A rattle can be a sensitive indicator of a baby's development.

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TACT will study early infant development using miniaturised sensors and recorders to monitor movements, and register where babies look and the sounds they make. The machines will build a database of normal patterns of behaviour that may allow much earlier diagnosis of disorders, such as autism which only become obvious after speech is acquired. The project initiates a new, interdisciplinary field of research, neuro-developmental engineering.

A new eye on child development

A baby with a rattle or a toddler bouncing a ball can show a keen observer a lot about normal development. The TACT project will reveal a great deal more by building new technologies into the rattle or the ball to record objectively how the child deals with his or her world. Integrating these data with traces from tiny cameras and sound recorders an infant can wear will bring together a whole range of ways of assessing how a baby interacts with objects and people.

Movements have meaning

This NEST project builds on the idea that movements are not merely reflexes, even in newborns. They are guided by intentions, so they can yield insights into the child's mind before speech develops. When the patterns of looking, grasping, and interacting with people that emerge in normal development are fully characterised, they can be used for comparison, to enable early detection of children at risk from neuro-developmental disorders such as autism.

Specialists in advanced robotics at the Scuola Superiore Sant'Anna in Italy will work with developmental neuroscientists and bioengineers from Università Campus Bio-Medico, and with developmental psychologists from Uppsala Universitet and the University of Edinburgh, to develop lightweight, portable, wireless devices using current technology from mobile phones and hand-held computers. The TACT machines will be small enough to be embedded in the toys or clothing of children from newborn to two years old, and tough enough to use at home as well as in the clinic. Toys will respond to movement in an adaptive way, by making sounds or playing a tune that is modulated by movement parameters, thus enabling researchers to tap into the expressive capacities of the baby. Other devices will register how the infants move, how they scan their surroundings, and how they interact with toys and with people.

Such data are already recognised as indicators of neuro-developmental status. TACT will deliver much more information about a single child, and under conditions that can be poorly controlled in a scientific sense, such as the clinical environment or the home. For example, in addition to quantifying movements, the toys will deliver data enabling the type of movement to be classified and the movements defined as stereotyped or repetitive. The devices will be tested on more than 400 infants, at each of the first four project partners' clinical centres for the study of infant behaviour.

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Interaction with other people will be measured.

AT A GLANCE

Official title
TACT – Thought in Action

Coordinator
Italy: Università Campus Bio-Medico di Roma

Partners
- *United Kingdom: University of Edinburgh*
- *Sweden: Uppsala Universitet*
- *Italy: Scientific Institute IRCCS E.MEDEA – Associazione La Nostra Famiglia*
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Toys that play with you

The interactive possibilities are illustrated by one of the first devices in the project plan, a motion-tracking music rattle that a four-month-old will be able to hold. It will record hand and arm movements, as well the configuration of the hand as the child grasps the rattle, and respond to movement parameters with simple sounds. To do this, the rattle will incorporate three accelerometers to sense motion in three dimensions, tactile sensors, data processors and a sound generator. Miniaturisation will allow the weight to be kept low enough. A second device, a bouncing ball, will be similarly equipped but also respond to the force a child applies to it. Other possibilities include shape-fitting toys and interactive mobiles, which will be used with older children to explore more complex intentions. An additional new aspect is that most devices can be used in combination with one another, allowing researchers to take a multidimensional perspective on child development.

Experts in machine-learning algorithms, at the Ecole Polytechnique Federale de Lausanne in Switzerland, will lead the development of software for analysing the complex data collected from each child. The software will exploit currently established ways of analysing movement data and visual scenes from the baby's point of view, as well as more experimental techniques for detecting what is significant in early infant behaviour. Patterns of activity in healthy children will be compared with infants who were born prematurely, have cerebral palsy, Down's or William Syndrome or have a sibling with autism and so may be at higher risk of the condition.

> **Research suggests that autism may manifest as young as six months, in different responses to human faces.**

Hopefully, TACT machines will find ways to diagnose abnormality reliably, much earlier and more objectively than is currently possible, and without the need for highly controlled conditions. Research suggests that autism may manifest itself through soft neurological and behavioural signs as early as at six months, but clinical diagnosis is not available before the age of two and a half years, until speech develops.

A new mass market

The ultimate goal of TACT is to establish a new, interdisciplinary research field, neuro-developmental engineering, that uses new technologies to understand human brain development, assess neuro-developmental milestones and offer early diagnosis of brain disorders. The devices may also be used in rehabilitation and therapy, in comparative studies of animal development, and in research with the elderly. Beyond that, this new application of technology may lead to sophisticated mass-market toys or 'edutainment' products, which can be used in the home to help boost motor skills and even intellectual development.

SIXTH FRAMEWORK PROGRAMME