THE USE ROBOTICS IN THE INTERVENTION WITH CHILDREN WITH ASD IN MACAO: AN EXPLORATORY STUDY WITH MILO

O USO DA ROBÓTICA NA INTERVENÇÃO COM CRIANÇAS COM AUTISMO EM MACAU: UM ESTUDO EXPLORATÓRIO COM O MILO

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Abstract   Robotics are being used in the intervention with children with Autism Spectrum Disorder (ASD) in many places and already for many years. Many robots were developed and different studies are being made in order to evaluate its effectiveness. "Socially Assistive Robotics" is shown to be effective in different areas mainly in social and emotional development. Milo, a robot developed by a team led by Richard Margolin for the Robots4Autism program (RoboKind, 2020), is one of the robots whose use is reported to be successful. In Macao there is no report of studies or experiences on the use of robots in the intervention with children with ASD. In a collaboration between the Macao Science Centre, the Macao Autism Association (MAA) and the University of Saint Joseph, an exploratory study was developed to understand the applicability of Milo to the work with children with ASD in Macao. The study showed that the robot is able to facilitate social and emotional competences of children with ASD. However, several limitations including language, cultural differences, the inexperienced facilitators and the level of sessions are too simple for the participants to be aware of that may affect the effectiveness of the intervention. It is important to show that the

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adoption of Milo in Macao for intervening children with ASD can be further implemented, with better practical solutions.

Resumo   A robótica tem sido utilizada na intervenção com crianças com Transtorno do Espectro do Autismo (TEA) em muitos lugares e há já muitos anos. Muitos robôs foram desenvolvidos e diversos estudos foram feitos para avaliar a sua eficácia. A "Robótica Socialmente Assistida" mostra-se eficaz em diferentes áreas, principalmente no desenvolvimento social e emocional. Milo, um robô desenvolvido por uma equipe liderada por Richard Margolin para o programa Robots4Autism (RoboKind, 2020), é um dos robôs cuja utilização é considerada como bem-sucedida. Em Macau não há relato de estudos ou experiências sobre a utilização de robôs na intervenção com crianças com ASD. Numa colaboração entre o Centro de Ciência de Macau, a Associação de Autismo de Macau (MAA) e a Universidade de São José, foi desenvolvido um estudo exploratório para compreender a aplicabilidade de Milo ao trabalho com crianças com TEA em Macau. O estudo mostrou que o robô é capaz de facilitar as competências sociais e emocionais de crianças com TEA. No entanto, várias limitações, incluindo o idioma, diferenças culturais, a falta de experiência dos facilitadores e o nível de dificuldade dos exercícios podem afetar a eficácia da intervenção. O estudo permite concluir que o Milo pode ser utilizado na intervenção com crianças com EA em Macau desde que com melhores soluções práticas.

1. Introduction

Robotics technology is being used in provision of educational and psychosocial services to different groups of people, in a multitude of social realms (Fosch-Villaronga & Albo-Canals, 2019; Hsu et al., 2020). The work with children with Autism Spectrum Disorders (ASD) is one area in which this technology is generating much research and continuous improvement.

Robots can be considered as a secure, stable and predictable environment in which children with ASD can be calm, relaxed and entertained (Ntaountaki et al., 2019). It complies with the need for repetitive actions and acts like an "attracting agent" to keep

the child with ASD engaged and focused during therapy (Shamsuddin et al., 2014). Besides that, "the robot itself is much simpler in appearance compared to real life objects, its behavior can be custom – made to suit different scenarios and it has the capacity to offer expected and simpler interaction with the autistic children" (Shamsuddin et al., 2014, p. 10). That's why different studies are showing that children with ASD interacts with different types of robots, keeping dyadic interactions with the robots, triadic interaction including the facilitator (Ntaountaki et al., 2019) and even promoting collaborative play among children with ASD (Wainer et al., 2014). Interestingly, it was also observed that children with ASD had, toward robots, behaviors that other children normally had toward human agents (Pennisi et al., 2016).

The literature is being identifying how different types of robots showed positive effects in many different areas as: the improvement of Social Skills; increasing attention and time on task; facial recognition skills of realistic emotions; imitation (facial expressions, positive behaviors); collaborating with adults; learning social behaviors; reduction of repetitive and stereotypic behavior; in language and communication skills; the ability to see the world from another person's perspective (Fosch-Villaronga & Albo-Canals, 2019; Ntaountaki et al., 2019).

Used as an approach to teach Social Skills, Socially Assistive Robotics is one of the areas in which the robots are being used with success in the work with children with ASD (Cho & Ahn, 2016; Scassellati et al., 2018; Tennyson et al., 2016). A greater improvement was observed in those children with ASD with borderline cognitive and receptive language abilities and children with ASD and with severely impaired abilities were unable to understand and effectively participate in this intervention (Lebersfeld et al., 2019). The potential for robots for improving social interaction in children with ASD is higher when they're Human-looking (Ueyama, 2015). That is the case of Milo, a robot developed by a team led by Richard Margolin for the Robots4Autism program (RoboKind, 2020). According to the authors, "Using the Robots4Autism program, individuals with ASD learn to: Tune in on emotions; Express empathy; Act more appropriately in social situations; Self-motivate; Generalize in the population" (RoboKind, 2020). The authors also claim that "students will engage with Milo for 52.5 minutes of every hour vs. only 1.5 minutes with a human" (RoboKind, 2020). In figure 1 it is possible to see a picture of Milo with its main features.

Figure 1. Milo and its main features
(retrieved from RoboKind, 2020)
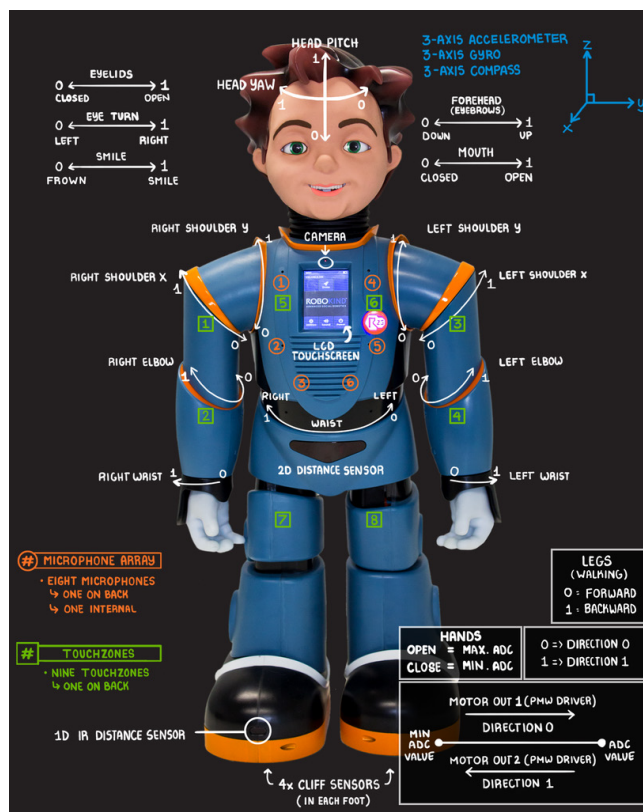
Besides the robot with the features presented in figure 1, Milo also includes a tablet with instructions and videos for the different exercises. It is recommended to be used with children from 5 to 17 years old who should:

"• Use consistent means (i.e., words, pictures, conventional gestures) to request.

• Demonstrate the ability to understand spoken language and/or use picture symbols/ icons (they need NOT be vocal).

• Monitor their care-giver's actions.

• Make predictions about what is coming next in an interaction (i.e., engages in routines and turn taking activities).

• Comment on and respond to comments about pictures, objects, and events that are present and in their view (note that commenting is different than labeling, without regard to communication partner).

· Answer questions, particularly yes/no questions.

· Have the fine motor abilities for direct selection on the tablet that permits the child to respond to queries as he intends" (RoboKind, 2020).

In spite of the numerous research and experiences around the world showing the effectiveness of robots in the work with children with ASD, it was never implemented in Macao. Aware of its social responsibility in contributing for the implementation of the most updated interventions for the population in Macao, the Macao Science Center (MSC) acquired Milo and contacted the Macao Autism Association (MAA) in order to put it in the service of children with ASD in Macao. However, it is also known that the use of robots with children with ASD also has limitations: difficulties in generalizing learned skills in a real social interaction with a human; restricted motor movement; limited and difficult wordiness; it requires to be being monitored by a technician for an efficient use (Ntaountaki et al., 2019). The use of robots might also bring some ethical concerns, related to the possible substitution of a non-human in the interaction with an individual with ASD, and that's why many people would prefer that the use of robots would always be done with the supervision of a facilitator (Coeckelbergh et al., 2016), being "a supportive tool operated by humans" (Ntaountaki et al., 2019, p. 13). In the case of Milo and its application in Macao, two limitations could be identified from the beginning: 1. Language: all the exercises and support materials are made in English and the maternal language of children in Macao is Cantonese; 2. Cultural sensitivity – all the exercises are made with characters, situations and places from a different cultural background. It would be expected that these could create obstacles for children's understanding and involvement in the tasks and also for the generalization to the situations of their real lives.

The main goal of this study was to understand the applicability of Milo, the way it is conceived now, to the work with children with ASD in Macao. Using a case study methodology, this study intends to answer the following research questions:

1. How do children with ASD in Macao react to Milo and its proposed exercises?

2. What are the difficulties, obstacles and possibilities perceived by the facilitators using Milo in the work with children with ASD in Macao?

3. What are the difficulties, obstacles and possibilities perceived by the parents with children with ASD in Macao observing their children working with Milo?

4. What strategies the facilitators using Milo in the work with children with ASD in Macao used in order to overcome the difficulties?

With this study we intended to:

- create guidelines and recommendations for the use of Milo with children with ASD in Macao;
- produce a list of suggestions to adapt the software and exercises to the reality of Macao;
- get relevant information to organize further studies on the effectiveness of robots with children with ASD in Macao.

2. Method

In this chapter it will be made a brief description of the methodology, a characterization of the participants and described the procedure for data collection.

2.1. Methodology

In this exploratory study it was used a case study methodology which can provide examples of real people in real situations, penetrating situations in ways that are not always susceptible to numerical analysis allowing "to portray 'what it is like' to be in a particular situation, to catch the close-up reality and 'thick description'" (Cohen et al., 2018, p. 376). For Cohen and colleagues (2018), a case study is appropriate to be used as an exploratory to other studies or research questions. In this case it was made a participant observation in which data was collected from two different sources, the facilitators and the parents. Thus, three different types of data were collected:

1. the field/session notes from the facilitator – the notes were recorded right after the observation;

2. transcription of the informal interviews to the parents – a phone conversation after the conclusion of all the observations;

3. transcription of the shared reflection with the facilitators – in a shared meeting as a mid-term evaluation; in an individual meeting after the conclusion of all the observations.

2.2. Participants

The participants in this study were 4 children with ASD, all boys, identified by the Macao Autism Association among its associates. In table 2 it is possible to see a summary of the main characteristics of the participants.

Table 2. Summary of the main characteristics of the participants

	Age	Level of ASD	Previous contact with English	Familiarity and interest with electronic dev.	School Grade	School Placement
Case 1	6	Mild	Yes	High interest	P.1	Inclusive Education
Case 2	7 years and 9 months	Mild	Know most of the alphabets. Without learning after first half year in K1	High interest with very good memorial skills	P.3	Inclusive Education
Case 3	8	Mild. High functioning	Learn English in school, and also take an interest class before school. Not able to communicate orally	Enthusiastic	P.3	Inclusive Education
Case 4	12	Moderate	Self-learning online and able to communicate in English	Enthusiastic, collecting relevant information by himself	S.1	Special small-class. Vocational School

Three of the participants are in primary inclusive schools and have ASD at a mild level. Case 4 is 12, a moderate level of ASD and is in a small special class in a vocational school. All the participants are familiar with the use of electronic devices and show enthusiasm with it. All of them have some contact with English language but are not fluent.

2.3. Procedure

The two facilitators were volunteers from the USJ's Master in Counselling and Psychotherapy. Before the starting the process, a previous training and study program for the two facilitators was implemented:

- An introductory meeting with the facilitators, researchers, a representative of the MAA and staff from the Macao Science Centre to introduce Milo and its main features;
- Study sessions (individual and small group) for the facilitators to become familiar with Milo and its exercises;
- A training session to the facilitators with Information on ASD, how to relate with children with ASD and how to organize a typical session.

A specific room was prepared for this study, having some specific features:

- A small space, without much were to go;
- Neutral, without many stimulus and distractions – only one table and two chairs, and nothing in the walls;
- Comfortable – a carpet and two bean bags (the floor was the preferred environment to perform the activities);
- With good natural light and in a quiet environment, without many noises.

In figure 2 it is possible to have a perspective of the space in a moment in which the child and the facilitator were using Milo in this study.

Figure 2. The setting

As it is possible to see, the child and facilitator are seated on the floor, in the bean bag and the carpet respectively, with Milo and the tablets in front of them. There is a big glass allowing natural light to come in and besides the table and the two chairs (and the rubbish bean), no other furniture or accessories are available in the room.

Each facilitator identified the preferable areas/exercises to be used, planned the sessions and prepared the exercises. In table 3 it is possible to see a summary of the planned activities for the different sessions:

Table 3. Summary of the activities for each session and case.

	Facilitator 1		Facilitator 2	
	Case 1	Case 2	Case 3	Case 4
Session 1	Establishing the relationship and defining the setting. First informal and non directive contact with Milo.			
Session 2	Find it Happy, Sad, Angry Calm Down Tools: Count to 10 Greetings Leave-taking: bye, goodbye, see you later	Find it Calm Down Tools: Count to 10 Greetings Leave-taking: bye, goodbye, see you later	Happy, sad, angry Hurt, tired, excited Scared, surprised, worried	Greetings Leave-taking Happy, sad, angry Hurt, tired excited
Session 3	Greetings: Hi, hey, hello Leave-taking: Bye, goodbye, see you later Happy, Sad, Angry: Identifying in videos	Greetings: Hi, hey, hello Leave-taking: Bye, goodbye, see you later Happy, Sad, Angry: Identifying in videos Red light Green light	Play date	Play dates
Session 4	When to greet – Do and don't for starting a conversation Responding to other people's leaving-taking Different greeting words – Hi, Hey, Hello	When to greet – Do and don't for starting a conversation Responding to other people's leaving-taking Discriminating hurt, tired or excited in photos of Milo/ photos/videos	Birthday party: being a guest	Birthday party: being a guest

	Facilitator 1		Facilitator 2	
	Case 1	Case 2	Case 3	Case 4
Session 5	Absence	Conversational turn-taking Non-verbal conversations with TLC Introduction to a Playdate Group Activities > Dance	Absence	Absence
Session 6	Birthday Party – Being a guest; Invitations	Birthday Party – Being a guest; Invitations Different Leave-taking words – Bye, goodbye, see you later Responding to other people's leaving-taking	Share feelings and opinions on the modules and robots	Share feelings and opinions on the modules and robots

Each facilitator worked with two children and tried to implement the same exercises to each of them. However, some changes had to be made during the process. As it is possible to see in table 3, only case number 2 had the six sessions. All the other participants missed session number 5 due to bad weather conditions on the day that session was scheduled.

To collect the data, the facilitator took notes right after each session. Those notes were shared later with the researchers and discussed in the interviews with the facilitators.

At the middle of the process, after session 3, there was a mid-term evaluation meeting. The first impressions about the process were discussed and some arrangements were agreed.

After the conclusion of all the observations, phone calls were made to the parents of the participants and individual meetings with the facilitators (see table 4).

Table 4. Summary of the meetings and phone interviews

Source	Type	Date	Duration
Facilitators 1 and 2	Meeting for mid-term evaluation	July 17	60 minutes
Mother case 1	Phone interview	September 18	30 minutes
Mother case 3	Phone interview	September 18	30 minutes
Mother case 4	Phone interview	October 3	20 minutes
Facilitator 1	Individual meeting	September 22	40 minutes
Facilitator 2	Individual meeting	September 25	35 minutes

The parents of case 2 were not available for the phone interview. The phone interviews took from 20 to 30 minutes and the individual meetings with the facilitators 25 and 40 minutes.

2.4. Ethical Concerns

In the implementation of this exploratory study, some ethical aspects were considered. All the participants are associates of the MAA. The invitation was made directly by the director from the MAA in a private and confidential contact. Each family gave a verbal consent for the participation in this study. Each participant was introduced to the facilitator and the main researcher. No personal information was disclosed – the researcher kept the phone number of the parents for scheduling the sessions and for the late phone interview. In this report no information was used to identify the participants and their families.

3. Results and Discussion

The results will be presented together with a brief discussion organized with two parts: First, to respond to the research questions with the following themes: 1. Reaction of children with ASD to Milo during the exploratory sessions (RQ1); 2. Comments on the features of Milo and its effectiveness by facilitators and parents (RQ2); 3. About the suitability and issue of the modules in Milo (RQ2); 4. How did facilitators cope with the identified difficulties? (RQ3); Apart from this, further presentation will focus more on the overall suitability of adopting Milo to the children with ASD, with the following themes: 5. Effectiveness of the exploratory study to the children with ASD; 6. Suggestions by parents and facilitators.

3.1. Reaction of children with ASD to Milo during the sessions

a) Boring during the sessions

Some children felt bored as the modules are too easy for them. They explicitly said to the facilitators that it is easy and therefore not having much interest in them. For example, case 3 and 4 mentioned that the modules on playdates are easy and boring. The facilitators reported that this is based on two reasons. First, the children were having

higher expectations of Milo. For example, case 3 complained that he was told to learn programming instead of this and didn't know why he needed to come here to learn those already learnt before. Therefore, he felt extremely angry and not willing to participate. Apart from this, most of them believed that some modules are not relevant to them, for example the birthday party, which they couldn't understand. Most of them mentioned that they didn't have friends or they didn't have birthday parties before. Therefore it is far away from their experience and thus they would feel bored. When the scenario doesn't relate to their real life experience, it will be difficult for them to generalize learning skills with a real social interaction with a human in their daily life (Ntaountaki et al., 2019).

b) Able to understand and follow the instructions

Despite the difficulties and issues, most of them understood the instructions either directly from Milo or from the facilitators and were able to follow the general instructions to finish most of the tasks, which is similar to what Ntaountaki et al. (2019) believed that children with ASD are able to keep dyadic interactions with the robots and with triadic interaction including the facilitator . From the observation of both facilitators, most of the children could follow the instructions by them and try to answer most of the questions. It may be affected due to the design of some of the scenarios. For example, some of them were not familiar with birthday parties and thus unable to concentrate well to finish the tasks.

c) Concentration and emotional fluctuation

From the observation of facilitators, they believed that the children were able to concentrate during the sessions, similar to what Shamsuddin et al. (2014) highlighted that they are able to engage and focus during the intervention. Even with some distraction, the facilitators could help them to focus back. This is also supported by the parent of case 1 that her child was able to focus on it and the role of facilitator was important to help her child for better concentration.

However, it was also observed by the facilitators that some of them may have emotional fluctuations especially when they answered the questions wrong. When they have tried several times with incorrect answers, they may feel annoyed and thus affect their concentration and emotion, which may affect their performance in the module. For

example, when case 1 answered the questions on the module 'greeting' wrongly for several times, he felt down and didn't want to talk for the whole remaining session.

3.2. Difficulties of adopting Milo: Observation from facilitators and parents

Nearly most respondents, including facilitators and parents, argued that the function of Milo is limited, despite the physical appearance being attractive to them. They criticized Milo for lack of interaction with children, the ineffectiveness of video as the media, and the issue regarding IPad which distracted the children.

a) Only one-way communication without interaction

Milo can only have one-way instructions without much interaction with the children with ASD. During the exploratory study, both facilitators and parents examined that Milo only performed with instructions based on videos and audios with most of the tasks. It is responded with the disappointment of parents because they expected that the robot could have basic interaction with the children, for example basic conversation. Parent of case 1 examined that the child has used Siri and another social robot (which are able to communicate with conversations) in daily life. The lack of related functions hindered the effectiveness of communication between children and the robot, which is expected by the children and parents before participating in this study.

b) Lack of eye contact during communication

Milo is lacking eye contact with children with ASD during the process. This is the limitation of the design of Milo, according to the responses from the interviewees. From their experience, Milo doesn't have any function to facilitate communication which could have a direct eye-contact with children. However, current design doesn't think of this part in detail and without any function on this. Facilitator 2 described such an issue by arguing that the children are out of the context of communication as they didn't 'feel' that they can communicate with Milo.

c) Problems with the videos

At the same time, the videos for the training purposes have some major limitations. First, the setting of the videos can only play from beginning to end as a one-off

process. Facilitators could not return to a specific scene in order to facilitate better communication with the children. If there are questions from the children, then it must be replayed from the beginning. In their opinion, this caused the negative response from the children to feel bored. Parent of case 1 mentioned that her child felt bored and distracted from the study because the videos kept repeating. Apart from this, the video played so slow that the children were easily distracted, especially when the children with ASD are easier to be distracted by other contexts. It is mentioned by both facilitators and parents that the original design is good which can let those children have better understanding. However, the pace should be able to change according to different levels of functioning of children with ASD that are currently unable to do so. They believed that Milo couldn't perform well in this part in order to let their children concentrate and learn in a more efficient and effective way.

Apart from this, some respondents believed that the current video may not motivate the children with ASD. Videos currently are with real people and scenarios. However, it is not attractive to them. Some parents believed that this should be aware as this may be ineffective to attract the children focusing on Milo and the module.

d) Problem of facial expression by Milo

Another issue responded by the facilitators is the problem of ineffective facial expression by Milo. As one of the major modules is the training of emotional expression, the function of facial expression by Milo is essential as this is the major way of teaching children with ASD on differentiating various emotions via different facial expressions. However, it is reviewed by the facilitators that the facial expression by Milo was not clear enough to teach the module effectively. When there are nine different modules on different emotions, it is criticized that some of them are hard to recognize even by the facilitators (or even by other people without ASD). If Milo's facial expression is one of the major features of assistive robotics, they believe that this is not as useful as expected to facilitate children with ASD to learn how to differentiate emotions.

e) Limitations on using IPad as the major tool

It is one of the most significant problems mentioned by most of the parents and facilitators. As IPad is originally planned as facilitating the communication between

children with ASD and Milo, it has unintended consequences that children only focus on IPad instead of Milo. From the parents of case 1 and 2, their children only put their attention on IPad when having the training while they believed that Milo is performing a minimal role during the whole exploratory study and somehow 'ignored' by the children. They examined that even if there are some functions provided by Milo, it is not useful to catch their children's attention. Child of case 4 mentioned in the last session that the whole study put too much emphasis on the IPad but not the robot. At the same time, when facilitators are the major person leading the questions and helping children to concentrate, it is responded by the parents that even their children paid more attention to the facilitator instead of Milo.

It is also agreed by both facilitators. Facilitator 1 argued that it is not necessary to have Milo in the sessions as an app is also capable of the same function that an IPad can actually replace the function of Milo on providing similar training. Milo, to some extent, becomes an 'outsider' in the training that may distract children's attention. Facilitator 2 believed that the over-dependence on IPad caused the unintended consequences on the lack of focus on Milo by the children. He explained that the children paid attention first to IPad for most of the tasks, with focus on the facilitators, while with least attention to Milo (as figure 3 shows).

Figure 3. Schematic diagram with the 3 levels of communication of children when working with Milo
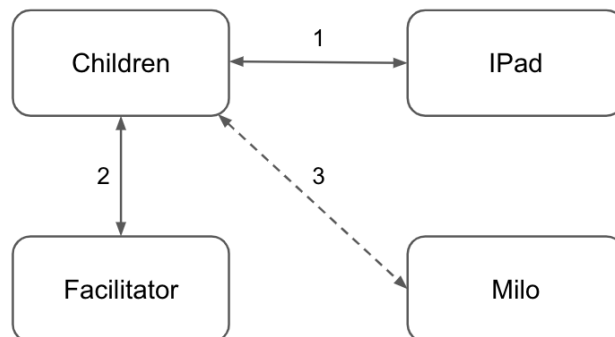
As it is possible to see represented in figure 3, Milo is the last resource for communication that the child uses in this situation.

f) English as the major language

As mentioned in the previous section, it is expected that there were difficulties. Indeed, some children may lose interest in Milo if they use English. For example, when case 3 knew that Milo can only use English, he kept asking the facilitator whether Milo could speak in Cantonese. Facilitator observed that once the answer was 'no', he immediately lost interest in Milo. From the point of view of the facilitators, the strategies of immediate translation of the video into Cantonese were only a last resort. They still needed to cope with the issue of inaccurate expression and difficulties on translation as the video was non-stop playing until the end. These may have an impact on the absorption of the children on relevant modules. Despite this, in general, most of the children with ASD can follow the module with the help of the facilitators. For case 2, it seemed that even though he got least English learning opportunities among other participants, he could still follow most of the instructions, from the observation of the facilitator.

3.3. About the suitability and issue of the modules in Milo

a) Scenario is not relevant to context

As mentioned in the previous part, it is expressed by most of the parents and facilitators that the modules on scenarios are not relevant to Macao context. For example, most of the children (case 1, 2 & 3) didn't understand the scenario of playdate and birthday as they didn't have relevant experience before (as host or guest). It is also shared by the parents that the scenario modules are not relevant to their children's daily life experience, which most of them are from the US (or Western) context and thus not useful enough for their children. Both facilitators shared the same comment that there are cultural differences that hinders the children from learning through scenarios. When they tried to conduct the module, it was not suitable for the children with ASD in Macao. As scenarios (playdate and birthday) are the major content in the modules, it severely impacts the effectiveness of the module on training children with ASD. While it couldn't relate to their daily experience, most of them were not able to concentrate on the modules.

b) The slow pace of playing repetitive videos in modules is boring and annoying

There are designing issues on the module which caused the children's negative responses during the exploratory study. A major problem is the repetitiveness of the video with a very slow pace in training, especially with some scenario modules. For example, facilitator 1 shared the experience of the module on a birthday card identifying the time,and place of the party. It repeated three times for only asking each content, with a very slow pace. Children became annoyed due to the slow pace and the repetitive content. A parent of case 3 had similar comments on the repetitive video with too slow pace may cause the child to become distracted. It is understood by both the facilitators and the parents that children with ASD need to have some repetitive training due to their features. It is, however, even the mild level children with ASD feel bored as the pace is too slow.

c) Modules are too easy / without many varieties for different levels

Some children expressed their comments that the modules were too easy for them to learn. For example, case 4 mentioned during the exploratory study that the module was too simple and boring, even though he followed all the instructions to finish all tasks. The same comments were also said by case 3. It was observed by the facilitators that the higher level of functioning the more bored feeling to participate in the modules. For case 3 & 4, both of them have finished all modules provided by Milo within four sessions, while for the other two cases, more time was needed. Parent of case 3 stated that the modules were not quite suitable for high-functioning children with ASD. She continued to mention that for high functioning children with ASD, the module should be more with putting them into other shoes with causation and reasons. However, the current module is more descriptive which may not be able to train them.

3.4. How did facilitators cope with the above issues?

Despite some of the limitations and issues are structural issues by Milo itself, facilitators were trying hard to cope with some of the above issues with the following strategies:

a) Translation for all modules in advance

As expected of English as the major language by Milo, facilitators were preparing the modules in advance by marking all the procedures, exercises and necessary information

of the video in Cantonese first. Once the videos are playing, they are able to translate as soon as possible to ensure the children with ASD can understand it.

b) Flexible scheduling for the exploratory study

When the exploratory study faced many unknown factors, especially the children's reaction. Facilitators decided to make a flexible schedule instead of a fixed one. They decided not to use Milo in the first class and to interact with the children to establish the relationship first. Afterwards, the modules adopted were based on the progress of the children which all four cases were in different schedules and modules. Once the facilitators realized that the children's status was not suitable to continue, the session would finish earlier instead of a fixed one-hour intervention.

c) Inviting parents to join the sessions

Both facilitators understood that they are not familiar with how to cope with children with ASD. Therefore, from the first section on, they have asked the parents to join the sessions whenever necessary. This was to ensure that the children would not be nervous that no familiar persons are nearby; at the same time, parents could be an assistant in facilitating the attention of their children to Milo; more importantly, the observation from the parents is essential to assess the possibility and effectiveness of the sessions in order to provide a solid foundation for any further formal interventions.

Based on the above observations, this exploratory study also finds out the general comments from the stakeholders on the overall effectiveness of adopting Milo to the children with ASD, with further suggestions.

3.5. Benefits of this experience to the children with ASD

a) Better in expressing emotion

Even though this is only an exploratory study with very few sessions, it is responded by some parents that their children can learn from the emotion module. From their observations, children are able to learn more types of emotions and are able to apply some of them in daily life. For example, parent of case 4 examined that her child

expressed more the feelings and emotions taught in the sessions. Also the child showed some interest in searching for relevant information via Youtube. For case 1, the parent mentioned that her child has learnt more feelings and facial expressions. It is also observed by her that the child would use some of the scenarios taught in the sessions, like greeting with others. This fits what the company's expectation to 'act more appropriately in social situations' (RoboKind, 2020). It is, however, necessary to highlight that the effectiveness is varied due to two major factors. First, it is only a perceived effectiveness by the parents after the exploratory study. A longer time for intervention and proper assessment may be able to measure the impact on children with ASD better; apart from this, the level of ASD may affect the effectiveness of Milo in emotional and scenario training. From observation, facilitators responded that children with higher functioning are less likely to be profited from Milo as some of them may already know about the relevant knowledge and skills.

3.6. Suggestions by parents and facilitators

a) About the features of Milo

There are three suggestions provided by parents, participants and facilitators. First, the issue of IPad must be solved. They suggested that, if technological feasible, the usage of IPad as minimum and put most of the videos and focus back to the chest of Milo. They suggested that the video / display should be put back to Milo so that it can become the direct communication tool towards children with ASD. Facilitator 2 suggested that it may be possible for Milo to perform the video instead of using an IPad. At the same time, the function of Milo should be improved. One of the major suggestions is to strengthen its interaction with children with ASD. While currently the communication is only single-way via robot-to-human interaction, both facilitators and parents recommended that Milo should be able to perform conversations with children. Perform like a human (with two-ways interaction) can model better for expected behaviour to children with ASD as they act similarly to interact with other human agents (Pennisi et al., 2016). Parent of case 1 mentioned that it is important to have the conversation between Milo and the children in order to help them to concentrate and better absorb the information. For example, just like other social

robots, the basic conversations can be achieved via machine learning and the storage of conversation with text and audio analysis (Figure 4).

Figure 4. One or two way communication of Milo and children with ASD

| Milo | → | Children with ASD | | Milo | ↔ | Children with ASD |

It is even more important to import the function of artificial intelligence into Milo. The adoption of AI is able to establish a large database facilitating effective training programmes for the development of children with ASD. The application of Milo (as robotic) should have better functions in detecting facial expressions for identification of emotions through AI. Facilitator 2 mentioned explicitly that the detection of facial expression via AI facilitates the training of identifying emotion and thus is able to improve the effectiveness of the training of emotion learning and expression. It is also important for Milo to collect more data from the children with ASD and perform more machine learning in order to have a better understanding of the effectiveness of the modules and for more customized modules for individual training in the future.

b) About the modules

For improving the modules, all parents and facilitators have the same suggestion on designing the localized module. This is the indispensable part especially when Milo is providing scenario training. From the above, it is clear that the scenarios provided by Milo are not suitable in Macao context. The children feel that the modules are not relevant to their daily life. It shows the importance of customization. The robot should make suitable scenarios and should be able to offer expected and simpler interaction so that children with ASD can be benefited with familiar context (Shamsuddin et al., 2014, p. 10). Therefore, the design of modules with local context is essential in the future, suggested by most of the stakeholders. There are two different ways of localization. First, the language of Milo (or other robot) should be in Cantonese. Second, the module content should be linked to daily life in Macao so that the children with ASD can relate to them in order to learn how to cope with different scenarios. Apart from the

localization of the module, it is also necessary to include modules with different levels in order to include different degrees of ASD. In the current situation, it is responded by the children, parents and facilitators that only those with low to medium functioning may be the most beneficial group while the high functioning group may feel too easy and bored. Therefore, different modules should be set up targeting different levels of ASD in order to maximize the variety of the beneficiaries. For example, the parent of case 3 suggested that the module for lower levels can design for more repetitive training, similar to the current module; for modules towards higher level, the module should have more causal relationship, and to let the children to stand in one's shoes to think about the reactions and actions. Finally, the presentation of the module should be more attractive. As most of the target population are children with ASD, the current video is not that attractive to real people. They, especially some participants, suggested that the videos can be created as animation so they can have more fun on it. It may also be games or apps in order to facilitate better training.

c) About the facilitators

Some parents believed that the facilitators may not have enough experience to cope with the emotion and reaction of children with ASD. They suggested that better training to the facilitator is needed. From the responses of observation by parents of case 3 and 4, they believed that the role of facilitators is important. However, both facilitators are relatively new to children with ASD. Therefore better training in advance can improve the facilitation skills, which the parents believe is essential.

d) About the participants

Both parents and facilitators believed that the current modules on Milo are more suitable to those who are with lower functioning instead of high ones. It is mentioned from above that those high functioning children felt bored because the modules are too easy for them. Before the new design of the modules works, Milo may still be able to work on those low to medium functioning children with ASD. Apart from this, facilitators also suggested that the potential participants of Milo could be those who are smaller in age. For those who are older, they may already feel that this is not useful to them. Focusing on kindergarten or early primary education may be better. This is also supported by the parent of case 3.

4. Conclusion

Concluding this paper, key findings were identified and recommendations have been made. It is possible to identify the key findings and to make recommendations in two main areas: 1. About the use of Milo with children with ASD; 2. Giving some contributions to the development and improvement of Assistive Robotics Technology.

4.1. Using Milo with Children with ASD

Key finding 1 – Milo can be used with children with ASD in Macao.
There are three types of evidence to support it:

- Children from the exploratory study were able to understand and complete the different exercises;
- The facilitators were able to compensate the limitations at the language level translating and providing instructions in Chinese;
- The parents perceived benefits, namely at the level of emotions.

Recommendation – to continue to develop initiatives in order to generalize its use in Macao.

Key Finding 2 – All the participants completed all the exercises in four sessions.
Recommendation: to use Milo as a supplementary tool in the educational process, not as the protagonist of an intervention designed exclusively with him – it would expire too fast.

Key Finding 3 – The participants of this study considered Milo and its exercises too easy and boring.
Recommendation – contrary to what was found by Lebersfeld and colleagues (2019) with a different robot, it seems that Milo would be more appropriate to be used with younger children and a bit lower functioning – it looks not that appropriate for children with ASD with high functioning as it looks too easy and boring for them.

Key finding 4 – With benefits in social and emotional competences
Recommendation – To continue using it with children with ASD. It also would be good to try with other children, not with ASD, who needs to develop those competences.

Key finding 5 – the facilitators didn't have experience in working with children with ASD

Recommendations – to introduce this technology to staff who are already familiar with working with children with ASD and the educational/therapeutic process itself – counsellors, social workers, special education teachers. They would use this as a tool for their specific goals and in a natural environment – a setting which is familiar to the child.

Key finding 6 – The question of language was not an impediment for children to understand and complete the tasks.

Recommendation – this was possible not only because the facilitators translated the materials, but also because many of the children are familiar with English – it would be good to try it also with children English speakers in this context.

4.2. Contributions to the development and improvement of Assistive Robotics Technology

This exploratory study with Milo also allows us to identify three areas that could eventually be improved: the scenarios, the task based design and the tablet.

The exercises and the scenarios are not culturally sensitive – not only the language, but also the characters, the situations, the places, all the elements of the scenario are "strange" and not familiar to children. That way, we could recommend:

- To make local versions of the exercises and scenarios;
- More variety of themes and situations;
- More levels of difficulty and complexity – more in higher functioning;
- To have flexibility for the user to adjust content, namely to include elements related to the children's interests. The facilitator could prepare/adapt the exercises "tailor made" to a specific child, modularly adapting to the user's needs (Fosch-Villaronga & Albo-Canals, 2019), a customisation allowing to create personalized scenarios as it happens in the case of KASPAR (Huijnen et al., 2017). As suggested by Huijnen and colleagues (2017), an "iterative multidisciplinary co-creation approach is expected to contribute to qualitative and meaningful robot interventions" (p. 3091).

The task-based design of the exercises – focused on the completion of a task, gives structure and makes it easier for the child with ASD to stay on task. However, the transference to the real life situations might be a problem as identified by Ntaountaki and colleagues (2019). Thus, it would be recommended that the exercise would include assignments or "homework" for transference – the "prescription" of concrete activities to be done in the natural contexts with the collaboration of teachers, peers, relatives or other people interacting with the child with ASD.

It was discussed that the tablet seems to be a "distractor" creating "noise" in the interaction of the child with Milo and the facilitator, introducing a fourth element. Besides that, indeed, most of these children are already familiar with tablets and it can work by itself. Thus, it seems that it would be important to consider the possibility of moving the screen to the robot. Could be on the chest, replacing the small screen or in the head like the ROBOJJANG developed by Robocare Co., Ltd. (Cho & Ahn, 2016).

Without doubt, the exploratory test has shown positive signs that the children are able to follow the instructions even if they may not be familiar with English, they were able to complete the exercises and some of them have learnt and practiced the emotional expression after the sessions. This is encouraging that the exploratory study has reached its original purpose in understanding the potentials of adopting social robotics into children with ASD in Macao, especially in the emotional control and expression modules.

In general, it shows that there is a possibility that Milo is able to perform the intervention tasks, especially when most of the children with ASD have some positive response. The result may be, however, affected by too many effects including the high expectation by the parents towards the programme, which the children may have some expectation towards the exploratory study. It is, at the same time, affected by the experience of the facilitators. When both facilitators in this exploratory study are not experienced ones, it is believed that more training can be provided in order to make the result better.

Despite that there may be some improvements, it is observed in this exploratory study that the adoption of social robotics on children with ASD is a possible intervention in the future when the technology can be better adapted into the training modules, and provided a better guide on what we can do next.

The key findings from this exploratory study should inform future studies with Milo in Macao namely for the assessment of the effectiveness of the intervention towards the children with ASD with low-to-medium functioning and children with other disabilities requiring the development of social skills and emotional competence (e.g. intellectual disabilities).

Further studies could also be developed in order to assess the potential design of the modules which fits the local context, or even the design of the new robots which suits better for the children with ASD.

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