Paper #39577

Discovering Novel Predictors of Minimally Verbal Outcomes in Autism through Computational Modeling

Background:

As many as a third of individuals with autism spectrum disorder (ASD) remain minimally verbal (MV), producing few if any spoken words. Significant gaps remain in our ability to predict which children will remain MV. Current approaches typically rely on measures taken at a single time point to predict language growth or outcome. In contrast, Continuous-Time Hidden Markov Models (CT-HMMs) make it possible to model early linguistic development as a series of stages corresponding to developmental milestones. Doing so allows the developmental trajectories themselves to become potential predictors of communication outcomes.

Objectives:

We aim to demonstrate the feasibility for using CT-HMMs for modeling early linguistic development of children with ASD as a step in identifying novel predictors of MV outcomes. One potential clinical use for inflection point-derived risk markers would be in identifying the appropriate timing for interventions. Inadequate progress for a child with ASD would be a basis for altering the intensity and/or type of intervention.

Methods:

Eight-seven children with ASD with MV skills (mean age = 35.2 months) were observed at five time points across 16 months (Yoder et al., 2015). We created CT-HMMs for total words said (MacArthur Communicative Development Inventory [MCDIPV]) and weighted raw score for words (Communication and Symbolic Behavior Scales [CSBSWDS]) for the whole group and when divided by MV status.

Results:

Some children made steady simultaneous gains in word production on both measures (Figure 1; diagonal left to right paths), whereas others made gains based on the CSBSWDS but not on the MCDIPV (horizontal left to right paths). A sizeable number of children remained in the initial vocabulary state (0 words) on both measures (large purple node in the upper left-hand corner) or made minimal gains up to 10 words (upper left-hand quadrant) before plateauing on both measures.

We then divided the sample by MV status at the final time point. Except for one participant, the trajectories of children who remained MV (n = 45; <5 words in language sample; Figure 2; left panel) are entirely confined to the upper left-hand quadrant of the state space, suggesting these children either remained in an initial state of 0 words or made minimal gains up to an average of 10 words. In contrast, children who were deemed verbal by study outcome (n = 33; Figure 2; right panel) were more heterogeneous. Some made steady simultaneous gains in word production on

both measures. Others made gains based on clinician observation, but not based on caregiver report.

Conclusions:

These findings support the promise of CT-HMMs for revealing developmental progressions that differentiate children by MV status. For example, we observed that the average dwell time for verbally developed children in state (1,1) was 4.69 months, whereas the average dwelling time for MV children was 8.08 months. It follows that children who remain in this state beyond 4.69 months are exhibiting below average progress, which could be the basis for making intervention changes. With continued development, a CT-HMM could be used in clinical settings to inform intervention decisions.

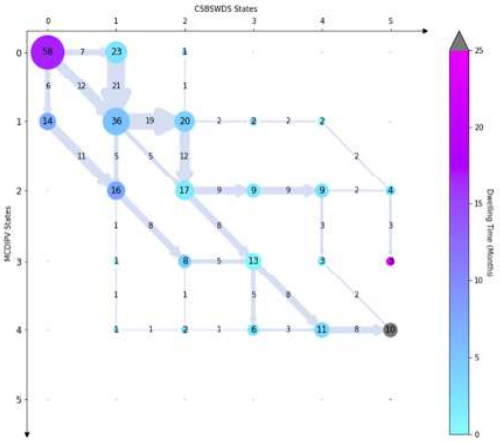

Figure 1. State trajectories of vocabulary acquisition on the CSBS (X axis) and MCDI (Y axis). Size and number inside each node denote the number of children that passed through that state. Thickness and number inside the arrow denote the number of children who made that state-to-state transition. The color of the nodes represents the dwelling time associated with the state.

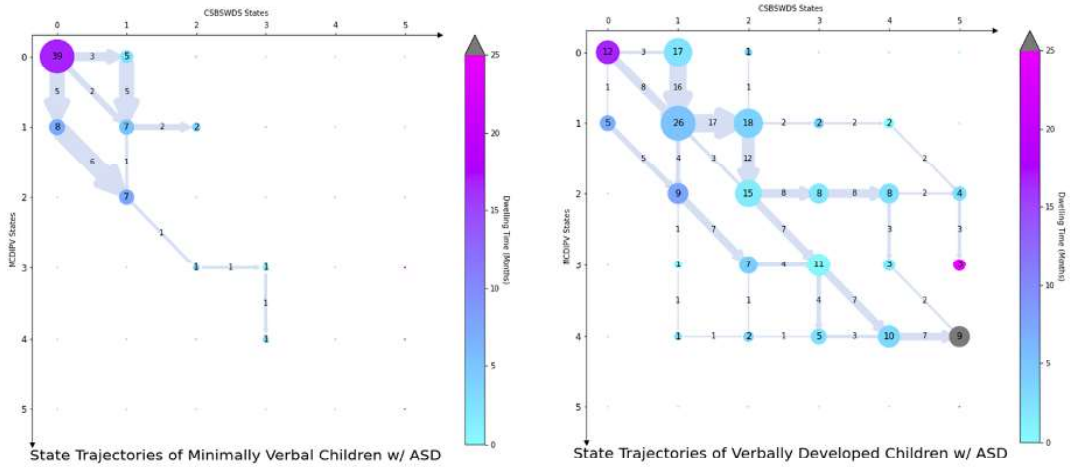

Figure 2. State trajectories of children with MV outcomes (left panel) and children who progressed to spoken language use (right panel). State trajectories of vocabulary acquisition on the CSBS (X axis) and MCDI (Y axis). Size and number inside each node denote the number of children that passed through that state. Thickness and number inside the arrow denote the number of children who made that state-to-state transition. The color of the nodes represents the dwelling time associated with the state.