OPENING NEW FRONTIERS IN CHILD DEVELOPMENT RESEARCH

BIRKBECK BABYLAB IS USING VICON TECHNOLOGY TO DIVE DEEPER THAN EVER INTO INFANT BEHAVIOUR

Although there's an old adage that you should never work with children or animals, there are Vicon users who do both. The work being done in the BabyLab and ToddlerLab at the Centre for Brain and Cognitive Development at Birkbeck, University of London, should be incredibly difficult, but the accuracy of Vicon motion capture combined with increasingly immersive lab environments is allowing researchers to gain fascinating insights into infant development.

Leslie Tucker, Centre Coordinator, Centre for Brain and Cognitive Development, Birkbeck College

Lisanne Schroer, Phd Researcher, Centre for Brain and Cognitive Development, Birkbeck College

"The unique thing about our research center is that it brings so many developmentalists together," says Leslie Tucker, Centre Coordinator. "We use all these different methods to try to understand very basic science questions about the brain and behavior."

The BabyLab includes a table that the toddlers can sit around, with six Vicon cameras providing complete coverage. The team wanted a more natural setting in which to observe the toddlers, however, and recently added a larger space modeled on a nursery setting, with 16 Vero cameras running with Nexus and two video cameras. The hope is that babies will behave more normally in a more familiar setting.

The new setup enhances the utility of the Babylab's studies, says Lisanne Schroer, one of the first PhD researchers to use the new volume. "The studies are more ecologically valid. They're environments that they could also encounter in preschool, in nursery or in school.

"Generally, a lot of studies in developmental research are very lab-based," she goes on. "They show a movie, they follow their eyes with the eye tracker. But now we're trying to move to studies that show a richness of behavior that infants would also display in real life. And with these kinds of wireless techniques, we're able to very deeply track movements alongside brain activation, while kids act more like they would at home or at school."

MAKING PLANS

The current phase of Schroer's research is acting as a pilot project for the new setup, combining motion capture with near-infrared spectroscopy brain-imaging.

"I'm interested to see how kids learn to plan complicated action sequences," Schroer says. She explains that actions which feel very easy to an adult are deceptively complex. "Even something

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as simple as making a cup of coffee in the morning requires you to keep track of a kind of goal hierarchy."

"The main goal consists of several sub-goals that we have to keep track of. And each of the sub-goals consists of several action steps, which often have to be executed in a certain order. Like if we're pouring milk, we first have to move the package towards the cup before we start pouring; you have to remember that you're making coffee and not tea; you want to remember whether you already added sugar; and you have to keep track of each of the steps.

"In my PhD research, we're trying to find out how kids learn to plan these kinds of actions. We know that very young babies can plan easy actions: they can grasp a toy, they can throw it away. But that does not cover the things we do as adults without even thinking about it.

"In a previous study, we asked children to build a house which had a goal hierarchy. It had a main goal of building a house, then it had several sub-goals and each of the sub-goals had several action steps. We asked the children to wear cycling gloves where there's a plate of markers on each, so we can keep track of the hand movement."

FEWER MARKERS, EXTREME PRECISION

This minimal approach to tracking is the key to working with the children in the study. Tucker notes that if a child feels uncomfortable with any part of the process they simply won't cooperate and the study will have to be redesigned. Full motion capture suits are not a plausible option, which is why the tracking is focused on the subjects' hands.

Fortunately, in her study Schroer is able to get the quality of data she needs from just four markers on each glove, making it much easier to get buy-in from her subjects. "I tell them, they're very cool magic gloves and they make them better builders. And actually, they just put them on. They might say 'it's a bit weird', but generally they keep them on throughout the experiment," she says.

The first phase of the research has already yielded interesting results, says Schroer. "We see an improvement in children's planning ability over the preschool years between three and five. But we also see that children who are better planners and follow the so-called structure show a kind of freezing of their movement in the hand that they don't use for building.

"So for example, if they're building a wall with their right hand, they freeze their left hand while they're building. Then at branch points when they have to switch from one sub-goal to another, that requires some planning and they unfreeze the hand. And we can really see that in the motion capture data."

NO MOTION CAPTURE, NO RESULTS

The findings are only possible thanks to tracking. "Without it," Schroer says, "we would have never seen these results. This is about really small hand movements, maybe even just a tiny tremble. It's something you would never be able to capture on a regular camera."

"In the olden days," says Leslie Tucker, "we used to do studies where you're just videotaping, and you have coders looking for small facial expression changes and that kind of stuff. All that is very, very labor-intensive. You're looking at these things frame by frame; it took hours and hours. Now we can do contingent studies, so what the child does determines what happens next in the experiment. So this new kit that we have has really changed developmental research over the last 20 years."

Schroer hopes that her research will have practical applications beyond the world of academia.

"We hope that it helps our understanding of how kids develop. If we know that three-year-old kids can't plan action sequences there's no point in telling them, 'We're going outside now, so prepare for the whole outside sequence'. Instead, it's better to say, 'Put your coat on, put on your shoes,' and so on.

"We also hope it will help with research for children with developmental disorders, such as autism and ADHD. It's well-known that they show difficulties and impairments in action planning. But it's generally the easier tasks that are the focus of research, such as grabbing an object, where we know that they show slightly different kinematics. But I hope that this research will also be useful in showing how they plan these more complex actions, and that we can help them with planning in daily life."

While the new volume Schroer has been using has already increased the level of naturalism that the Centre can bring to its studies, there are more plans in the works. By the end of 2021 the Centre for Brain and Cognitive Development will have a Cave Automatic Virtual Environment (CAVE) facility installed.

"People have ideas for changing the environment that a child is in," explains Tucker. "You could have street scenes and look at attentional learning, you could throw kids into a farmyard environment. Anything you can program, we can put them into these scenarios."

In the CAVE, the Centre's researchers plan to tie together the motion capture and near-infrared spectroscopy used in Schroer's study with further measurements such as eye-tracking and EEG.

"With that in mind," says Tucker, "a lot of the stuff we're working on right now is technology development. What we're going to be doing is figuring out ways to time-lock events in these naturalistic environments so that we know what we're looking at, basically."

That combination of imaginative study design with powerful, linked up technology will mean more immersive studies, broader datasets and, most importantly, even deeper insights into this crucial stage of human development.

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