Development of Robot-enhanced Therapy for Children with Autism Spectrum Disorders

# Project No. 6113914

# DREAM
# Development of Robot-enhanced Therapy for Children with Autism Spectrum Disorders

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# D8.5 DREAM Lite System: long term exploitation

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Organisation name of lead contractor for this deliverable: **Softbank Robotics Europe (formerly Aldebaran Robotics[1])**

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| **Dissemination Level** | | |
| **PU** | Public | |
| **PP** | Restricted to the other programme participants (including the Commission Service) | |
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| **CO** | Confidential, only for members of the consortium (including the Commission Service) | **CO** |

[1] Aldebaran Robotics' legal name has changed to Softbank Robotics Europe in April 2015. This change is now reflected in the EC Participant Portal.

# Contents

## Executive Summary

WP8 is dedicated to the dissemination and exploitation of the results of the DREAM project to the international scientific community, including the one concerned with providing primary care for Autism Spectrum Disorder children (ASD). Within that frame, deliverable D8.5 aims to report all the steps, functionality, experimentations and dissemination made towards the development of the DREAM Lite System, which goal is to reduce the DREAM system setup complexity to prepare exploitation with the NAO robot in schools and intervention centers.

## Principal Contributors

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## Revision History

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Version 1.2 (10/05/2019): Minor Fix + insert NAO Blind in the document as “Annex 1”

# 1 Overview of the Work Package

The dissemination and the exploitation of the scientific and technical results obtained in the DREAM project are one of the strategic objectives of the consortium, which is mainly achieved through WP8. This WP aims to disseminate the results of the project to the international scientific community, and more specifically the one concerned with providing care for Autism Spectrum Disorder children (ASD), including therapists and educators. It also aims to facilitate the exploitation of the results of the project, which is at the core of this report

# 2 Outline of Deliverable D8.5

## 2.1 Description of Deliverable D8.5

This deliverable is related to task T8.6, and will detail the functionality, experimentation and dissemination done toward the DREAM Lite Solution.

## 2.2 Description of Task 8.6

This task focuses on developing a ‘light’ version of the DREAM system that should be able to run on the Nao robot alone (i.e. without the additional sensors mounted on the intervention table), but still integrating as much as possible of the complete DREAM system’s functionality. Naturally, this DREAM Lite version will most probably not be as powerful as the complete systems, but it will be significantly more mobile/portable, and thus hopefully will also facilitate real-world application and commercialization.

This task aims to elevate the DREAM exploitation achieved in the earlier tasks during the middle of the project. In addition to the sensing part, the theoretical and scientific results of the DREAM project and the partners' expertise, this task will also incorporate some DREAM modules, like behavior subsystems (attention, reaction, etc.) directly onto the robot, in a coherent technical framework, by using onboard sensors.

This task will also experiment with the solution through some pilot studies, which will be developed in partnership with UBB in order to test the effectiveness of the solution in increasing the children's engagement. The aim will be towards exploring a future version of the DREAM system with significant potential for commercialization.

# 3 DREAM Lite Description

## 3.1 Exploitation Solution

The deployment of a solution that has been developed as part of a research project can pose several challenges. First, the solution has to comprise as many of the features that have led to the experimental positive results, or otherwise it might not keep all of the advantages that were demonstrated via research. On the other hand, when deploying, several constraints coming from the ecosystem must be taken into account, such as ease of implementation, reduced time for setup and deployment, robustness and economic constraints. The exploitation phase of the DREAM project, called DREAM Lite, focused mainly on simplifying two aspects: removing sensors external to the robot and merging the role of the assistant (controlling the robot) and the therapist. The decision to remove the external sensors greatly reduced the decision-making capabilities of the robot, but it was considered as not feasible otherwise. Next, the use of a specifically developed tablet interface allows the therapist to control the robot while keeping enough attention for the interaction with the child, without necessarily needing an assistant.

Figure 1 was taken during the DREAM project experimentation, and shows the installation of cameras and other sensors, as well as the roles of the therapist and that of the assistant who controls the robot. This gives an overview of the framework that had to be put in place: cameras positions must be calibrated and the complete system is likely to be unfamiliar to a child. In comparison, figure 2 shows the first tests of the DREAM Lite solution. In addition to its simplicity, it gives an idea of the ecological aspect of such a solution: the child and the robot interact in a more familiar environment and the therapist has a great proximity with him or her. The child and the therapist can also move during the experiment if necessary.

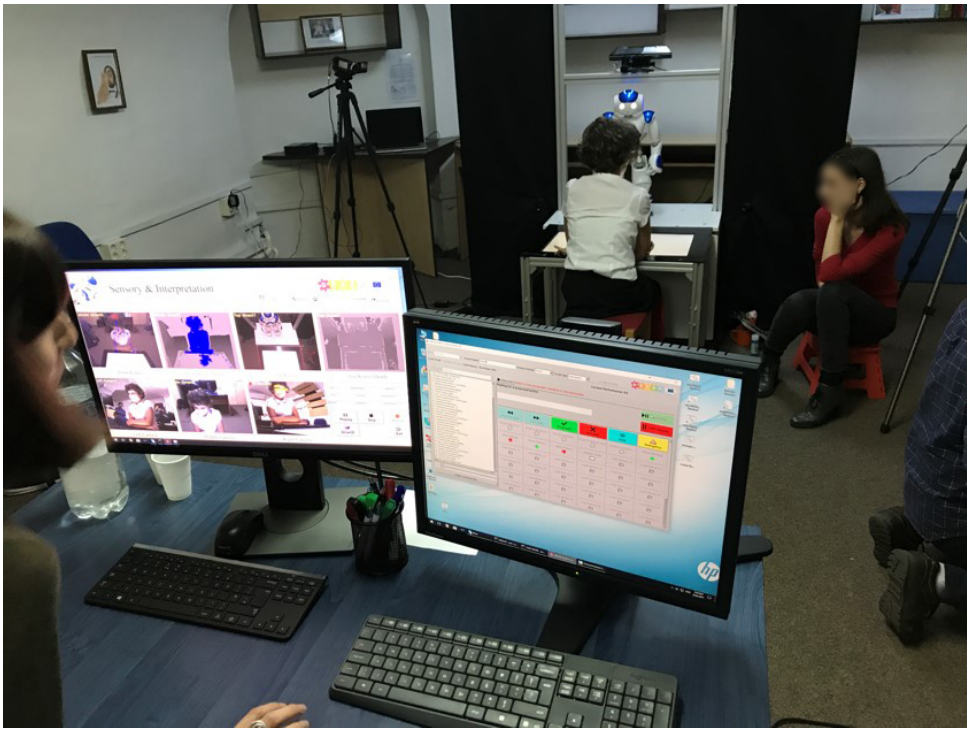

*Fig.1 : The DREAM project experimental setup.*

*Fig.2 : The DREAM Lite solution being tested.*

In the following chapter we will describe the detail of the solution's applications.

## 3.2 Technical Architecture

A complete description of the technical architecture and the interaction between NAO's system and AskNAO Tablet interface can be found in the Deliverable D8.4 DREAM Lite Architecture.

## 3.3 Applications descriptions

The applications developed within the framework of this exploitation were based on the "AskNAO Tablet'' interface, distributed by ERM[2] in France; the launcher of this interface is depicted in figure 3. The applications that can be run using the tablet interface cover each protocol developed and tested in the DREAM project: imitation, turn taking, and joint attention. Particular attention was paid during applications' development to make them very easy to use, while allowing responsiveness, so that the robot can adapt as quickly as possible to the needs of the child.

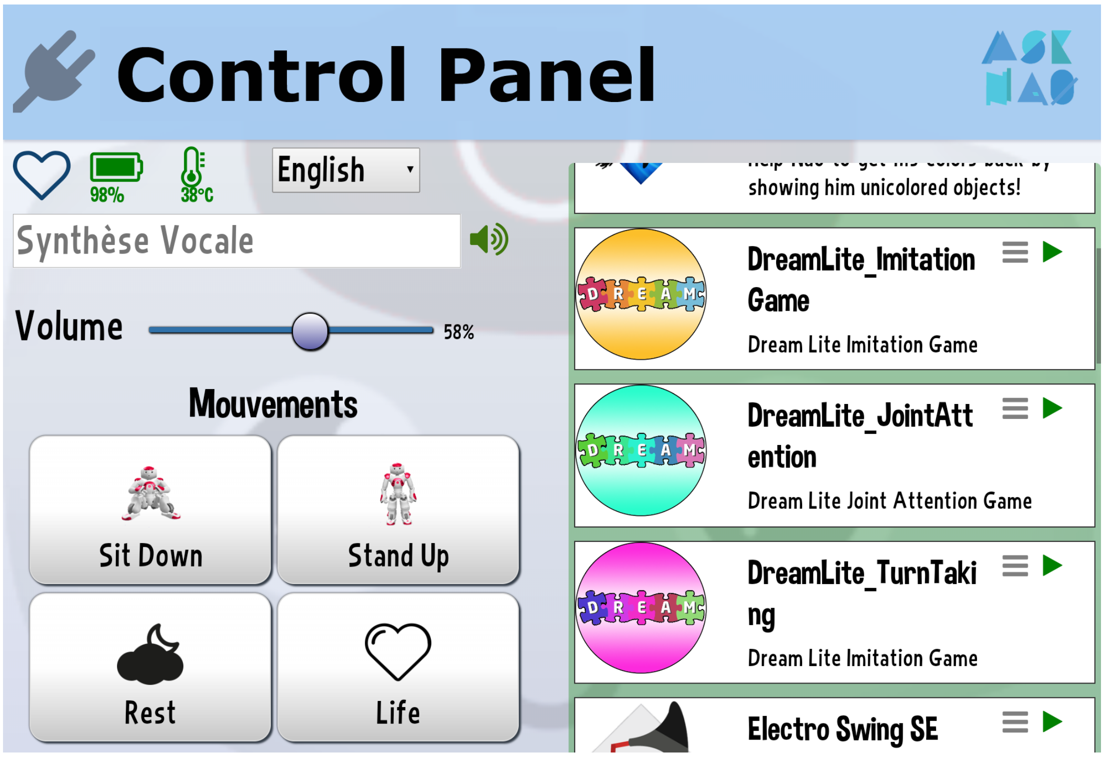


*Fig.3 : The AskNAO Tablet Menu.*

[2] ERM Robotique, http://www.erm-robotique.com/

### 3.3.1 Imitation

The purpose of this application is to improve the children ability to imitate. This application includes five different sets of exercises: (1) a level in which the child must imitate movements and sounds related to a specific object, such as moving a toy car while also imitating the sound of the engine; (2) a symbolic set of exercises where the child must do the same type of movements as the previous ones, but this time with a generic purpose object, such as a wood play block; (3) the next level requires the child to imitate movements that represent daily life gestures, such as waving hand while saying goodbye; (4) the interface depicted in figure 4 is used for the next set of exercises which are related to the imitation of movements representing emotional expressions (anger, fear, joy and sadness); (5) finally, an additional set of exercises was added and targets the recognition of emotional expressions.


*Fig.4 : The Imitation App Tablet Interface.*

### 3.3.2 Joint Attention

This application makes use of one of the features of the humanoid robot NAO, namely its ability to simulate human gaze. In this exercises, the child learns to engage in joint attention episodes, by looking at objects designated by the robot, which are placed either on the left side or the right side of the robotic agent. Depending on the level of difficulty, the robot will use multiple cues to show the object of interest (pointing with its arm, using a vocal indication, and simulate a gaze by turning its head towards the object), or it will use just a single cue (simulate a gaze). This task teaches children to synchronize their attention focus with that of the play partner. The tablet interface is visible in figure 5.


*Fig.5 : The Joint Attention App Tablet Interface.*

### 3.3.3 Turn Taking

This application teaches the child to play a structured game with a partner while respecting the rules of the game: the partners make their moves in turns and one has to wait for his or her turn. In this exercises the child and the robot must take turns in indicating their favourite food or activity by choosing one of several cards placed in front of them (each card belongs to a category such as sweets, dishes, or hobbies). The interface is visible in figure 6.


*Fig.6 : The Turn Taking App Tablet Interface.*

### 3.3.4 NAO Blind

The setup used during the clinical experimentation conducted in the DREAM project did not allow for the exploitation of all the advantages brought by a mobile humanoid robot such as NAO. Namely, the robot remained mostly static during exercises, which limited the physical interactions between the child and the robot, and reduced the dynamics of the game play. The overcome this issues, we have developed an extra application to explore the potential provided by the mobility that the robot is capable of. This gave rise to a fourth application in which the robot simulates that it has been blinded and asks the help of the child to walk and move in the environment. The child can guide the robot by controls on the tablet, and thus the application offers opportunities for interactions that are both dynamic and close. An example of setup can be seen in figure 7.

This application integrates four different stages, 1) an introduction to NAO for a general familiarisation, in this sate the robot will show some moves and dances, 2) a phase of demonstration of the robot abilities to navigate, 3) an explanation of the way to control NAO to help him to navigate and 4) an exercise when the child has to pilot NAO to help him to exit a maze. More information on this application can be found on the document « [NaoBlind] Explanation, scientific point of view and functionality » (NDA: added in this document as Annex 1).

*Fig.7 : NAO Blind first testing.*

## 4 First Experimentations

This solution have been first tested with no specific methodology in various places and setup. We experiment them with G.M. a 4 years old girl typically developing children in Paris, A.J. a 5 years old boy with an Asperger diagnosis. H.J. a 3 years old boy with a moderated autism diagnosed at the age of 2. We then show this solution to some professionals in various places to gather more feedbacks.

*Fig. 8 : Imitation Game experimentation.*

After the interesting feedbacks we got from those first experimentations, we decide to launch an ambitious experimentation with the UBB DREAM Partner.

# 5 Effectiveness Study with UBB

This section will describe in detail the experimentation done in Romanian institutions with UBB.

## 5.1 Methodology

In order to test the DREAM Lite solution and to validate its feasibility, stability and its real-life clinical utility, we used an ecological study design - an effectiveness study - which was implemented in 10 educational institution in Cluj-Napoca, Romania. The sample consisted of children with ages between 3 and 10 years old, who had an ASD diagnosis or had ASD symptoms as presented in their medical file. Sixty eight children were chosen for the study to date. Children were included if they were in the specified age range, they had a formal diagnosis or psychological assessment indicating the presence of ASD symptoms, and they had the minimum abilities to understand and follow the assessment or intervention tasks. We did not exclude children based on the presence of other mental health and neurological problems (e.g., learning disorders). The children were randomly allocated to one of two conditions: a) a RAT intervention delivered via the DREAM Lite solution, or b) a wait-list (WL) condition in which the children waited for two weeks before they receive the same intervention. All children were recruited from special education institutions and thus children allocated to the control condition

(WL) followed regular education activities for two weeks. The comparisons between RAT and WL actually reflects the benefits that the children could gain form the DREAM Lite solution if this therapeutic tool would be added to their treatment routine.

The intervention consisted of five sessions: a behavioral assessment based on the Autism Diagnostic Observation Schedule-2 (ADOS-2), which was meant to evaluate the baseline of the children' social interaction skills; three intervention sessions of about 30 minutes each, performed daily or every second day, which targeted imitation, joint attention, and turn-taking skills; and a final evaluation session which was identical to the initial one. The intervention sessions followed the discrete trial training in which the robot partner presented a discriminative stimulus in the form of an instruction (e.g., ``do like me'', for the imitation intervention), waited for the behavioral response of the child, and offered a contingent feedback (positive social reinforcement or an indication to correct the behavior). The WL group was also assessed at the beginning of the wait period and just before starting the RAT intervention.

## 5.2 Measurements

We measured the social interaction skills of the children based on the dedicated module form the ADOS-2, as well as the imitation, joint attention and turn-taking skills, based on behavioral tasks performed in interaction with a human partner. We also measured the performance in imitation, joint attention and turn-taking during each intervention session. To increase measurement accuracy, an external observer coded the performance during these sessions using a standardized observation grid. The performance of the child in each trial, across each tasks and each level of difficulty was coded as good or bad performance. We also video recorded each sessions and an experienced supervisor reviewed the initial coding. Finally, we used self-report questionnaires to assess parents' satisfaction with the intervention, as well as the perception by the staff in the institutions regarding the usability and acceptability of the DREAM Lite solution.

## 5.3 Results given by the Effectiveness experimentation on DREAM Lite solution

Although the intervention protocol that we developed has been delivered over a brief number of sessions, the results for the effectiveness of the robot-enhanced intervention (RET) delivered with the DREAM Lite solution indicated several positive results. The children in the RET group showed significant improvements over the three intervention sessions on the imitation (IM) and joint attention (JA) tasks. A positive trend was also present for turn-taking form session 1 to session 2, but it slightly decreased towards session 3. Comparisons on the initial and the final assessments indicated positive trends from pre-test to post-test scores across all targeted abilities in both groups, but with larger improvements for the DREAM Lite intervention. The difference between the two groups at post-test reached statistical significance for imitation skills, favoring the DREAM Lite intervention. When comparing the reports of parents and teachers over changes in social skills using standardized instruments, we found a statistically significant effect showing that parents of children allocated to the RET intervention reported more improvements than parents of children in the control condition. However, this pattern was not present for teachers' and therapists' reports. Finally, the percentage of parents that reported scores of satisfactions towards the RET intervention that indicated good to high satisfaction was 77.1%, pointing that the DREAM solution was well accepted by the parents.

Given that most of the children were affected by multiple developmental disorders (e.g., language disorders, attention deficit and hyperactivity disorder), it was decided not to include the NAO Blind application in this experimentation, as it might have increased the complexity of the therapy sessions. Thus, a next step would be to test this application, either as a stand alone RAT activity, or in combination with the other DREAM Lite applications, using a sample that is capable of following more complex instructions.

The complete results and explanations are detailed in the UBB's report D2.3.3 Tasks for social robots (supervised autonomous version) on developing social skill.

### 5.4 Conclusion

The DREAM Lite solution showed promising results in our effectiveness study, despite the fact that it was brief, and it was delivered to a heterogonous and severely impaired sample. More research is needed to assess its long-term effects, but our results support the idea that this simplified implementation of the DREAM framework could be used easily to disseminate RET interventions for ASD children in real-life context. DREAM Lite could be used as an additional tool to standard therapy to enhance the learning of social skills in ASD children.

## 6 Future exploitation plan

### 6.1 Quetigny UEMA

Following conclusion from the UBB effectiveness study, we decide to start soon a first exploitation of this solution with the Quetigny UEMA (Unité d'Enseignement Maternelle Autisme) school, an ASD specilialised school already using NAO and AskNAO Tablet (figure 9). The local team is animated by one specialised teacher, one specialized educators, four children assistant, one psychologist, one psychometrician and one speech therapist and have an accommodation capacity of 7 children between 3 and 5.

*Fig.9: NAO robot in Quetigny UEMA.*

This experimentation will be included in the NaotismIA initiative: an operation we're doing in coordination with the French Dijon's DANE (Délégation Académique au Numérique Educatif) and ERM.

### 6.2 Hopital Pitié Salpétriere

After having met the head of pedopsychiatrist ASD service during a conference, he shows great interest about this solution, so we are spoking about using it in their speciliased schools: 13 classrooms are part of the hospital, so it can offer us to test on many children aging between 4 and 12.

# 7 Dissemination toward DREAM Lite

During the last year we were invited to present our work on DREAM Lite, it was a nice way to gather feedback, advices and encouragement. Here's a list of the major intervention SBRE had:

- 14/03/2018: Presentation at a Workshop "Robotics & Education in the World of Digital Transformation » at the ERF 2018, Tampere, Finland.

- 19/06/2018: Keynote on a workshop on "Assistive Technologies for People with ASD and other Disabilities" held at the MED'18 Conference, Zadar, Croatia.
  During the discussion, we have interesting discussion with members of the ADORE (Autism

Diagnostic Observation with Robot Evaluator) research project[3]

- 13/09/2018: Invited to present and take part into reflexion in a meeting on the exploitation plan for the DE-Enigma (Playfully Empowering Autistic Children) research project[4]. Held in Twente University, Netherland.

- 27/09/ 2018: Support for Silviu Matu presentation and DREAM Lite demonstration during coffee break at Xxx 2018, a national psychologist conference, Cluj, Romania.

- 09/11/2018: Presentation to the Animatas[5] Innovative Training Network (Partners and Beneficiaries), Paris, France.

- 18/12/2018: Presentation in a cycle of public conference "Conférences et Présentations cliniques » at the « La Salpétrière » Hospital. Dr Cohen's enthusiasm will lead to some future experimentation with their schools as described in the previous « future exploitation plan » section.

- 11/03/2019: Poster at a Workshop «Social Robots in Therapy and Care » at the HRI 2019, Daegu, Korea. We present there the first version of our publication on DREAM Lite « DREAM Lite: Simplifying Robot Assisted Therapy for ASD Development - deployment and validation of the DREAM European project's exploitation part » with preliminary results.

- 17/04/2019: SBRE Acaday: conference and exchange organised by SBRE where various researcher from europe in education field discuss about their work. It was a good opportunity to present DREAM Lite solution to people interested by ASD solution, and it leads to interesting exchange with Arsea (Colmar/France) and the french association «Entraide Autisme » from the val d'oise region (France)

- *pending*: extended version of our publication « DREAM Lite: Simplifying Robot Assisted Therapy for ASD Development - deployment and validation of the DREAM European project's exploitation part » which will include full results, discussions and conclusion.

[3] https://larics.fer.hr/larics/research/adore
[4] http://de-enigma.eu/
[5] http://www.animatas.eu

*Fig.10 : «Conférences et Présentations cliniques » at the « La Salpétrière » Hospital.*

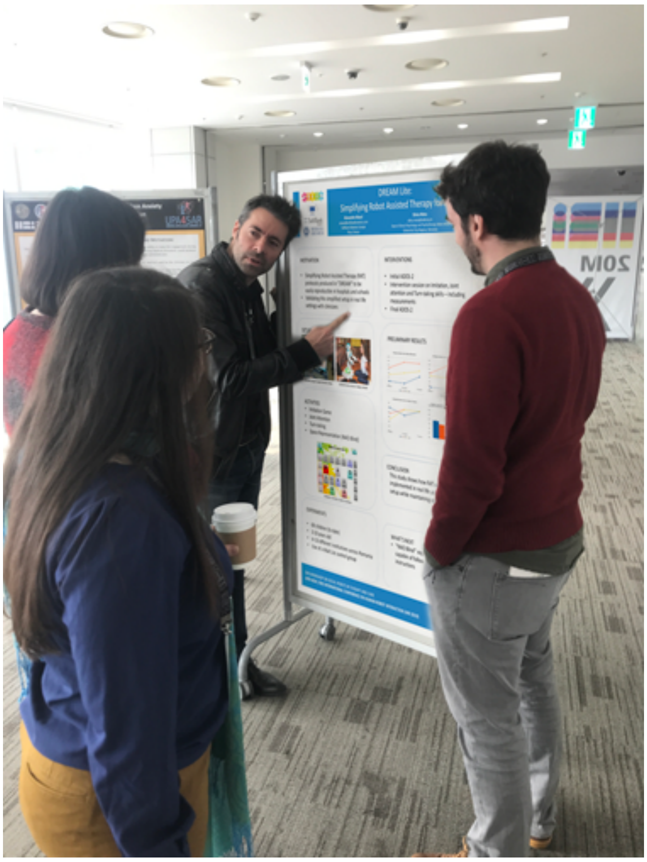

*Fig.11 : «Social Robots in Therapy And Care » at the HRI 2019.*

# 8 Annex 1: NAO Blind Explanation and functionalities

# NAO Blind

a different application for specialized education

Florian Verneuil & Alexandre Mazel

June-November 2018

## 8.1 The Idea

SoftBank Robotics Europe (SBRE) was looking for developing new applications for Robot Assiste Therapy. The main idea was to propose new concepts and ideas to enrich the actual AskNAO Tablet software. Those applications had to address more well-known issues of the Autistic Spectrum Disorder (ASD). Few ideas and concepts were suggested at SBRE. One of the most interesting idea was Nao Blind – an application based on the work of Ozonoff & Miller (1995), thought to work on other's physical perspective and, doing it so, initiating a work on others' perceptions and theory of mind; known to be affected in children with ASD (Dautenhahn et Werry, 2004; Murray, Johnston, Cunnane et al., 2017).

This new application is planned to be tested first during DREAM Lite experimentation, the exploitation part of the DREAM research project, then if results are positive, with other local partners.

## How it works?

The main idea is to let the children adopt the robot's perception by allowing them to monitor a robot through a maze using vocal command or a controller. To succeed, the children have to represent robot's point of view. Nevertheless, in order to justify the need for help, the robot was blindfolded.

To make this application works, the therapist/experimenter will need to make sure that the children acknowledge the robot's ability to take visual information from the environment – the Nao Sight step. To do so, the robot will need to walk across a room, avoiding obstacles on its own or monitored by the therapist in a Wizard of Oz (WoO) setting (cf. Fig. 1).

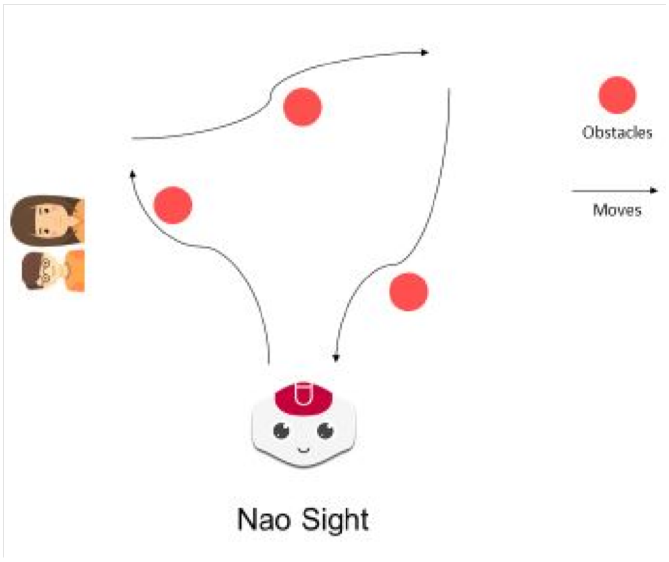


*Figure 1 Representation of the Nao Sight step. While the children and the therapist watch the scene, the robot will avoid obstacles.*

Once the children acknowledge that the robot can see, the therapist blindfold the robot to justify the need of help into the maze – the Nao Blind step. During this step, the robot walks across the same room and do not succeed to avoid obstacles (cf. Fig. 2).

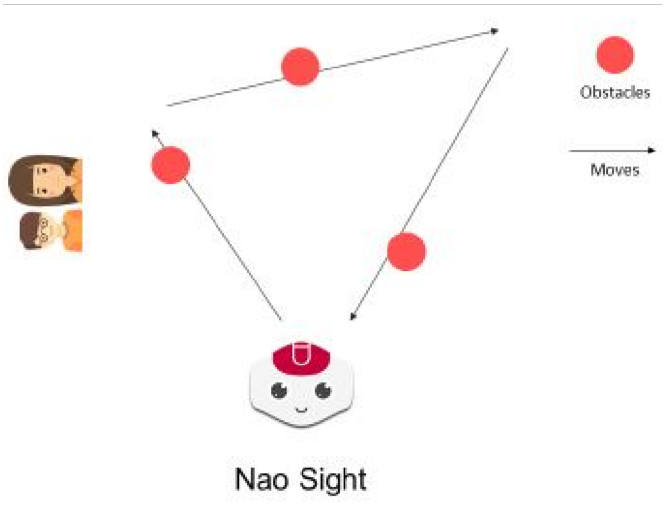


*Figure 2 Representation of the Nao Blind step. While the children and the therapist watch the scene, the robot will not avoid obstacles.*

## 8.2 First tests

On the 31 July 2018, a SoftBank Robotics Europe team conducted an experiment with two children with ASD. The aim of this experiment was to ensure that the application could be used by a young children. Not only feedbacks about the controller, but also feedbacks about the concept in itself have been gathered. Given the poor sample, only qualitative information were taken into account. However, this first test is important to gather information about the use and perception of Nao Blind, allowing it development.

### 8.2.1 Participants

Two children participated to the experiment. The first child, A. J., is 5 years old and was diagnosed with Asperger at the age of 2. Since he was diagnosed, he is follow by therapists in order to work on different aspects of social life. The second child, H. J., is 3 years old and was diagnosed with a moderated autism at the age of 2. Since he was diagnosed, he has been followed by therapists to work on different aspects of social life.

While A. J. was capable of interacting with us and free speaking about robots and his different fields of interest, H. J. has difficulties to speak to or to look at others. It has to be noted that the first child has already interacted with Nao.

### 8.2.2 Method

During the experiment, the children were proposed to play to a new Nao game. In order to reduce anxiety that a new environment may cause, the experiment was set up at their home. All the interaction with Nao were captured on video for later possible qualitative analyses.

The experiment was inspired by several works (Feil-Seifer et Mataric, 2011; Robins, Dautenhahn, te Boekhorst et al., 2004; Vanderborght, Simut, Saldien et al., 2012) and was divided into three phase:

1. **The Nao familiarization** phase was meant to last 5-10 minutes depending on the child's reaction. The experimenter briefly presented Nao the robot to the child. When the child seems to be comfortable with the presence of the robot the following scenario was presented:
    a. Nao first interact with the child and ask him how he was doing
    b. Then, Nao sit down, lay down to the ground before rising himself up
    c. Finally, Nao initiate a dance

During this scenario, if the child was not interested enough by the robots, the therapists gave verbal encouragements such as "Oh look!" or "What Nao is doing?"

2. **Nao Sight** phase then **Nao Blind** phase (cf. *How it works?* )

3. **The application familiarization** phase was meant to last 5 minutes or more, depending on the child's understanding of the application's operation. This phase is a free-game phase. During this phase, the children was invited to control the robot thanks to a tablet (cf. Fig. 3) and make it move forward, backward, right and left several time. Once it was clear that the child understand how to make the robot moves, the experiment invited the child to start the **Nao Blind Maze**

4. The **Nao Blind Maze** phase was meant to last until Nao reach the end of the maze. The child was assured that he could stop whenever he wants to, even if he did not reach the end of the maze or if it was too difficult for him.

    The maze was built with long plastic rods disposed as presented on Fig. 4.

*Figure 4: A simple maze*

## 8.3 Results and discussion

### Child 1: A. J.

A.J. was very enthusiast during all his interaction with Nao. Since the beginning of the familiarization phase, the child never stop looking at Nao and showing his interest toward it. A. J. even refers his own experiences to the Nao's ones (*e.g.* While Nao was dancing, the child said that he (the child) know this kind of dance too). However, while the child still was interested by Nao during the Nao Sight phase, we did not clearly acknowledge his perceptions of the robot's visual abilities. Consequently, at this stage, we were not sure that the children perceived the robot as being capable of taking visual information from the environment. It seems to be interesting to include questions prior to the Nao Blind session in order to control the child's perception of the robot.

Nevertheless, we suggest that the child understand the difference between Nao Sight and Nao Blind, since he started to want to help the robot to walk at the very beginning of the Nao Blind session. Moreover, the child even reacts to the robot's situation by acknowledging his lack of vision: "Oh, indeed, now he cannot see the obstacles" (it's interesting to note that A. J. refers to Nao as a highly intelligent actor, and not a machine). This reaction suggests that leading the Nao Sight phase may be interesting to help children understanding the necessity of their help and, thus, rise their implication to the task in the end.

Using the tablets to control Nao seemed to be natural for A. J. He immediately understood how to make Nao move, even before the experimenter told him how to do so. Moreover, A. J. quickly understand that he is the one who makes Nao moves ("Oh, it's true that I can control him with that"). Therefore, the use of the tablet to control the robot seems to be adapted to young children.

The maze task in itself was very challenging for A. J., most of all at the beginning of the task, because he was not in the same position than the robot, he said that he does not know how to do when "he is like that". Therefore, it takes time for A. J. to make the robot moves how he wanted it to. For example, at the beginning since the child was well-oriented and would have needed to go straightforward to progress in the maze, he asks the robot to go forward – while it needed to be do a turn of 90 degree. While this position was not predefined, it was interesting since the child had to make inference about the robot's spatial orientation. However, even if it was difficult at the beginning to orient the robot, the child progressively understand where the robot had to go to reach the end of the maze. This interaction is interesting since it may suggests the use of the child's mentalizing abilities. The child's progression in the task also suggest that this exercise may help to work on taking other's visual perspective.

It should be noted that A. J. also had difficulties since, while the robot moves it only makes predetermined turn or distance, the child did not well understood that he could stop the movements by pressing a button right after a first one. This situation may be due to the fact that we might not have gave enough time for the child to train all the movement possibilities. More time may be needed for children to fully understand how to interact with the robot.

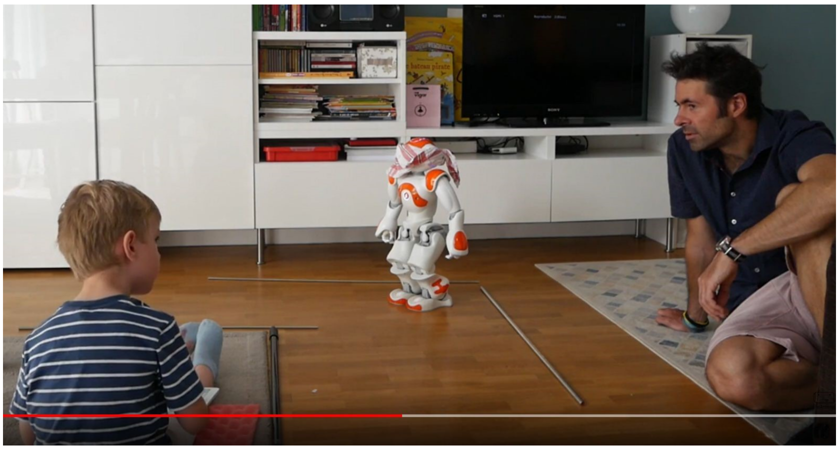

*Figure 6 :An example of the blind piloting part*

*https://youtu.be/WakpGRBYi2U*

## Child 2: H. J.

H. J. had a different approach with Nao. While A. J. was very enthusiastic and immediately wanted to interact with the robot, H. J. took time before looking at him and never wanted to play with it.

However, even if H. J. never went through the robot maze phase, he allowed us to fully test and experiment the familiarization phase. The two simple moves we predefined for the familiarization (Nao lay down and Nao dance) were not effective to catch H. J.'s attention. Nevertheless, H. J. seemed to be interested in Nao's ability to get back on his feet. Therefore, he played with Nao several times by pushing it on the ground and then helping it to pick itself up. Since the behavior is autonomous, we did not implement it as a part of Nao Blind, even though it effectiveness to catch attention should be noted. Another behavior were tested, such as new dances along music, speech or Nao's autonomous life. If the speech (*e.g.* "Let's play a game!") succeeded to briefly catch H. J.'s attention, a particular dance based on the music "If you are happy and you know it clap your hands" managed to attract him. While he was looking at the Nao for the entirety of the song and dance, the child also dance with Nao and physically interact with it. The Nao's autonomous life did not rise any form of interests to H. J. After this difficult familiarisation H.J. doesn't want to interact anymore this morning with NAO.

Since A. J. was immediately attracted by Nao, the familiarization phase only deepened his interests and amazement toward Nao. Having H. J. allows us to have interesting insights on possible enhancement of the Nao Blind application. While our predefined moves for familiarization seemed to work on A. J., this interaction suggests that it would be interesting to integrate more various movements and speech sentences into the Nao Blind application to get around first interaction difficulties.

### 8.3.1 Global discussion

This preliminary work allowed us to gather a large amount of information, helping us to enhance Nao Blind. Not only the application in itself, but also the method can now be improve to fit with the expectations for ASD experiments. Nevertheless, this experiment was only a first step to understand the possibilities and usability issues for Nao Blind. The interaction between A. J. and the robot in the Nao Blind phase suggest that this application may be interesting to work on other's perspective. This information was also underlined by A. J.'s father who told us that this application is really interesting "since the child really need to work on how the robot perceive his world."

Nevertheless, several limits of the work has to be underlined. First, even if we do not intend to, the sample is too small to make generality about those feedbacks. More works with children with ASD are needed to fully apprehend the entirety of the Nao Blind's issues. Moreover, since the environment was not fully controlled, it can have impact the way the children interact with Nao. For example, even though H. J. did not want to interact with Nao, he asked several time for the tablet or the TV, because we were in his living room. He had habits in this environment and probably come in this room specifically for these kind of activities. Another room or another might have been more neutral for him and maybe would have allow richer interaction with Nao. Moreover, even though he did not went through the Maze phase, H. J. might be too young to perform this task as suggested by several works (Wellman, 2001; Williams, Whiten, Suddendorf et al., 2001).

## 8.4 References


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