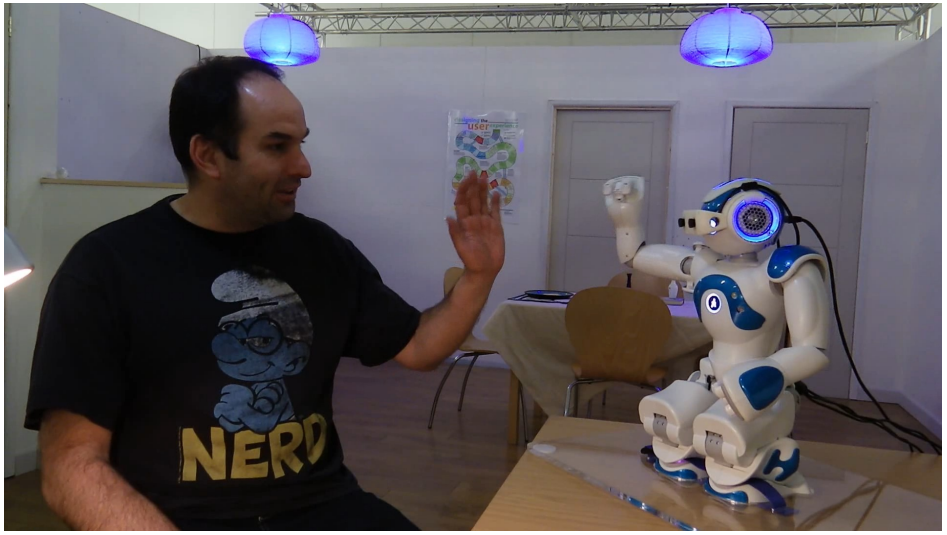
Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Social Robot Avatars



Dr. Paul Bremner

paul.bremner@brl.ac.uk

Bristol Robotics Laboratory

University of the West of England

University of Bristol

Outline

- Definition and Motivation
- Initial explorations of the idea
- Motion capture based tele-operation
- Speech and gesture integration
- Emotion effects in interaction
- Personality perception
- Usage Behaviours
- Puppet Presence

Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Definition and Motivation

- A social robot avatar is a means to allow someone to have a physical and social presence somewhere that they are not, by giving them a physical form to inhabit, and relaying their speech and motion.
- Audio and video communication is lacking compared to face-to-face communication. Using a robot as a telecommunication medium might give some advantages over simple audio and video.
- We can learn from tele-operated interactions to aid future development of autonomous socially interactive robots.

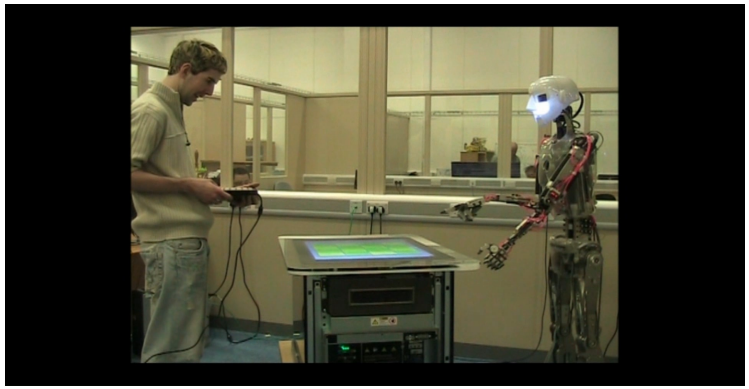
Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Action Awareness

- One possible reason for the disparity between face-to-face and mediated communication is the lack of action awareness, and relatedly intention awareness.
- By using a humanoid robot avatar to perform pointing gestures to locations selected by a remote user, action awareness was improved (measured by speed and accuracy of location identification). A humanoid avatar was better than an industrial robot arm performing equivalent actions, and close in performance to a person.



Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Interaction Behaviours

- An additional metric for the utility of a robot avatar system is patterns of interactive behaviour, and if these differ from when people interact face-to-face.
- We tested this in a collaborative puzzle solving task. We found that although a humanoid avatar led to fewer errors than an industrial arm avatar, there was little difference in terms of interactive behaviour (task behaviours and leadership).
- However, embodied communication behaviour was closer to face-to-face interaction than audio only communication was.

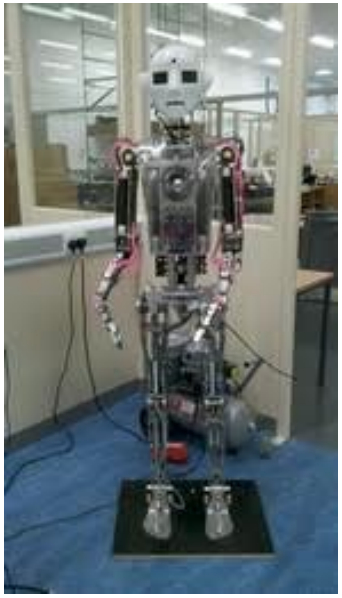
Bristol Robotics Laboratory

University of the West of England BRISTOL

University of BRISTOL

Social Presence

- Another suggested reason for the disparity between face-to-face and mediated communication is difference in social presence. Social presence can be defined as how an individual can perceive the other members of a group on an interpersonal level.
- Measured by means of questionnaire, and using persuasion as behavioural indicator.
- Using the 'Desert Survival Problem', we found that a humanoid avatar exhibits greater social presence than an industrial arm avatar.



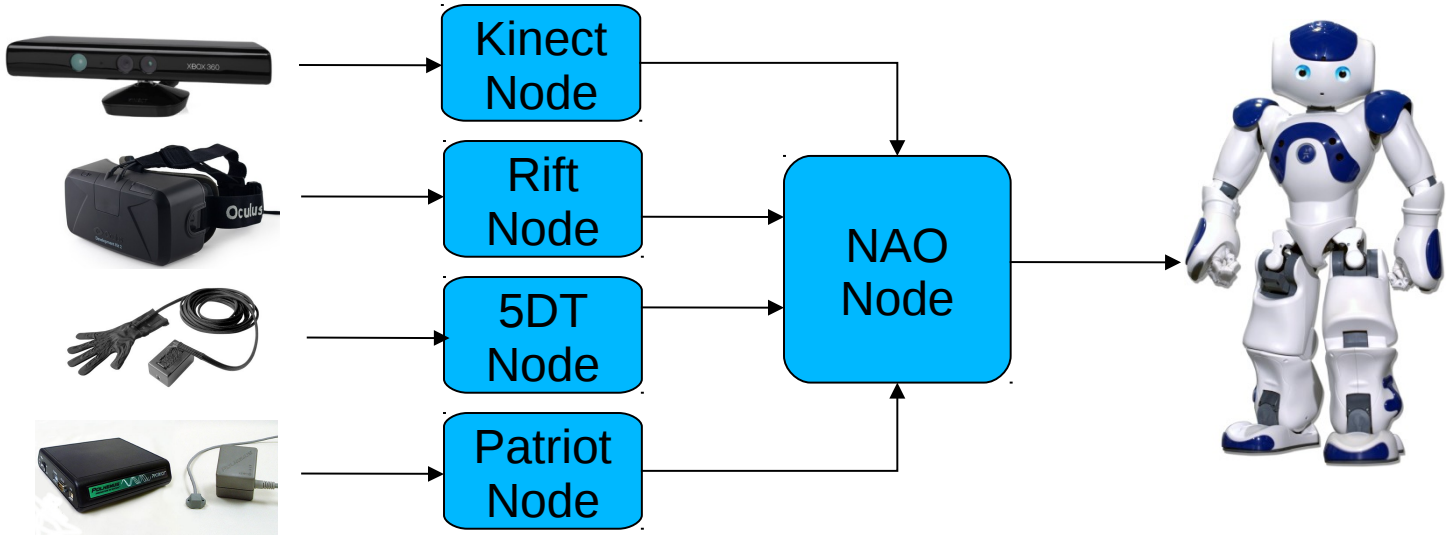
Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Tele-operation Controls

- Intuitive control interface using Microsoft Kinect, 5DT data gloves and Polhemus Patriot (to overcome missing DoF from Kinect).
- Oculus Rift for vision and head movement.
- ROS based architecture for sensor-robot communication.



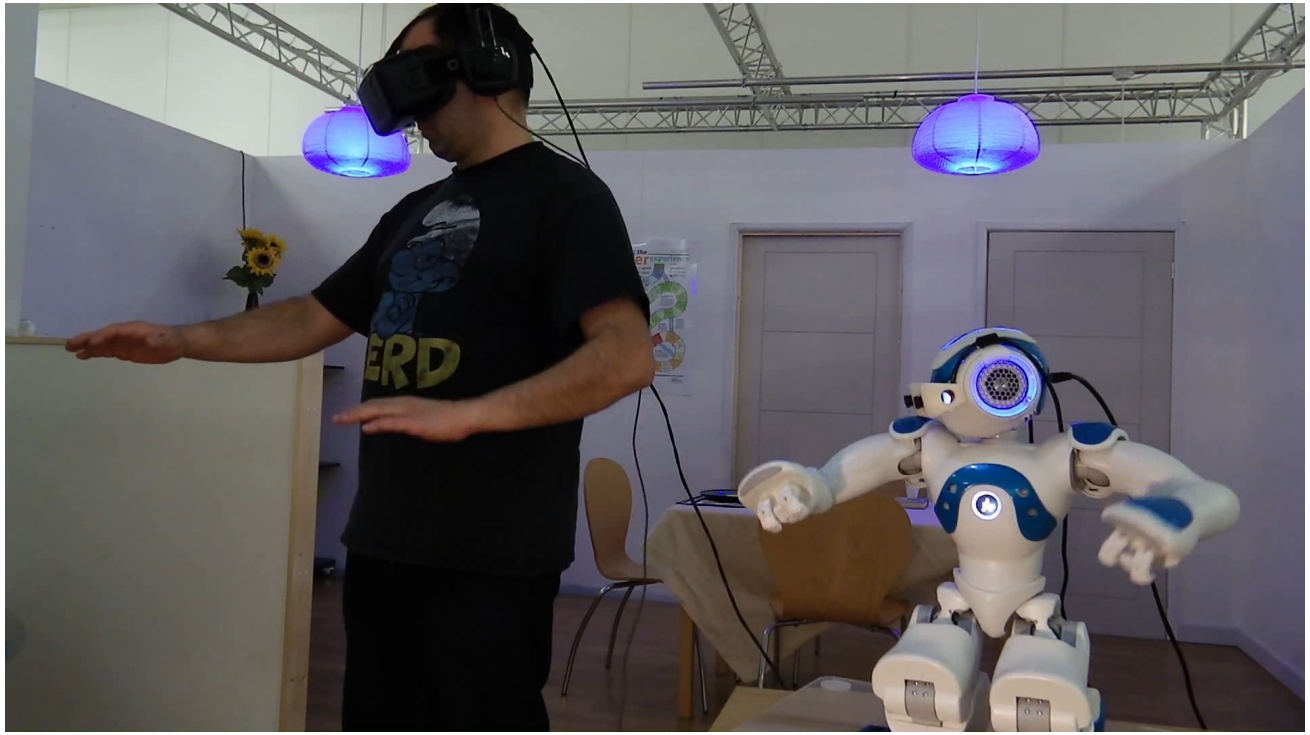
Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Tele-operation Controls

- Kinect data smoothed using a moving average filter with a predictive component, which together with a NAO control module, results in smooth movement with minimal lag.



Bristol Robotics Laboratory

University of the West of England

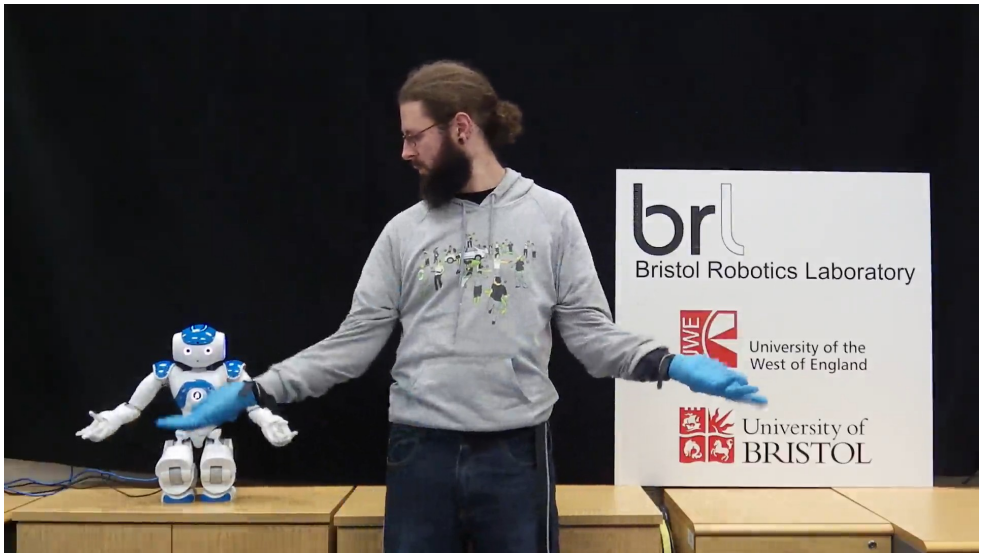
University of BRISTOL

Tele-operated Gesture Evaluation

- A key feature of human communication is co-speech gesture, hence this is one of the primary requirements for the developed tele-operation system.
- There are 2 elements of gesturing that have been tested in the initial experiments:

    1. Gesture comprehension

    2. Speech and gesture integration



Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Beat Gesture Integration

- Syntactically ambiguous sentences can be disambiguated to have different meanings by emphasising different words in the sentence. This emphasis can be verbal and/or by means of beat gestures. We investigated whether these effects were the same for humans and robots.

- We used ambiguous sentences of the form 'The sun shone on the propeller of the plane the mechanic was so carefully examining'. The mechanic could be carefully examining the propeller (high attachment) or the plane (low attachment) depending on emphasis.

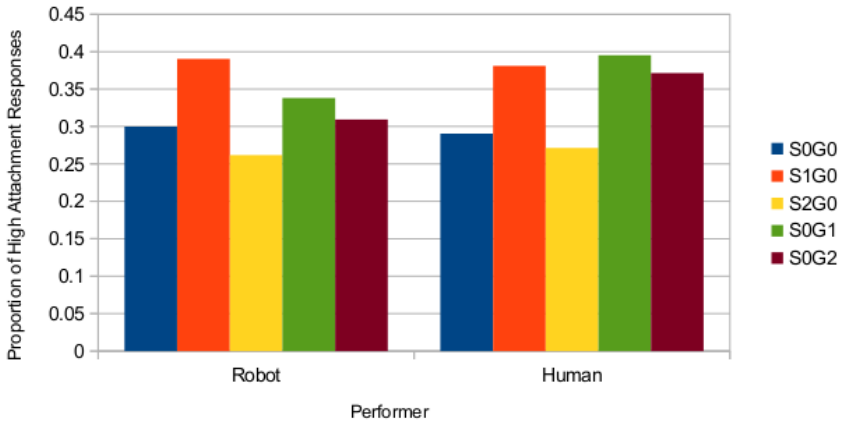
- Participants had to select which meaning was appropriate in various emphasis conditions.

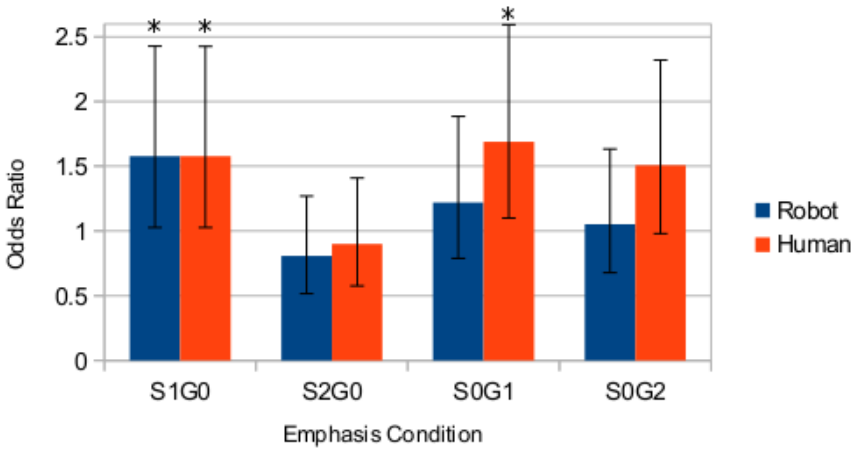
Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Results





- Speech emphasis had the same effect for human and robot performances. However, beat gestures had a much weaker effect when performed by the robot.

Bristol Robotics Laboratory

University of the West of England

University of Bristol

Iconic Gesture Integration

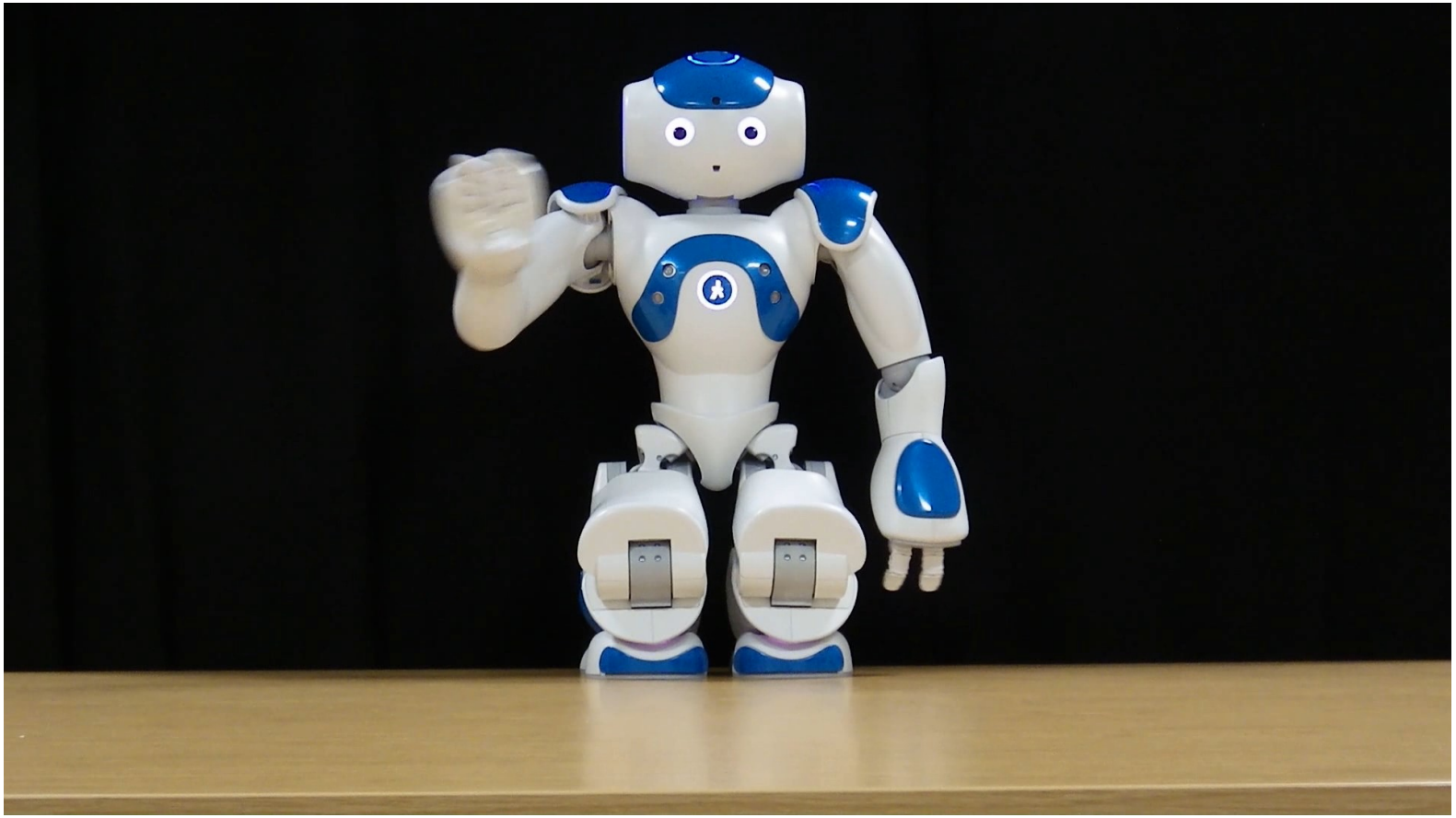
- Gestures can convey semantic information such as how an action is carried out. When they accompany speech information can be conveyed more efficiently and effectively. We investigated whether such gestures could be understood, and whether information integration occurred for humans and robots.
- Participants observed a series of verb phrases both with and without gestures. They had to select an appropriate meaning, from a set containing meanings that match the speech only, speech plus gesture, and gesture only.
- If integration occurs the meaning selected should be the one that matches both speech and gesture.

Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Iconic Gesture Integration

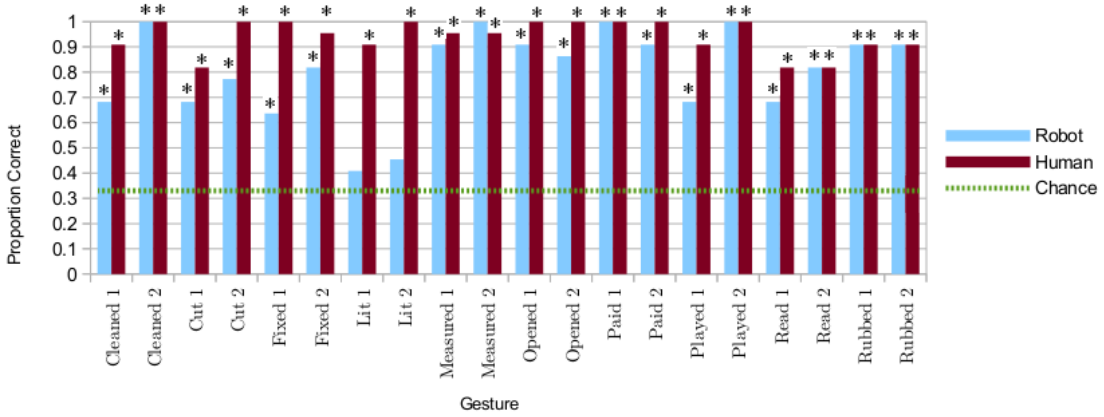


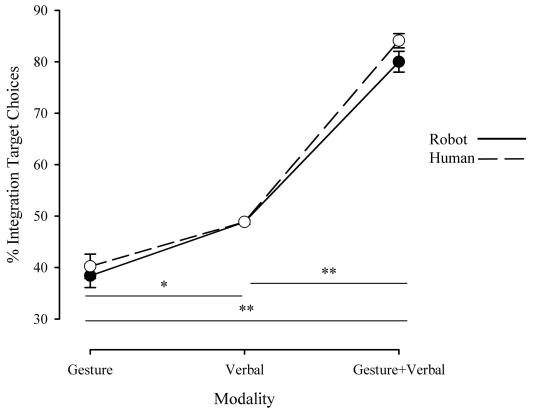
Bristol Robotics Laboratory

University of the West of England

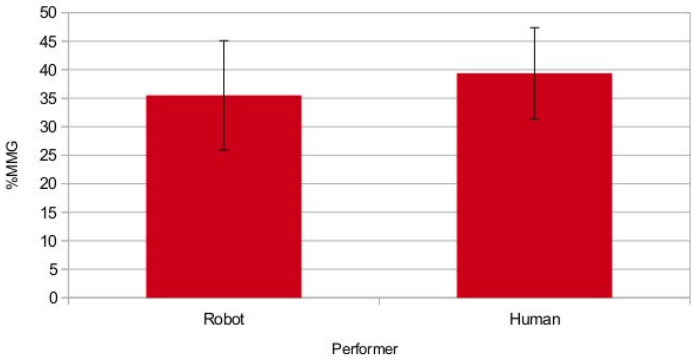
University of BRISTOL

Results





- Gestures alone were harder to understand on the robot (robot 80% correct, human 94%), but integration was equally successful for the two performers.



Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Emotion Effects

- Emotion of one person can instil emotions in people they interact with: either the same emotion, a process called contagion, or complimentary emotion, i.e., empathy.
- We carried out a study where an actor portrayed emotions (happiness or sadness) in the context of an instruction giving task, and evaluated participants emotions.
- The actor appeared either in person, via the tele-operated NAO, or via audio only communication.
- Extensive rehearsal and scripting was required to ensure a consistent performance.

Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Emotion Effects

Collaborative study between the
University of Exeter,
Bristol Robotics Lab and
Queen Mary University of London

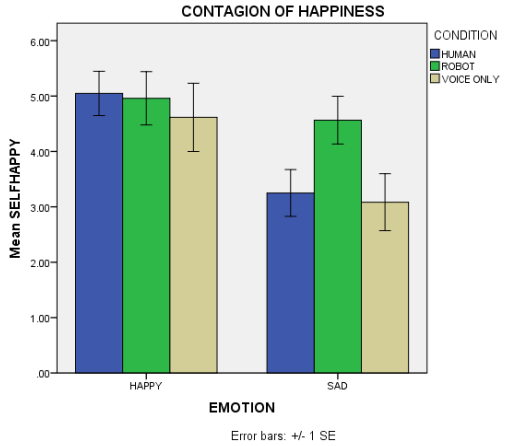
Bristol Robotics Laboratory

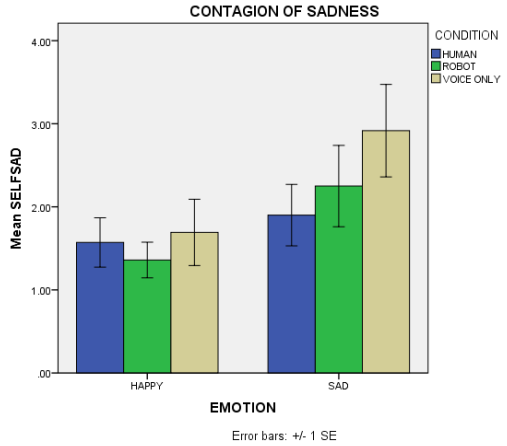
University of the West of England

University of BRISTOL

Results

- Both happy and sad emotions were correctly perceived. Additionally we observed the behaviour of the actor used to convey the emotions.
- Emotion contagion was observed for happiness for F2F and voice only, sadness for voice only and tele-operated robot conditions.
- Instructions and tasks reported as equal difficulty but behaviours indicated they were harder in the robot condition. Additionally we observed how instructions were adapted to participant behaviours.





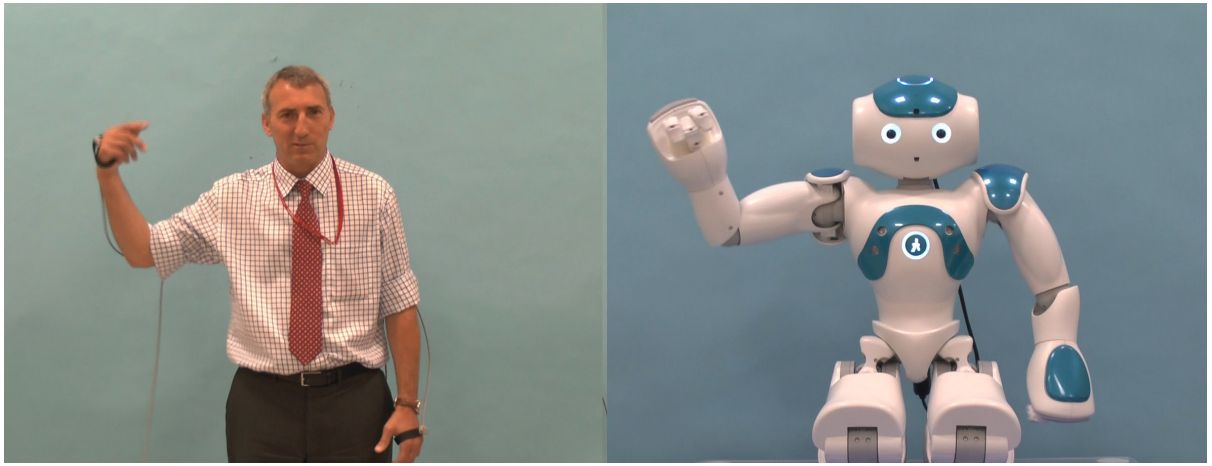
Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Personality Perception of Tele-Operators

- Personality perception is an important facet of communication, playing a key role in forming interpersonal relationships, and predicting future behaviours.
- We investigated how first impression personality perception is affected when people use the NAO avatar to communicate, i.e., does a different appearance have an influence?
- 20 target participants performed a set of communication tasks and were recorded on video and using the motion tracking part of the tele-operation system.



Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Personality Perception of Tele-Operators

- Videos clips were created for each task from the original video, video recording of the captured gestures performed by NAO (with audio from the original video), and an audio only version.
- Judges recruited through CrowdFlower rated the personality of the people in each clip using the BFI-10.

Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Results

	Audio-Visual (AV)			Audio-Only (AO)		Tele-Operation (TO)		
	Hobby	Story	Mime	Hobby	Story	Hobby	Story	Mime
EX	0.64	0.56	0.63	0.57	-0.15	0.61	0.39	0.19
AG	0.54	0.41	0.6	0.61	0.33	0.4	0.56	0.37
CO	0.47	0.6	0.54	0.5	0.21	0.54	0.56	0.57
NE	0.76	0.76	0.78	0.75	0.42	0.66	0.54	0.3
OP	-0.6	0.05	0.22	-0.14	0.12	0.17	-0.24	-0.14

Intra-Judge Agreement (Cronbach's alpha)

Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Results

	Audio-Visual (AV)			Audio-Only (AO)		Tele-Operation (TO)		
	Hobby	Story	Mime	Hobby	Story	Hobby	Story	Mime
EX	0.84***	0.81***	0.74***	0.72***	0.51*	0.72***	0.63**	-0.12
AG	0.46*	0.61**	0.4	0.25	-0.15	0.21	0.54**	-0.95
CO	0.78***	0.67***	0.71***	0.37	-0.1	0.32	0.65***	-0.35
NE	0.80***	0.71***	0.55**	0.57**	0.12	0.70***	0.36	-0.56
OP	0.12	0.67***	0.4	0.49	0.4	0.34	0.17	0.04

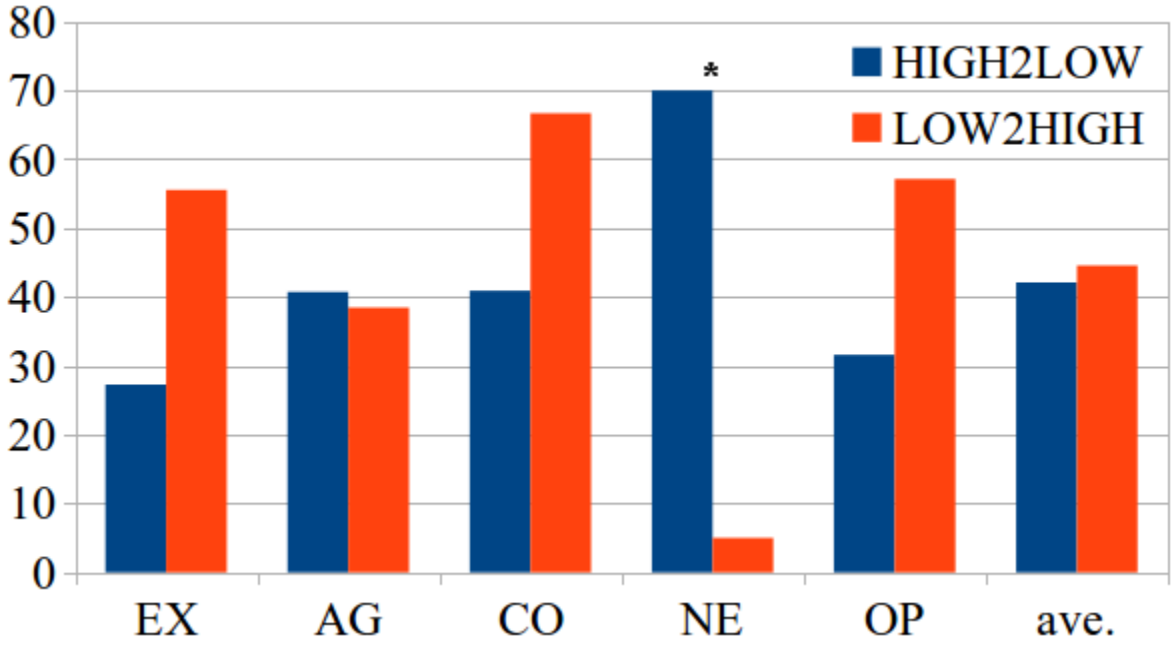
Inter-Judge Agreement (ICC(1,K))

Results

	Audio-Visual (AV)			Audio-Only (AO)		Tele-Operation (TO)		
	Hobby	Story	Mime	Hobby	Story	Hobby	Story	Mime
EX	0.34***	0.32**	0.26*	0.44***	0.01	0.12	-0.02	0.04
AG	0.04	0.13	0.04	0.28**	-0.05	0.08	-0.01	0.1
CO	-0.17	0.09	0.16	0.13	-0.13	0.05	0.16	-0.16
NE	0	-0.07	0.05	0.07	0.09	0.02	-0.08	0.04
OP	0.06	0.03	0	0.1	0.04	0.16	0.07	0.03

Self-Other Agreement (Pearson's Correlation)

Results



Personality Shifts

Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Usage Behaviours

- The system was deployed in At Bristol Science Centre, so we could see how people might use it to communicate, and react to the person using it.
- To get more ecologically valid results we ran experiments with people outside of the lab.

Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Usage Behaviours

- Typically there was an initial experimentation phase where users explored the system capabilities.
- Operators intuitively used pointing and gaze behaviours to communicate.
- Waving played an important part in successful communication and engagement.
- Fewer other gestures than we would expect.
- Further fine grained coding of behaviours in progress to better understand how people use and react to the system.

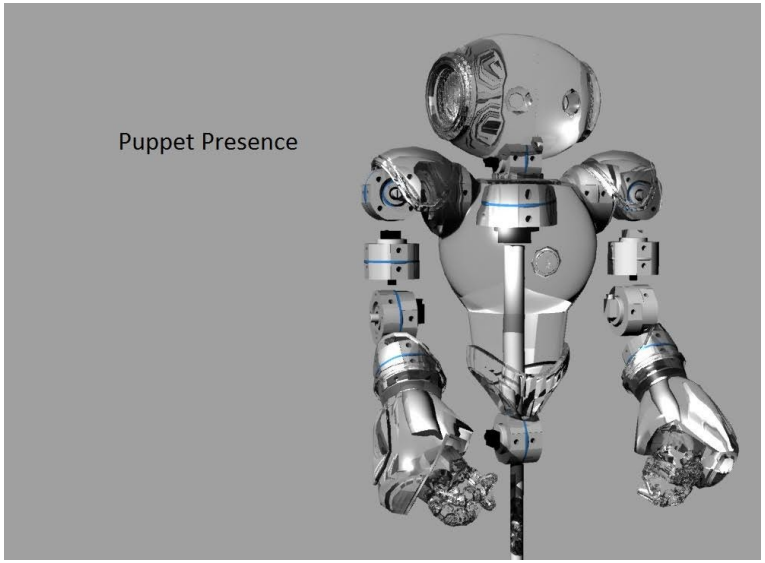
Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Puppet Presence

- What can robotics learn from puppetry?
- Collaboration between BRL, University of Bath, and Rusty Squid.
- Public event where we will be comparing a puppeteer controlled robot with the Kinect controlled robot, and using it to inform how to make the avatar system semi-autonomous.



Bristol Robotics Laboratory

University of the West of England

University of BRISTOL

Questions

This research grant is funded by the EPSRC under Digital Personhood call. Grant reference: EP/L00416X/1.