Towards Robot-Assisted Social Skills Training for Adults with ASC

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ABSTRACT

Despite the popularity of research on robot-assisted therapy for children with autism spectrum conditions (ASC), there has been a lack of study of the use of robots in therapy for adults. This paper describes progress towards designing robot-assisted therapy for adults with ASC that will allow people to rehearse workplace-relevant social skills. We summarize our prior work on designing interpretable facial expressions for our low degree-of-freedom robot face and describe an in-progress human-robot interaction study involving interruption during a realistic workplace scenario.

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KEYWORDS

Human-Robot Interaction, Autism, Facial Expressions, Interruption

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INTRODUCTION

A 2016 survey by the National Autistic Society found that only 16% of adults with an autism spectrum condition (ASC) in the UK are in full-time employment[21]. Contrast that with the current UK unemployment rate of 4% [23] and it becomes clear that this group is overrepresented in terms of unemployment. One reason that people with ASC have problems securing and maintaining employment is that they struggle to correctly interpret social signals, the expressive behavioural cues through which people manifest what they feel or think. Failure to understand facial expressions, gestures and other nonverbal behaviors leads to difficulties in interactions with co-workers and supervisors. Another challenge is dealing with the flexibility needed to respond to multiple tasks and changing priorities in the workplace.

BACKGROUND

Individuals with ASC experience difficulties in social interaction and communication and can often exhibit restrictive repetitive behaviours [25]. For example, the aspects of conversation, such as turn taking, may not be resolved intuitively as it is by a typically developing adult [6], leading to a breakdown in communication fluency. Further, these individuals often prefer to complete tasks as they are described verbatim, rather than interleave different elements to optimise efficiency [24]. A general preference for routine and lack of social interaction leads to downstream challenges in communication and task completion in the workplace, as revealed by survey studies of employed autistic adults [2, 17].

Behavioural Skills Training (BST) [12] is recognized as one of the most effective training approaches for the effects of an ASC. BST is a behaviourist training approach involving phases of instruction, modelling, rehearsal, and feedback in order to teach a new skill [7]. It has been used to teach social skills to people both with and without disabilities [27]. However, BST is too labour-intensive to be widely applied. We are developing a system based on BST to allow people to rehearse social skills with an expressive, autonomous social robot in realistic workplace scenarios.

Research from the field of HCI has shown that interruptions are common at work [5] and are known to adversely affect an individual's workflow, causing delayed task resumption time and reduced accuracy [4]. Literature from related psychological concepts (e.g. multitasking, executive function [10, 24] suggests that the necessity to break from routine and adopt a flexible strategy make interruptions especially challenging for autistic individuals. From the few studies that have addressed interruptions with this group, it appears that coping strategies can be developed through video-modelling and conversation based intervention [28]. Another option would be to roleplay workplace interruptions with a social robot.

Social robots are being deployed primarily for children with an ASC, with the intention of laying the foundations for social and communicative skills from an early age [13, 30]. Preliminary evidence in this field indicates that autistic childrens robot-based

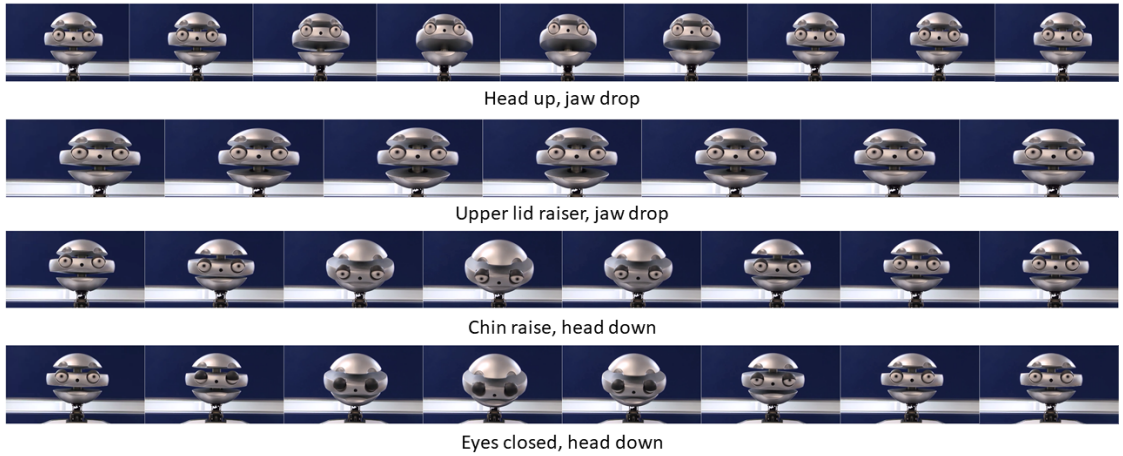

Figure 1: Alyx's facial expressions.

interactions leads to morec frequent social engagement with peers in the classroom [29]. Conceptually, robots are ideal for therapy with this population due to their simplified appearance and predictive nature [8]; potentially combating over-sensory stimulation issues [14, 20]. So, while work in human-robot interaction with children focuses on the development of socio-communicative skills and understanding, here we extend work in this domain to adults' workplace interactions.

PRIOR WORK

Designing Expressive Behavior

For our work, we focus on office-based scenarios with the aim of training high-functioning ASC individuals to decode communication signals from their employer or co-worker. Therefore, we are primarily concerned with broad groups of emotions such as approval (positive) and disapproval (negative) expressions [26]. Our preliminary work has concentrated on evaluating the interpretability of facial expressions by our robot, Alyx. We first identified which mappings of facial action units onto our low DoF robot face are well-categorised by an undiagnosed population [19] (see Figure 1). We then investigated whether there were differences in interpretability of these expressions in undiagnosed adults depending on the prevalence of autistic traits. We found no significant differences in expression categorization by adults with a low or a high prevalence of autistic traits [18]. This suggests that the robot's simplified expressions may be more easily interpretable than human facial expressions across the autism spectrum.

Rather than working exclusively with an ASC population, we have used the Autism-spectrum Quotient (AQ) [3] to explore potential association between the presence of autistic traits and the ability to interpret the robot's expressive behaviour. The AQ is a well-used tool is psychological research as it is an effective screening tool for ASC [31], and gives a score indicating

the prevalence of autistic-type traits in the wider non-autistic population. The use of high-AQ individuals as a proxy for those diagnosed with ASC is supported by the literature and simplifies recruiting a representative sample to evaluate our system, as it can be difficult to access large numbers of adults with ASC.

Involving Stakeholders

It is critical to the success of this project that the workplace scenarios chosen be both ecologically valid and useful to adults with an ASC. In order to ensure this, we consult with stakeholders on the selection and design of the scenarios prior to modeling. In cooperation with "All In Edinburgh", a local supported employment consortium that help ASC adults find and secure employment, we conducted focus groups with both support staff and adults with ASC, to identify which social skills are most problematic for ASC adults in the workplace, what scenarios would best allow people to practice these skills, and how the system can support rehearsal of those scenarios in an ecologically valid manner. Based on this feedback, we identified a scenario involving interruption as our first scenario for study. We have designed the experiment to involve representative clerical tasks that one might do in an office environment. Office work was selected because these types of jobs are both desirable, being readily available and well compensated, and often challenging for individuals with an ASC.

STUDYING INTERRUPTIONS

Interruptions have not been studied extensively in the ASC population, and there are no studies on interruptions by robots with these individuals. Therefore, our first workplace scenario-based study will focus on how individuals with and without an ASC respond to interruptions. The manipulated condition will be the interrupter type: either robot or human.

Extrapolating from results on the use of robots with children with ASC, we hypothesise that adults with an ASC will perform better when interrupted by a robot than by a human. Better in this sense refers to a number of dependen variables under investigation. Generally, these dependent variables relate to the level of distraction an individual experiences while interrupted in the workplace scenario. Examples include, the time participants take to respond to the interrupter, the response time and accuracy to words semantically related to the pre-interruption task in a lexical decision task, and participant heart rate variability between those who experience a human and robot interruption.

We also hypothesise that adults with an ASC will generally perform slightly less well than adults without an ASC in both human and robot conditions given the unique difficulties these individuals demonstrate on tasks of executive functioning [11] and cognitive control [9]. For those in the neuro-typical group, we expect to see similar performance for both interrupter types.

Methodology

This experiment will be conducted with IQ-matched groups of participants with and without an ASC. At the beginning of the trial, the participant will be asked to complete as much as they can of a clerical task; emailing a list of employees about bonuses. At a fixed time, the interrupter (either robot or human) will approach the participant and ask them to stop what they are doing and perform a different task (a lexical decision task, presented as a word identification task) before resuming the initial email task. One of the research team - previously unknown to the participant - will interrupt participants in the human interruption condition, whereas Alyx the robot will interrupt in the robot condition. A human interruption level has been included in the design as a

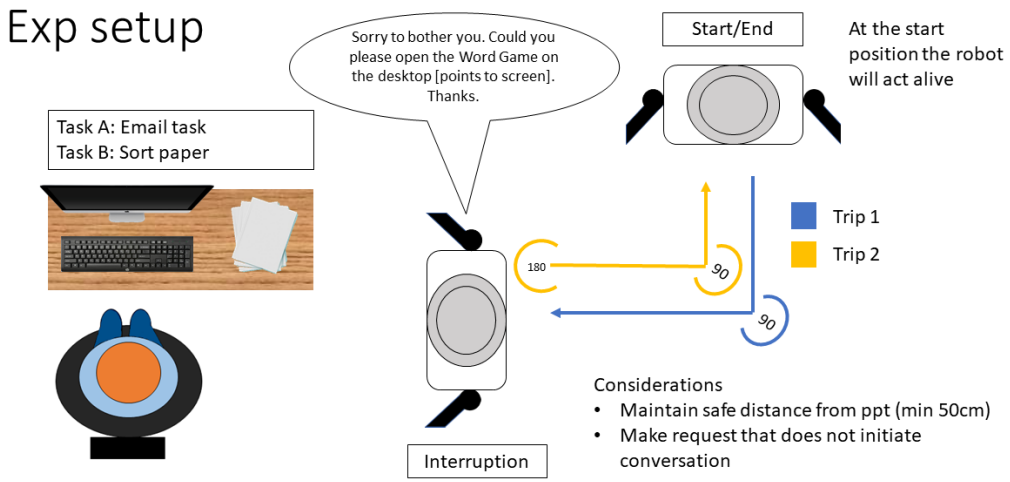

Figure 2: Setup for the interruption experiment.

baseline for variance related to people's responses in the robot interruption condition. The setup of the experiment can be seen in Figure 2.

Studies of interruptions with neuro-typical adults show that an initial task is often resumed at a lower intensity following an interruption, in terms of speed, sub-tasks completed, and accuracy [1, 4], and on occasion is not resumed at all [22]. Further, cognitive studies of "attention residue" demonstrate that information related to an initial task (Task A) can remain active while switching to a new task (Task B) [15, 16]. That is, attention residue is indicated by a reduction in response time (RT) and increase in accuracy to stimuli related to Task A whilst transitioning to Task B, as measured by an intermediary lexical decision task.

We will use a modified version of the paradigm developed by [15] to examine whether being interrupted by a robot or a human causes more or less attention residue while switching from Task A to Task B. Performance will be measured by participants attention residue from the email task; that is, response time (in milliseconds) and accuracy to words in the lexical decision task that relate to the email task (e.g. "email") compared to a word pair matched on frequency and length. Also, the speed, number of sub-tasks completed, and accuracy of Task A after completing Task B will give a general indication of how the interruption has affected Task A performance.

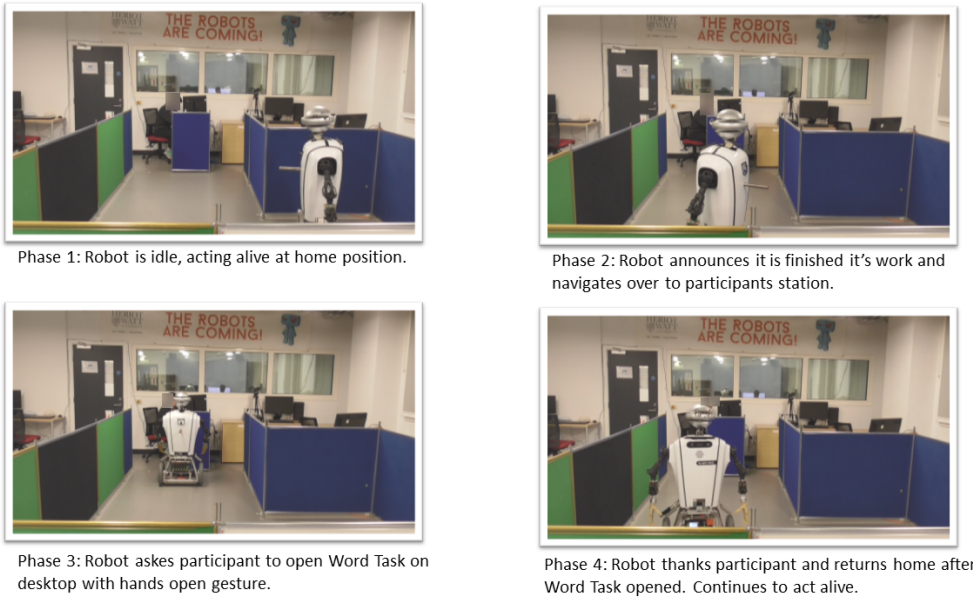

Figure 3: Interruption experiment protocol.

CONCLUSIONS AND FUTURE WORK

This abstract presents progress towards a system for robot-assisted social skills training for adults with ASC. We have designed facial expressions for a low DoF robot face and validated their interpretability by individuals with both low and high prevalence of autistic traits.

In our first workplace scenario-based study, we focus on learning how individuals with ASC are affected by interruptions. Once we have this baseline understanding, the next step is to increase the realism of the scenario by introducing the social and communicative aspects of responding to interruptions in the workplace, including emotionally expressive behavior by the robot interaction partner. This research is an important step towards investigating whether the promising results of the use of robots in therapy for children with ASC can extend to the adult population.

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