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Julie Golliot, Tamie Salter, Catherine Raby-Nahas, Mark Vezina, Yves-Marie Merat, et al.. A Tool to Diagnose Autism in Children Aged Between Two to Five Old: An Exploratory Study with the Robot QueBall. Human Robot Interaction, the Tenth Annual ACM/IEEE International Conference, Mar 2015, Portland, United States. 10.1145/2701973.2701975 . hal-02875196

HAL Id: hal-02875196

<https://hal.science/hal-02875196v1>

Submitted on 19 Jun 2020

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A Tool to Diagnose Autism in Children Aged Between Two to Five Old: An Exploratory Study with the Robot QueBall

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ABSTRACT

QueBall is a spherical robot capable of motion and equipped with touch sensors, multi-colored lights, sounds, and a wireless interface with an iOS device. While these capabilities may be useful in assisting the early diagnosis of autism, no detailed guidelines have yet been established to achieve this. In this report, we described the exploratory study conducted with an interdisciplinary research team to adapt QueBall's capabilities in order to have clinicians observe how children interact with QueBall. This is the preliminary phase in designing an experimental protocol to evaluate the use of QueBall in diagnosing autism for children from two to five years of age.

Categories and Subject Descriptors

1.2.9 [Robotics]. 1.5.2 [Design methodology].

General Terms

Design, Experimentation

Keywords

Spherical Robot, Exploratory Study, Children with Autism.

1. INTRODUCTION

Robots have been used with children with autism for more than a decade now [1,2]. One of the challenges is to find a match

between the capabilities of the robot and their use with children with autism. Many possibilities still remain to be examined, such as their use for diagnostic or as a pedagogical tool, what should they do to provide insights about the child or to provide an incentive for interaction, etc.?

The idea of conducting an exploratory study with a spherical robot came after presenting demonstration videos of Roball [3] to clinical researchers interested and working with children with autism. Investigating the use of a spherical robot in a clinical setting was found to be an interesting idea to pursue. To conduct the trials, we decided to use an updated version of Roball, named QueBall [4]. QueBall is a spherical robot with a transparent shell, capable of rolling at different speeds. Four touch sensors facing up allow the user to interact with the robot, and multi-colored lights and sounds can be used to provide visual and audible cues. QueBall is controllable by an iPad connected wirelessly.

Since the brain develops quickly before five years of age, with long-term effects on the brain's functional and structural capacities [5], the earlier the diagnostic of autism can be the better the greater the benefit [6]. ADOS-G (Autism Diagnostic Observation Schedule) is a semi-structured and standardized assessment tool to evaluate social interaction, play, communication and imagination of children with autism [7]. Interviews with the family allow clinicians to acquire information about child behavior in various situations. The hypothesis that we want to study is if a robot like QueBall can be a complementary tool in making this assessment, for children from two to five years of age.

Then, the next step is interdisciplinary in nature: both the roboticists and the clinicians (child-psychiatrics, occupational therapists, speech therapists, rehabilitation experts) do not really know what must the robot do. Therefore, we conducted an exploratory study with QueBall to try to identify and outline ideas about its use in an experimental protocol.

2. METHODOLOGY

To avoid starting with any preconceived ideas about what QueBall should and should not do, we simply put the robot and a child in the same room, activating manually QueBall's motion, lights and sounds capabilities. It appears lights mostly attracted children's attention. To generate interaction, we added a touch-game: each time the child touched one of the sensor, the robot changed of color, played a different sound or did both at the same time. We also played with sounds, which revealed to be useful to calm down (nursery rhyme) anxious children and to generate interest (cartoon credits). These trials also help clinicians observe how the robot work and the iPad interface.

We then elaborated a set of six tests conditions, programming QueBall and the iPad interface to facilitate executing and data gathering by the clinicians. This development was done following an iterative design strategy, testing our setup and adjusting the test conditions after each trial. This allowed us to determine which sounds were the most pertinent (animal sounds, rings, laughs, cries, etc.) and the appropriate timing for each test. The trials were conducted in a Snoezelen room with QueBall, the child and a clinician, in minimal lighting and without any other stimulating object or visible mirrors. The iPad interface was programmed to have the clinician enter whether or not the child responded appropriately to the different interaction programmed in the test conditions. Thirty-one trials with 16 children were done during 18 mornings over a period of 12 weeks.

3. RESULTS

The six test conditions with timing for each are:

- A. Interaction modality preference. During the first 15 sec, QueBall tries to catch the child's attention and initiate joint attention by turning slowly, activating a blue light and playing soft music. Then, for the next 40 sec, QueBall asks twice to be touch with a 5 sec interval, and if not the clinician takes over. Each time QueBall is touched, it changes color. The next 40 sec is used to observe hearing preference, having QueBall playing a different sound every time it is touched. Finally, QueBall is set to move differently every time its touched for the last 40 sec.
- B. Turn taking. QueBall changes color and asks to be touched when a specific color is generated. If successful, QueBall says "Yipee". The clinician begins, and then it is the child's turn, and so on. This test lasts 30 sec.
- C. Verbal imitation. QueBall asks to imitate the sounds of different things (cow, train, dog, cat, firefighters), asking twice every 5 sec and waiting 13 sec for the child to comply. The clinician then says "Hey there!", twice every 5 sec, and see if the child responds. This test allows us to see if the child prefers to interact with QueBall or with the clinician.
- D. Motion imitation. QueBall says "Do as me", turn by saying "Turn" and stop saying "Stop", waits for 5 sec, and repeat the same pattern twice (each sequence lasting 15 sec). Then QueBall does the same thing but saying "Forward" and then "Backward".
- E. Ability to ask for help. QueBall is placed in a plastic box with the top closed. QueBall says "Come and catch me!" while flashing (three colors per second) twice with an interval of 5 sec. The child must ask the clinician to open the box to get to the robot. Then QueBall says "Hello there!" while flashing again. It repeats it after 10 sec.
- F. Presence of stereotypes. The goal is to generate excitement in order to observe stereotyped behaviors. For 60 sec, QueBall plays a circus song while showing gradient of colors in rotation and moving in rotation rapidly.

A video presenting QueBall and its functionalities is available at <https://introlab.3it.usherbrooke.ca/mediawiki-introlab/images/2/2b/QueBall.mov>.

4. DISCUSSION

This exploratory study revealed to be quite interesting, both from the robot-child perspective and from the robot-clinician perspective. Clinicians that were reluctant at first to use the iPad interface became regular users. There is also a certain degree of subjectivity in these trials, as clinicians may intervene differently between children. Since each child is different, this is a natural constraint to take into consideration. Also, each test could be stopped and passed in the case where the child was not responsive or showed anxiety. We also developed an interface on the iPad that allowed the clinicians to directly control QueBall's interaction modalities, and a simple interface that allowed children to do the same.

We are currently continuing gathering and analyzing data to design an experimental protocol targeting the use of QueBall in the assessment of autism for children between two and five years of age.

5. ACKNOWLEDGMENTS

The authors want to thank the Fonds de recherche du Québec – Nature et technologies, and the Natural Science and Engineering Council of Canada for their financial support. The authors also want to acknowledge the help from Que Innovation inc. regarding the technical support provided.

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