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Longitudinal study of interactions among Ghanaian autistic children and Rosye, a humanoid robot

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Abstract:

Children on the autism spectrum have unique learning needs and require extra support and care. This has led to the surge in research on diverse technological interventions which could aid in their therapy. Currently, there is mounting evidence on the potential benefits of robot-mediated interventions for such children. However, research has proven that cultural backgrounds, costs and ease of use play a crucial role in the acceptance of technology. In middle-to-low income countries, the potentials of a lot of children on the autism spectrum are left untapped due to limited expertise to provide early intervention services to them, lack of requisite technological aids and the stigma attached to the disorder. This paper presents results from a longitudinal study of interactions involving some Ghanaian autistic children and Rosye, a humanoid robot in a classroom setting. Varying results were obtained due to the multifaceted nature of the disorder. Some of the children were consistent in their responses to the robot over several sessions, others began to communicate with the robot as the sessions went by and for a few, their interest in the robot declined with time. However, the results suggest that there are some children on the autism spectrum in Ghana for whom robot mediated interventions would be beneficial.

Keywords — **robots, autism, imitation, Ghana, Africa, study**

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I. INTRODUCTION

Autism Spectrum Disorder (ASD) is a complex disorder characterized by impairments in imagination, social communication and repetitive behaviours [1]. ASD occurs among all races and ethnic groups and it is more prevalent in boys than girls [2]. The disorder has no cure but early interventions could improve the quality of life of affected people [3]. Research suggests that, autistic children are easily drawn to robots because robots are deterministic and can behave in the same way for a long period of time [4][1]. Due to the multifaceted nature of the disorder, designing robots for autistic children require a multidisciplinary approach involving the children, their caregivers, healthcare professionals and designers. A user-centered approach needs to be utilized to understand end user requirements, produce design solutions and evaluate these solutions in the natural setting. Currently, robots being used in autism education research have been developed based on requirements and conditions in the Western world and may or may not be well situated for children and their caregivers in developing countries. More so, majority of the research on investigating the efficacy of robots as assistive technologies for children on the spectrum and technological acceptance by caregivers have mostly involved participants from developed countries.

Notwithstanding, several researchers have underscored the diversified influence of cultural variables and religious beliefs on suitability, acceptance and effectiveness of technology [5][6][7][8][9]. In autism management, research presented in [10][11][12] have indicated that culture and sociodemographic variables need to be incorporated in the design of technological interventions targeted at managing the disorder. Research on assistive technologies for persons living with disabilities in middle-to-low income countries is minimal [13]. Matter et al. [14] indicate that, only 5–15% of people in need of assistive technologies obtain them; the prohibitive costs and unavailability of trained personnel have also impacted negatively on the situation.

The unmet growing need of technology in special needs education coupled with lack of enough studies on robots in autism therapy in middle-to-low income countries motivated this research. Our previous research [15], was the first of its kind in the African continent and Ghana as a country to investigate the suitability of robots in the classroom setting for children with autism. It presented results from preliminary experiments involving an initial encounter of some Ghanaian autistic children with a novel humanoid robot, Rosye. Feedback from the children and their caregivers indicated that the robot appealed to the children and encouraged them to participate in the imitation games and general activity tasks. However, the reaction of children on the autism spectrum towards play objects could be unpredictable; an object which was once their favourite could irk them on a different day. In order to assess whether the children's attitudes and reactions to the robot would be same, better or worse with time, a longitudinal study was undertaken to engage the children in repeated interactions with the robot.

II. RELATED WORK

Social robots have been utilized in diverse domains such as rehabilitation [16] and elderly care [17]. These robots are gradually finding their way into special needs education for children with autism [18]. Research by Robins et al [4]., Duquette et al. [19] and Stanton et al.[20] indicate that children on the autism spectrum easily familiarize with robots as playmates because robots are more predictable as compared to humans. Scassellati et al. [21] presents that the amount of exposure (i.e. number of interaction sessions) significantly influences the effects of a robotic technology on a child with autism. This is because autistic children are sensitive to changes in their environment and their routines. Their initial reaction to a novel robot may differ from the behaviour the child may exhibit once the robot becomes familiar [21].

Experiments presented in literature on robot mediated therapy are either single interaction sessions or repeated exposures. Single session experiments enable researchers to determine the initial reaction of autistic children to social robots and the effects of robot designs on acceptance by these children. Examples of autistic child – robot single subject interactions are Michaud and Serge [22], Stanton et al.[20], Robins et al.[23] and Valadão et al.[24]. Michaud and Serge [22] conducted experiments involving a mobile robot, Roball and autistic children. The results indicated that the robot caught the attention of the children. In a research by Stanton et al. [20] where autistic children interacted with a robotic dog AIBO, the results indicate that the children spoke a lot more to AIBO as compared to a simple mechanical dog. Robins et al. [23] report from an experiment that a social robot KASPAR was able to serve as a mediator between autistic children and adults present during interaction sessions. Another research by Valadão et al.[24] indicate that the robot MARIA was able to elicit social skills in some autistic children and these children had more physical contact with the robot compared to the control group.

On the other hand, repeated exposure of the children to the robot is likely to increase familiarity but is susceptible to factors such as mood swings and conditions in the environment where the experiments take place. A lot of longitudinal studies in autistic child-robot interactions have been performed over several weeks with typically a maximum of five interaction sessions per child [21]. Longitudinal studies for assessing the behaviour of autistic children towards robots reduce the influence of variables [4].

Some longitudinal studies of autistic child(ren)-robot interaction are Robins et al. [4], Kozima et al.[25], Duquette et al. [19], and Wainer et al.[26]. Robins et al. [4] discovered from repeated interactions that a social robot can be a salient mediator of joint attention in children with autism. Kozima et al.[25] conducted interaction sessions among Keepon, a robot and autistic children for some years and realized that robots are likely to facilitate social interactions among children. Duquette et al. [19] present that during multiple autistic child-robot interactions, the children paired with the robot Tito exhibited increase in shared focus attention as compared to those paired with a human instructor. Wainer et al. [26] report from a longitudinal study that, autistic children played more and regarded the robot KASPAR as a partner as compared to their play sessions with a human.

The autistic children who have partaken in robot mediated experiments are mostly from developed countries [27] such as UK [26][4], USA[20][18], Germany[23], Canada [19], Japan [28]. A few have been undertaken in developing countries such as Brazil [24]. Similar to these autistic child-robot interaction studies, investigations on the prevalence of autism in middle-to-low income countries are scarce [27]. However, it is essential to research on how variables such as cultural influence and etiology affect identification and treatment strategies for autism. Blacher and Mink [29] point out that, cultural sensitivity should be considered when importing knowledge and cultural practices from one culture to another. Culture could also influence how people react to, accept and interact with technology. Interventions developed and experimented with autistic children in the Western world need to be tested with participants from diverse cultures and resource constrained environments rather than presuming that these technologies would be adequate for children with special needs from these areas. Consequently, there is the need for indigenous research on robot assisted therapy for children from developing countries.

Our previous research[15] established a baseline (initial reaction of the children towards a novel humanoid robot). To investigate the effects of the "diminishing novelty effect", a longitudinal study was undertaken to engage seven autistic children who took part in the first study in interactions with the same robot. The objectives of the research were:

i. to determine the effects of repeated interactions on responses of the children to the imitation and general activity tasks.
ii. To find out whether the children would learn from the robot through continual interactions.
iii. to determine the frequency of physical contact (ie the number of times each child touched specific parts of the robot.)

The results of this longitudinal study are presented in this paper.

III. RESEARCH QUESTIONS

The research sought to address the following questions.

1. Would repeated interactions among the Ghanaian children and the robot affect their responses to imitation and general activity tasks over time?
2. Would the children on the autism spectrum learn from the robot through continual interactions?
3. Would the autistic children have a lot of physical contact with the robot during the interaction sessions?

IV. METHODOLOGY

A. Participants

Seven (7) autistic children who had partaken in our previous study[15] were selected from an Autism Center in Ghana as participants of this longitudinal study. Five (5) of them were males and the other two (2) were females. Five of the children had the tendency to ignore their own names when called and

Kommentar [R1]:
Kommentar [R2]:
Kommentar [R3]:

all the children sometimes ignored instructions irrespective of who was issuing them. The mean age was 10.43 and standard deviation 1.62. Consent forms were given to the parents of the participants and they agreed for their children to be part of the study. All the names of the participants have been pseudonymized for privacy reasons.

B. Experimental Scenario

The experiments were structured as individualized child-robot interaction sessions and the duration of each session was flexible to accommodate each child's needs. The experimental script played by the robot was similar to the script used in our previous study. All the interaction sessions took place in the sensory room of the Autism Center. Each child was accompanied by the caregiver. The interaction session began with the robot introducing itself by saying "Hello my name is Rosye". The robot then played a local song, danced by turning its neck around, raising its hands up and down and blinking its LED eyes. After the music session, the robot presented six imitation tasks, followed by a musical interlude and then finally five general activity tasks.

At the beginning and end of each session i.e. music time, imitation games and general activity session, the robot prompted the child using phrases like "it is music time", "music time is finished", "it is exercise time", "exercise time is finished", "it is interaction time", "interaction time is finished". This routine adopted was in line with the standard used in their classroom where care givers prompt children at the beginning and end of each session with picture exchange communication session (PECS) or verbal instructions. The robot repeated each task for a maximum of three times and afterwards the task was aborted if the child did not respond by the third prompt. The robot was remotely operated by the researchers via the Wizard-of-Oz approach. A few of the children did not report to school on some of the scheduled days and therefore could not participate in all the interaction sessions. Table 1 represents an overview of the imitation and general activity tasks.

TABLE I
OVERVIEW OF IMITATION AND GENERAL ACTIVITY TASKS

Task Number	Tasks (T)	
	Imitation	**General Activity (GA)**
1	Left Hand Up	Robot says: What is your name?
2	Left Hand Down	Robot calls child by name
3	Right Hand Up	Robot says: Hello "name of child" how are you"?
4	Right Hand Down	Robot says: "name_of_child", take the ball
5	Both Hands Up	Robot says: Hi "name_of_child", give me the ball
6	Both Hands Down	

C. Robotic Platform

The humanoid robot, Rosye, depicted in figure 1 was used in the study.

Fig. 1 Rosye, a humanoid robot

This initial version of Rosye communicates with a computer interface via wifi and has accessories such as ultrasonic sensors, speakers and a camera. It has motor and verbal skills and uses LED lights for facial emotion expression.

D. Data Recording and Analysis

All the interaction sessions were video recorded for analysis. The data gathered from each autistic child-robot interaction was scored as follows: Each task (both imitation and general activity) had a score of 1 when it was done correctly by the child and a score of zero (0) if the child failed to correctly perform the task after three prompts. The metrics used during the data analysis phase were:

1.The imitation and general activity score per day for a maximum of eight sessions
2.The number of times each child had physical contact (touched the robot) during the various sessions
3.Comparison of the children's responses to both tasks (imitation and general activity) against the number of times each child touched the robot.

V. RESULTS

A: Child 1, James

James is a nine (9) year old male child with autism. He follows instructions given by his caregiver but finds it difficult to approach, interact with and obey instructions from unfamiliar people. During his first encounter with the robot (session 1), it took a while before he got close to it. The task "James give me the ball", which required him to walk to the robot and give the ball to it, made him go near the robot. Afterwards, it was observed that he felt more comfortable and remained close to the robot throughout the eight different encounters he had with it. His responses to the imitation tasks were consistent except during the seventh session. Figure 2 depicts the pattern of the responses of James in both imitation and general activity (GA) tasks.

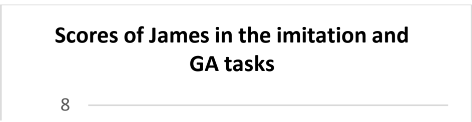
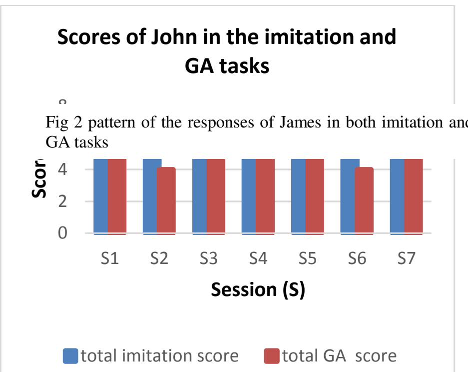


Fig 2 pattern of the responses of James in both imitation and GA tasks



James' score for the imitation tasks was 44 out of a maximum score of 48. His score for the GA tasks was 32 out of a maximum score of 40, indicating that he performed better in the imitation game as compared to the GA tasks. Over the eight sessions, the task for which he had the least score of 2 was "what is your name". In his first and second interaction sessions, he did not touch any part of the robot. Then from sessions four to eight, he touched the robot multiple times. James touched the robot one hundred and forty-two (142) times during the longitudinal study. This score for physical contact was the highest recorded value compared to the number of times the other children touched the robot. After the first two sessions of interaction with the robot, James became familiar with the routine of the games presented by the robot. For instance, he learnt the pattern of the actions in the imitation games, therefore he was able to follow the robot quickly in those tasks. Similarly, in the GA tasks, he also learnt that after the robot asks him to take the ball, the next instruction would be for him to hand over the ball to the robot. As a result, in some of the sessions, he would pick the ball when instructed by the robot and then hand it over to the robot (without being told to do so).

B: Child 2, John

John is a thirteen (13) year old male child with autism. He is verbal, likes to shout and yell for no reason and mostly ignores instructions, especially from strangers. He was present for 7 out of the 8 sessions of the experiment. In the first session, immediately he was ushered into the experimental room, he went to touch the robot and hugged it and called out "robot". During all the sessions, he danced to all the songs played by the robot. From session one to seven, he performed all the imitation tasks correctly but missed out on some of the GA tasks. Figure 3 depicts the pattern of responses to the imitation and GA tasks for John.

Fig 3 pattern of the responses of John in both imitation and GA tasks

During all the interaction sessions, John touched various parts of the robot's body; In all, he touched the robot one hundred and twenty-five (125) times during his interactions over the seven days he participated in the study. He was the second person who touched the robot the most. He scored 42 out of the maximum of 42 score for imitation tasks (for seven sessions) and 33 out of the maximum score of 35 for the GA tasks (for seven sessions). John also became familiar with the robot's actions and was quicker to engage in interactions with it as the sessions progressed. He was full of smiles every time he had to interact with the robot and showed affection by hugging it on some days.

C: Child 3, Ama

Ama is a thirteen-year-old verbal female with autism. She is calm, likes to smile and easily approaches strangers. She however sometimes fails to follow instructions. She partook in the experiment for seven sessions The first day she saw the robot, she walked to it, smiled and touched its midsection. As robot played music, she came to the researcher, held her hand and said "dance". After taking a few dance moves with her, she was asked to continue dancing but she rather went back to touch various parts of the robot. On the first to third days of her encounter with the robot, she did not perform any of the imitation tasks. From the fourth to the seventh sessions, she was able to perform some of the imitation tasks.

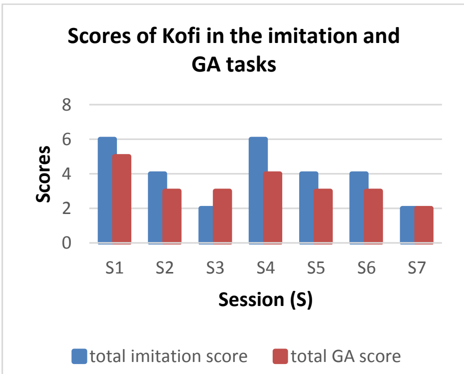
Ama had a score of 10 out of the maximum 42 for the imitation tasks over seven sessions. For the GA tasks, she scored 26 out of 35 marks. Figure 4 depicts the pattern of responses of Ama to the imitation and GA tasks over seven sessions.

Fig 4 pattern of responses of Ama to the imitation and GA tasks

She touched the robot the most in the first session and as the sessions went by, the number of times she touched the robot reduced. Ama touched the robot 45 times during her interactions with the robot over the sessions. Whenever the robot played music, she called out to the researcher to dance with her. She sometimes repeated the robot's instructions instead of performing them; this trait is called echolalia, a common characteristic of some children on the autism spectrum. Ama also familiarized with the robot over time and from the third session onwards, whenever the caregiver informed her it was time to play with robot, she left her classroom to come to the experimental room without anyone directing her.

D: Child 4, Kofi

Kofi is a thirteen (13) year old child with autism. He is verbal and just other children on the spectrum, he sometimes ignores instructions. On the first and fourth sessions, he performed all the imitation and GA tasks and touched various parts of the robot. His responses to the tasks reduced on the other sessions. In all the sessions, he would draw closer to the robot, touch its parts and returns to a corner of the room to play with other toys. However, it was realized that even when his attention seemed to be off the robot, he was actually listening to it; especially for the GA tasks, he answered some of the questions such as "how are you", "what is your name" (while he was still playing with an object) and for the tasks which required actions, he sometimes got up to perform the needed action. Figure 5 depicts the pattern of responses of Kofi to both imitation and GA tasks.



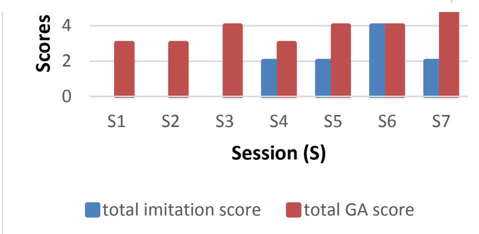


Fig 5 pattern of the responses of Kofi in the imitation and GA tasks

Kofi partook in the experiment for seven (7) sessions. His score for the imitation tasks was 28 of a maximum of 42 over seven sessions. For the GA tasks, he obtained a score of 23 out of a maximum of 35. He touched the robot 95 times during his interaction over the sessions.

E: Child 5, Akwasi

Akwasi is a ten-year-old male child with autism. He is verbal, tends to ignore his name and instructions most of the time and has difficulty sustaining attention to learning tasks. He had five interaction sessions because he did not report to school on some of the scheduled days. The first day he was ushered into the experimental room, he walked towards the robot and lifted its hand up. He danced and sang along to the songs played by the robot. He did not respond correctly to any of the imitation tasks throughout his five interaction sessions with the robot. He got all the GA tasks correct on the first day, three of the tasks in the second session and on the third to the fifth sessions, he did not perform any of the GA tasks correctly. Figure 6 depicts the pattern of responses of Akwasi to the imitation and GA tasks over five sessions. He touched the robot more on the first session as compared to the other sessions of his interaction with the robot. In all, he touched the robot 37 times while interacting with the robot over the sessions.

Fig 6 pattern of the responses of Akwasi in the imitation and GA tasks

F: Child 6, Yaw

Yaw is a nine-year-old male child with autism. He is nonverbal, ignores his name, instructions and hits others for no particular reason and has difficulty sustaining attention to tasks. He partook in the experiment for eight sessions. He performed one imitation task correctly in his first session of interaction with the robot and two tasks correctly on sessions 2,3 and 7. On most of the sessions, he turned his attention to the robot when it called his name. However, for the GA tasks “what is your name”, “how are you” and “give me the ball”, he scored very low. Notwithstanding the fact that he is nonverbal, on session 1, he responded to “how are you” by using sign language. Figure 7 depicts the pattern of responses of Yaw to the imitation and GA tasks. Yaw touched the robot more on the first session as compared to the other sessions. His overall score for touching the robot was 68.

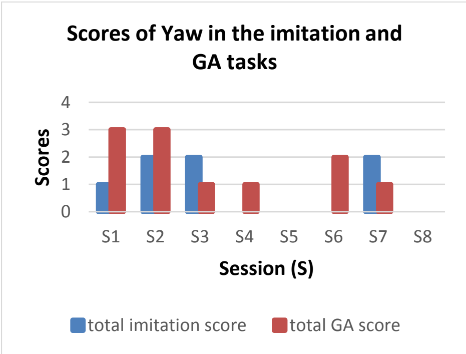
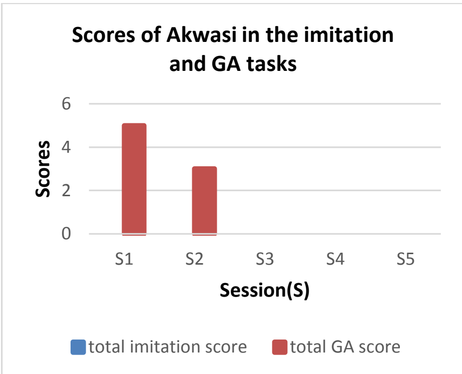


Fig 7

pattern of the responses of Yaw in the imitation and GA tasks

G: Child 7, Afia

Afia is a nine-year-old female child with autism. She is verbal, sometimes ignores name, instructions, yells for no reason and has difficulty sustaining attention to tasks. The first day she was ushered



into the experimental room, she expressed visible signs of fear upon sighting the robot. She did not draw close to the robot. She got scared when the robot began the imitation task and therefore her session had to end. She was present for all the interaction sessions and as the sessions went by, she felt more comfortable with the robot. From session 2 onwards, she danced to songs played by the robot but would not move close to it. She was neither able to do any of the imitation tasks nor the GA tasks but spent forty-one minutes nine seconds dancing and watching the robot over the interactions.

H: Physical contact with the robot

Figure 8 indicates the pattern of responses on the number of times the seven children who participated in the study touched the robot. Data from the study indicates that the child who touched the robot the most was James with a score of one hundred and forty-two (142), followed by John with a score of one hundred and twenty-five (125), Kofi, a score of ninety-three (93), Yaw, sixty-eight (68), Ama, forty five (45), Akwasi, thirty seven (37) and Afia scored zero (0).

From figure 8, it is observed that all the children except Afia touched the robot multiple times. Therefore, it is evident that most of the children were not scared by the humanlike appearance of the robot. Akwasi and Yaw who had lower scores for the imitation and GAS even touched the robot a lot of times. Throughout the experiments, the children touched various parts of the robot; eyes, mouth, head, midsection, shoulder, neck and hands. Some of the parts were touched more than others. The hands (both left and right) were the parts touched the most with a score of two hundred and forty (240). The second most touched part was the robot's midsection with a score of one hundred and four (104). The third was the head with a score of seventy-two (72), followed by neck and mouth with a score of twenty-nine (29) each. The shoulders of the robot were touched twenty-five times (25) and the eyes were touched the least with a score of eleven (11). The robot was touched five hundred and ten (510) times during the experimental sessions.

Figure 9 compares the responses of the children to the tasks as against the number of times each child touched the robot.

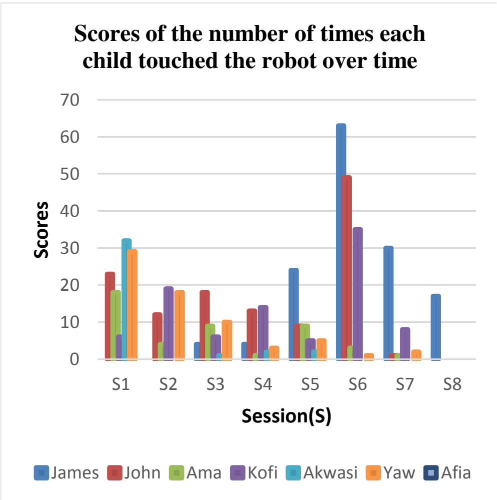


Fig 8 Trend of scores for physical contact each child had with the robot over the sessions

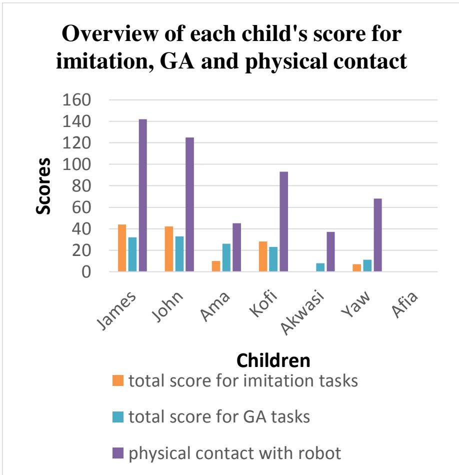


Fig 9 Comparison of the children's responses to both tasks (imitation and GAS) and the number of times each child touched the robot

VI. SUMMARY OF FINDINGS

Over the eight session period, two hundred and eight two (282) imitation were presented by the robot to the children. The number of imitation tasks completed by the children was one hundred and thirty-one (131) whereas number of imitations tasks not done was one hundred and fifty-one (151). The number of tasks not done outweighed the number of tasks done for the imitation game. The robot presented two hundred and thirty-five (235) GA tasks to the children in the longitudinal study. Out of this number, one hundred and thirty-five (125) tasks were successfully completed by the children while the remaining hundred (100) tasks were not done. As opposed to the imitation score, it is observed that the children performed better by completing more of the GA tasks.

VII. DISCUSSION

Research Question (RQ) 1: Would repeated interactions among the Ghanaian children and the robot affect their responses to imitation and general activity tasks over time?

Four hundred and two minutes twenty-six seconds (402m 26s) of videos recorded during the child-robot interaction sections have been analysed. The patterns of responses of the children to the imitation, GA tasks and the number of times each child touched the robot over a maximum period of eight sessions have been presented. Consolidated data on the performance of the children in the imitation game indicates that the number of tasks which were not done were slightly more than the number of imitation tasks successfully completed by the children. On the other hand, for the GA tasks, the number of them completed successfully outweighed the number of tasks which were not done.

For many children involved in this experiment, continuous exposure to the robot had a positive impact on them. Three of them who scored high during their interaction with Rosye in the first session exhibited similar levels of engagement and enthusiasm over the days. One child was able to engage in the imitation tasks from the fourth session onwards. Another child did not respond to the imitation tasks after the third session but responded to a few on the seventh session. Only one child showed disinterest and would not engage the robot as the sessions went by. The child who was scared of the robot at first overcame her fears and improved by smiling and dancing to songs played by the robot on subsequent sessions.

The children also touched various parts of the robot multiple times during their interaction sessions and affection (hugging, smiling) was shown by some of the children to the robot. Some of the children learnt from and became familiar with the robot's activities and therefore were able to request actions from the robot via speech or sign language. These results have indicated that the robot can serve as an educational and entertainment tool for Ghanaian children on the autism spectrum. During the course of interactions, the children exhibited a few of the autistic traits they usually express in their classrooms when being taught by the caregivers. Most of the children did not become bored with the robot but rather engaged and continually responded to prompts from the robot. To address research question 1, we present that continual interactions between the robot and the children can help a lot of them become accustomed to the robot and respond positively to it.

RQ 2 Would the children on the autism spectrum learn from the robot through continual interactions?

To effectively function as an assistive technology to these children, robots should be able to entertain, engage and more importantly teach the children new skills. This research sought to find out whether apart from responding to instructions posed by the robot, the children would be able to pick up new skills and also learn from the robot. Presenting the robot to the children over the eight session period and repeating the same tasks in this timeframe afforded the children the opportunity to become used to the robot. Observations from the experiments indicated that from the third session onwards, some of the children began to learn from the robot. The pattern of hand movements made by the robot were picked by some children and they could follow through the imitation exercises easily.

The general activity tasks which involved the children taking the ball and giving it to the robot also became familiar to some of the children over the sessions. For some of the children, they realized that the next task after "take the ball" was to give the ball to the robot. As a result, whenever these children were asked by the robot to take the ball, they would take it and hand it over to the robot even before the robot instructed them to do so. A few took notice of the experimental room and would come there themselves as soon as their care givers told them it was time to play with robot. These indications have provided some evidence that some of the children learnt from the robot as a result of continuously engaging with it.

RQ3: Would the autistic children have a lot of physical contact with the robot during the interaction sessions?

Autistic children may experience sensory sensitivities to environmental stimuli such as sounds, light, smell and touch. Some may demonstrate aversion to touching new objects and people touching them. Others may also get stuck on objects of interest. In order for the robot to serve its purpose, it is important for the children to feel comfortable around it and see it as a "friend". Notwithstanding the humanlike appearance of the robot, six out of the seven children had physical contact with the robot on multiple instances. The robot was touched five hundred and ten (510) times over the eight session period. Three of the children whose performance over the sessions decreased also touched the robot less as the sessions went by. Also, three of them who were more consistent with their responses to the robot touched the robot multiple times. One child did not touch the robot at all. Both hands of the robot recorded the highest number of touch followed by the midsection, head, mouth, neck, shoulders and eyes respectively. One of the children went a step further to hug the robot. Perhaps the hands may have been touched the most due to their motion capabilities.

This research indicates that many of the participants got close to the robot, expressed emotions towards it and touched its parts. Therefore, the effects of the uncanny valley during the robot interaction sessions was minimal. The humanoid appearance and design of the robot seemed to have contributed to the enthusiasm expressed by the children since they saw it as similar to them. The children were more responsive to the general activity tasks as compared to the imitation tasks. The robot was also able to persuade some "non-cooperating" children to respond to the robot by giving several prompts. Presenting the robot to the children continuously enabled them to familiarize with it and learn from it as the sessions went by. Some of the children maintained consistency in their interactions with the robot, others picked up over time and just a single child who expressed interest in the robot on the first session did not engage much with it on subsequent sessions.

VIII. CONCLUSIONS

Researchers ought to focus more on approaches to investigate the capabilities, challenges and needs of people with special needs who are often underrepresented in the design of technology. Findings from this research suggest that some of the Ghanaian autistic children have engaged and responded well to the robot. However, due to variability in autism manifestation among individuals, there is the need for robot and software customization to cater for individual preferences. Consequently, the robot is a promising tool which can be harnessed as an assistive technology to aid in educational, social and entertainment therapy sessions for some Ghanaian children with autism.

Children on the autism spectrum learn through repetition and consistency and robots are better situated to deliver the same tasks over and over again without getting tired or bored. As a result, robots can be effective tools to supplement the efforts of caregivers of autistic children. Robots for use in autism therapy need to be cost effective and easy to program by professionals and caregivers of these children.

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