Design and Preliminary Assessment of a Virtual Reality Driving Environment for Adolescents with ASD.

Joshua Wade[1], Dayi Bian[1], Lian Zhang[1], Amy Swanson[2], Medha Sarkar[5], Zachary Warren[2,3], and Nilanjan Sarkar[4,1]

[1] Electrical Engineering and Computer Science Department
[2] Pediatrics and Psychiatry Department
[3] Treatment and Research in Autism Spectrum Disorder (TRIAD)
[4] Mechanical Engineering Department
Vanderbilt University, Nashville, TN 37212
[5] Computer Science Department
Middle Tennessee State University, Murfreesboro, TN 37132

Introduction:
Adolescents and young adults with ASD often display potent impairments in metrics of adaptive outcomes and functional abilities (Shattuck, Narendorf et al. 2012). While much of ASD intervention literature focuses on ameliorating social communication deficits and diminishing challenging behaviors, less work has been paid to specific programs targeting focal aspects of adaptive skill development (Palmen, Didden et al. 2012). Independent driving is often seen as an important skill for optimizing functional adaptive independence and enhancing quality of life. Research suggests driving presents a substantial challenge for many with ASD (Cox, Reeve et al. 2012), including different gaze patterns and physiological responses within driving environments (Reimer, Fried et al. 2013).

Objective:
In the current work we present the design and preliminary application of a novel virtual reality (VR) designed to improve driving skill in individuals with ASD. The VR system was designed to gather data regarding performance, gaze, and physiology in real-time and ultimately via data fusion algorithms to make decisions regarding alteration of tasks to enhance learning.

Methods:
The VR environment was developed using CityEngine and Maya for 3D-modeling and Unity for interactivity. The user interface for the driving simulator consisted of a Logitech G27 controller and a playseat. We used a Tobii X120 remote eye-tracking device to obtain participants' gaze information (e.g., blink rate, fixation duration, as well as the x-y coordinates of the gaze position) and log specific regions of interest (ROI). Participants' physiological signals were collected using a Biopac MP150 physiological data acquisition system and a program developed in MATLAB recorded the data at a sampling rate of 1000 Hz. The game consisted of a set of levels of increasing difficulty during which the participant performed some driving task (e.g., braking, turning at light). Difficulty was manipulated in various ways including increasing the number of vehicles in the environment, increasing the aggression level of other vehicles, and decreasing the

responsiveness of the steering wheel. A small pilot study was carried out with five pairs of age-matched teens (between 13 to 17 years of age) with ASD and controls participating in a single 90 minute session with the system.

Results:
A comparison of participant groups indicated (1) the ASD group clearly reported experiencing a higher level of frustration and difficulty than the TD group, (2) there are significant differences in gaze duration time for particular ROI between both groups within the environment (e.g., looking at different targets of environment), and (3) the ASD group failed trials more frequently than the TD group and spent more time overall completing the trials.

Conclusion:
VR systems may represent important intervention platforms for targeting important areas of skill not readily approachable in naturalistic environments without substantial risk of harm (e.g., driving). VR systems capable of responding not just to performance, but important differences in physiology and gaze pattern may be particularly promising. We will present our preliminary gaze contingent VR driving simulator along with the current data.

References:

Cox, N., R. Reeve, et al. (2012). "Brief Report: Driving and Young Adults with ASD: Parents' Experiences." Journal of Autism and Developmental Disorders **42**(10): 2257-2262.

Palmen, A., R. Didden, et al. (2012). "A systematic review of behavioral intervention research on adaptive skill building in high-functioning young adults with autism spectrum disorder." Research in Autism Spectrum Disorders **6**(2): 602-617.

Reimer, B., R. Fried, et al. (2013). "Brief Report: Examining Driving Behavior in Young Adults with High Functioning Autism Spectrum Disorders: A Pilot Study Using a Driving Simulation Paradigm." Journal of Autism and Developmental Disorders: 1-7.

Shattuck, P. T., S. C. Narendorf, et al. (2012). "Postsecondary education and employment among youth with an autism spectrum disorder." Pediatrics **129**(6): 1042-1049.