Robot-mediated Job Interview Training for Individuals with ASD: A Pilot Study

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Abstract— **This study aimed to evaluate the effectiveness of robot-mediated training for job interviews for young adults with autism spectrum disorder (ASD). The six-week intervention involved mock job interviews with a Furhat social robot to target nonverbal behaviors and communication skills. To measure the efficacy of the intervention, four common nonverbal behavioral challenges among individuals with ASD were investigated: eye gaze, excessive body movement, atypical vocalization, and orientation toward the interviewer. Results indicated varying levels of improvement among participants, with some showing consistent improvement and others exhibiting unexpected results from session to session. This underscores the need for personalized, objective, and quantitative analysis. The study highlights the importance of addressing nonverbal communication challenges for individuals with ASD and equipping them with the necessary job market skills. While the pilot results from robot-mediated training appear promising, further research with a larger group including a wider range of participants with ASD is required to generalize the outcomes.**

I. Introduction

The Center for Disease Control estimates that 1 in 45 children have autism spectrum disorder (ASD) in the United States [1]. ASD is a life-long developmental condition that affects an individual's capability to communicate and relate to others. Despite such challenges, studies have shown that individuals with ASD can live independently and contribute to society through the workforce [2]. In particular, young adults with ASD that attend college are more likely to pursue science, technology, engineering, and mathematics (STEM) majors compared to peers in 10 other disability categories [3]. While there is strong interest for these individuals to develop a career in a STEM field, high-functioning adults with ASD still have high unemployment rates and one of the biggest challenges in successfully attaining employment for these individuals is navigating the interview process [4], [5]. Namely, individuals with ASD are most disadvantaged during the interview process because it is unscripted and requires sound judgments on a variety of social scenarios (e.g. introductions, whether or not to conduct a handshake, small talk, eye contact).

Interventions are already being developed and evaluated to improve interviewing skills for adults with ASD [6]. For example, in [6] an interview skills curriculum was designed for groups of young adults with ASD to improve their social skills during job interviews. The curriculum was over a 12-week period using various formats (e.g. discussions, role-play, video feedback, and games) and consisted of weekly meetings focusing on topics such as 1) character, attitude, and persona, 2) small talk, non-verbal communication, hygiene, and 3) interview questions, closing the interview, and follow-up. Participants that participated in the curriculum demonstrated improved social skills during mock job interviews. Although such programs have shown immediate positive short-term outcomes, they provide minimal repeated real-world practice interview scenarios because it is often infeasible (i.e. time-consuming and requires the availability of trained interviewers) to provide such opportunities for short-term large-group interventions. However, such repeated practice and rehearsal in realistic settings have been observed to be effective in improving the social skills of individuals with autism in the targeted contexts [7].

In response to such needs, virtual reality job interview training technology has been developed for individuals with ASD to provide them with accessible interview practice [8], [9]. For example, in [8] a virtual reality job interview training software was utilized by individuals with ASD. The software allows a user to practice for interviews by selecting from scripted responses based on video-recorded interview questions presented by a virtual reality interviewer displaying a range of emotions, personalities, and memories. Furthermore, immediate scripted feedback is provided by the software based on the verbal responses a user provided in the given scenario. Similarly, in [9] a web-based interview skills program JobTIPS was developed for adolescents with high-functioning ASD. The program focused on instructing individuals on interview topics relating to behavioral interview questions, situational interview questions, nonverbal behaviors during interviews, and norms and expectations during interviews. The program also follows with virtual reality interview practice sessions using virtual characters to simulate the interviewer-interviewee interaction. In the practice sessions, a healthcare professional acts as the interviewer and provides feedback to the individual with ASD based on the content of his/her verbal responses to interview questions.

The aforementioned virtual reality-based interview training programs were demonstrated to be effective for improving the verbal content utilized by individuals with ASD during job interviews but had limited applicability to practicing as well as providing feedback for non-verbal social skills (e.g. body language, eye contact, and facial expressions) [8], [9]. Virtual reality interfaces also do not allow individuals with ASD

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to practice socially interacting with a physically embodied social agent. Such limitations in virtual reality technology may impact the overall efficacy of the interview training for real-world scenarios because individuals with ASD enjoy and are more comfortable communicating in a virtual environment than the physical world [10]. Hence, there is a need to develop socially assistive robots to facilitate interview training for individuals with ASD to provide frequent accessible interview practice with a physically embodied social agent.

In this research, we address this need by developing a social robot interface to deliver mock interviews and improve job interview skills for individuals with ASD. As a preliminary step, this work focused on training educated individuals with ASD because they are presently an untapped/underutilized resource in the workforce.

II. Related Works

Numerous socially assistive robots have been already developed and utilized for interventions targeted towards individuals with ASD. Some applications of these robots for individuals with ASD have included: 1) imitation therapy [11], 2) improving social skills (e.g. turn taking, joint attention, eye gaze, greetings/goodbyes) [12]–[14], 3) encouraging self-initiated social interactions [15], 4) reducing challenging behaviors [16], and 5) improving emotion recognition [17]. In general, these robot-based intervention scenarios had positive outcomes with children and adolescents with ASD, which has been the main demographic for such interventions.

Although such positive outcomes have been observed with children and adolescents with ASD, applications targeting adults with ASD are notably limited. There have only been two recent research efforts from Kumazaki *et al.* towards utilizing a teleoperated human-like android to conduct practice interviews with young adults with ASD [18], [19].

In [18], a study was conducted with seven adults with ASD interacting with an android in one-on-one practice interview scenarios. Results showed practice interview scenarios with the robot improved participant self-confidence in their performance and reduced anxiety in human-facilitated interviews. The intervention also focuses on improving individual comfort (e.g. self-confidence and reducing anxiety/stress) towards interviewing. This study does not directly improve an individual's specific nonverbal or verbal social skills during the interview process. Such social impairment during a job interview has been identified as the most problematic issue for high-functioning young adults with ASD. Researchers have suggested that vocational practitioners should provide targeted training to enhance an individual's social skills during the interview process [20], [21].

In [19], a study was conducted to investigate the effect of robot-based interview training on improving the nonverbal behaviors of individuals with ASD such as posture, gaze, voice volume, nodding, and facial expression. The study compared an intervention that only utilized interview instruction with a teacher to interview instruction that also included a robot-based interview practice component. Participant nonverbal behavior during the interviews was evaluated on a 7-point Likert scale by two independent observers. However, relying solely on such subjective evaluations can be problematic due to the potential for bias. Additionally, subjective evaluations of behaviors such as posture, gaze, voice volume, and nodding may not provide actionable feedback for participants. Using quantitative evaluations would provide interviewees with actionable feedback on their performance and can be less stressful than being judged by others [22]. Moreover, the ASD varies from person to person and this variability can make it difficult to draw general conclusions.

This study aims to address these gaps by evaluating the efficacy of a social robot in delivering mock job interviews to young adults with ASD. We target four common inappropriate conversation behaviors among individuals with ASD during an interview: inappropriate eye gaze, excessive body movements, atypical vocalizations, and inappropriate orientations toward an interviewer. The occurrence of each behavior was measured throughout a six-week interview training program. We evaluate this intervention based on a personalized analysis of each participant's behavior and their improvements in nonverbal behavior during interviews.

III. Experimental Design

To assess the impact of robot-mediated job interview training for young adults with ASD, we used a personalized quantitative approach to evaluate their progress in exhibiting appropriate nonverbal behaviors during mock interviews. This analysis was part of a larger job skills training program that aimed to improve the interview skills of participants. We focused on participants' abilities to follow directions and display appropriate nonverbal cues during interviews conducted with a robot. This study was approved by an institutional review board (#IRB-FY2022-103) and consent was obtained from participants as well as their parental guardians prior to the study.

A. Job Skills Training Program

Participants were enrolled in a university-based program intended to teach job skills to young adults. This program focuses on developing ”soft” interpersonal skills (e.g., communication, social awareness, and teamwork), understanding employment (e.g., resumes, interviews, and maintaining a job), and independent living skills (e.g., hygiene, money management, and goal setting) for individuals with ASD. The robot-mediated intervention was integrated as a part of this program to support participants in practicing their interview skills. The intervention consisted of two phases: 1) human-led instruction on improving job interviews; and 2) interview practice through mock interviews facilitated by a robot interviewer.

The human-led instruction included lectures on improving job interview skills and personalized feedback on specific verbal as well as nonverbal behaviors that participants could improve upon during interviews. The verbal behaviors the intervention focused on included: utilizing the Situation, Task, Action, and Result (STAR) technique [23] to provide structured responses to interview questions, improving upon participants' capabilities to share relevant professional information, and avoid oversharing during an interview as it is a common challenge faced by individuals with ASD [24]. The STAR technique teaches individuals to provide clear and structured responses so that interviewers can better understand their skills and experiences and assess their fit for the job [25]. In addition, the intervention consisted of a human instructor providing feedback to participants on nonverbal behaviors to improve upon during interviews. This included maintaining appropriate eye contact, avoiding excessive body movement, refraining from making atypical vocalizations, and facing the interviewer. These nonverbal behaviors were targeted because these are common challenges that individuals with ASD face when participating in job interviews [26], [27].

The intervention's second phase involved conducting six robot-mediated mock interview sessions. Before conducting each session, participants were instructed that they were interviewing for a position at a pet store, and they were informed that a robot would interview them. Researchers considered three difficulty levels of interview questions, as detailed in Table I. During the initial two rounds of interviews, participants were asked Level 1 questions, which were common interview questions designed to establish a baseline for their interview skills. These questions included asking participants to "tell me about yourself," "describe your strengths," "describe your weaknesses," "tell me why you would be a good candidate for this position," and "where do you see yourself in 5 years."

During the third round of interviews, if the program administrator deemed that the participant was prepared to tackle more complex questions, the robot mediator proceeded to Level 2 questions; otherwise, the participant was asked the same Level 1 questions. The same process was repeated in the final three rounds of interviews, where participants were either moved to the higher-level questions or kept at the same level based on the program administrator's guidance.

B. Participants

The participants self-identified their ASD diagnosis. The inclusion criteria for this study were individuals: 1) 18 years or older, 2) diagnosed with ASD, 3) fully vaccinated for COVID-19, and 4) a native English speaker. A total of 6 young adults met the inclusion criteria and participated in our study. There was one female and five males ranging in age from 19-28 ($\mu = 21.6$).

C. Experimental Setup

We developed a Wizard of Oz (WoZ) interface to control a Furhat social robot. The robot-mediated interviews were conducted at a university-based autism clinic in a therapy room. The robot interviewer was placed on a table across from the interviewee. Two video cameras were used to record the interaction for post-session analysis. One camera was placed on top of the robot's head to provide a front view of the participant and the second camera provided a side view of the robot and participant (Figure 1).

The operator controlled the robot's verbal and nonverbal behaviors from a room adjacent to the interview room. In order to control the robot's behaviors during interviews, the operator was able to see the participant using Furhat's camera

Fig. 1: Experimental setup in the interview room

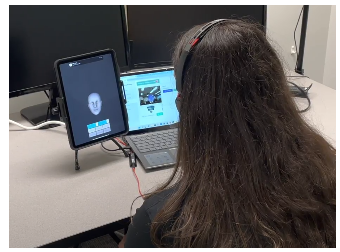

Fig. 2: The WoZ GUI on the computer and the Face Cap application on the iPad in front of the robot's operator

and utilized a Graphical User Interface (GUI) to control the robot. The participant communicated with the interviewer with an audio headset. The Face Cap[1] application was used on an iPad to capture the robot operator's facial expressions, eye gaze, and head orientation so that it could be mapped to the robot's nonverbal behaviors during the interview (Figure 2).

Furhat Social Robot: The Furhat social robot[2], depicted in Figure 2, utilizes a technique referred to as "blended embodiment" in which an animated human-like face is projected onto a physical mask located at the back of its head. This results in more realistic facial expressions, eye gaze, and human-like appearances. The robot is also designed with a human-like neck and equipped with a 135-degree field-of-view camera, 2 microphones, and a speaker.

D. Procedure

The study was conducted over a six-week period, during which participants completed one mock interview session per week based on their availability. Each interview session lasted between 100 and 582 seconds, depending on factors such as the number of questions in the interview and each participant's speed and thoroughness in answering. At the start of the interview sessions, Furhat introduced itself and asked participants if they were ready to begin the interview before proceeding to ask interview questions. At the end of each session, participants were given the opportunity to ask questions about the job position.

E. Data Collection

Videos of all interview sessions were coded to measure participants' interview skills and their adherence to the training instructions. The focus was on collecting personalized quantitative data on participants' performance in exhibiting appropriate nonverbal behaviors during the interviews. We targeted four common nonverbal behavior challenges faced by individuals with ASD during job interviews:

[1] https://www.bannaflak.com/face-cap/
[2] https://furhatrobotics.com

TABLE I: Interview Questions

Difficulty Levels	Questions
Level 1	Tell me about yourself.
	Please describe your strengths.
	What would you say is your biggest weakness?
	What makes you a good candidate for this position?
	Where do you see yourself in 5 years?
Level 2	**Level 2 includes Level 1 Questions and the following ones:**
	How would you handle an upset customer?
	Can you tell me about a time you worked as part of a team?
Level 3	**Level 3 includes Level 2 Questions and the following ones:**
	Can you tell me about a time you took initiative?
	When was a time you learned from your mistake?
	What would you say is your proudest accomplishment?

1) Eye Gaze (EG): Maintaining appropriate eye contact can be challenging for individuals with ASD due to a variety of factors related to the social and communication difficulties associated with the disorder, including difficulties with social reciprocity, sensory sensitivities, and differences in the way their brains process social and emotional information. These challenges can make it difficult for individuals with ASD to understand and respond to social cues, including eye gaze, and can lead them to avoid eye contact or have difficulty maintaining it for extended periods of time [28].

2) Excessive Body Movement (EBD): Individuals with ASD may find it hard to avoid excessive body movement due to challenges with sensory processing and motor control. They may experience difficulty in coordinating their movements, and maintaining a steady posture, and may exhibit fidgeting as a way to regulate their sensory input or to feel more comfortable. Moreover, differences in motor planning and execution can affect their ability to control their movements, which may result in excessive body movements during social interactions such as job interviews [29], [30].

3) Atypical Vocalization (AV): Individuals with ASD may face challenges when it comes to avoiding atypical vocalizations due to communication difficulties associated with ASD. Differences in the way they process auditory and sensory information can cause them to become hypersensitive to certain sounds or unaware of the sounds they make themselves. As a result, they may vocalize in atypical ways, such as making repetitive or atypical sounds, repeating phrases heard from others, or perseverating on the same words or phrases. These vocalizations can disrupt job interviews, making it difficult to communicate effectively [30].

4) Orientation Toward the Interviewer (OTI): Individuals with ASD may have sensory sensitivities that make it uncomfortable to be in close proximity to others or to face them directly. These sensitivities can make it challenging to maintain a comfortable distance and orient toward the interviewer during a job interview. For example, they may feel overwhelmed by the sound of the interviewer's voice, the sight of the interviewer's face, or the sensation of being close to another person. This discomfort can impact their ability to engage in effective communication and establish rapport with the interviewer, which can make it harder to make a positive impression during an interview [31].

Nevertheless, individuals with ASD can improve their eye contact, body awareness, and vocalization through facilitating social support and training. Collecting quantitative data from the challenges mentioned above, provides researchers, program administrators, and participants with a tangible sense of progress in overcoming these challenges. To accomplish this, by considering the nonverbal behavioral challenges explained above, we define and collect data from the metrics detailed in Table II. The higher value for each metric would be interpreted as the better result.

TABLE II: Evaluation Metrics

Metric	Description	Measurement	Measurement Scale
Eye Gaze (EG)	Direction and focus of a person's eyes	The time participants maintained eye contact with the interviewer divided by the session time multiplied by 100	Percentage (%)
Excessive Body Movement (EBM)	Any movement that is frequent, repetitive, and distracting, such as fidgeting by tapping feet or fingers, shifting in the seat, constantly adjusting clothing or accessories, and hair and nose touching	Frequency of EBMs during an interview session divided by the session time	Periodicity (Every n Seconds)
Atypical Vocalization (AV)	Making sounds or noises that are not part of the typical conversation, such as grunting, humming, or making animal noises	Frequency of AVs during an interview session divided by the session time	Periodicity (Every n Seconds)
Orientation Toward the Interviewer (OTI)	Orienting the head and torso toward the interviewer	The frequency that participants turned away from the interviewer divided by the session time	Periodicity (Every n Seconds)

F. Interobserver Agreement

EG, EBM, AV, and OTI data were coded by two independent researchers. Thirty percent of each metric was double-coded to ensure that the Interobserver Agreement (IoA) was over 80%. The interval-by-interval method was used to calculate IoA scores for each metric, which involved dividing the agreed-upon intervals by the total number of intervals in a session. If the IoA score was below 80%, the researchers would collaborate to re-code the session and correct the score.

IV. Data Analysis and Results

Data collected from six participants during the six weeks of robot-mediated mock interviews are presented in Table III. As expected, due to differences in individuals with ASD, participants exhibited different levels of nonverbal behavioral challenges at baseline. Some participants did not have challenges with all nonverbal behaviors. When participants did not have challenges with a nonverbal behavior, they were marked with Not Applicable (NA) in the table. We present a personalized analysis of each participant's interview because each individual had their own individual challenges.

EG was the only common measurable metric among all the participants. Participants' EG performance over six weeks of mock interviews with the robot is presented in Figure 3. Since some of the participants did not show up for some sessions, the data points related to those weeks were not applicable. These sessions are marked with Not Applicable (NA) in the table too.

A. Personalized Results and Analysis

Considering the data in Table III, the individual results of each participant's interview performance over the six weeks are presented as follows:

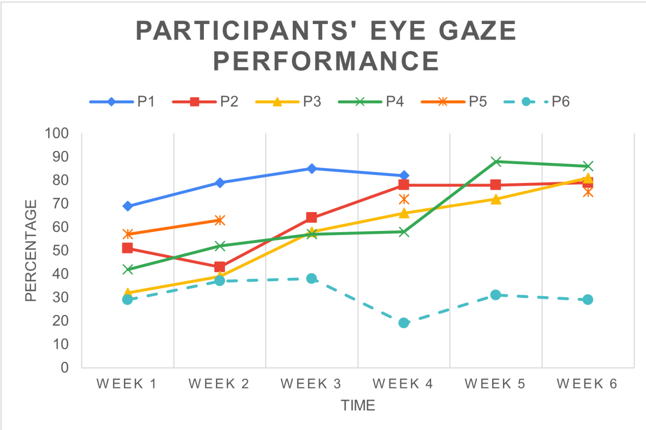

Fig. 3: Participants' Eye Gaze Performance over six weeks of robot-mediated interview skills training

TABLE III: Participants' performance data

W	IL	ST	%EG	#EBM	P of EBMs	#AV	P of AVs	#OTI	P of OTIs
Participant 1									
1	1	260	69	4	65	0	NA	0	NA
2	1	121	79	1	121	0	NA	0	NA
3	2	153	85	3	51	0	NA	0	NA
4	3	206	82	1	206	0	NA	0	NA
5	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	NA	NA	NA	NA	NA	NA	NA	NA	NA
Participant 2									
1	1	328	51	12	27.3	1	328	0	NA
2	1	135	43	2	67.5	0	NA	0	NA
3	2	145	64	4	36.25	1	145	0	NA
4	3	230	78	7	32.8	1	230	0	NA
5	3	225	78	4	56.25	1	225	0	NA
6	3	207	79	3	69	0	NA	1	207
Participant 3									
1	1	300	32	28	10.7	1	300	1	300
2	1	275	39	9	30.55	0	NA	3	91.6
3	2	508	58	11	46.1	0	NA	1	506
4	3	567	66	7	81	0	NA	2	283.5
5	3	537	72	4	134.2	0	NA	0	NA
6	3	582	81	2	291	0	NA	0	NA
Participant 4									
1	1	201	42	19	10.57	9	22.3	16	12.5
2	1	109	52	1	109	2	54.5	1	109
3	2	166	57	4	41.5	3	55.3	1	166
4	2	177	58	8	22.1	0	NA	6	29.5
5	3	447	88	1	447	2	223.5	1	447
6	3	410	86	2	205	1	410	1	410
Participant 5									
1	1	162	57	1	162	3	54	3	54
2	1	117	63	0	NA	4	29.25	0	NA
3	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	2	121	72	0	NA	2	60.5	0	NA
5	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	3	282	75	1	282	9	31.3	1	282
Participant 6									
1	1	158	29	0	NA	0	NA	0	NA
2	1	100	37	0	NA	0	NA	0	NA
3	2	118	38	0	NA	0	NA	0	NA
4	3	199	19	1	199	0	NA	0	NA
5	3	165	31	2	82.5	0	NA	4	41.25
6	3	200	29	2	100	0	NA	1	200

W = Week, IL = Interview Level (1, 2, 3), ST = Session Time (seconds), EG = Eyegaze toward the Interviewer (%), EBM = Excessive Body Movement, P = Periodicity (defined as Every n Seconds), AV = Atypycal Vocalization, OTI = Orientation Toward the Interviewer

Participant 1: This participant participated in the first 4 weeks of the robot-mediated mock interviews. They experienced level 1 questions in sessions 1 and 2, level 2 questions in session 3, and level 3 questions in session 4.

They maintained eye contact with the robot for 69, 79, 85, and 82 percent of each session's duration. EBMs were displayed by this participant as follows: every 65 seconds (4 times) during the first session (260 seconds), 1 EBM during the second session (121 seconds), every 51 seconds (3 times) during the third session (153 seconds), and 1 EBM during the fourth session (206 seconds). They did not show any AV and OTI during the interview sessions.

Participant 2: This participant participated in all the sessions. They experienced level 1 questions in sessions 1 and 2, level 2 questions in session 3, and level 3 questions in sessions 4, 5, and 6. They maintained eye contact with the robot for 51, 43, 64, 78, 78, and 79 percent of each session's duration.

This participant displayed EBMs every 27.3 seconds (12 times) during the first session (328 seconds), every 67.5 seconds (2 times) during the second session (135 seconds), every 36.25 seconds (4 times) during the third session (145 seconds), every 32.8 seconds (7 times) during the fourth session (230 seconds), every 56.25 seconds during the fifth session (225 seconds), and every 69 seconds (3 times) during the last session (207 seconds).

They had AVs once in the first, third, fourth, and fifth sessions, and did not have AVs in sessions two and six. Also, only one turning away from the orientation toward the interviewer was captured from this participant at the last session.

Participant 3: This participant participated in all the sessions. They experienced level 1 questions in sessions 1 and 2, level 2 questions in session 3, and level 3 questions in sessions 4, 5, and 6. They maintained eye contact with the robot for 32, 39, 58, 66, 72, and 81 percent of each session's duration.

This participant displayed EBMs every 10.7 seconds (28 times) during the first session (300 seconds), every 30.55 seconds (9 times) during the second session (275 seconds), every 46.1 seconds (11 times) during the third session (508 seconds), every 81 seconds (7 times) during the fourth session (567 seconds), every 134.2 seconds during the fifth session (537 seconds), and every 291 seconds (2 times) during the last session (582 seconds).

They had AV only once in the first session and turned away OTI once in the first and third sessions. This participant showed this behavior every 91.6 seconds (3 times) in the second session and every 283.5 seconds (2 times) in the fourth session. They did not turn away their OTI during the fifth and sixth sessions.

Participant 4: This participant participated in all the sessions. They experienced level 1 questions in sessions 1 and 2, level 2 questions in sessions 3 and 4, and level 3 questions in sessions 5, and 6. They maintained eye contact with the robot for 42, 52, 57, 58, 88, and 86 percent of each session's duration.

EBMs were displayed by this participant as follows: every 10.57 seconds (19 times) during the first session (201 seconds), once during the second session (109 seconds), every 41.5 seconds (4 times) during the third session (166 seconds), every 22.1 seconds (8 times) during the fourth session (177 seconds), once during the fifth session (447 seconds), and every 205 seconds (2 times) during the last session (410 seconds).

AVs were displayed by this participant as follows: every 22.3 seconds (9 times) during the first session, every 54.5 seconds (2 times) during the second session, every 55.3 seconds (3 times) during the third session, did not have AV during the fourth session, had AVs every 223.5 seconds (2 times) during the fifth session, and once during the last session.

They turned away their OTI every 12.5 seconds (16 times) during the first session, and once during sessions two, three, five, and six. This participant also had this behavior every 29.5 seconds (6 times) in the fourth session.

Participant 5: This participant did not show up in the third and fifth weeks. They experienced level 1 questions in sessions 1 and 2, level 2 questions in session 4, and level 3 questions in session 6. They maintained eye contact with the robot 57 % and 63% of the first and second sessions, 72% of the fourth session, and 75% of the last session.

EBMs were captured from this participant once at the first and once at the last sessions. However, they had AVs every 54 seconds (3 times) during the first session (162 seconds), every 29.25 seconds (4 times) during the second session (117 seconds), every 60.5 seconds (2 times) during the fourth session (121 seconds), and every 31.3 seconds (9 times) during the last session (282 seconds). This participant turned away their OTI every 54 seconds (3 times) in the first and once in the last session. They did not show this behavior in the other sessions.

Participant 6: This participant showed up in all the sessions. They experienced level 1 questions in sessions 1 and 2, level 2 questions in session 3, and level 3 questions in sessions 4, 5, and 6. The EG metric was measured but did not apply to this participant due to their impairment in eye contact. Hence, their EG performance is shown by a dashed line in Figure 3.

They showed EBMs once in the fourth session, and twice in both sessions five and six. This participant did not have AVs, but showed turning away OTI every 41.25 seconds (4 times) during the fifth session and once during the last session.

V. Discussion and Conclusion

This study investigates the effectiveness of robot-mediated training on the job interview performance of young adults with Autism Spectrum Disorder (ASD). Over a six-week intervention period, six participants underwent mock job interviews conducted by a social robot. The program aimed to teach participants essential skills for securing employment, including responding to interview questions and demonstrating appropriate nonverbal behavior. Individuals with ASD often struggle to exhibit nonverbal behavior, which significantly impacts how interviewers perceive them. It is worth noting that only 7% of communication relies on the literal verbal meaning of spoken words [32]. Consequently, this study aims to address this challenge by helping job seekers recognize and overcome their personalized challenges in nonverbal communication, equipping them with the necessary skills to succeed in the job market.

The study focused on addressing four common nonverbal behavioral challenges encountered by individuals with ASD by using quantitative metrics: EG, EBM, AV, and OTI. These metrics were targeted to evaluate the efficacy of social robots in interview training interventions. Participants in the study received weekly guidance from a human instructor on how to improve their performance on the aforementioned metrics. They were asked to practice these directions during the robot-mediated interviews to improve their nonverbal communication skills. The results demonstrated that participants' nonverbal behaviors during mock job interviews varied significantly from person to person. Therefore, all the metrics did not apply to all the participants.

Considering the participants' data during the sessions (Table III), the following findings on the evaluation metrics could be discussed:

EG: Comparing participants' EG performance on their last sessions with their baseline shows consistent improvement among all the participants (this metric did not apply to participant 6). Participants 1 to 5 showed 13%, 28%, 49%, 44%, and 18% improvement in their EG performance. This improvement is depicted in Figure 3.

EBM: Participants 1 to 4 had successfully decreased their EBMs. Their EBM statistics in the first session were higher than in the other sessions. Their stress level on their first interview experience with the robot could have influenced their EBMs. However, the training interventions led to remarkable improvements as the sessions progressed. This improvement was not consistent among all the participants and some fluctuations were observed in their performance but altogether comparing the first and last sessions demonstrates a promising result for the robot-mediated interventions in decreasing EBMs.

AV: Participants 4 and 5 were the only participants who had a challenge with AVs. Program training and the robot-mediated interview practice helped participant 4 to decrease AVs notably. However, participant 5, who missed sessions 3 and 5, did not display a sustained decrease in AVs

OTI: Participants 4 and 5 also demonstrated more turning away their orientation from the interviewer than the other participants. However, the intervention was effective for both in decreasing this behavior.

While analyzing the common metrics of the participants in this study revealed some patterns and trends in their nonverbal communication performance, unexpected results were observed from some participants from session to session. For instance, Participant 6 did not display any EBM and OTI issues in the first four sessions but exhibited these behaviors in the last two sessions. This highlights the challenges in analyzing nonverbal behaviors in individuals with ASD.

These observations also underscore the need for a personalized, objective, and quantitative analysis of interviews to gain deeper insights into the effectiveness of robot-mediated interview training. Furthermore, objective analysis can provide impartial feedback to the participants, enabling them to understand their nonverbal communication strengths and weaknesses better.

To generalize the findings of this research, it is crucial to expand this pilot study to larger groups of young adults with ASD, encompassing a wide range of the spectrum. The participants should be classified based on their baseline data, and their performance analyzed within their specific level. We will extend this study to future job skills training programs, building upon the findings obtained in this pilot study.

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