Robot Expressive Behaviour and Autistic Traits

Socially Interactive Agents Track

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ABSTRACT

The present experiment used a task-based approach to examine participants social signal recognition of an EMYS robot head and whether autistic traits, measured by the Autism-spectrum quotient (AQ), mediated this recognition. In line with Autism spectrum disorder (ASD) research, we predicted that participants with high AQ scores would produce more social signal recognition errors. In the task participants (N = 57) offered RFID-tagged objects to a full-bodied FLASH robot (called Alyx) and Alyx autonomously reacted with a either an approval or disapproval expression. Data analysis found no relationship between autistic traits and recognition accuracy. The findings are discussed in terms of experimental design and autistic traits.

KEYWORDS

Social robotics, Autism spectrum disorder, social signal processing

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1 INTRODUCTION

1.1 Autistic Employment, Social Skills, and Robotics

Presently, a disproportionate number of adults with an autism spectrum disorder (ASD) in the UK are unemployed with an estimated 16% holding full-time positions [12]. Difficulties securing and maintaining stem from the conditions social and communication impairments [8], over and above an individual's capabilities [17]. So, developing a robotic system to improve autistic adult's social skills, such as interpreting facial social signals [16], could improve this group's employment prospects as well as have other positive downstream effects (e.g. greater independence).

As initial work toward the proposed system, here we tested participant's recognition of an expressive robot head (EMYS; [7]) using a task-based approach. The EMYS falls into a cartoon-like more machine-oriented category [7] and we follow the argument that a simplified set of expressive features helps to counter the known issues of sensory over-stimulation [5] for those with an ASD processing social signals.

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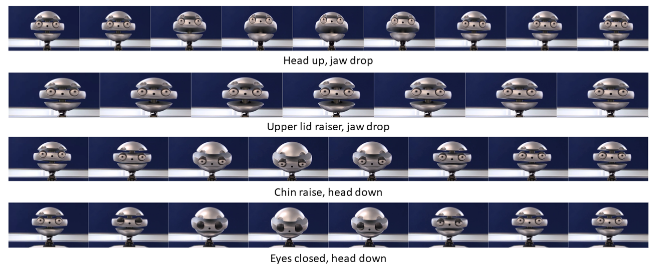

Figure 1: Robot expressions: Head up, jaw drop (HU-JD); Upper lid raiser, jaw drop (ULR-JD); Chin raise, head down (CR-HD); Eyes closed, head down (EC-HD). ***Note: these acronyms are used henceforth.***

1.2 Robot Expressive Behaviour

Previous work designing EMYS expressions [9] took a bottom-up approach using the psychological literature, by cross-referencing the head's degrees of freedom (DOF) to the single facial movements defined by the Facial Action Coding System (FACS) [2]. These sets of DOF were then matched against affective states in the Pleasure-Arousal-Dominance (PAD) [11] dimensional model, generating a set of eight expressions. We selected the four most accurately recognised expressions from this set, shown in Figure 1, including two approval (HU-JD, ULR-JD) and two disapproval expressions (CR-HD, EC-HD; [9]). We tested a neuro-typical sample's interpretation of these expressions and measured their *autistic traits* as ground work for future study with an ASD group.

1.3 Autistic Traits and Expressive Behaviour

Although autism is widely considered a 'spectrum' condition, it may also be conceived as a 'continuum', with phenotypic cognition and behavior expressed at varying sub-clinical levels in the wider population [4]; often referred to as the *broader autism phenotype* [15]. Studies of autistic traits and emotion recognition are equivocal, with negative correlations reported for studies of high-functioning autistic (HFA) adults [3], but no effects reported with neuro-typical adults [10]. Our hypothesis fell in line with the former for two reasons. First, our task-based approach ensured that the social signals elicited by Alyx were embedded within a contextually relevant, dynamic interaction, differing to traditional recognition tasks that often require passive evaluation of static face stimuli (e.g. [6]). Secondly, the EMYS head's simplified composition and increased signal-to-noise ratio (relative to a human face) offered a uniquely sensitive assessment means, reducing the number of social signals elicited. We argue that the novel combination of these two elements created a task capable of detecting subtle differences in social signal processing (i.e. emotion recognition) based on an individual's autistic traits.

1.4 Objectives and Hypothesis

The purpose of this study was to examine how a neuro-typical adults level of autistic traits affected their ability to interpret robot social signals. It was predicted that adults with high levels of these traits would produce a greater number of recognition errors.

2 METHODOLOGY

2.1 Participants

Fifty-seven university staff and students (Mean age = 25.84, SD = 8.60) participated, including 24 females and 33 males. Participation criteria included aged 18+ years, no diagnosed psychiatric condition, and normal or corrected vision. Participants provided written consent and were entered into a prize draw. The experiment was given ethical approval by the Heriot-Watt University School of Social Sciences: ethical code 2017-516.

Autism-spectrum Quotient(AQ) The AQ [1] is a 50-item self-report questionnaire assessing an individuals level of autistic traits. Items indicative of an autistic trait score 1, with a maximum score of 50. In the original paper individuals diagnosed with ASD scored ⩾32, with neuro-typicals averaging around 16 [1]. For analysis, scores on the AQ were considered from both a continuous and categorical perspective; in the latter a median split was performed (Median AQ score = 17), creating the groups Low AQ (n = 28) and High AQ (n = 29). The test is not diagnostic, and care should be taken with its interpretation.

2.2 Design and Procedure

The study adopted a mixed-design. Participants viewed four social signals (order counterbalanced) and completed the AQ. Independent variables included robot expression (see Figure 1, AQ score (continuous), and AQ group (Low AQ, High AQ). The dependent variable was recognition accuracy (Correct, Incorrect). Participants were tested individually at Heriot-Watt University's Robotarium HRI lab. Two large poster screens sectioned off the testing area, blocking potential visual distractions. Participants sat at a desk opposite the robot, on top of which RFID tagged plastic food items and two plastic boxes marked 'Like' and 'Dislike' were placed. An RFID reader was attached to the robots right hand. To begin, the experimenter explained the task protocol: to offer the food items to Alyx one at a time, and that an auditory signal (beep) indicated Alyx had recognised the food and would produce an expression in response to this offering. Participants were told explicitly to attend to the Alyx's face and place the food item in one of the two response boxes (Like, Dislike) from their interpretation of Alyx's expression.

3 RESULTS

3.0.1 Emotion Recognition and Autistic Traits. Data analysis computed using R [14]. Participant's AQ scores ranged widely (Range = 4-35; Mean = 16.77, SD = 6.89, Median = 17). As shown in the graph 2 participants in each AQ group recognised expressions with similar accuracy, other than HU-JD (Low AQ = 79% v High AQ = 64%).

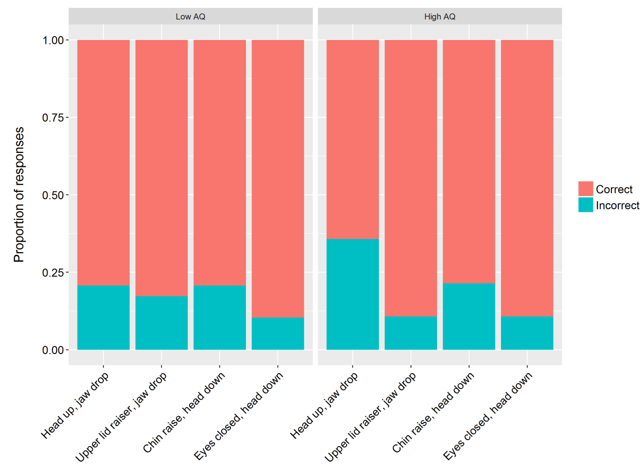

Figure 2: Response accuracy modeled by robot expression and AQ group.

Binary logistic regression was performed to ascertain if the variables expression (HU-JD, ULR-JD, CR-HD, EC-HD), 'AQ score', 'AQ group' (High, Low) predicted participants recognition accuracy (a binary response variable; 1 = Correct, 0 = Incorrect). Stepwise regression found an effect of expression, specifically EC-HD (β = 1.20, *Odds ratio* = 0.768, p = 0.022), but not of AQ score or AQ Group.

Given the indication that AQ group may have affected participant's interpretation of HU-JD shown in Figure 2 a Chi-square binomial test was executed to compare proportions of correct responses per between the the Low AQ (n = 28) and High AQ (n = 29). Results from this Chi-square were however non-significant, χ = 2(1), p = 0.157.

4 DISCUSSION AND CONCLUSIONS

This experiment used a task-based approach to study how autistic traits affected the recognition of robot social signals, namely facial expressions. Data analysis did not find an effect of these traits when considered as both a continuous and categorical variable.

A potential reason for this result is our sample characteristics. Previous work successfully found a relationship between autistic traits and emotion recognition of high-functioning autistic adults [3], but not with a neuro-typical sample [10]. This suggests that social signal processing between individuals with high autistic traits and an ASD diagnosis in reality be markedly different. Furthermore, many of the empirical papers that successfully report neuro-typical group differences with the AQ draw on large samples (e.g. [13]), suggesting that the social signal processing of individuals with an ASD is not equally experienced among neuro-typical adults. Future work with either with an ASD and neuro-typical sample, or a larger neuro-typical sample would help shed light on this issue.

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