ROBOT-ASSISTED PSYCHOSOCIAL TECHNIQUES FOR LANGUAGE LEARNING BY HEARING-IMPAIRED CHILDREN

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Abstract: The primary goal of the proposed interactive robot-assisted psychosocial intervention is to develop spoken language through listening and/or visual cues. The interactive humanoid robot Pepper, developed by SoftBank, has been chosen as an assistant. Example scenarios how Pepper assists parents or therapists in auditory, visual or combined approaches for language learning are demonstrated. A research protocol for intensive sound stimulation via Pepper that has been developed in collaboration of speech therapists and technical scientists is proposed. How to create scenarios applying auditory-verbal or visual approaches for language learning is presented. The interaction with the child can be accomplished either through robot gestures, poses and voice or with the help of human tutor, serious game or sign language exposed on the tablet to teach the meaning of the signs. These protocol and scenarios can be easily personalized to the family daily routine and automatically adapted by the robot according to the special educational needs of the child..

Key words: hearing-impaired children; socially-assistive robots; neurodevelopment; sign language, Pepper robot.

1. INTRODUCTION

Hearing and speech rehabilitation in infants/toddlers, born with hearing loss, can be called neurodevelopmental emergency [1, 2] because when the brain is not stimulated by sounds, it reorganizes itself by cutting the synapses in the audio centres in the brain. Thus, it maximizes the processed information by other sensory systems, most often the visual one, and gradually the area of the audio centres in the brain are rewired. Babies, born with hearing loss, have missed around 20 weeks of handling the auditory sensory information in the brain [3]. Then it is crucial for the baby to wear a device in the ear or ears in order to amplify the sound during all waking hours and subsequently to be imposed on intensive sound stimulation. Neuro-developmental emergency comes because the optimal period for the rehabilitation are the first three years and especially during the first one. About 90% of infants learn about the world incidentally and passively. Infant and toddlers with hearing loss require three more times the exposure to learn new words and concepts because of their reduced ability to hear the sounds in the surrounding environment [3]. To reach the level of toddlers without hearing loss a lot of efforts are required by the family members. It does not matter what communication mode the family chooses. What is important for the toddler's communication development, is the intensive exposure as soon as possible in all of their activities on a daily basis. Furthermore, more assistance has to be provided to family members, such as image/video representation of the audio, controlling the volume of audio content and free navigation and exploration of the surrounding environment. To achieve that, a robot needs high level functioning, machine learning and artificial intelligence techniques, as well as rich set of sensors, such as cameras, proximity sensors, microphones and display screen for providing an additional interface to receive touch, textual or visual information.

Hearing-impaired children often need special skills and assistance to be able to learn language and to communicate. These children develop internal language through individual therapy for early and consistent listening experiences. It is important hearing aids and cochlear implants to be used together with language learning. Each family is free to choose the methodology that is compatible with the family and child's needs. Families need to work with the child's therapist(s) to learn different psychosocial techniques for developing listening and speaking skills. Parents can choose between Auditory Approach (AA), Visual Approach (VA) or Combined Approach (CA). AA highlights spoken language development through listening using hearing aids. VA includes the development of both native language and Sign Language (SL). The CA relies on listening and visual cues. Examples for CA are: Auditory-Oral approach for using the remaining hearing through amplification and natural gestures or visual cues for child's understanding of language; Cued Speech - combining natural mouth movements for each sound (phoneme) with hand cues for understanding, Simultaneous Communication (SC) for instantaneous use of spoken language and SL. By learning a second language these children have the opportunity for academic achievements and integration in both the hearing and hearing-impaired communities.

One of the newest forms of psychosocial techniques for language learning and communication is by the use of Socially Assistive Robots (SAR). Social robots are specifically designed to interact with people and the goal of SAR is to provide assistance to people when needed [4]. Such assistance would only take place through social interactions rather than physical interactions [5]. SAR are supposed to have two main advantages over other forms of technology – on the one hand they give the learner the chance to interact with the real-life physical world which differs from computer-assisted lectures. On the other hand their humanoid appearance allows for more natural contact. In addition, a lot of SAR use nonverbal signals such as body movements, pointing, eye gaze, gestures with the arms. These characteristics enable children and adults to perceive the robots as peers and friends and not as machines [6]. The results in [7] lead to a conclusion that people have a positive opinion about the robot being a companion and the human-like movements made people trust a robot. Preparing a robot to mimic human speech can be an effective tool for sound stimulation in terms of hearing loss or impairments. Humanoid and programmable robots, such as NAO and Pepper from SoftBank Robotics, successfully support speech therapy for hearing impaired children. The technology has unique characteristics - NAO does not have a human mouth and therefore does not allow lip-reading or other non-verbal cues, had been successfully used in [8]. Case studies on robot-assisted learning of sign language are scarce. In [9], authors compared the effectiveness of two robots Robovie and NAO in teaching Turkish sign language with hearing-impaired children. The results indicated that the children learned most of the signs from the robots. Another humanoid robot for SL representation is TEO [10]. The robotic hands are more complicated than those of Pepper or Nao, however, TEO has the following disadvantages: 1) It teaches only the expression of signs and not the meaning of the signs; 2) Its appearance is not suitable for this age group.

Although the above studies found that NAO, TEO and Robovie created playful and engaging auditory-verbal sessions, these therapies cannot be applied to infants or toddlers. Moreover, combining listening and visual cues in an integrated multi-agent system is not possible. The Pepper's functionalities allow this robot to assist in developing spoken language for all auditory-verbal, visual, cued speech or other combined approaches and to teach the meaning of the signs.

The intelligent humanoid robot Pepper, developed also by SoftBank Robotics, has different modalities for interaction: it can perform gestures, play sounds, recognize words, move and can be navigated. It can exploit all the capabilities of its tablet to show presentations, videos, animations. Gestures and some mouth movements, even sign language, could be also shown on the tablet of Pepper in case they cannot be performed by the robot. These unique features mean that the toddler can watch and listen to Pepper over and over again and get something new out of it each time. Pepper can be embodied as a social agent to give the child attention-evoking cues or to encourage it through sensory rewards: eye lighting, clapping hands, playing music or saying suitable words. Thus, the robot stimulates the neurodevelopment by a 3D model that can feed all five senses rather than get a passive experience from a video, for instance. The study also demonstrates the ongoing research for sign language tutoring (visual approach) in a multi-agent system involving a humanoid robot and a human on a tablet to teach the meaning of the signs.

To the best of our knowledge, we are the first who proposed the humanoid robot Pepper as an assistant to parents or therapists in order to maintain consistency in auditory, visual or combined approaches compatible with the needs of the hearing-impaired child. The proposed research protocol (RP) and the scenarios for SL were created after a discussion with speech therapists and educators from the Educational Center for Children and Youth with Hearing Loss “Yanika” in Sofia, Bulgaria. The specialists help more than 70 children to develop listening and speaking skills and prepare them for mainstream kindergartens and mainstream schools. They found as very interesting the idea the humanoid robot Pepper to aid the parent care in the intensive sound stimulation by catching toddler’s attention immediately and extending the sound stimulation via meaningful interaction.

The purpose of the current study is to present the capabilities of the humanoid robot Pepper as an assistant to parents or caregivers, regarding sound stimulation and language learning. A research protocol for intensive audio therapy via meaningful interactions with the robot is proposed. First, the requirements for the role of Pepper in this intervention are identified. Then the authors describe their results derived from a pilot experiment, which has proved that the robot Pepper can serve as a sympathetic and useful humanoid assistant in the intensive sound stimulation and tutor in language learning. Pepper never gets tired of repeating meaningful sounds consistently. It can also demonstrate the meaning of words or sign language via performing natural gestures or showing images/videos on its tablet at the same time. The proposed protocol could be easily personalized to the family daily routine and automatically adapted on the robot according to the special needs of the infant/toddler.

2. PEPPER-ASSISTED PSYCHOSOCIAL TECHNIQUES FOR SOUND STIMULATION OF CHILDREN BORN WITH HEARING LOSS USING AUDITORY-ORAL APPROACH

Currently, robot-assisted therapy mainly considers passive or remote-controlled robots. Robots need to become more autonomous, mainly to reduce the burden on parents and to be able to provide, in long term, stable and consistent rehabilitation [11]. Autonomy means that the robot is able to execute a sequence of desired actions without the interference of a technician [4]. The programmable robot Pepper meets these requirements: it is humanoid, autonomous, socially intelligent and makes contact with a human as natural as possible, which allows design and implementation of custom stand-alone behaviours and interactions with built-in-anti-collision system to detect people and obstacles. Pepper possesses 20 degrees of freedom and can move freely using his three omnidirectional wheels. It is 120 cm tall (see Fig.1.a), equipped with many sensors and actuators. The 3D camera and the two RGB cameras along with the four directional microphones, together with the laser sensors, sonar sensors, inertial sensors, and infrared sensors allow Pepper to localize a person approaching or talking to it, distinguish multiple faces, determine eye contacts or simple emotions. The robot is safe and the EU regulations as well as the privacy policy can be seen on the site of the SoftBank Robotics for Europe [12].

2.1. Interactive behaviour and responses of Pepper

For active interactions Pepper uses pre-programed gestures uploaded on the robot. There is also an animation mode in the robot software [13] that allows programing of custom gestures and movements. Another option for active interactions is via a touch screen tablet (see Fig.1.b) with 10.1-inch display by which the proposed research protocol can be easily personalized to the current infant/toddler and its family for stable and consistent rehabilitation. Contents and options for interaction can be shown on the tablet.

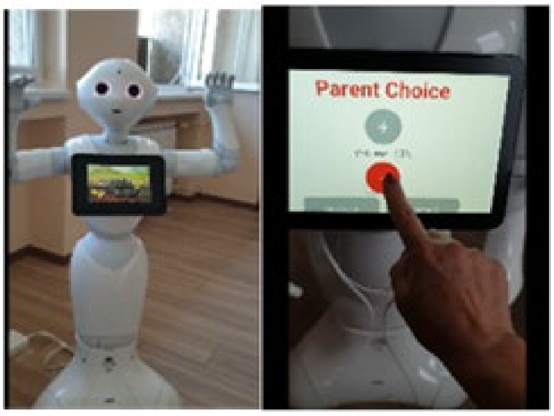

Fig. 1. Softbank's robot Pepper: a) dimensions and gestures; b) Pepper tablet

Pepper has a preinstalled Operating System either NAOqi or Android. We use the former. Programming Pepper can be performed in two ways: by using graphical interface of the Choregraphe environment [13] (see Fig. 2) and/or in Python programming language inside in Choregraphe or from external IDE (integrated development environment). The Choregraphe environment, developed by SoftBank Robotics, is used for graphical programing of the robot by dragging predefined boxes or custom-defined python boxes, and connecting their inputs and outputs. Choregraphe is a multi-platform desktop application for creating animations, services, different types of behavior and dialogues. It also has a robot simulator and logging window for debugging. A memory window provides information about the current state of the actuators, sensors and events in terms of key-value variables.

2.2. The used NAOqi modules and methods

NAOqi Application Programming Interface (API) provides pre-programmed modules and methods by which the interactive behaviour and responses of Pepper is programed in different modalities including more complex actions rather than only movements and animations in timeline. The useful NAOqi modules and methods for user interaction by face detection and recognition, autonomous navigation and tablet services are described in brief.

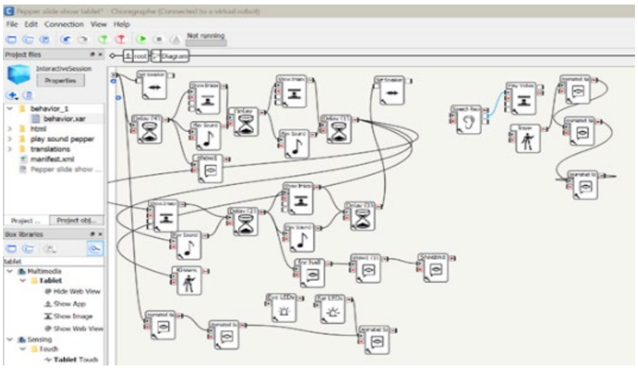

Fig. 2. Diagram view of Choregraphe for the proposed RP

The *PeoplePerception* module includes the *ALGazeAnalysis* API. It allows for analyzing the direction of the gaze of a detected person in order to know if he/she is looking at the robot. It also detects whether the person's eyes are open or closed. After detecting the face and studying its orientation, this module raises special events that are triggered even if the person does not look at the robot. First a scoring value, called *LookingAtRobotScore*, is computed for each person in the detected population. This score, between 0 and 1, describes the confidence in the fact that the person is looking at the robot. It is stored in the memory key *PeoplePerception/Person/<ID>/LookingAtRobotScore*. Then this score is compared to a threshold value, which is possible to be changed. In our RP the events *ALGazeAnalysis/PersonStartsLookingAtRobot() and ALGazeAnalysis/ PersonStopsLookingAtRobot())* are used.

Another useful module is ALTabletService that allows tablet operations. The tablet supports showing media content on its. It can be used to load web application, show a web page, play videos, show an image, and manage the tablet itself. In Choregraphe the predefined tablet box library is available in the Multimedia. Any html page with or without JavaScript can be executed on the tablet. *ALTabletService::onTouchDown* APIs support people to interact with the robot by pressing virtual buttons on the tablet. Touch events and coordinates are available in *ALMemory* for further use.

Applying the *Navigation and Exploration API* allows sound stimulations to be performed from different places. The robot performs any safety action to ensure non-collision with the environment. Pepper chooses its own path and speed while moving around. By the method *ALNavigationProxy::explore* Pepper explores autonomously its surrounding environment in the limit of the radius passed as parameter. Using *ALNavigationProxy::saveExploration* Pepper saves the current exploration data on disk for a later use. Then based on the *ALNavigationProxy::getMetricalMap* and *ALNavigationProxy::navigateToInMap* the robot can be navigated to a desired target by using the explored map.

On a touch screen tablet (see Fig.1.b) with 10.1-inch display by which the proposed research protocol can be easily personalized to the current infant/toddler and its family for stable and consistent rehabilitation. Contents and options for interaction can be shown on the tablet.

2.3. Research protocol for intensive sound stimulation mediated by Pepper and results

We designed and developed interactive robotics psychosocial intervention for intensive sound stimulation in collaboration with speech therapists and educators. We discussed different scenarios for rehabilitation sessions via the robot how to mature the auditory brain centres. Special educators from Yanika agreed that the robot couldn't replace the parental care in the intensive sound stimulation. However, Pepper can help significantly in some repetitive actions that limit either parents or therapists in a playful and personalized way. The educators said that they faced difficulties with repetitions for the mouth positions during the lessons for the Ling Six Sounds (LSS). Through the LSS test an audiologist, teacher or therapist checks if the child hears the range of speech sounds. The six sounds are different sounds from low to high pitch.

Our research protocol is based on Anderson's recommendations in [3] what the family can do to 'grow' the auditory brain centres: (1) Ensure that the baby hears by a child's doctor and the child's hearing must be tested frequently; (2) Ensure that the baby wears its hearing aid(s) or cochlear implant(s) 12 hours a day or during all the time it is awake; (3) Minimize the background noise at home because infants/toddlers can't effectively separate noise from speech; (4) Language has to be learned from meaningful interactions with the family and caregivers and not from TV; (5) Call the baby's attention to sounds heard in the environment. Use complete sentences, talk about everything you and your child do and see, name objects using as many varied words as possible; (6) Play and have fun with your baby - sing songs often and read ten books a day.

The proposed here research protocol describes psychosocial intervention for intensive sound stimulation by bringing repetitive speech, daily live sounds, gestures, songs and storytelling into the therapy. Parents and Pepper can show and hold objects. At the same time they can use gestures which demonstrate the meaning of words, related to the objects, the so called "portrait gestures" [14]. The most useful gestures are the ones which show the form or the function of an object. For example, parents can hold their hands in the form of a ball, while saying "a ball". This amplifies the meaning of a word. Pepper also performs this activity being preprogramed in the animation mode in Choregraphe. Pepper behaves like a puppet and by guiding its arms or torso, specific gestures or shapes of objects can be created. Thus Pepper can interact with real-world objects and an infant through non-verbal or affective modalities. The image of a ball can also be shown on the tablet and at the same time a voice sound is played. In the software design we suggested an easy way to personalize the scenario by the mother's voice of the infant/toddler [15].

Additionally, the colours, shapes and movements performed on the robot help parents attract the toddler's attention and make the audio-visual connection. We used Bulgarian songs and story tales that have been taken from YouTube only for illustration.

Instead of using Pepper's low level functioning to capture and decode the toddler's reaction to the sound stimulation (microphones or cameras records), we applied the Pepper's high level functions in a playful environment and logged only the valuable information. In this way the therapist is focused only on the individual learning skills, while the assessment of the toddler's attentiveness and auditory-verbal skills are obtained in a quantitative way by the robot and online. Pepper is programmed to explore the environment (the room) and to walk by using the free zones only. Then, it is navigated by the parent to a remote place in the room. Pepper calls the name of the toddler and tests its hearing by using the modules PeoplePerception and ALGazeAnalysis. Pepper gives a reward (kiss and hug) to the toddler if it is able to hear the robot from different places in the room. The assessment is based on the score for looking at the robot. It must exceed a predefined threshold.

Since the delay in developing the auditory brain pathways in infants/toddlers with hearing loss is neurodevelopmental emergency, the robot's role is not only the proactive sound stimulation but also the exposure of the child's brain to intensive sound stimulation by different modalities and in familiar environment. The proposed research protocol for intensive sound stimulation has been designed from a technical point of view. It is adaptable to different degrees of hearing loss, so the parents and special educators can personalize the intervention quickly and automatically in order for the auditory neurons to be rewired actively.

3. PEPPER-ASSISTED PSYCHOSOCIAL TECHNIQUES FOR LANGUAGE LEARNING BY CHILDREN BORN WITH HEARING LOSS USING VISUAL APPROACH

In this Section an ongoing research for using the visual approach for language learning which aims the Bulgarian Sign Language (BSL) tutoring by integrated multi-agent system involving a humanoid robot Pepper and a human tutor, exposed on its tablet. The interaction with the child is accomplished through robot gestures for sign language and the meaning of the signs visible on the tablet. First some important challenges are discussed and after that Pepper interactive behaviour for BSL tutoring is proposed. The results obtained from the research are then analysed.

Fig. 3. BSL signs reproducing the word "apple". Adapted from [16].

3.1. Challenges

The age for learning SL as a second language is just as important as the one for verbal language [16]. Children have better mechanisms for mastering a foreign language than adults due to the presence of a sensitive period for language acquisition. Pepper can be programmed to mimic the movements for simple signs (Fig.3). However, the word order in SL is radically different from the characteristic order for the verbal language (which is the first for the toddlers), and this leads to numerous grammatical errors. Thus, we consider that it is important for the children to know how to connect the sign gestures and make a sentence. Another factor that is very important in learning the SL as a second language, considered in [16], is the contact with native speakers of SL, i.e. with representatives of the Deaf Community, for whom SL is the first one. Therefore, we strictly followed the guidelines in the Methodological guide for Bulgarian gestural language training in preschool and primary school age of the Ministry of Education and Science [16]. These guidelines were implemented in the design of the multi-agent system of a humanoid robot and a human tutor, exposed on a tablet. (Fig.4). The results in [16] show that the vocabulary of hearing-impaired children of preschool age is not characterized by richness and variability. The percentage of the most common gestures in the course of the study is very low (52 sign gestures) and most of the described meanings appear in communication alone. The fact that the leading meanings are from the group of words for acting is of particular interest.

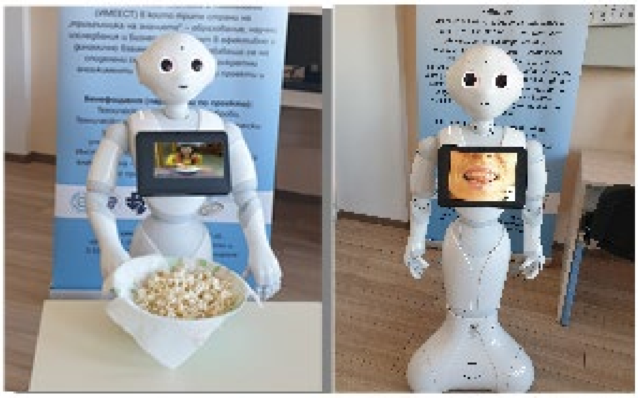

Fig. 4. Humanoid robot and a human tutor, exposed on a tablet – a) and b).

How to create interactive scenarios that combine auditory-visual approach for language learning is presented. Since, the preschool age is the period for mastering the fund of life concepts, we accomplish the interaction with the child either through daily robot gestures, poses and sounds or with the help of a human tutor, serious games or objects exposed on the tablet to teach the meaning of the signs.

3.2. Pepper interactive behaviour for BSL tutoring

For active interactions via BSL custom gestures and movements need to be programmed. There is an Animation Mode in the Choregraphe software [13] that allows to create movements within a Timeline Editor. After dragging a Timeline box, the double click on it gets into inner Timeline (see Fig.5) where in each key frame the positions for the head, arms and torso are setup and later can be edited. After clicking the Animation Mode button in Choregraphe or touching the middle head tactile sensor to toggle the stiffness of the robot, it behaves like a puppet that you can manipulate, letting you record its posture in a Timeline.

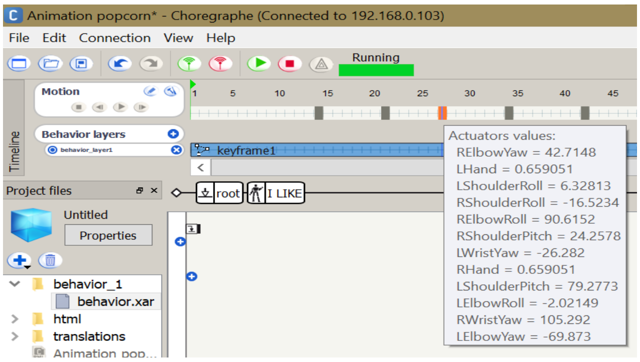

Fig. 5. The 3rd key frame for the sign "I like" in the Timeline Editor

Pepper was programmed to mimic the movements either for simple signs or sign connection for reproducing sentences. The selected Bulgarian signs reproducing the sentence “I like to eat popcorn” was used to be rendered on a tablet. The example video is part from a video with basic Bulgarian words in sign language taken from YouTube [17].

The synchronization of the Pepper signs with those of the human tutor on the tablet was made in the Timeline Editor through adjusting the time intervals between the key frames by simple key frames sliding.

3.3. Results and discussion

The video representing how Pepper interacts in the process for BSL of the signs reproducing the sentence “I like to eat popcorn” is available online as a supplementary material for this study [18]. The robot setup and demonstration of the four BSL signs with the snapshots representing them: “I like”, “to”, “eat”, “popcorn” are displayed in Fig.6. In the snapshots from 7 to 12 the right hand goes up and down, while in snapshots from 13 to 18 - forward and backward. The tempo in SL is important. All gestures correspond to the signs performed by the human on the tablet. The visual approach can be easily transformed into Combined Approach, such as Simultaneous Communication or Cued Speech (Fig.4 b). By using the verbal functionality of Pepper, such as text-to-speech or playing sound (*.wav, *.mp3), instantaneous use of spoken language and SL could be applied. Scenarios can be adapted according to the age. Cued Speech approach for language development could be designed by combining natural mouth movements for each sound (phoneme) on the tablet together with Pepper hand cues and pronunciation by playing the corresponding sound.

We are in a process to test and assess the proposed tutoring system for BSL learning based on robot-assisted psychosocial techniques. Our objective is to observe and evaluate the consistency of the proposed interaction scenarios. We tested the proposed robot-assisted interactive scenario that combine auditory-visual approach for SL learning with a typically developed toddler. Our next objective is to test whether the proposed visual approach for BSL learning is an effective teaching material for improving the interaction skills of hearing-impaired children.

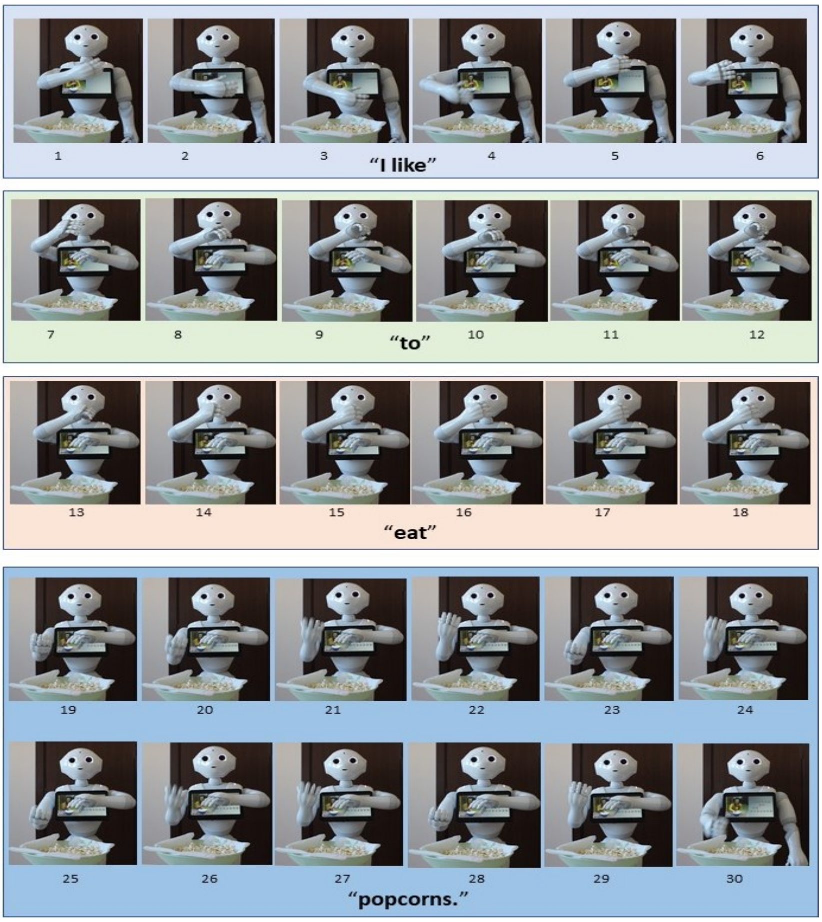

Fig. 6. Snapshots from the video how Pepper interacts in the process for BSL learning of the signs reproducing the sentence "I like to eat popcorns" [18]

4. CONCLUSION

Children born with hearing loss are at risk not only in speech and language deficits but in poor academic performance and social or emotional difficulties. An attractive way to develop not only early language concepts but life habits and other cognitive skills by humanoid robot assistance has been presented. New robot-assisted psychosocial techniques for language learning and communication by hearing-impaired children has been proposed. We recommend a multi-agent system of a humanoid robot and a human tutor, exposed on a tablet in order to use SL. Easy management of the used approaches for language development, tailored to the family and individual needs and decision about the amplification and opportunity a child to be bilingual. The hypothesis in our research protocol is that the early intervention of infants (especially the first three years) via the humanoid robot Pepper for intensive sound stimulation will enhance the maturation of their neurons and neural connections in the brain, which are responsible for auditory processing of sound information. The idea behind the proposed robot-assisted psychosocial intervention is to be interactive, performed repeatedly, consistent and easily personalized to the family. It is necessary for educators and therapists to understand how to best utilize the integration of socially intelligent robots when it comes to hearing impairment or hearing loss. The study has important implications in the technology-enhanced learning by showing a practical scenario of a humanoid robot with influence on the physical world. We consider that the findings of our study can encourage further exploration to utilize the full potential of socially intelligent robots in the context of therapy and language learning by hearing-impaired children.

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REFERENCES

[1]. D. Dimity. Research supports hearing loss as a neurological emergency. *Volta Voices*, Vol. 16, No. 3, 2009, pp.26-29.

[2]. A. Mease. *Infant Hearing Loss: A Neurodevelopmental Emergency*. Available Online: http://epubs.democratprinting.com/publication/?i=652195&article_id=3615961&view=articleBrowser. (accessed October 2021):

[3]. K. Anderson. *Brain Development & Hearing Loss*. Available Online: https://successforkidswithhearingloss.com/wp-content/uploads/2011/08/Brain-Development-Hearing-Loss.pdf (accessed October 2021).

[4]. V. Holeva, V. Nikopoulou, M. Papadopoulou, et al. Toward robot-assisted psychosocial intervention for children with ASD. In: Salichs M. et al. (eds) *Social Robotics. Lecture Notes in Computer Science*, Springer, Cham, Vol 11876, 2019, pp.484-493.

[5]. A. Tapus, M.J.Mataric. Emulating empathy in socially assistive robotics. In *AAAI Spring Symposium*, Stanford, California, USA, 2007, pp.1-4.

[6]. R. Van den Berghe, J. Verhagen, O. Oudgenoeg-Paz, , S. Van der Ven, , P. Leseman Social robots for language learning: A review. *Review of Educational Research*, Vol. 89, No. 2, 2019, pp. 259–295.

[7]. M. Podpora and A. Rozanska. Making eye contact with a robot - exploring user experience in interacting with Pepper. In: Hunek W., Paszkiel S. (eds) *Biomedical Engineering and Neuroscience. Advances in Intelligent Systems and Computing*, Vol 720. Springer, Cham, 2018, pp.173-183.

[8]. A. Ioannou, A. Andreva. Play and learn with an intelligent robot: Enhancing the therapy of hearing-impaired children. *Proceedings of the IFIP Conference of Human-Computer Interaction*. Cham, Switzerland: Springer, 2019, p. 436-452.

[9]. P. Uluer, N. Akalın and H. Köse. A new robotic platform for sign language tutoring: Humanoid robots as assistive game companions for teaching sign language. *International Journal of Social Robotics*, No. 7, 2015, pp. 571–585.

[10]. J. Gago, G. Victores, C. Balaguer. Sign language representation by TEO humanoid robot: End-user interest, comprehension and satisfaction. *Electronics*, Vol. 8, 57, 2019.

[11]. A. Pandey and R. Gelin, A mass-produced sociable humanoid robot: Pepper: The first machine of its kind. *IEEE Robotics & Automation Magazine*, Vol. 25, No.3, 2018, pp. 40-48.

[12]. *EU Declaration of Conformity for Peppe*r, Available Online: (accessed October 2021). https://www.softbankrobotics.com/emea/sites/default/files/inline-files/declaration-of-conformity-pepper-1.8.pdf

[13]. *Softbank robotics choreographer*. Available Online (accessed October 2021): https://developer.softbankrobotics.com/pepper-naoqi-25/naoqi-developer-guide/choregraphe-suite (accessed October 2021).

[14]. *Important milestones: Your child by one year*. Available Online: (accessed Oct 2021) https://www.cdc.gov/ncbddd/actearly/milestones/milestones-1yr.html

[15]. *Robot-assisted psychosocial techniques for language learning by hearing-impaired children - supplementary materials and videos*. Available Online: http://alekova.aabg.eu/index.php?option=com_content&view=article&id=10

[16]. N. Balkanska, S. Lozanova, K. Dionisieva. Methodological guide for Bulgarian gestural language training in preschool and primary school age, *Ministry of Education and Science*, 2020. Available Online: (accessed October 2021) https://www.mon.bg/upload/24851/1.rakovodstvo-BGZhestovEz_PUV-i-NUV_130121.pdf

[17]. *Basic words in sign language*, Available Online: (accessed October 2021): https://www.youtube.com/watch?v=dY6JpAVcek4&ab_channel=Binar

[18]. *Supplementary video how Pepper assists in BSL tutoring*. Available Online: (accessed October 2021): http://alekova.aabg.eu/I_like_to_eat_popcorns.mp4

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