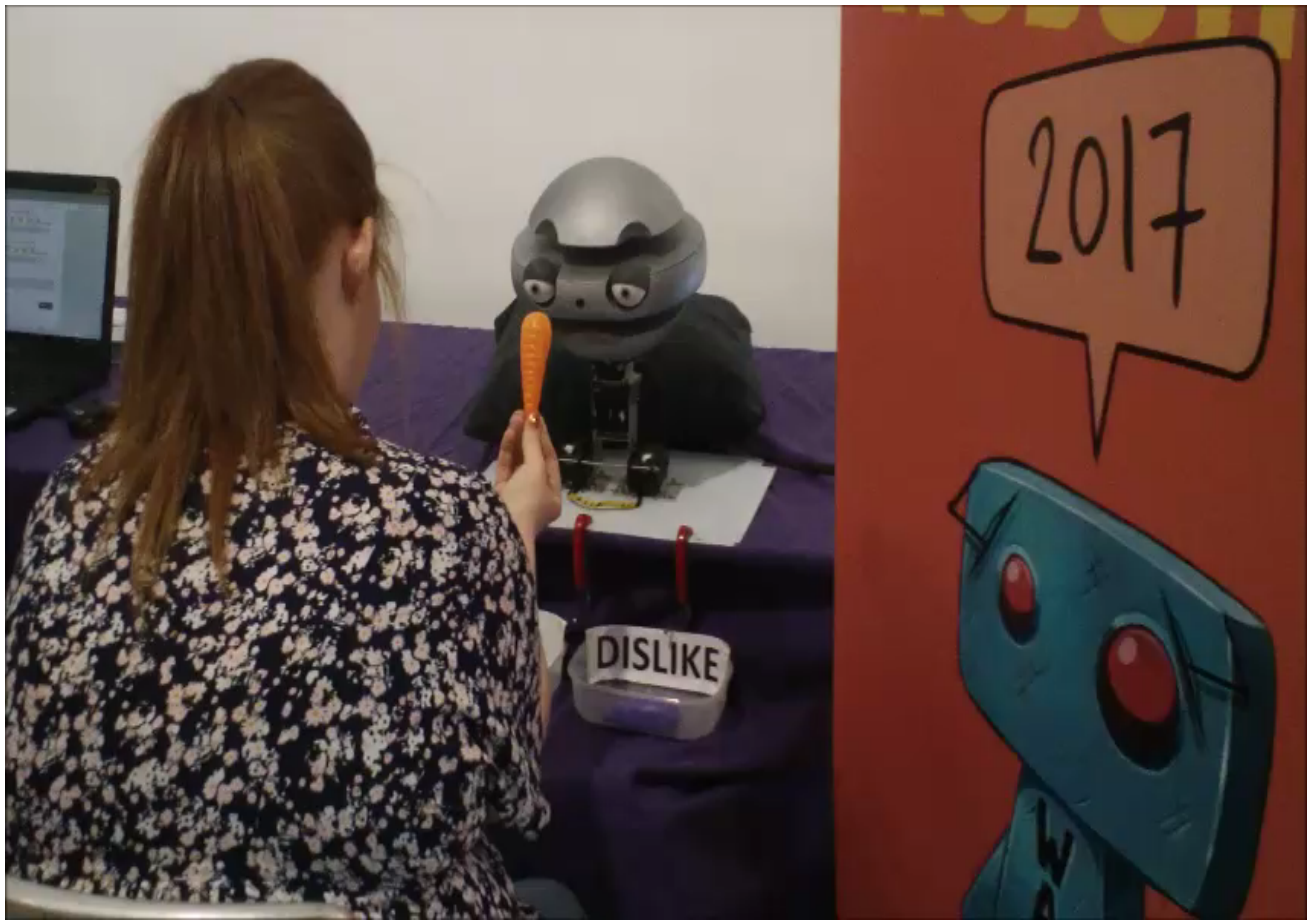
Experiment 1: Example trial





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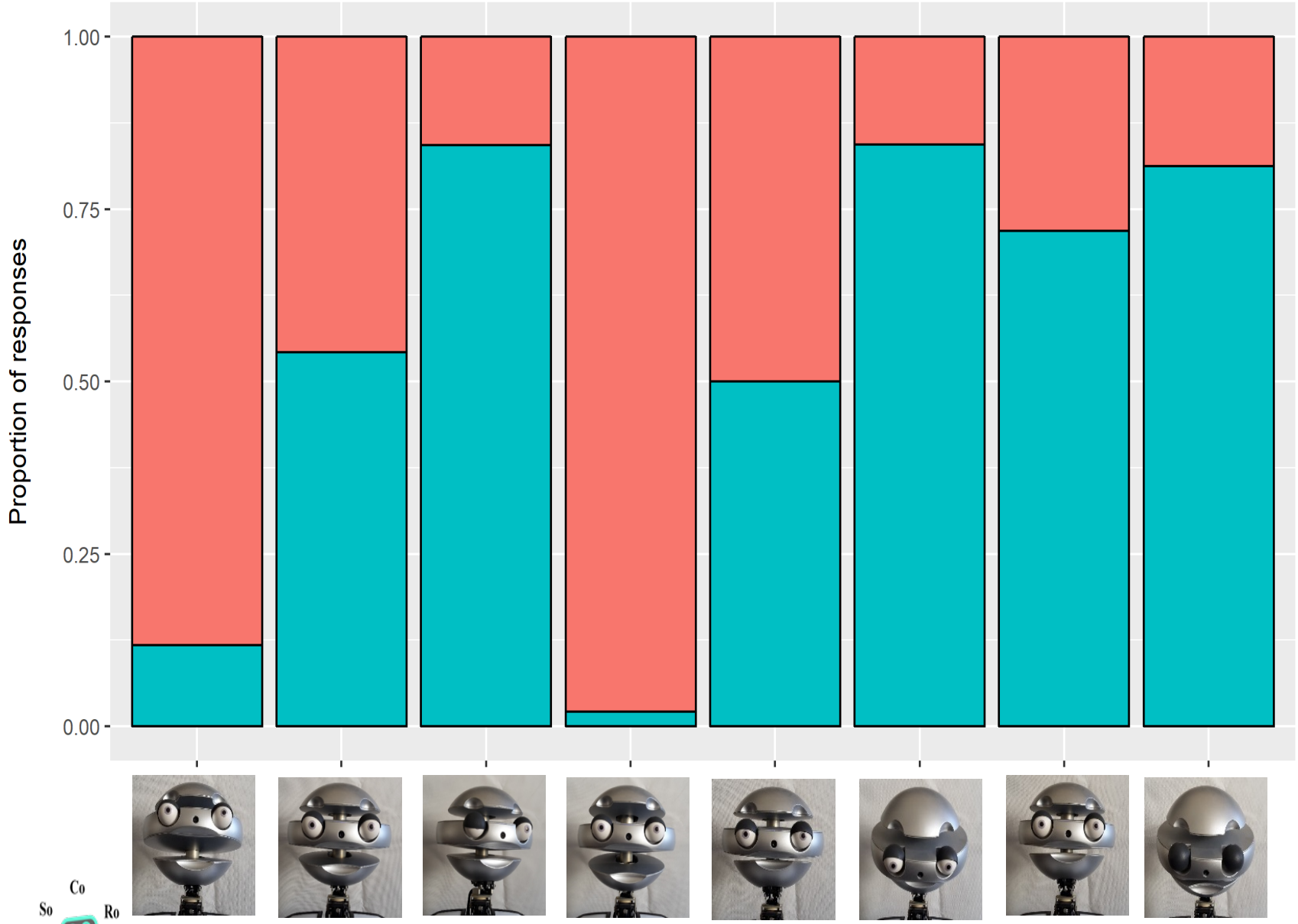

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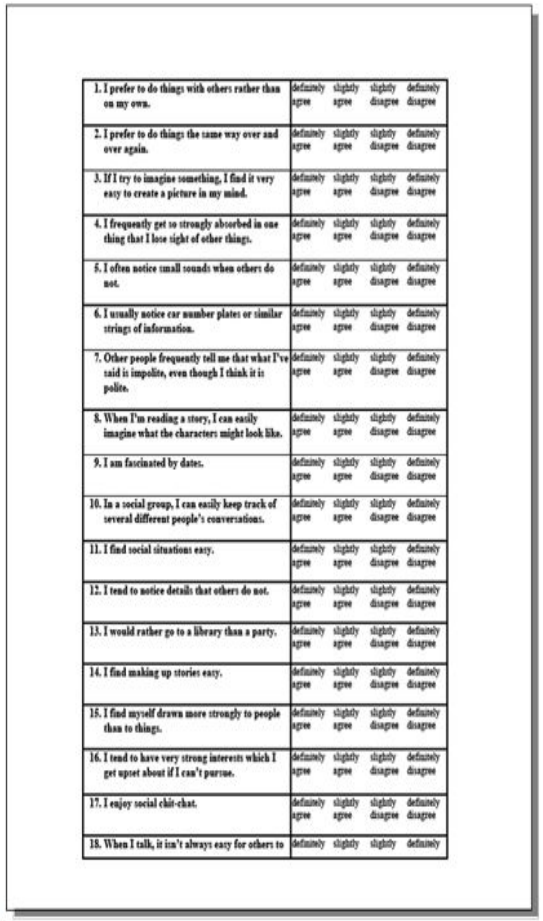
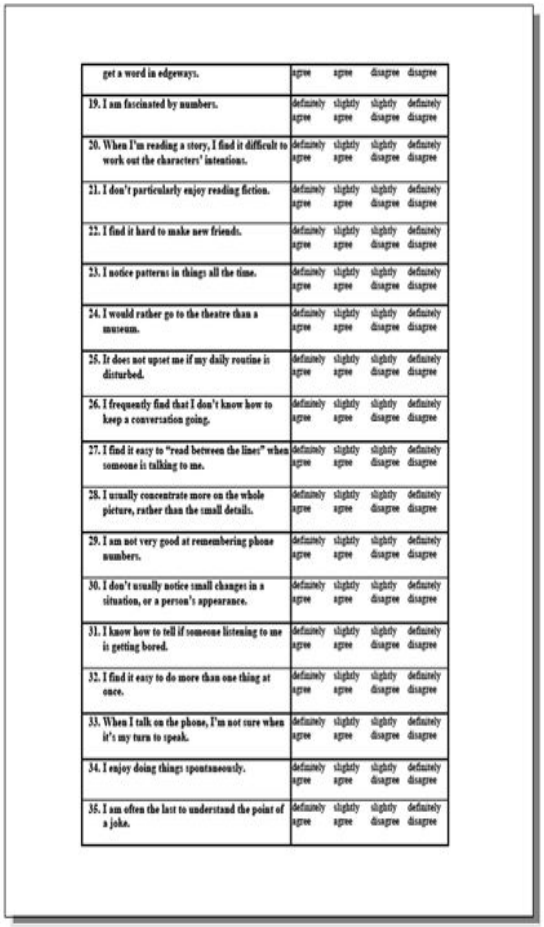
Experiment 2

Autism-Spectrum Quotient (AQ)



1. I prefer to do things with others rather than on my own.	definitely agree	slightly agree	slightly disagree	definitely disagree
2. I prefer to do things the same way over and over again.	definitely agree	slightly agree	slightly disagree	definitely disagree
3. If I try to imagine something, I find it very easy to create a picture in my mind.	definitely agree	slightly agree	slightly disagree	definitely disagree
4. I frequently get so strongly absorbed in one thing that I lose sight of other things.	definitely agree	slightly agree	slightly disagree	definitely disagree
5. I often notice small sounds when others do not.	definitely agree	slightly agree	slightly disagree	definitely disagree
6. I usually notice car number plates or similar strings of information.	definitely agree	slightly agree	slightly disagree	definitely disagree
7. Other people frequently tell me that what I've said is impolite, even though I think it is polite.	definitely agree	slightly agree	slightly disagree	definitely disagree
8. When I'm reading a story, I can easily imagine what the characters might look like.	definitely agree	slightly agree	slightly disagree	definitely disagree
9. I am fascinated by dates.	definitely agree	slightly agree	slightly disagree	definitely disagree
10. In a social group, I can easily keep track of several different people's conversations.	definitely agree	slightly agree	slightly disagree	definitely disagree
11. I find social situations easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
12. I tend to notice details that others do not.	definitely agree	slightly agree	slightly disagree	definitely disagree
13. I would rather go to a library than a party.	definitely agree	slightly agree	slightly disagree	definitely disagree
14. I find making up stories easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
15. I find myself drawn more strongly to people than to things.	definitely agree	slightly agree	slightly disagree	definitely disagree
16. I tend to have very strong interests which I get upset about if I can't pursue.	definitely agree	slightly agree	slightly disagree	definitely disagree
17. I enjoy social chit-chat.	definitely agree	slightly agree	slightly disagree	definitely disagree
18. When I talk, it isn't always easy for others to	definitely	slightly	slightly	definitely



get a word in edgeways.	agree	agree	disagree	disagree
19. I am fascinated by numbers.	definitely agree	slightly agree	slightly disagree	definitely disagree
20. When I'm reading a story, I find it difficult to work out the characters' intentions.	definitely agree	slightly agree	slightly disagree	definitely disagree
21. I don't particularly enjoy reading fiction.	definitely agree	slightly agree	slightly disagree	definitely disagree
22. I find it hard to make new friends.	definitely agree	slightly agree	slightly disagree	definitely disagree
23. I notice patterns in things all the time.	definitely agree	slightly agree	slightly disagree	definitely disagree
24. I would rather go to the theatre than a museum.	definitely agree	slightly agree	slightly disagree	definitely disagree
25. It does not upset me if my daily routine is disturbed.	definitely agree	slightly agree	slightly disagree	definitely disagree
26. I frequently find that I don't know how to keep a conversation going.	definitely agree	slightly agree	slightly disagree	definitely disagree
27. I find it easy to "read between the lines" when someone is talking to me.	definitely agree	slightly agree	slightly disagree	definitely disagree
28. I usually concentrate more on the whole picture, rather than the small details.	definitely agree	slightly agree	slightly disagree	definitely disagree
29. I am not very good at remembering phone numbers.	definitely agree	slightly agree	slightly disagree	definitely disagree
30. I don't usually notice small changes in a situation, or a person's appearance.	definitely agree	slightly agree	slightly disagree	definitely disagree
31. I know how to tell if someone listening to me is getting bored.	definitely agree	slightly agree	slightly disagree	definitely disagree
32. I find it easy to do more than one thing at once.	definitely agree	slightly agree	slightly disagree	definitely disagree
33. When I talk on the phone, I'm not sure when it's my turn to speak.	definitely agree	slightly agree	slightly disagree	definitely disagree
34. I enjoy doing things spontaneously.	definitely agree	slightly agree	slightly disagree	definitely disagree
35. I am often the last to understand the point of a joke.	definitely agree	slightly agree	slightly disagree	definitely disagree

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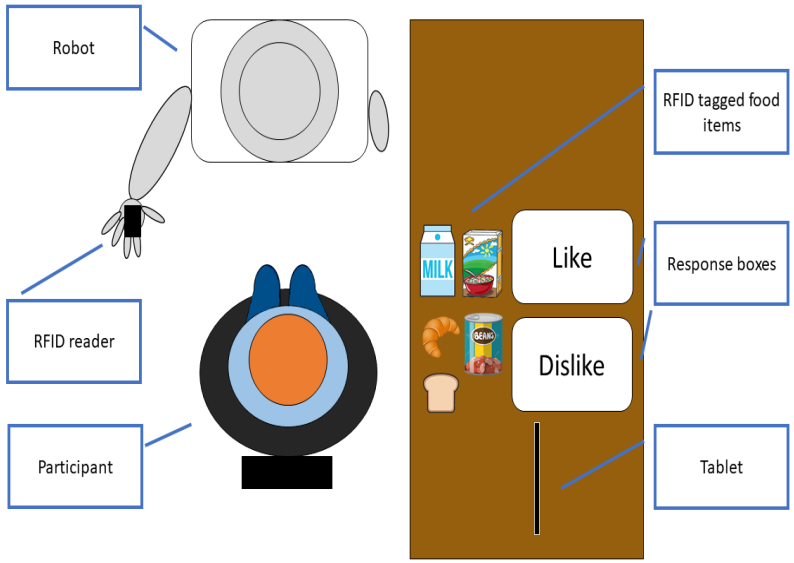
Exp2: Expression recognition and autistic traits



McKenna Peter E, Ghosh Ayan, Aylett Ruth, Broz Frank, Ingo, K., & Rajendran, T. (2018). Robot Expressive Behaviour and Autistic Traits. In *ACM Proceedings of AAMAS 2018: Socially Interactive Agents Track*. ACM.

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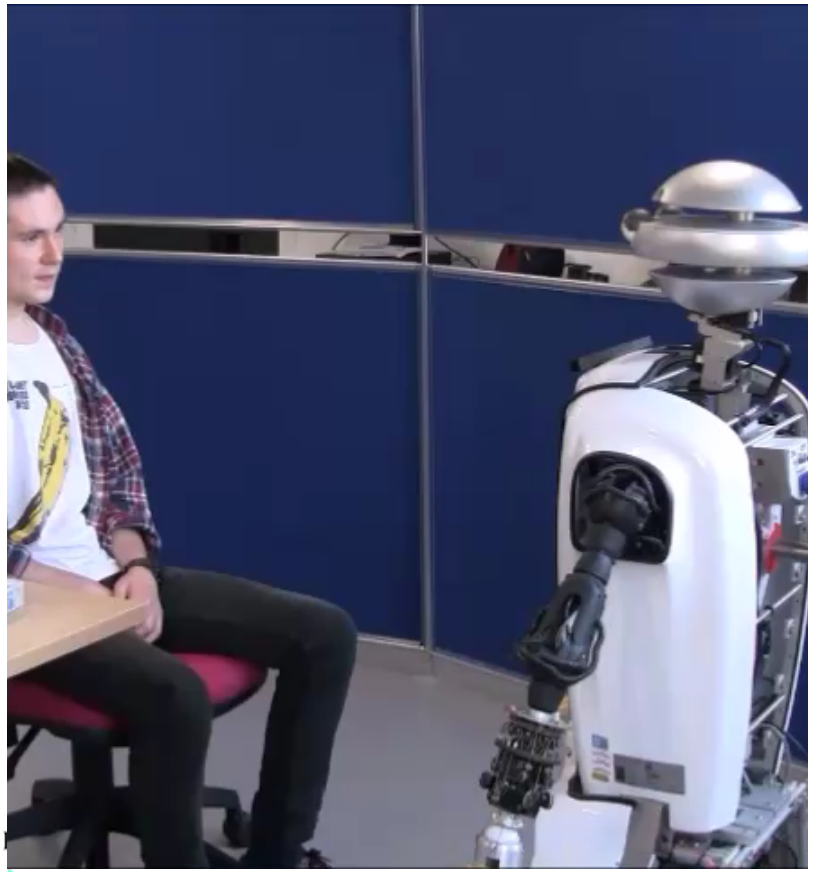
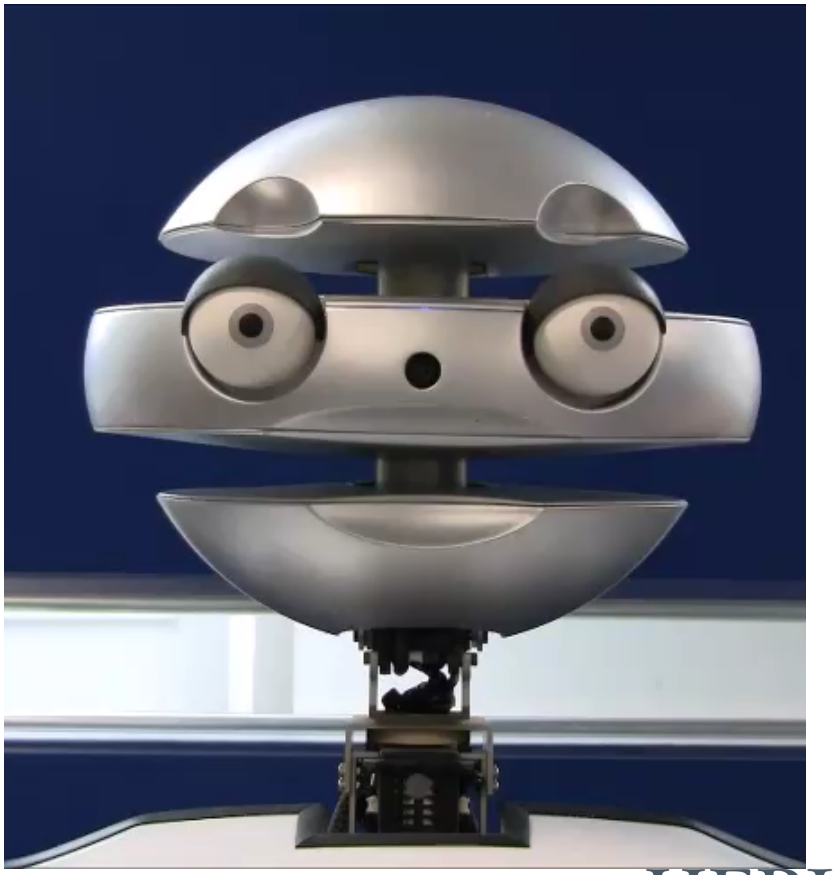
Experiment 2: Example trial





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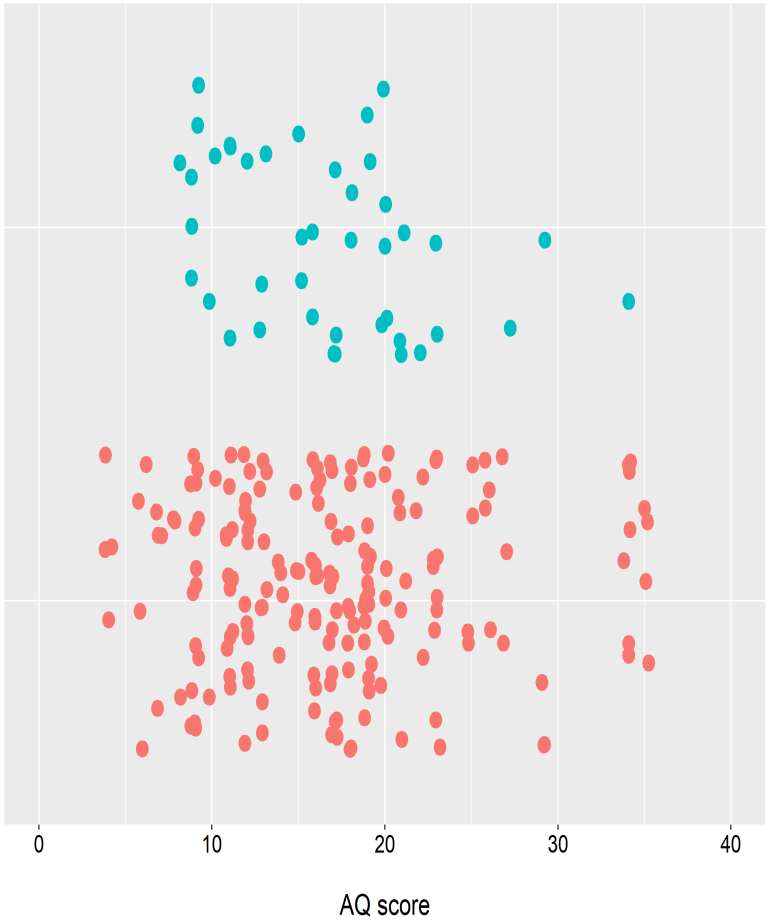

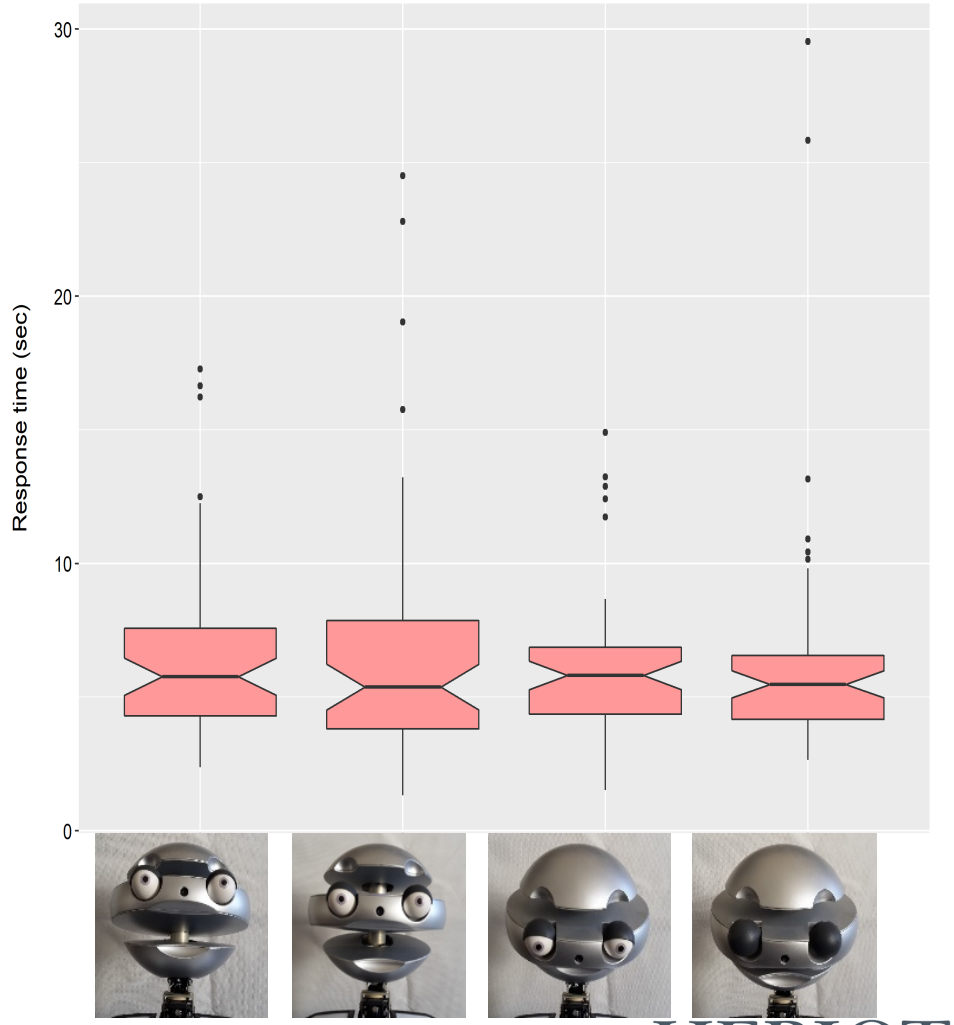

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However… an effect of native language

Table 1: Response Accuracy (% Correct) According to Robot Expression and Native language.

EMYS AUs	Native English	Non-native English	Overall
Approval			
Head up, jaw drop	76.47%	68.18%	71.93%
Upper lid raiser, jaw drop	94.11%	72.72%	85.96%
Disapproval			
Chin raise, head down	88.24%	63.63%	78.94%
Eyes closed, head down	94.12%	86.36%	89.47%
Overall	88.24%	72.72%	81.58%

Table 2: Exponent B and significance values of optimal model predictors.

	B	*S.E.*	*Low CI*	*Upp CI*	*Wald*
Intercept	5.45	1.373	0.410	94.061	1.235
Response accuracy	0.378	0.436	0.157	0.877	-2.227*
Response time	0.922	0.041	0.849	1.001	-1.955.
Friendliness	2.912	0.258	1.797	4.954	4.144***
Likeability	0.342	0.345	0.075	0.292	-5.382***
Voice clarity	1.174	0.239	0.724	1.867	0.672
Interaction rating	1.652	0.231	1.058	2.637	2.163***

Signif.codes : '.' $p < 0.1$. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Peter E. McKenna, Ayan Ghosh, Ruth Aylett, Frank Broz, and Gnanathusharan Rajendran. 2018. Cultural Social Signal Interplay with an Expressive Robot. In *IVA '18: International Conference on Intelligent Virtual Agents (IVA '18), November 5-8, 2018, Sydney, NSW, Australia.* ACM, New York, NY, USA, 8 pages. https://doi.org/10.1145/3267851.3267905

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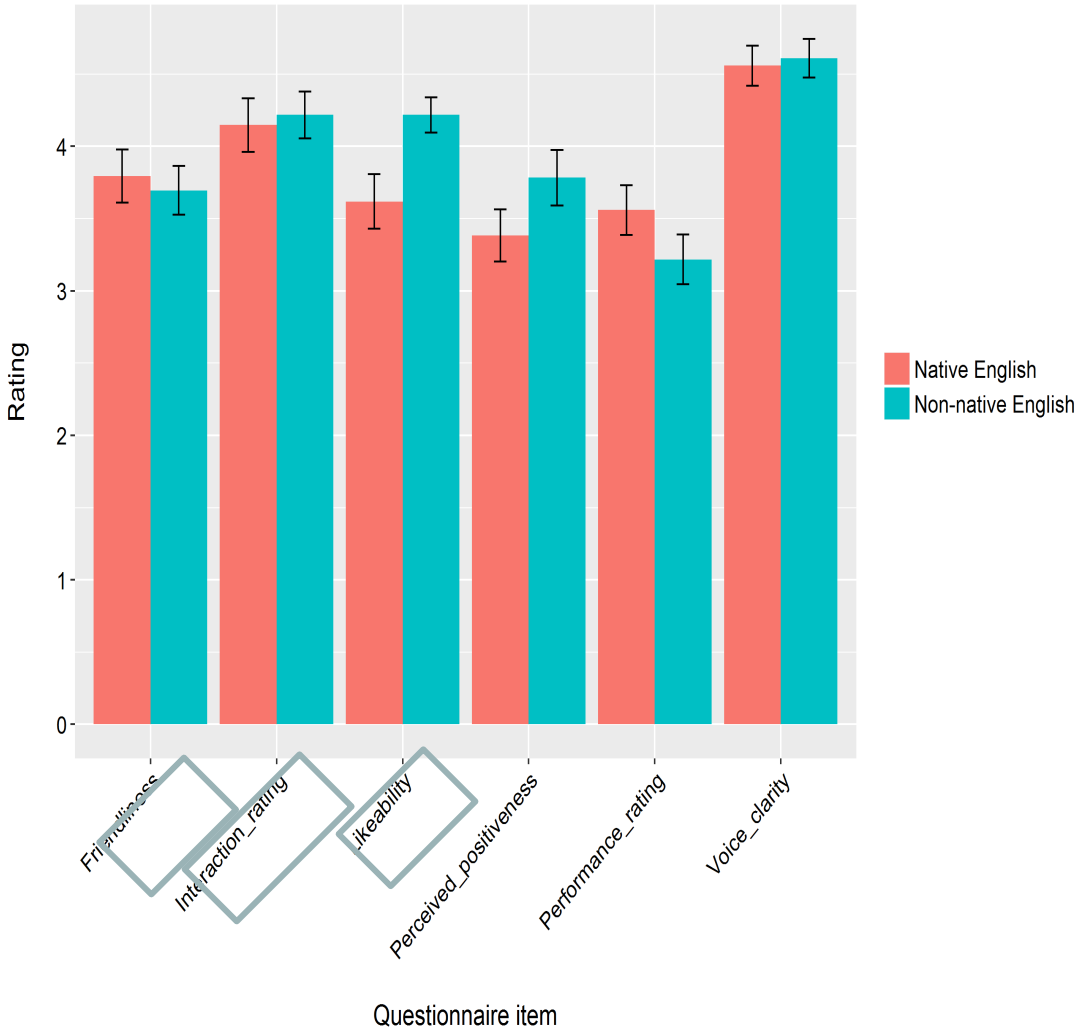
- Native-English ppts thought robot was more friendly than non-native ppts
- Native-English were sig more likely to rate interaction rating higher; though the means are similar
- Non-native ppts liked the robot to significantly greater degree than native-English ppts



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Similar pattern of performance?

- Group similarities in responses also of interest
- Ran a Kendall's correlation between continuous predictor variables
  - Mean accuracy
  - Response time
  - Q'nnaire items
- $\tau_b = 0.786$, $p < 0.05$; both groups showed a similar pattern of performance despite the statistical differences

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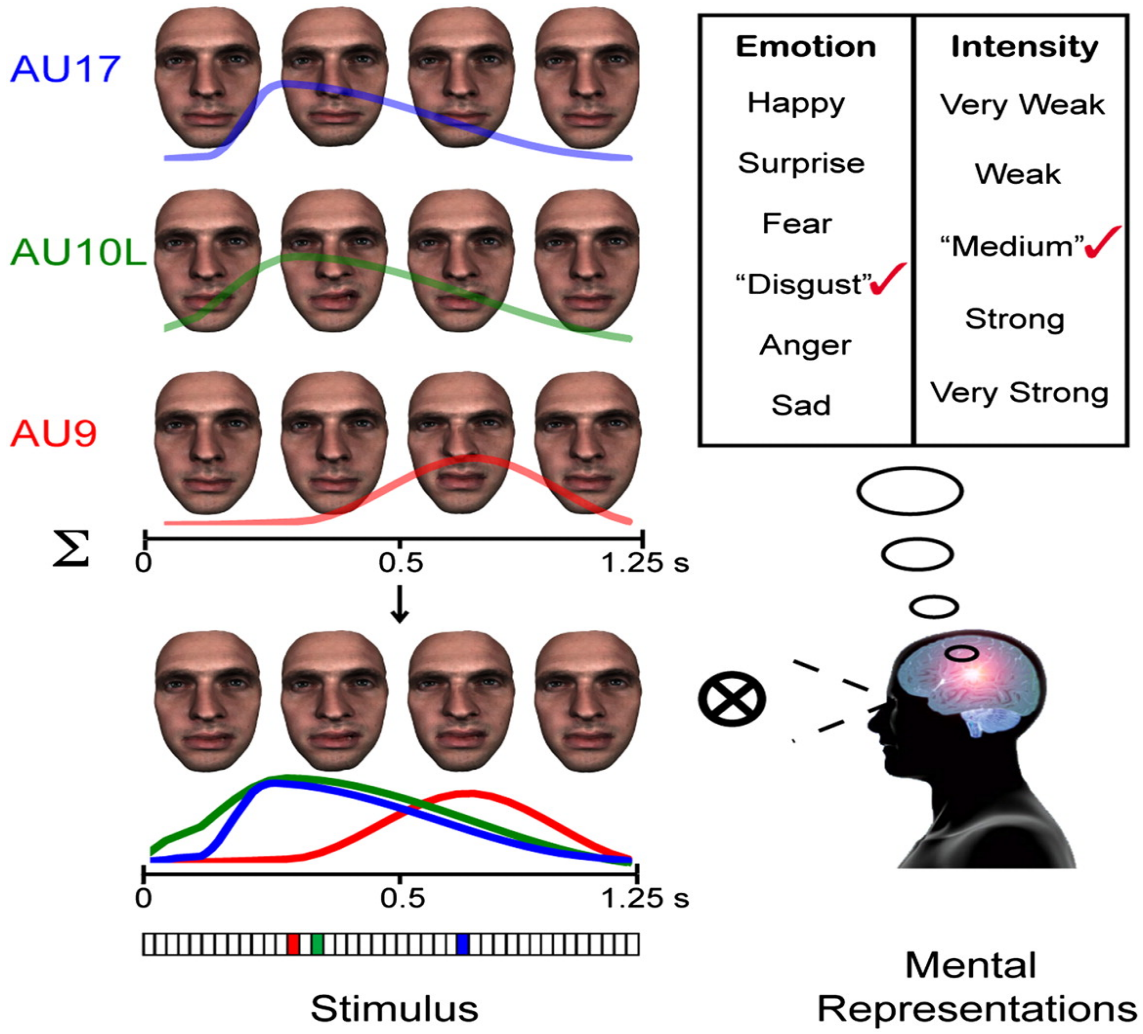
RACHEL JACK: Random generative grammar of facial movements and the perceptual categorization of emotions.



Rachael E. Jack et al. PNAS 2012;109:19:7241-7244

©2012 by National Academy of Sciences

- Qualitative analysis using FACS
- Do participants mimic the facial expression of Alyx?
- Mimicry witnessed in a small number of trials; mostly to express either uncertainty or to share a smile
- Participants mostly maintained a neutral expression.

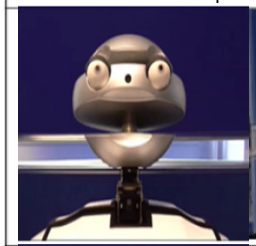
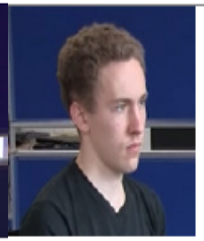
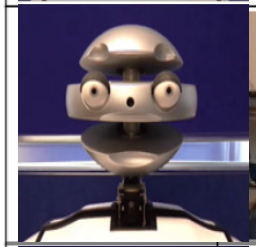
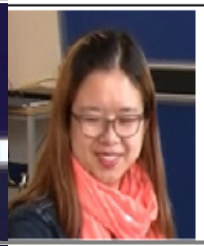
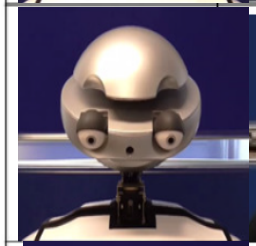
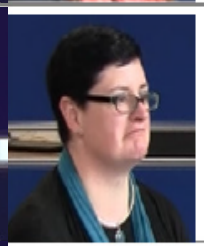
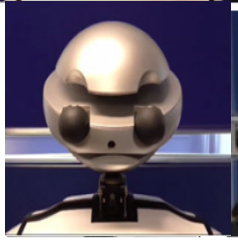
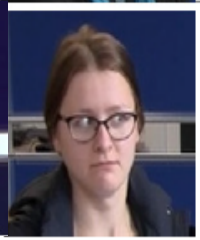
Robot Expression	Participant Facial Response	Participant Facial Action Units (Ekman, 1978)	Descriptive Category	Percent of trials
		N/A	Neutral	55%
		AU6 Cheek raiser AU 12 Lip corner puller AU13 Cheek puffer	Positive	15.84%
		AU9 Nose Wrinkler AU15 Lip Corner Drepressor AU17 Chin Raiser	Negative	5%
		AU4 Brow Lowerer AU44 Squint AU14 Dimpler AU23 Lip Tightener AU25 Lips Part	Not sure	23.95%

Figure 5: Qualitative assessment of participant expressive behaviour immediately following robot expression.

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Mimicry and native language results

Table 3: Participant expressive behaviour (% of trials) according to native language

Category	Native English	Non-native English	χ
Neutral	57.35%	51.76%	21.214^{***}
Positive	14.71%	17.65%	0.703
Negative	7.36%	1.18%	12.410^{***}
Not sure	20.59%	29.41%	6.172^{*}

Signif.codes : $'.'\ p < 0.1.\ ^{*}p < 0.05.\ ^{**}p < 0.01.\ ^{***}p < 0.001.$

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Summary

- Autistic traits did not affect participants expression recognition
- A caveat to this q'nnaire is the required number of ppts for a normal distribution
- Differences related to native language can be understood in terms of cultural differences
  - *Chin raise, head down* similar to a bow rather than an expression of disapproval
  - Greater number of uncertain expression's produced by non-native speakers demonstrates the cultural uniqueness of the models we used to generate the expressions
- Correlation between non- & native-English shows sample as a whole understood most of Alyx's behaviour, and were positive about the interaction

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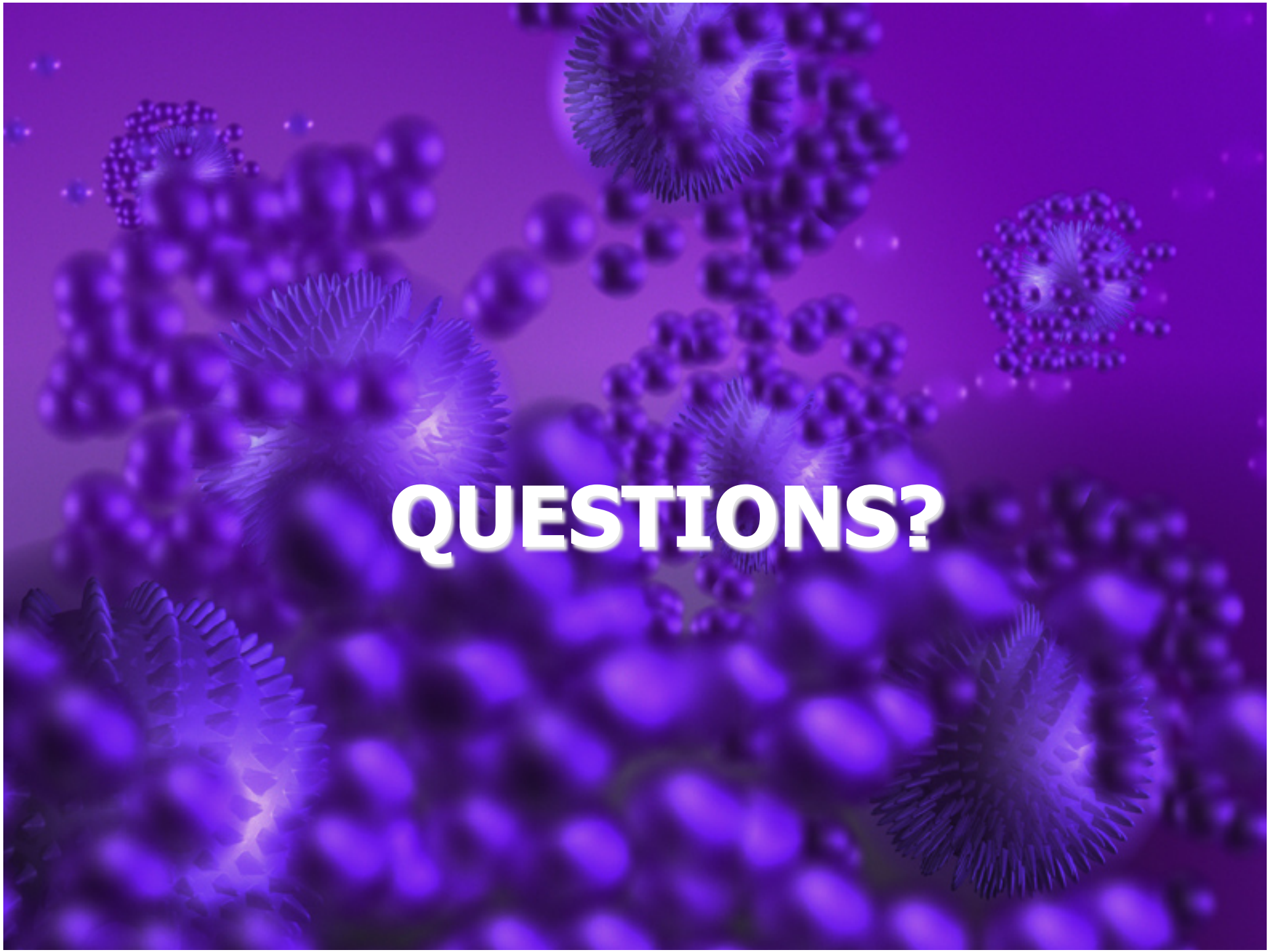
QUESTIONS?