Discrepancy-Detection in Virtual Learning Environments for Young Children with ASC

Alyssa M. Alcorn
University of Edinburgh, School of Informatics, UK
a.alcorn@ed.ac.uk

Abstract. This PhD project lays the groundwork for a future VLE that adaptively introduces discrepancies (i.e. novel or rule-violating occurrences) in order to support young children with autism spectrum conditions (ASC) in practicing foundational social skills. This paper suggests a taxonomy of discrepancy types and briefly summarises a completed analysis of discrepancy-detection in existing video data from 8 children with ASC using the ECHOES VLE. It then describes planned future work, which will explore possible types of discrepancies for exploratory social content (as present in ECHOES) and address other key questions about how they might impact this group of learners, and be incorporated into the design of a future VLE. It also considers how the current work relates to existing literature on metacognition and use of erroneous worked examples in tutoring systems.

Keywords: Virtual environments, discrepancy, novelty, Autism, children, social communication, initiation, learning, evaluation, HCI, design.

1 Introduction and Background

The autism spectrum conditions (ASC) are a set of pervasive developmental conditions, characterized by notable difficulties in communication and social interaction, plus the presence of repetitive behaviours, which often manifest themselves as relatively narrow interests and a strong desire for sameness [1]. The predictability, relative simplicity of virtual environments (VEs) (compared to human-human interaction) are frequently given as reasons why they may be particularly suited to teaching specific skills to people with ASC and supporting daily-life tasks [2].

Recent observations from the ECHOES technology-enhanced learning project (see Section 2; [3]) suggest that VEs and virtual characters (VCs) may also support and motivate young children with ASC when their behaviour is unpredictable. In an analysis of children with ASC working with ECHOES, it was noted that intermittent software errors unpredictably altered the behaviour of both the VE and VC, violating child expectations about how the environment and its contents “should” behave. There were multiple examples of children clearly reacting to these errors by

---

1 Errors do not mean error messages, or system freezes/crashes. They are errors in that the system violated its own patterns of object or VC behavior, or acted counter to activity goals.
making spontaneous, social initiations, including shared positive affect, verbal comments, and social referencing. Such reactions are noteworthy: children with ASC\textsuperscript{2} are particularly unlikely to share sharing objects and information for social purposes [1]. Supporting initiation is thus a prominent target of behavioural interventions. The current PhD project is empirically motivated by these initial observations of discrepancies in the ECHOES VE and the subsequent child reactions, a phenomenon unrecorded elsewhere in the ASC literature.

These errors or rule-violating occurrences are discrepancies. Discrepancies may result from a novel aspect: one which is as yet unknown (i.e. no expectations; not yet in the mental model). Alternatively, the aspect may be a surprise— one where something is known about it, but it does not behave as was expected (i.e. mismatch between mental model and environment). Surprise has two subcategories: surprising events, or discrepant aspects that are present but behave in unpredictable, expectation-violating ways, and non-events, in which aspects are discrepant by their unexpected absence, unresponsiveness, or failure to occur.\textsuperscript{3}

Note that discrepancy is not an inherent property of the VE, but is defined in relation to individual children and their process of comparing the state of the environment to their mental model and detecting a “mismatch”. Thus, the current unit of analysis is the discrepancy-reaction pair, not discrepancy alone. As the child’s understanding of the environment is generally private, observable reactions are the main evidence for detection of a discrepancy.

2 The ECHOES Project

The first phase of the current project has been a re-analysis of existing video data from the ECHOES technology-enhanced learning project [3]. ECHOES uses exploratory, game-like learning activities to provide opportunities for young children with ASC (target chronological ages 5-7 years) to practice foundational social skills such as turn-taking and gaze- and point-following. The activities are set in a “Magic Garden”, and accessed through a 42” touch-screen. Andy, an autonomous, childlike VC, functions as the child’s guide and playmate in the VE. The AI plans Andy's behaviour both deliberatively and in reaction to the child's system actions (or non-actions). A researcher at a second monitor used a GUI for limited system control, mainly managing inter-activity transitions.

The broad goal of the ECHOES summative evaluation study (results in preparation) was to assess a variety of social and communication skills before, during, and after six to eight weeks of using the ECHOES environment. 28 children with ASC from four UK school sites each completed multiple 10-20 minute sessions of learning activities per week, gradually attempting more complex material over time. Video data was the primary record of the child’s communicative and social behaviour, as

\textsuperscript{2} By “children with ASC” we are not referring to those diagnosed with high-functioning autism or Asperger syndrome, as those children are likely to show a very different communication profile to the target group, and indeed may struggle to limit their initiations appropriately.

\textsuperscript{3} A taxonomy of discrepancy, developed as part of this research programme, is proposed in [5].