

# Machine Learning for Stratification of Children at Risk of Language Delay Following Preterm Birth

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## Abstract

### Background

Survivors of preterm birth are at increased risk of language deficits that persist into school age and are associated with a range of negative sequelae across the life span. Language trajectories are amenable to early intervention, which presents a window of opportunity to have a profound, long-lasting effect on later life.

### Objective

The objective of this study was to predict language outcomes at two years corrected gestational age (CGA) for children born preterm.

### Methods

We analysed data from 89 preterm neonates (median gestational age 29 weeks) who underwent diffusion magnetic resonance imaging (dMRI) at term-equivalent age and language assessment

at two years CGA (median age 24 months) using the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III). We explored three widely used feature selection approaches to identify the most parsimonious feature subset from 24 clinical, demographic and brain dMRI variables, which was presented to a random forests classifier in order to differentiate typical versus delayed (Bayley-III language composite score <85) language outcomes at two years CGA. We report out-of-sample performance using leave-one-participant-out cross-validation.

## **Results**

The most efficient model achieved 91% balanced accuracy (sensitivity: 86%, specificity: 96%) of language outcome at two years CGA, using eight perinatal features: peak width of skeletonized fractional anisotropy (PSFA), radial diffusivity (PSRD), and axial diffusivity (PSAD) derived from dMRI, twin pregnancy, course of antenatal corticosteroids, any antenatal steroid exposure, sex, and feeding method. The probability of language delay at two years CGA rises following a twin pregnancy, no antenatal steroid exposure, male sex, and higher PSFA, PSRD, and PSAD values. On the contrary, a complete course of antenatal corticosteroids and exclusive breast milk feeding in the weeks following preterm birth improve language outcomes.

## **Conclusion**

We demonstrate the combination of information extracted from clinical and imaging modalities leads to accurate prediction of preterm infants who are likely to develop language impairment at two years CGA. The model comprises clinical features that are collected as part of routine care and image features that are readily calculable from dMRI. We envisage these findings may be useful towards early identification of infants who are at risk of language delay, thus facilitating targeted early intervention and provision of further developmental support.