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SOCIAL ROBOTS SUPPORTING THE INCLUSION OF UNACCOMPANIED MIGRANT CHILDREN: TEACHING THE MEANING OF CULTURE-RELATED GESTURES

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Social robots are being used successfully as educational technologies, playing roles of tutors and therapeutic assistants. In our research, we wish to explore how social robots can be used to tutor a second language to unaccompanied minor migrants and support their integration in a new culture. These young migrants are among those most at risk in the area of child and youth welfare. In this paper, we focus on a particular aspect of a second language teaching that concerns culture-related gestures that are important for supporting the social inclusion of these children. Since gesture learning relies on the understanding of the social situation, in which interaction and repeated practice are essential, social humanoid robots seem to be an adequate interaction mean since they can provide both examples of gesture executions, explanations about the meaning and the context in which the gesture should be used. Moreover, as in other assistive domains, social robots may be used to attract the children attention and support the

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social operator in establishing a contact with these children that very often, after the difficulties of the journey, do not trust adults. Results of a preliminary study show the efficacy of the proposed approach in learning gestures.

1 Introduction

In 2016, 63,280 UnAccompanied Children (UAC) applied for international protection in EU countries. EU have the responsibility of supporting these children and, at the same time, the chance to nurture their potential to enhance their contribution to our societies. Even if in 2018 the number of UAC decreased, social services are key for guaranteeing their protection and development ensuring access to care, education and health, as well as programs fostering their social inclusion. In this context we developed a project aiming at teaching Italian to UAC. In particular, we included in this project the teaching of culture-related gestures.

Linguistic deprivation is very often a prerequisite to social exclusion and learning how to communicate can be the first step towards integration and inclusion in a new cultural context. However, human communication is multimodal and, according to some studies (Poggi, 2006) and in some cultures the vocabulary of hand gestures is much richer, such as Italy. Gestures are used to convey the meaning of a message (McNeill, 1992). There are several types of gestures: metaphoric gestures (i.e. those that explain a concept), deictic gestures (i.e. pointing movements), and iconic gestures among others. However, many gestures are culture dependent and do not have a unique meaning and symbolism. The same gesture can mean something quite nasty and disrespectful to a person from a different cultural background. Hand gestures are a very important part when learning a foreign language. In addition, when UAC arrive in a country, after the migration process, they are very scared and do not trust humans due to the experience they just had.

Social Robots are embodied autonomous intelligent entities that interact with people in everyday environments, following social behaviors typical of humans (Billard & Dautenhahn, 1997; Fong *et al.*, 2003). Social robots are mainly used to improve people experience in several application domains, language teaching among the others (Schodde *et al.,* 2017). Alemi *et al.* (2014) show that children who are taught by a robot as opposed to a human teacher store new words of a second language faster and better in their long-term memory. Moreover, social robots are less complex and less intimidating than humans and may provide an effective support during triadic therapy or intervention. They may be programmed in order to have a deterministic behavior that can be repeated as many times is needed.

In this project, we developed the NaoKi application that uses a social robot for teaching culture-dependent gestures to UAC. As social robot we used Nao, due to its characteristics, which make it suitable for the context, and to recognize gestures in real time we used Kinect, a device able to detect and the user's skeleton. An important component of the application is represented by the gesture database that has been designed using the formalization proposed by (Poggi, 2006).

Results show that gestures and especially their reproduction significantly influence the memorisation of second language (L2) lexical items as far as the active knowledge of the vocabulary is concerned (being able to produce words and not only understand them). This finding is consistent with theories on multimodal storage in memory. When reproduced, gestures not only act as a visual modality but also as a motor modality and thus leave a richer trace in memory.

The paper is structured as follows. The first Section of the paper briefly describes what is a social robot and its use in assistive domains, with emphasis on research work on gesture recognition. Section 3 introduces issues concerning the reception of UAC. Then, we briefly explain the structure of the Italian Gestionary (Poggi, 2006) and than, in Section 5, how it has been used in the NaoKi application. Then we report results of a preliminary evaluation study. Conclusions and future work are discussed in the last section.

2 Social Robots

A social robot is a physically embodied, autonomous agent that communicates and interacts with humans at a social and emotional level. They should be able to interpret properly the human behavior, to react to changes during the interaction in a socially plausible manner. The use of social robots in education have been shown to be successful in diverse contexts (Kennedy *et al.*, 2015, Wainer *et al.*, 2014, Schodde *et al.,* 2017). In particular, the use of robots may increase attention, engagement, and compliance, which are critical components of successful learning (Ramachandran *et al.*, 2018).

Factors of social intelligence increase the complexity of programming a socially interactive robot. A social robot is expected to sense its surrounding, to handle natural and multimodal dialogs, to recognize and express emotions, and to adapt the interaction to some characteristics of the user. Social robots are employed in education with the main aim of engaging students and they are particular successful with those special needs. For instance, social robots are widely applied to teach basic social skills to children with autism, since they resemble humans but are less complex, seem to be able to manage these issues successfully (Palestra *et al.,* 2017; Pennazio, 2017; Duquette *et al.*, 2008).

As far as the efficacy of using social robots in the teaching of a foreign language is concerned, recent research show that it may lead to interesting results (Boccanfuso *et al.*, 2017; Alemi *et al.*, 2015). In particular, (Alemi *et al.*, 2015) employed a social robot as an assistant to teach English vocabulary to Iranian students. They found that the use of the robot assistant significantly improved the learning task. In addition, the robot-assisted group showed improved retention of the acquired vocabulary.

Moreover, some studies suggest that the sociality of the robot increased the learning improving learning outcomes (Alemi *et al.*, 2014; Kanda *et al.*, 2004; Saerbeck *et al.,* 2010; Tanaka & Matsuzoe, 2012). Then, robots open up new possibilities in teaching that were previously unavailable, leaving space to explore novel aspects of language learning, as culture dependent gestures.

Gesture recognition in Human-Robot Interaction has been proposed in (Henriques, 2017) to allow people, especially those with physical limitations, to give instructions to the robot in an easy and intuitive way. The system uses a Kinect for gesture detection, and recognition is performed using a Microsoft software, Visual Gesture Builder. A research similar to the one described in this paper has been conducted on children with autism spectrum disorders (So Wing Chee *et al.*, 2018). Since these children have delayed gestural development, a social robot was used to teach them to recognize and produce eight pantomime gestures that expressed feelings and needs. This study reports that children in the intervention group were able to recognize more gestures and generalize the acquired gestural recognition skills to human-to-human interaction. Also in (Kose *et al.,* 2011) the social robot Nao has been used in conjunction with Kinect for developing a serious game for sign language tutoring. All these studies report how a social robot represent a successful interface for teaching a second language and, in teaching gestures to children, especially to those with special needs.

3 Unaccompanied Migrants Children

In the last years Italy, along with other European countries, has become the landing place for numerous UAC (UnAccompanied migrants Children also defined Unaccompanied Foreign Minors - UFM -, isolated children, separated children). After the first reception phase in communities for minors without a family, the second level reception of the Protection System SIPROIMI – Protection System for International Protection Holders and Unaccompanied Foreign Minors (L. 132/2018, previously called SPRAR - Protection System for Asylum-seekers and Refugees) has the aim of ensuring to children the living conditions appropriate to their age, to be able to undertake a project of life aimed at social integration and autonomy, and the minor will be assigned, through the Juvenile Court, to a tutor.

According to the data until the 31st March 2019, provided by the Foreign Child Protection Services of the Ministry of Work and Social Affairs, in Italy there are 8.342 UAC (MSNA – Minori Stranieri Non Accompagnati -as per Italian language) of which 7.774 are male and 568 female, ranging from 13 to 17 years of age, mostly coming from Albania and North Africa, protected by the L.47/2017.

Due to their age the UAC live a double status: that of a minor and a migrant, experiencing both the difficulties related to the abrupt and rapid passage to adulthood, and to the integration into a new and totally different society. The many difficulties encountered along the way to reach Italy (repeated beatings, threats, abuses, hunger and thirst), have determined in minors' profound traumas that add up to the cultural shock and abandonment of parental figures of reference, essential in the life of any child. For these reasons, the minors show distrust towards the operators and any physical contact, even a simple hand on the shoulder, can generate a sense of agitation in the kid. Reception activities, specifically designed by the government, are implemented with the aim of offering psychological support following the disastrous journey. Among the various activities, whose objectives have been defined based on the characteristic of the target group, the BLUE and GREY activity aim to share key words about greetings and moods (in Italian) and to know customs and cultural habits of the country of origin, respectively.

At this stage, a social robot could play an important supporting role for cultural mediators, who have the important task of trying to understand the child's expectations and lived experience, to transmit information about integration into Italian society, then acting as a bridge between the two cultures. Especially regarding child victims of trafficking, gaining child's trust by the operators is very difficult. One of the major difficulties is to attract and keep the attention of the child that is scared and does not accept physical contact. Most of the young migrants have their gaze down, indicating their emotional situation and their lack of self-awareness, they speak with a low voice and have difficulty in looking at operators. The robot could be of great help both for the operators so that they can enter into relationship with the minors, and for the latter who, through the interactions with the robot as a "game", could learn the first necessary information to start the integration process that, initially is based primarily on the knowledge of the Italian language, which must already be learned in the first reception center. Looking at the activity table, with regards to the BLUE activity, the robot, through games, images and sounds, can facilitate the acquisition of the first words in Italian, useful to be understood. This could be integrated with lessons from the robot on the Italian culture and on that of the different countries of origin, in order to analyze the two cultures, highlighting differences and elements in common. Finally, in this phase the robot can be fundamental in order to facilitate the process of understanding the rules and gestures typical of Italian culture that favor their integration.

Learning the Italian language for UAC is very difficult, both for the complexity of the grammatical structure of the language itself and for the phonetics completely different from the non-Romance languages. The useful language to communicate can be learned in a short time frame. A good solution to be able to favor the formation of friendship ties and at the same time promote school learning could be the robot. Regarding the relationship with the teachers, initially there are problems regarding the linguistic understanding of the work to be performed and the rules to be respected and often the men of the male gender show a certain distrust of the female gender due to their culture of belonging. For these reasons it is important to create individual forms of support, to create appropriate educational programs so that children can feel welcomed and can trust their teachers.

The robot can therefore compensate for the main problem of learning Italian in UAC: motivation and attention. Through the activity of the games the lesson will be fun and highly interesting, capturing the attention of the boy and with the desire to try again the same game/exercise without wanting to give up.

4 Gesture Dictionary

Communication is the process of sending and receiving messages through verbal or nonverbal signals. In verbal communication, the purpose of communicating is almost always intentional, instead, when implemented with other types of non-verbal signals such as, for example, gestures, the purpose is defined as unconscious. The correspondences between signals of our body (gestures, expressions) and meanings are different from culture to culture even if, in many communication systems, facial expressions, physical contact and gaze are almost universal.

The word gesture derives from the Latin gestus which means "to perform". Therefore, we can call gesture any movement made with hands, arms and/or shoulders. In a communicative act, typical of Italian culture, hands play a significant role in that they can articulate the rhythms of discourse, create pauses, place concepts in the space and express, tacitly, a desire or a thought. Gestures can be of various types:

- **Deictic**, which indicates an object or a person (i.e. pointing with the index finger);
- **Iconic**, which depict, in the air, the form or imitate the movements of an object, an animal, a person;
- **Batonics**, in which the hands move rhythmically from the top to the

bottom to scan and highlight the accented syllables in a sentence;

- **Symbolic**, in which, in a given culture, they have a meaning and a culturally shared translation. In fact, these gestures are said to be socially coded because they are learned from an early age by observing them on a daily basis, than they are often incomprehensible to people of different cultures (Desmond, 1978).

The latter have particular relevance in the application context of this work.

When we talk about communicative gestures, which correspond to a signal-meaning pair, It is necessary, for those who have different cultures, to have a "dictionary" of such gestures, to allow a better translation of the communicative act. To this aim, the "Italian Gestionary", proposed by (Poggi, 2006), is a useful resource since, in it, each gesture is presented through a picture, a description of the movement and the corresponding verbal description, as shown in Table 1.

Gestures can be considered as a semantic information present in the mind of those who want to communicate. It is possible to extract the meaning and use of a gesture by analyzing the Gestionary that, for each gesture, provides:

- **Verbal formulation:** each symbolic gesture is paraphrased or accompanied by a verbal formulation. For example, the gesture of applauding can be paraphrased "compliments!".
- **Context:** describes the contexts in which the gesture is more typically used.
- **Synonyms:** different gestures to express the same meaning.
- **Meaning:** is the definition that aims to highlight the common meaning of a gesture in different contexts, similar to that of word dictionaries.
- **Grammatical classification:** unlike words, in gestures there is no grammatical categories (name, verbs, etc.), but it is possible to distinguish "gestures-sentences", called holoprasics, from "word gestures", called articulated, depending on that have the meaning of a whole sentence or only a part.
- **Pragmatic classification:** concerns only the "phrase-gestures" which are also classified according to their specific performative just like the gesture of praise (the applause, "Congratulations!").
- **Semantic classification:** among the numerous Italian symbolic gestures, many provide information on the world, some of these serve to indicate the times ("yesterday", "after"), quantities ("two") etc. Other gestures can express information about the mind, emotions and degree of knowledge of the person with whom you are communicating.
- **Rhetorical meaning:** also in the gestures the rhetorical figures are present, that is a rhetorical use of the gesture, therefore different from the literal one. For example, the gesture of hitting the chest with the

hand, with the palm facing downwards and the fingers touching, means "I do not digest it", but in a rhetorical way because what is not digested is not a food but a person who metaphorically "can't stand".

Table 1
AN EXAMPLE OF GESTURE DESCRIPTION (POGGI, 2006)

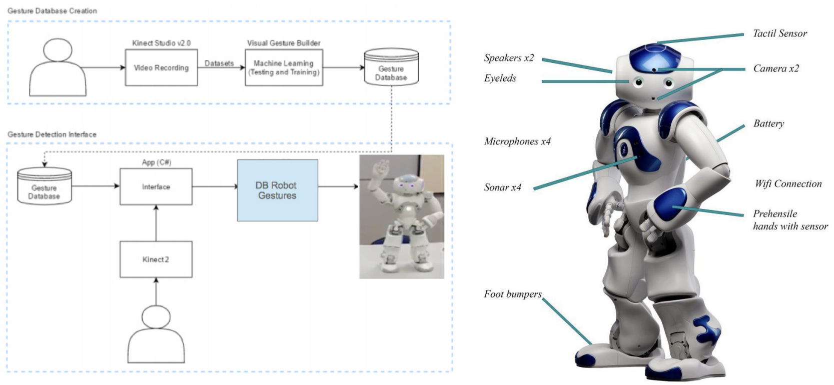
Gesture	Verbal Formulation	Hand shape	Orientation	Location	Movement	Nonmanual components
	I pray you	hands open with palms touching	fingers pointing towards the chin	neutral space	United hands moving slowly forward and backward always keeping your fingers pointing upwards	

5 The NaoKi Application

In order to execute, recognize and explain the meaning of the gestures using a social robot, we integrated the Nao robot with Microsoft Kinect through the NaoKi application (Figure 1a).

The proposed architecture has two main components connected to two different devices. The first one uses Kinect to build the database of gestures and to recognize them when performed during the learning session. Kinect for Windows is a device that allows to recognize and track the body (via the skeletal tracking function) of one or more people (up to 6). The Kinect SDK 2.0 is a library that is essential for recording the video of the gesture to be recognized and, then, converting and analyzing it with the Visual Gesture Builder. Using this technology, the application allows to create a database of gestures that can be recognized and the degree of correctness of the recognized gesture respect to the selected one.

The second component is connected to the Nao robot (Figure 1b), a small-sized humanoid social robot that is strongly used in therapeutic assistance to autistic children due to its characteristics such as physical appearance, autonomy, and programmable behaviors (Palestra *et al.*, 2016). Indeed, an ecological robot assisted treatment for children requires to simulate intelligent behavior and interaction, based on human speech and body language understanding, emotion recognition and eye contact ability, and other typical intelligent behaviors (Palestra *et al.*, 2017). The Nao robot is controlled by a Linux-based operating system called NAOqi. This operating system powers the robot's multimedia system which, as illustrated in Figure 3, includes four microphones, two speakers, and two HD cameras. The main CPU is the Intel ATOM 1.6 GHz CPU located in the head that runs a Linux Kernel and supports the proprietary middle manager of Aldebaran (NAOqi). The second CPU is located in the chest and dedicated to motors functions. Nao can move and perceive its environment using the multiple sensors on its body. The robot is fully programmable through the suite of named software Choregraphe. This software allows, therefore, to program the robot through a user-friendly graphical interface.



a) b)

Fig. 1 - a) The architecture scheme of the NaoKi application; b) Nao's hardware features

Nao is used, in this case, to interact with the children and tutor them in learning the gestures. To do so we enriched the robot gesture database with the coordinates of the gesture in order to allow the robot to play it. To so, we used an interesting functionality of the programming environment (Choregraphe) that of being able to memorize a new movement using the "Timeline" scripts (Figure 2) where, just moving the robot's limbs and then click on "save" it is possible to save the gesture and the behavior and then re-run it when selected.

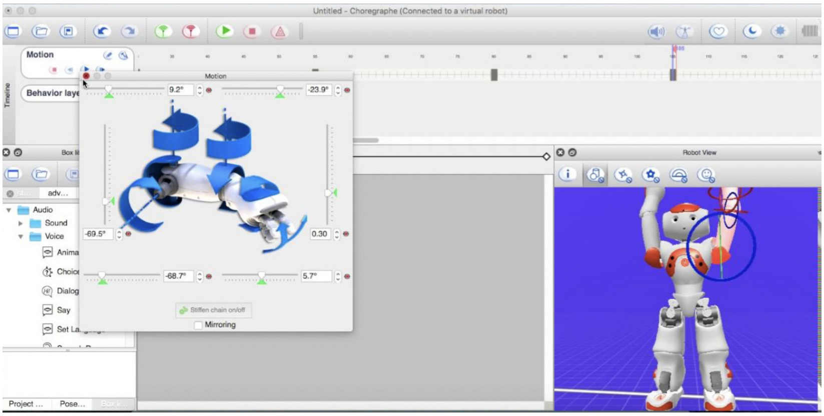
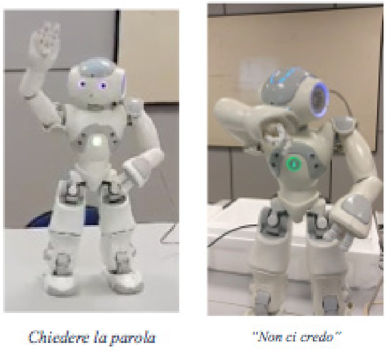


Fig. 2 - An example of the "Timeline Script" used to build the robot's gestures.

The database is running in the background of both components and contains the description of the gestures. It has been structured according to the gestionary presented in Section 3 with, in addition, the coordinates of the gestures recorded by the Kinect SDK and the Gesture Builder and the description of the gesture as programmed in Nao. In particular, we store the movement coordinates of static/discrete (i.e. hand on the forehead) and continuous/dynamic gestures (i.e. waiving to say hello). Another important functionality regards the check of the correctness of the performed gesture. To allow this, we need to query the ".gbd" database (DB Robot Gesture in Figure 1a) containing the coordinates of the gestures recognized by the Kinect; the coordinates are searched based on the gesture and then the curve of correctness and finally the evaluation is done.

The interaction may have three learning goals and may be initiated by the robot or the child. In the first modality the robot may show a gesture to the child, explain the meaning of the gesture and ask the child to reproduce it (Figure 4). In the second modality the child may ask the robot to perform a specific gesture or a gesture conveying a specific meaning. Moreover, the child may ask for an explanation about the gesture meaning, Figures 3a and 3b show Nao that executes two different gestures.

The third modality is to interact freely with the robot by creating both a mix between the first two and introducing other features such as "basic cognitive dialogues" or entertaining the child with small "ballets" made by the robot to always maintain an atmosphere " fun "and comfortable.



"Ask to speak" "I don't believe it!"
(a) (b)

Fig. 3 - Two different gestures performed by the Nao robot.

An example of interaction in which Nao teaches a gesture to a kid is shown in Figure 4. In this case the robot is teaching the gesture "I pray you". First the robot shows to the kid how to execute the gesture and then asks to reproduce it. When the kid performs the gesture, the robot gives him a feedback score that is calculated according to the correctness score calculated by Kinect.

5.1 Preliminary Evaluation

We performed a preliminary formative evaluation test of the application. Even if the application is intended to be used by foreign children, for ethical reasons, we could not involve them in the study. Then, our subjects, were 4 Italian children (sons of some Department staff members with an age from 6 to 10 y.o.) and 6 adult migrants (with an age from 19 to 24 y.o.). We asked to each subject to learn and perform the following gestures for three times: "I pray you", "Hello", "This disturbs me", "Are you crazy?", "I don't understand".

Before the experiment we collected the written informed consent from all adult subjects. Child subjects gave verbal informed consent themselves, and written informed consent was provided by a parent or guardian.

At the end of the interaction we asked subjects to answer to a simple survey about the interaction. The survey was composed of six statements and users were asked to evaluate each of them on a scale from 1 to 5. Some statements concern the evaluation of the interaction in general, some other were specifically concerning gesture execution and recognition. The statements were the following:

1. I was able to interact with the robot

2. It was easy to understand how to perform gestures
3. It was easy to understand the feedback
4. The system had an adequate response time.
5. It had a low number of misidentified gestures.
6. Interacting with the robot was engaging.

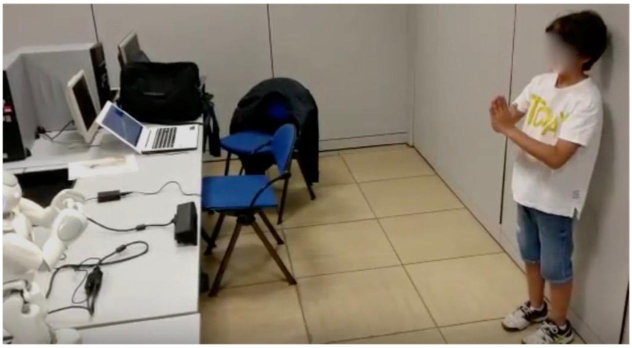


Fig. 4 - An example of interaction in which the child is learning the "I pray you" gesture.

As far as task completion is concerned, each subject has been able to complete the tasks and to perform the required gesture. However, taking into account the average time and the average number of repetitions to execute the gestures correctly, initially subjects needed more time and a higher number of repetitions, as long as they got used to the interactive approach the number of repetitions to reproduce correctly a new gesture decreased as well as the time need to learn it.

In Table 2, we show an example of the data collected during the execution of the gesture "Are you crazy?" and "Hello". In particular, for each test session, the table shows the average time spent in seconds by the subjects to perform the gesture correctly, the number of repetitions done (before performing the gesture correctly).

Table 2
AN EXAMPLE OF COLLECTED DATA DURING TRAINING

Gesture	Time (In second)	Attempts
"Are you crazy?"		
1° session	9	6
2° session	11	4
3° session	2	1

Gesture	Time (In second)	Attempts
"Hello"		
1° session	6	4
2° session	4	4
3° session	2	1

In Figure 5 the results of the survey are shown. They indicate that the interaction was quite satisfactory both from the engagement and gesture learning points of view. The weakest point seems to be related to feedback provided by the system that was not easily understood.

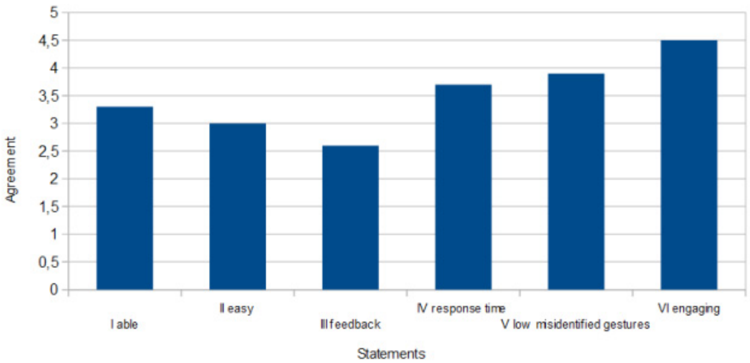


Fig. 5 - A summary of the answers to the survey.

Even if the study was performed with a limited number of subjects, they encourage us in going on with this research.

Conclusions and Future Work Directions

In this paper, we have considered the problem of teaching culture-related gestures to UAC in the context of their social integration in a different country and culture. These young migrants are among those most at risk in the area of child and youth welfare.

Our approach is based on the integration of Microsoft Kinect with a Social Robot, Nao in particular. This approach seems to be particularly suitable to addressing an effective mean to teach gestures in this context since the robot, being humanoid, allows for a believable reproduction of the gesture. Moreover, the interaction and practice can be repeated as many time as necessary. Moreover, as in other assistive domains, the robot has the capability of attracting the children attention and support the social operator in establishing a contact with them that very often, after the difficulties of the journey, do not trust adults. Results of a preliminary study show the efficacy of the proposed approach in learning gestures. In particular, the interaction was judged engaging and quite natural.

We are aware that the main limitation of this work concerns the number and the categories of subjects involved in the evaluation study. Even if there were not UAC, the preliminary results shows the feasibility and efficacy of the approach. In our future work we plan to perform a new experiment. In Apulia, 318 UAC are hosted in communities for minors without a family, across the six districts. This study could be conducted during the school year 2019-20, on 40 UAC included in the classes of the Centre for Adults' Education of Bari, CPIA, which has signed a Framework Agreement for cooperation with the University of Bari. This would be the first experiment of innovative educational methods in Apulia (Della Penna, 2014). In fact, currently in Europe, University of Bielefeld in Germany is the only institution to have started, since 2015, programs of educational robotics to facilitate literacy and social inclusion of foreign students; unfortunately, though, no scientific results of the experiments with the robot Nao have published yet.

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