Dr Armel Crétual introduces his research into the rehabilitation of children with cerebral palsy and shares insights into the therapeutic tool he has developed to complement existing options.

Can you briefly describe facial dyspraxia?

Dyspraxia, a developmental coordination disorder which affects motor skills, is common in people with cerebral palsy (CP). Speech disorders are usually only one of the multiple motor deficiencies, and the neurological disturbances these disorders come from also have implications on buccofacial motions, such as eating. This is usually due to too broad a control of the musculoskeletal system, which is often quite ‘all-or-nothing’. It means, for example, that children with CP can open their mouth widely or narrowly, but tend to be unable to maintain an intermediate position. The importance of adequate buccofacial functions on daily living – for instance, eating and swallowing – is the reason we focus on dyspraxia.

Why have you decided to focus on the rehabilitation of Facial Dyspraxia in Cerebral Palsy Using Interactive Avatar (RePliCA) project?

RePliCA is to build rehabilitation software for children with CP. During a session, the child will see several facial gestures on a screen given by a virtual speech therapist that he or she will have to try to reproduce. After watching the model gestures, the child will animate his or her avatar using facial motions.

The virtual therapist and the child’s avatar will obviously not look the same to avoid confusion, but they are mentally analysed with the same process. As children with CP might have cognitive issues in addition to motor problems, our hypothesis is that reproducing the instruction gesture will be easier as well as diminish the cognitive load.

What are the concepts underlying the game at the centre of RePliCA?

The exact content of the rehab sessions is still to be precisely defined and will be adapted for each child. It will likely start with some kind of very short puppetry game in which, without any instruction, the child will make his or her avatar move. The goal is for them to become familiar with interacting with their avatar in order to bring about identification with it. Then, during the next 10–15 minutes he or she will have to repeat words pronounced by the virtual therapist. The words list will have been previously chosen by the child’s real speech therapist, depending on which gesture, phoneme or articulation they had planned to focus on during a particular session.

What sort of tasks are children undertaking during these 20-minute rehabilitation sessions?

Is a multidisciplinary approach important to the overall success of the project?

Each partner of the project agrees that RePliCA will only succeed if all of our skills are combined. Supélec and Dynamixyz bring the software capabilities, while HSM is both the initiator and end user. M2S’s role is twofold: first, it brings the motion analysis expertise and then, as a team of engineers accustomed to working with rehabilitation services, it bridges the gap between the software teams and the end user. Finally, the Centre for Research in Psychology, Cognition and Communication is involved in the acceptance of the system in children with CP, which is a crucial point for the project’s success.
A playful process

The team behind the multidisciplinary RePliCA project has devised an original rehabilitation-focused computer game that aims to help children with cerebral palsy improve their facial muscle control.

CEREBRAL PALSY (CP) is a group of neurological disorders that affect an individual’s muscle coordination. Damage to the brain in utero or very early in a baby’s life – for example, through an infection, birth complications, bleeding in the brain or abnormal development – is the leading cause of the condition. While the disorder currently has no cure, patients can be offered a range of therapies – such as speech, occupational and physiotherapy – to help relieve symptoms and improve quality of life.

Facial dyspraxia and buccofacial or orofacial apraxia – a set of symptoms referring to difficulty in controlling and coordinating the movement of muscles in and around the face – pose significant problems for people with CP by affecting important functions such as speech and eating. Rehabilitation sessions for children with the condition are currently used by healthcare systems around the world to combat these issues, and while largely effective, these programmes have limitations. Sessions have to be short and delivered regularly over a protracted period of time, since maintaining the child's attention is a major challenge. Typically, sessions are delivered on a one-to-one basis, with the child being asked to imitate certain movements given by the therapist, who will then assess the level of response. At present, there is no completely objective and accurate method of measurement.

A MULTIDISCIPLINARY SOLUTION

A multidisciplinary research team based in France is showing how technological innovations can open doors to new rehabilitation solutions for children with CP. The Rehabilitation of Facial Dyspraxia in Cerebral Palsy Using Interactive Avatar (RePliCA) project has brought together speech therapists, engineers, software developers, motion analysis experts and child development psychologists to work on this issue, and they have been designing a tool that can be used to complement existing rehabilitation options.

A ‘JUST DANCE’ FOR THE MOUTH

Given the attention span issue, the type of marker-based motion capture system commonly used at M2S would be out of the question for capturing facial movements in children with CP, since they require a large number of markers to be placed on the face in what is a fairly lengthy process. Supélec, a postgraduate engineering school, and Dynamixyz, a French start-up specialising in facial animation software, were therefore enlisted for their technical expertise. They suggested devising a marker-less system, using a helmet-mounted camera, which they
INTELLIGENCE

REHABILITATION OF FACIAL DYSPRAXIA IN CEREBRAL PALSY USING INTERACTIVE AVATAR (REPLICA) PROJECT

OBJECTIVES

To design and test innovative software dedicated to buccofacial motion rehabilitation in children with cerebral palsy. The novelty is to propose a game in which the child will animate an avatar in order to try to reproduce the speech motion of a virtual therapist.

KEY COLLABORATORS

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FUNDING

The project is funded by ANR

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ARMEIL CRÉTUAL obtained his PhD in Robotics and Computer Vision, and he received his Habilitation in Human Movement Science in 2010. He has been Assistant Professor in Rennes 2 University for 12 years. His research interests focus on normal and pathological motion analysis, modelling of interaction while walking and computer simulation based rehabilitation.

BUILDING THE GAME

In the two years since the proposition, the team has performed a number of tasks to lay the necessary groundwork for the game’s development. In April and May 2013, they conducted fieldwork in around 230 typically developing children aged between four and 12, in order to build up a database of the motions of the 1,000 words to be used in the software. The researchers then used this information to define a metric of healthy mouth motions, leaving room for variations between different children. Then, Dynamixyz had the complex job of adapting their real-time facial animation algorithm in order to accommodate unusual motions.

IDENTIFICATION IS KEY

A major part of building the game was designing its characters; the project’s success will hinge on whether users will cooperate and respond to the virtual speech therapist and, importantly, identify with their avatar. It is also crucial that the game engages the child for the length of the rehab programme, which involves four sessions a week over a three month period. The RePliCA team has therefore gone to great lengths to ensure it achieves its goals, seeking advice on whether users will cooperate and respond to the virtual speech therapist, and, most importantly, identify with their avatar.

The game’s success as a therapeutic tool depends on whether the user will cooperate with and respond to the virtual speech therapist and, most importantly, identify with their avatar.

With the project set to end in summer 2015, the partners are finalising the software and entering the test phase. Early studies have shown the game to be a success, with children accepting and using the platform. In autumn 2014, the game will go to clinical trial in two sub-groups. If each receive a green light from the trial, the RePliCA team will look to apply their programme to other rehabilitation centres, as well as investigate whether they can exploit their technology to help other patient groups, such as those with head injuries.