

The matter of language

DR HEIDI FELDMAN

Dr Heidi Feldman discusses the research she and colleague **Dr Anne Fernald** are conducting into language disorders associated with white matter injury to newborns and its possible implications



Could you outline the aims of your current research collaboration with Dr Anne Fernald?

The overall goal of the research is to apply a novel and sensitive method of assessing language comprehension in young children – the ‘looking while listening’ technique – to the evaluation of toddlers who are at risk of language disorders because they were born prematurely. We want to establish whether performance on ‘looking while listening’ is correlated with standard measures of language at the same age in this group of children. We also need to determine if the new method allows us to predict more accurately than the standard

measures which children will have evidence of language difficulties when they are about to enter kindergarten.

How problematic are developmental delays and language learning disorders amongst children born prematurely?

On measures of language and learning, children who are born two months or more prematurely or who weigh less than 1,500 g at birth score about ½-1 standard deviation below peers born at term and matched for gender and socioeconomic status. Difficulties in language and learning co-occur with weaknesses in attention capacity, executive function, social skills, and higher rates of anxiety, compounding their impact. However, as adults, most individuals born prematurely report a good quality of life.

What are the primary challenges associated with studying language development in infants and children, and how do you overcome these?

It is very challenging to assess language development in infants and toddlers because they are not developmentally ready to take formal tests or even accustomed to talking to strange adults. One traditional method to assess language has been parent report measures. However, these measures rely on the capacity of the adult to listen carefully and record accurately what they hear. Comparatively, the analysis of eye

Understanding language development in children

An innovative collaborative project at **Stanford University** in the US is underway, aiming to provide a new approach to the assessment of language and cognitive development in children born preterm

THE HUMAN CAPACITY for language is fundamental to development. Beyond its use as a communication tool, language provides a platform on which to represent both the physical world and that of abstract concepts and ideas, allowing interpretation of the objects, experiences, emotional responses, and many other elements that contribute to consciousness.

In recent years great strides have been made in the understanding of how language skills develop, including the mechanisms of healthy progression, and the causes of language and behavioural disorders. Advances in technology and new assessment techniques for even the youngest of children enable behavioural scientists to probe ever further into the origins of language difficulties.

Moreover, research has indicated that children born prematurely are at substantial risk for developing language delays and disorders, with 50 per cent of the youngest and smallest at birth experiencing some level of moderate neurobehavioural disability, which may not be detected until the children reach school age. Considering that approximately one in eight children in the US are born before 37 weeks gestation, the need to more fully understand these links could have a bearing on a significant portion of the population, and therefore is of the highest importance.

FIRST STEPS

To this end, a new research project is being undertaken by developmental-behavioural paediatrician Professor Heidi M Feldman and

developmental psychologist Professor Anne Fernald, both of Stanford University, US. The project draws on the combined expertise of the collaborators and aims to evaluate the language development of children born prematurely. A primary goal is to determine whether the findings from new methods of assessment can be used to accurately predict which children could benefit from preventative measures in an effort to avoid the intellectual and social hardships which children born preterm may face.

Feldman and her colleagues have been conducting studies in school aged children born preterm for over seven years, aiming to establish how language, reading, and other neuro-developmental outcomes may be adversely effected by a shorter gestation. In particular, she has been investigating how injuries to the white



movements in response to language is not at all stressful for the children and produces data that are accurate, reproducible, correlated with other measures and predictive of future functioning.

To what extent is injury to the brain's white matter pathways resulting from preterm birth associated with adverse neurodevelopmental outcomes?

In our studies, within the group of school-aged children and adolescents born preterm, we found strong correlations between measures of white matter coherence and behavioural results, including intelligence, language, reading, parent-reported inattention and parent-reported anxiety. Different white matter pathways were associated with various aspects of language processing and reading and accounted for 27-44 per cent of the variance in the behavioural measures.

Are you involved in any other research projects?

I am involved in another study of children born prematurely in which we are evaluating their reading skills and relating them to white matter characteristics. When school age children experience difficulty reading they are considered to have a specific learning disability. They are often given tutoring or individualised educational instruction to help them in reading. We want to know if the children born preterm who are poor readers have the same behavioural patterns as children born full term who are poor readers and whether they may need a different type of intervention.

Could you provide an insight into your efforts to improve the delivery of healthcare to children with developmental and behaviour disorders?

Typically our healthcare, education and social services do not provide dependable and systematic support for the families who raise these children, though the families often experience social, emotional, financial and other stresses. We essentially wait for children and their families to fail before we give them

early intervention or therapeutic services. This approach is short-sighted as well as heartless; we often miss the opportunity to intervene when the interventions would most likely make a major impact. I believe we could design a system in which children could be referred for a low-level supportive intervention based on parental or primary care physician concerns. The intervention could then be customised to the child and family's response to intervention.

What advice do you give parents who want to help their young children's language learning?

Children at the youngest stages of language learning cannot learn from the television or radio. They do not learn through programmes on an electronic tablet, or even from the adult conversations they overhear around them. Indeed, nothing substitutes for rich, mutually satisfying verbal interactions between parents and children. Among the activities where language can be used, reading holds the distinction of being the richest language environment. So daily reading, maybe 15 minutes per day, is an important contribution to the child's developmental outcomes. Since 15 minutes per day adds up to more than 90 hours per year, this can be a substantial investment in helping children reach their full potential in language learning!



Research has indicated that children born prematurely are at substantial risk for developmental language delays and disorders

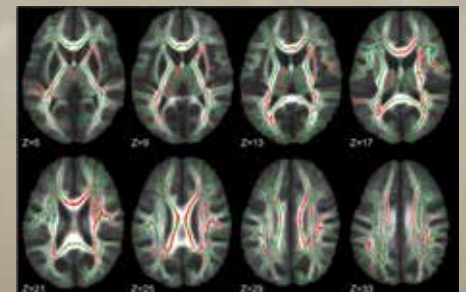
White matter in the brain may have an effect on the language abilities of children born preterm when they are school aged and adolescent.

WHITE MATTER

White matter consists of bundles of axons, which are the fibrous extensions of nerve cells that connect neurones to each other. Axons are wrapped in myelin, which is a white fatty substance that serves as an insulator. Nerve cell bodies are concentrated in the grey matter of the brain. Grey matter regions act

like microprocessors and contribute semi-specialised computations to mental activity. White matter acts like cables connecting up the microprocessors. By using an MRI method known as diffusion tensor imaging (DTI) and analysing a measure called fractional anisotropy (FA), Feldman and her collaborators have demonstrated a strong association between the structural integrity of white matter and language, reading, intelligence and behaviour traits in the children born preterm.

As Feldman outlines, this link between white matter findings and language difficulties observed in their previous work led to the creation of the current project: "The older children born prematurely showed slower linguistic processing speed and poorer verbal memory than full-term peers, even after controlling for differences in intelligence quotient," she explains. "It was our interest to explore the origins of these findings that inspired the collaboration."



Regions (red) of the white matter-skeleton (green) where behavioural measures of language or reading correlated with fractional anisotropy in the preterm group (n=23).

LOOKING WHILE LISTENING

The collaborative research programme is based on a procedure developed by Fernald, known as the 'looking while listening' (LWL) technique. By monitoring infants' eye movements in response to familiar words, and recording both their accuracy in looking at a related picture, as well as the reaction time (RT) in shifting their gaze from the incorrect to the correct image, the technique allows the researchers to explore how young children develop the ability to interpret speech efficiently as they listen to language for meaning. The technique

INTELLIGENCE

LANGUAGE AND THINKING

OBJECTIVES

- To establish the concurrent validity of online measures of language processing efficiency in relation to standardised assessments of language and cognition in all groups
- To prospectively establish the predictive validity of online language processing to differentiate children with poorer language/ cognitive outcomes from their higher-functioning peers

KEY COLLABORATORS

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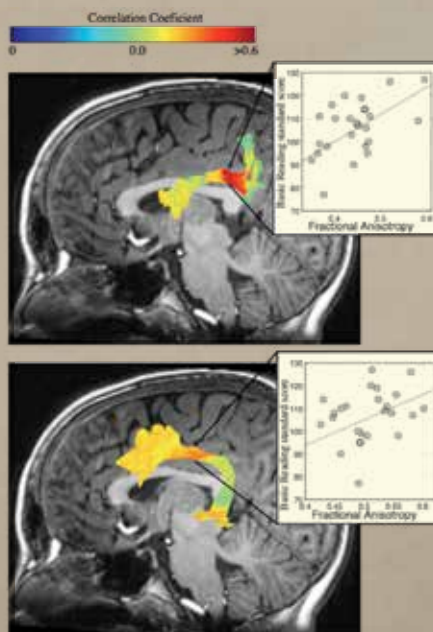
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ANNE FERNALD, PhD, is an Associate Professor of Psychology, the Josephine Knotts Knowles Professor in Human Biology, and Director of the Language Learning Laboratory at Stanford. Her research assesses early language development in English- and Spanish-speaking children, deaf children learning American Sign Language, and Wolof-learning children in rural Senegal.



Regions of the Arcuate and Superior Longitudinal Fasciculi in which FA along the tract correlates with reading skills in preterm children.

is necessarily unobtrusive, as Feldman explains: "The advantage of this method is that it demands very little of the participants. Children sit in a booth on their parent's lap, look at two pictures, such as a baby and a dog, and hear a sentence, such as 'Where's the baby?'" All they need to do is shift their gaze to the picture that matches the word.

Over the last 15 years, Fernald's research has shed light on both the efficiency in language comprehension in early development and also how this progresses with age. "Professor Fernald has demonstrated that children change dramatically over the first three years of life in what they understand," outlines Feldman. "Children who are faster and more accurate at recognising spoken words at 18-months have larger vocabularies at two years old and higher scores on language and learning measures into school age."

CURRENT RESEARCH

Feldman and Fernald's longitudinal study that began in 2011 is investigating the language processing efficiency in preterm children aged 18 to 54 months. The results will be compared to full-term controls matched for socioeconomic status and gender. Crucially, the first aim of the researchers has been to validate the online measures in relation to standardised assessments of language in all the groups. In this regard, they hypothesise that the children born preterm would score more poorly on online and offline measures than their full-term counterparts. They also predict that the individual differences among the children born preterm would correlate with measures of offline language and cognition. The initial findings suggested that the experiment was successful, as Feldman indicates: "We have found that the preterm children were above chance in familiar word recognition at the youngest age tested. Indeed,

this result shows that the task is appropriate for the population and that the children are not extremely delayed".

PREDICTING THE FUTURE

The other major objective of the project is to establish the predictive validity of online language processing efficacy in differentiating between the preterm and full-term cohorts. While the early results show that preterm children improve in accuracy and speed, it has become clear that, on average, the preterm cohort performs more poorly when compared to both their chronological peers and those who are the same age when counted from the time of conception. Critically, they also perform below children who are three months or so younger than even their age from conception. Feldman believes that Fernald's previous establishment of the LWL technique as a strong predictor of later academic development provides a solid basis from which to demonstrate the efficacy of these measures of inefficiency in language processing related to prematurity: "If these relations are similar in the group of children born preterm, we can improve detection of the children likely to have significant delays at an age when early intervention and enhancement of the environment are likely to make a substantial improvement in outcomes," Feldman observes.

AN EARLY WARNING SYSTEM

The suggestion that the LWL technique, in combination with more traditional methods of evaluation, could provide an early warning system for those at the highest risk, may help hundreds of thousands of families to minimise the adverse effects of premature birth. By accurately identifying children at a very young age who may struggle with one of the most important aspects of life, intervention could be targeted to those at highest risk to give every child a strong chance of learning language and succeeding in increasingly complex linguistic environments.

