Infant Motor Screening via Parent-Led Video: Using a Machine Learning Regression-Derived AIMS Salient Set

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The Alberta Infant Motor Scale (AIMS; Piper & Darrah, 1994) is used across clinical and research settings due to its short administration time, extensive cross-cultural validity, and its use of objects already found in the child's home. Our team (funded by SBIR grants HD095783, MH107063) has examined AIMS for its development of a secondary screening tool during an infant's first year using EMMA: Early Markers Movement Analyzer (in progress). EMMA aims to gather video data from multiple brief parent-led motor play sessions which are uploaded to a smartphone app at the parent's convenience. The videos are then parsed for scorable motor movements and presented to an early interventionist (i.e. occupational therapist) for validation. Such a tool breaks free from constraints currently found in clinic and telehealth screening, including the need for synchronous sessions which are limited by a provider's availability and not necessarily conducive to the infant's best motor performance. These constraints contribute to long wait times in the early intervention (EI) pipeline. Delivered asynchronously, EMMA engages the parent in motor play at home and leverages advances in telehealth, mobile technology, and computer vision allowing automation to make home-based motor screening feasible and efficient. Typical infants (n = 61) in their first year were videotaped in facilitated floor play and manually coded for AIMS motor items (producing over 11,000 coded items) which were used to establish the "ground truth" on which the machine learning models are trained. While examining the subjects on video, even our subject matter experts had difficulty in distinguishing between several closely resembling motor items within a subscale, making it unreasonable to expect a machine learning system to discern them. Our team identified and combined those "tricky" pairs and re-examined the data to determine whether the identified items do, in fact, need to be distinguished from each other for the purposes of screening for motor delay. Does a salient set of AIMS motor items (combined for those not easily distinguished), acceptably predict motor delay in infants over the course of their first year? If so, what items would comprise that salient set? Two different methods were used to determine salient sets in each subscale of the AIMS motor items (Prone, Supine, Sitting, Standing) using a Support Vector Machine Regressor (SVR). The first model used recursive feature elimination (RFE) and the second used an exhaustive search. Results indicate that salient sets determined by exhaustive search performed better than the RFE method in constructing SVRs that automatically predict AIMS scores. Using 'leave one out' prediction (SVRs trained on $n - 1$ samples and tested on the remaining), if we use the 10th percentile score as the cutoff for clinical referral, and predicting AIMS scores using only 15 salient items (Prone:4, Supine:4, Sitting:5, Standing:2), we can achieve high sensitivity (95.2) and specificity (97.5) for the screening tool. This initial presentation of salient sets of observed motor items produces results that indicate that salient sets may acceptably predict motor delay in infants within their first year. This paves the way for additional research and analysis using salient sets and automated extraction of said salient set from observational videos. The impact of this finding could allow early interventionists to complete efficient screening using videos collected from the child's natural environment, as well as other applications such as efficient community-based screening or family resource center kiosks, capturing an underserved population that may not be completing well-child visits or readily accessing early intervention services.

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