Using Technology in Autism Research: The Promise and the Perils

Jeff Munson and Phillip Pasqual
University of Washington

Entertainment technology could play a significant role in developing computing-based assessment tools that lead to improvements in the treatment of children with autism.

The professionals studying, assessing, and treating those with disabilities often have little awareness of the enormous potential of using entertainment technology to develop better assessment tools that can both create an inviting and engaging experience and record a rich set of important behaviors.

In recent years, we've been fortunate to have the opportunity to pick the brains of a few people in the gaming industry, and we've been working to develop ways to utilize this information in our own autism research.

UNREALIZED POTENTIAL

Nearly 25 years ago, Robert Sternberg, an expert on human intelligence, wrote that the assessment of intelligence would be transformed by computing technology through the dynamic presentation of problems that adapts to the examinees' behavior (*Intelligence Applied: Understanding and Increasing Your Intellectual Skills*, Harcourt Brace Jovanovich, 1986). This transformation, however, has yet to take place.

Our sense is that the gaming industry has achieved this dynamic adaptation to a much greater degree than the field of clinical assessment. Compared to the average computer game, the computer-based tasks often used in psychological research and assessment are, frankly, uninspiring. At one meeting at Valve, a Washington-based software development company, we shared examples of the type of computer-based tasks commonly used in autism research from a fairly typical scientific paper. In response, Bill Van Buren, a producer at Valve noted, "These are hideous and deadly dull." Uninspiring indeed.

Autism is characterized by difficulties in social and communication development and the tendency to exhibit restricted, repetitive behaviors. The specific neurodevelopmental processes that go awry in autism remain largely a mystery. The primary diagnostic test continues to be observation by a trained clinician who interacts with the child and interviews the parents regarding the child's developmental history.

THE NEED FOR ASSESSMENT TOOLS

With up to one-quarter of individuals diagnosed with autism spectrum disorder unable to speak or engage in reciprocal communication with others, there's a huge need to develop better assessment tools to help us understand and document the competencies of these individuals. This in turn can lead to improved treatments. Entertainment technology is poised to play a significant role in meeting this need.

Despite a dramatic increase in autism research over the past 20 years, there's an unfortunate disparity

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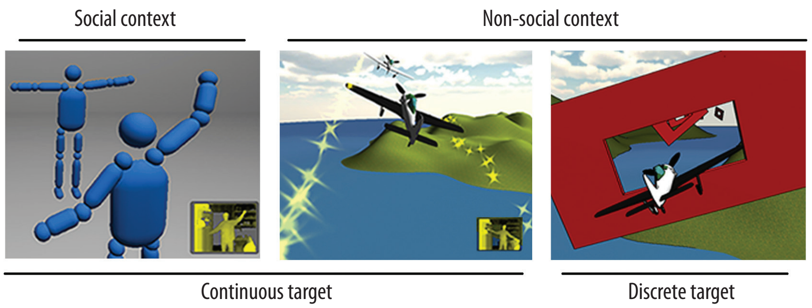

Figure 1. Prototype activities for investigating imitation and motor planning abilities.

in the proportion of work that has focused on those with the most severe impairments. Based on citations in the PubMed database, during the 1990s, an autism publication was 1.5 times more likely to specifically refer to higher-functioning individuals on the spectrum than lower-functioning or severely impaired individuals. Since 2000, this has been three times more likely to occur.

Chief among the many challenges in working with individuals who can't speak is the limited set of tools that can effectively measure meaningful variations in behavior.

Standardized cognitive testing is in many ways a fairly intense interpersonal experience. A good examiner will attempt to help subjects be at ease to allow them to achieve their best performance. However, for many individuals with autism, being alone with a stranger in an unfamiliar place while being asked to perform a wide variety of novel tasks isn't a rewarding or pleasant experience.

Standardized testing of lower-functioning individuals routinely places them on the "floor" of the measurement scale because many direct measures of cognition and behavior aren't appropriate for them. Consequently, our work has turned to using entertainment technology to develop tools for making reliable and valid inferences about the cognitive competencies these people do have, rather than simply documenting the extent of their impairment.

CREATING A FRAMEWORK

Our goal was to create a framework of activities that would be engaging and accessible to almost anyone. Although the framework should support a wide range of input devices, it shouldn't require using any specific ones. Transitions from one activity to another should be quick. It should be possible to administer these activities in a wide range of settings and to meaningfully repeat them at close intervals.

The framework should also support comprehensive data logging with minimal use of on-person instrumentation. When an individual fails to demonstrate competence in a given task, the recorded data should provide clues about the underlying reasons for why success wasn't achieved.

Current mainstream technologies have put this within reach without needing a million-dollar budget. We've been using the Microsoft Kinect depth camera and the Unity3D game engine as the cornerstones for building our framework.

In contrast to tablets and other small-screen devices, using Kinect on a large screen very naturally creates a shared experience in which individuals with a wide range of intellectual and communication abilities can all participate. This is no small feat for individuals who have such difficulty sustaining meaningful interactions with others.

Figure 1 shows prototype activities that investigate various aspects of imitation and motor planning abilities. Using Kinect makes it possible to embed the same target behavior—in this case, arm rotation—in a variety of contexts to examine the degree to which the context's social nature affects body movement.

Kinect provides the flexibility to use either an avatar embedded in a virtual scene or an augmented reality RGB image in a less abstract scene. By tracking two players simultaneously, the imitation tasks can include both a test subject and a computer-controlled model.

Figure 2 shows some prototype data collected from two adolescents with autism while they were participating in an activity that requires piloting a virtual airplane through a series of rings (right panel of Figure 1). Player A's data shows a clear understanding of the task, producing a wide variety of dependent measures that can shed light on various aspects of motor function and imitation ability. In contrast, player B's data exhibits a pervasive rhythmic, side-to-side rocking motion. Very little alteration in movements occurred in response to what was presented on the screen.

In a traditional assessment setting, we would simply conclude that player B couldn't successfully complete the task. However, Kinect records a detailed stream of behavior that raises a series of secondary questions that the examiner can pursue. Can the rhythmicity change as a function of additional visual feedback? What about auditory or tactile feedback?

This type of assessment shifts the focus from monitoring success versus failure to exploring the exhibited behavior and the context in which it occurs regardless of "success." Given the game-like setting, repeating the task is straightforward, and it can be performed in other settings such as at school or home.

We've also integrated real-time measures of gaze position (for non-Kinect, screen-based activities) and heart rate, and we're actively working on using the Affectiva Q sensor to measure electrodermal activity as an index of physiologic arousal. Although this requires the test subject to wear a small arm band, this device provides important information about physiological functions that can help us make better inferences from the behavioral measurements.

THE PROMISE AND THE PERILS

The creative application of entertainment technology offers a great deal of promise toward improving the understanding of the competencies of individuals with severe impairments. It also allows observing and recording the learning process as it unfolds. This will help refine research into underlying genetic and neurobiological mechanisms and ideally could lead to more effective treatments for older individuals who have made little progress despite heroic efforts made by clinicians, educators, and families.

The rapid growth of consumer-oriented devices such as the iPad have dramatically improved the availability of technologies that are much more accessible to people with disabilities. However a peril lies in overestimating their value without rigorously studying their effectiveness. This leads to a bit of a chicken-and-egg problem between the design and assessment of a tool's efficacy. When an individual is not successful in an interaction with technology, what failed—the user, the designer, both, or neither? When the target user is an individual who can't effectively communicate, answering this question is never easy.

Finally, we can't assume that user engagement or proficiency equals an effective design. The positive skills employed while interacting with technology may or may not impact other aspects of a person's life. Determining what happens after the power goes off is a critical part of the picture. Transitions into and out of activities are notoriously difficult for many people with autism, and successful generalization of skills to new contexts is rarely automatic.

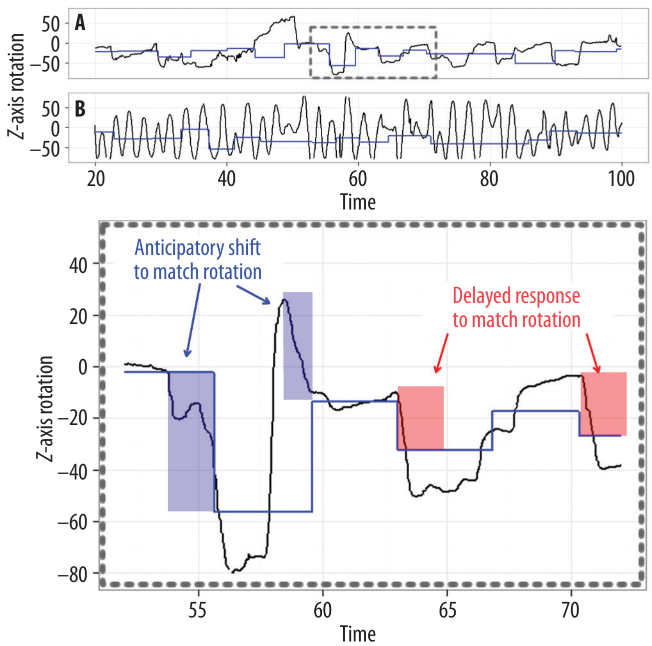

Figure 2. Prototype data collected from two adolescents with autism while they were participating in a task demonstration motor function and imitation ability.

Developers and designers need to collaborate with those working on behalf of individuals with disabilities, thinking through how they can carefully integrate these technologies into the broader social context so that they enhance the person's exposure to and impact on the surrounding environment.

A familiar *Far Side* cartoon depicts hopeful parents looking admiringly at their videogaming son as they dream about want ads filled with lucrative offers for game designers. While all parents naturally daydream about their children's future success and happiness, for the parents of a child with severe disabilities, the dream might be as simple as hearing that child say, "I love you."

Entertainment technology is not a panacea, but perhaps it can amplify the subtle but unmeasured abilities of people with autism, shedding some light where we now can't see. The design challenges are steep, but we're hopeful that our work will have a significant impact on improving the technology available for the assessment of these individuals. ■

Jeff Munson *is a research assistant professor of psychiatry and behavioral sciences at the University of Washington. Contact him at jeffmun@uw.edu.*

Phillip Pasqual *is an undergraduate at the University of Washington, majoring in applied and computational mathematical sciences and informatics. Contact him at phillpas@uw.edu.*

Editor: Kelvin Sung, Computing and Software Systems, University of Washington, Bothell; ksung@u.washington.edu