Another year has flown by here in the labs! We want to update you all on the progress we have been making and tell you a bit more about what we’ve discovered over the last 12 months. Enjoy reading our news!

THE BRAIN STUDIES

In December of 2016, we launched an intensive study of working memory and early brain development here in the UK. We are now 3.5 years into this project – called the ‘Brain Study’ – with 151 families enrolled. We are also running a companion study in Uttar Pradesh, India to examine how early adversity including poverty and under-nutrition impacts working memory. We have 257 families enrolled in this project. Thus, across the two projects, we are studying over 400 families worldwide!

These studies are focusing on visual working memory, a cognitive system used over 10,000 times per day to remember where objects are in the world (my coffee mug is on the kitchen table) and to detect changes when they occur (my son just accidentally picked up my mug instead of his glass of juice). As you might imagine, any system that is used 10,000 times per day is probably pretty important to development.

This is indeed the case. Visual working memory develops dramatically in the first few years of life: infants can only remember properties of a single object, while children around the age of 3 can keep track of 2–3 visual objects at once. Critically, differences in working memory are predictive of later school outcomes. Thus, if we could invent ways to improve visual working memory in infancy, we might be able to give children a boost early on, particularly in cases of early adversity.

Our study is progressing really well thanks to the wonderful contributions of families in Norfolk. We have achieved full enrolment, and each week, new families complete the study. Thanks to everyone who has helped out—you are all so great!!

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In terms of results, we are moving through the mountain of data we have collected (over 14 Tb to date!) So far, we have nice behavioural results showing that your children are getting smarter over development. For instance, 6-month-old infants are good at detecting changes in objects when we show them 1 item, they are a bit slower to detect changes with 2 items, and they had a hard time finding changes with 3 items. By contrast, our 30-month-olds are great at detecting changes with 2 and 4 items, but had a hard time with 6 items.

At present, we are looking at our brain data to understand what’s happening ‘under the hood’ as children engage in the working memory task. One initial finding on this front is that children with better working memory scores show more myelin in parts of the brain we think are involved in working memory. Myelin is a fatty material in the brain that makes brain signals more efficient. Thus, it looks like better working memory is associated with more efficient brain activity – something we hope to confirm using data from our optical imaging system (the ‘brain caps’).

Stay tuned for more results next year, and thanks again to all the families enrolled in the study!

A few of the amazing Child Scientists joining us on this adventure!

SLEEP AND HEALTHY BRAIN DEVELOPMENT

We all know how much children need sleep, and we know how important it is that they get as much as they need. One of our tasks in the DDLab has been to look at how sleep ties into the development of visual working memory and healthy brain development.

To investigate this, we’ve been combining the lab fNIRS task, the MRI scans at the hospital, and the actigraphy devices you’ve had the little ones wear for a week or so to measure their sleep. We take the MRI scans and try to calculate the concentration of myelin, a sheath that forms around nerves that aids in communication in different brain areas, while the lab-based fNIRS task gives us data on the visual working memory development. All these data are complicated, and we are still only part of the way into our investigation, but our early analyses seem to reflect the fact that visual working memory, sleep, and myelination are all interconnected, even in children as young as 6 months of age!

Not to worry though if consistent sleep is still eluding your children, stable sleep patterns can normally take a long time to develop and there is a lot more to this story. Our investigations have shown that the patterns of association between sleep and visual working memory are incredibly complex, so there are still a lot of questions for us to answer.

In the future, we want at start looking at how individual sleep patterns change as we get older, and what that means for our visual working memory.

All of us looking at these questions are so grateful for all your help, and we look forward to being able to share more results with you in the future.

A rare image of a child sleeping soundly!
image: Freepik.com
THE EARLY LANGUAGE PROCESSING

Young children acquire language with seemingly little effort. In their second year of life children experience what we call “language explosion”, this is because between the ages of 12 and 24 months, children’s language abilities increase drastically. At 12-months of age children understand an average of 35 words. However, during their second year of life, children start understanding more complex words and sentences and by their second birthday, can understand an average of 316 words. We want to understand how this process occurs. We designed the ELP (Early Language Processing test) to study four key interrelated aspects that help children learn new words: the number of words they already understand (i.e. their vocabulary), how quickly they can recognise those words, their capacity to learn new word-object mappings, and how well they can remember those new mappings. ELP uses an eye tracker to measure these processes and how they work together.

We show images of two objects or actions on the screen while an animated character in the center says “Look, where is the chair”. Then we measure where the child looks. The ELP tests understanding of nouns, verbs and adjectives; some of which are usually learned early, and others learned later. To test learning of new mappings, we show new and unfamiliar objects alongside a known one (like the book in the picture), and say a new word like “kiv”.

We have tested over 100 children on the ELP task, many of which came back a week later for a retest. We use this second test to measure the stability of the results from our task. We are currently testing the same children at an older time point to see how word learning changes at 30 months of age.

Our first findings show that children are very good at recognising nouns, they are still quite good at verbs, but they find the adjectives difficult. This is not surprising as this pattern fits the distribution of these types of words in British English, with nouns being highly frequent in comparison to verbs and adjectives. We can also see that children get better at ELP as they get older. We are still analysing the different ELP measures for the various groups of children.

ELP is also being run on a population in rural India where there are high levels of poverty to see how environmental factors, such as nutrition, impact on children’s language processing abilities. We hope that these studies will contribute to better understanding language development, which is crucial to inform interventions for children at risk or children with language impairments or difficulties with word learning.

STUDENT EXPERIENCES OF WORKING IN DDLABS

Sehar Raza
“I value every minute I have spent in such a cooperative team towards dissecting how children learn words. I will miss watching the children rummage through the toy box after completing the iPhone study and the look on their faces as they tried to make the decision of taking ONE toy home rather than all.”

Milena Bakapolou
“Being part of the lab team has been an amazing learning experience, as I am interested in working with children in the future. I had the chance to have experience with hands-on cutting edge research, involving children’s Novel Language Learning while they were handling novel objects. I gained knowledge regarding the collection of data with young children and their parents. I loved communicating with 15- to 36-month-old children and enjoyed their spontaneous reactions and naming of objects in the activities. It was often funny to see them preferring their own rules in the study. It was great meeting families who were happily involved in various studies and seeing children’s proud smiles while becoming scientists, helping towards research in language development.”
LANGUAGE INPUT AT HOME

Studies show that quantity of talk to children (or language input) is related to their language outcomes. But what is it about language input that helps children developing language? To answer that question, we are using LENA (Language Environmental Analysis).

LENA is a recording device children wear and a software package that can analyse the recorded speech directed to the child. Families participating in this study get a LENA for a whole day. The child wears the LENA in a vest as they go about their day, then we use the LENA software to automatically quantify how much language the child experiences (but not the specific content). LENA classifies speech produced around the child as adult (female or male) or child, counting the amount of words or vocalisations they produce. We can also extract measures of noise, radio and TV speech and vegetative sounds such as crying or laughing. LENA also gives information on parent-child turns. Turns are linguistic interactions between adults and the child wearing the LENA, where speech occurs without a silence of more than 5 seconds.

Turns are a key measure of our study because conversational turn taking involves a rich experience of high-quality linguistic, attentional, and social features. We think that the more turns a child experiences, and the higher the quality of those interactions, the better the child’s language development will be.

So far, we have collected and analysed data from 117 children from 6- and 30-months-of-age. The graphs below show the averages for the total amount of adult talk to the child per hour (AWC), the number of child vocalisations produced in an hour, the number of turns per hour, and the percentage of turns per hour that were led by the child. While the amount of parent talk (yellow bars) slightly decreases from 6 to 30 months, this is probably because children talk more at 30 months (green bars). Because children are linguistically more active when they are older, the amount of turns between parents and the child increases drastically with age (purple bars) as does the number of turns where the child speaks first (leading the turn).

Analysis of language data

The LENA measures are part of a longitudinal study that follows children from 6- to 54-months-of-age. The aim of the study is to measure cognitive development and functional brain activity related to attention, working memory and language. Because we tested the same children with the cognitive, language and brain measures, we will be able to see how language input at home related to children’s cognitive processes. For example, some previous studies show that higher quantity and quality of speech directed to the child is related to higher speed of word recognition and early vocabulary size. We will be able to capture those differences using our language test (ELP). This study will help us to better understand how language input directed to the child influences language development and this data will help develop interventions to boost early language at home.
As children grow, they change physically and develop many different kinds of skills: cognitive, social and emotional. However, sometimes the processes of development are delayed. The most common form of developmental delay in children is related to language and speech. To help these children, scientists need to understand the root causes and exact mechanisms of how children typically learn language and how this learning changes over development. This is exactly what we are trying in our language simulator project. In this project, we designed a language-learning computer that mimics a developing child’s process of linking new words to referents and building a vocabulary.

Our model, called WOLVES for Word-Object Learning via Visual Exploration in Space, can mimic many early word learning behaviours that infants and toddlers demonstrate. WOLVES focuses on processes of visual exploration because early in the word-learning process infants spend a lot of time visually exploring objects while carers name them. WOLVES shows some amazing mimicking of the child development process. Just as children figure out over experience what words mean, the simulator keeps track of objects it sees and words it hears to fish out the correct mappings between them. If it has been taught the words “cow” and “shoe” by seeing the objects and hearing the names repeatedly, then later when asked to pick the shoe when shown both it can do so. It can also pick the word that goes with an object when asked “what is this”. It also gets bored looking at the same thing over time and prefers to look more at novel and salient things, just like kids do! The simulator also learns to shift attention from one object to another based on how familiar the objects are, for example it pays less attention to a familiar object than a novel one but when it hears a name it pays more attention to that object.

WOLVES provides some cool insights into the language learning process. It suggests that older kids and adults may be learning words at nearly the same speed but that children forget new words faster than adults. This suggests that learning to learn the name for a new object, not only do children need to hear the word many times, they need to have lots of time looking at the object so they can remember it. So, children who can maintain their attention for longer durations learn more words.

The simulator also suggests that with age, the ability to retain information for longer periods may be driving vocabulary development. The simulator also challenges many of the current methods that psychologists use to measure learning in children and suggests alternatives that can provide results that are more accurate.

We are currently trying the predictions made by the simulator in our lab experiments with kids.

This will serve the main goal of this simulator i.e. to help find ways that make our kids smarter! Results from these experiments will be particularly relevant for children who are at risk of language learning delays, helping us design therapies to support children with difficulty in acquiring words and language.

A cool extension of this project may be integrating our simulator into robots to help them learn our language and thus serve and communicate with us more effectively. Such robots can then help children in making learning fast and fun!
CHILDREN SEE THE WUG FIRST

Toddlers seem to learn a new word almost every day and can use these words not just for the example mum or grandpa named, but to talk about for a new object they have never seen before. This is especially amazing because they can do this with words for many kinds of things—cars that are similar in shape or foods that are made of the same kind of stuff. How do they know when to use shape versus material to extend a new word?

To answer this question, we look at what children do with objects they have never seen or heard the name of before. Imagine a child is presented with three objects—a smooth ball, a furry ball, and a smooth box which is made out of the same material as the ball. The child is then told that the smooth ball is called a ‘dax’ and is asked to find another ‘dax’...which object do you think the child will pick?

Adults typically pick the furry ball because it has the same shape. We call this a “shape bias”. We find that children do this too, but not until they have already learned to say many names for things. And as they learn more names, they also learn to choose material matches for things made out of nonsolid substances, like porridge, which don’t hold a shape. We think of it this way, when presented with new unfamiliar things and words, and asked to pick what goes together, children guess based on what has worked best for the words they already know—a smart strategy that usually works.

In the past couple years, we have been working to understand how they make these guesses by looking not just at what they pick, but also at what they look at when deciding what is “another dax”.

One of our Child Scientists taking part in our Novel Noun Generalisation task

We find that even the children who don’t always show a “shape bias” often spend more time looking to objects that are the same shape. This suggests they are starting to use perceptual cues to learn and use new words.

This is important because children who have trouble with early word learning are not as good at using perceptual information for word learning. We hope that by understanding how typical language learners use these cues we will be able to find ways to help children who are having trouble with word learning.
Visual exploration is one of the key tools for infants to explore their surroundings and learn from them. This exploration often takes place with their parents, at home. Previous research has shown the importance of parent-infant interaction and its long-term outcomes in facilitation of early infant learning such as word learning. For instance, when a caregiver refers to a new object, the infant follows into the parent’s gaze and gesture to attend to the correct object. Therefore, it is important to understand how parent’s looking behaviour influences infant’s looking behaviour. This is particularly important to understand in areas where infants are experiencing severe adversities since intervention with parents can better the cognitive outcomes for these infants.

We are studying this in the UK and with two studies in rural India. The first study in India was to understand infants’ looking behaviour in the laboratory through a visual working memory task. The second study in India, was to understand how parents and children coordinate their attention via a parent-infant play session. These two studies aim to answer the following questions—how does parent-infant interaction differ across cultures? And what cognitive outcomes does this interaction have for infants?

We see that there are cultural differences in how the moms interact with their infants. While in the UK, parents tend to teach the child how to use an object (drink from the mug), parents in rural India tend to make sounds with toys to keep the child entertained (banging a spoon on a plate to make a sound). These differing behaviours reflect differing cultural goals and values related to child development.

Overall, we found that the more the parent switches between objects, the less the infants holds their attention to one object. In previous research, switching between objects has been related to slower visual information processing. We analysed our data to see if this result held true in each of our samples. We found that the negative relationship between switching and being able to hold attention on something for a long time was particularly the case for parent-infant dyads from Lower Socioeconomic groups in India but not for those in the Higher socioeconomic groups in India and the UK. Findings such as these are particularly crucial to understanding the impact of poverty on infant development in their natural settings and will help us to create interventions that are sensitive to the context and culture that infants experience.

**Ellie Johns**
“I have had the opportunity to work for many projects in the lab, including a NIRS project involving parents and children playing with toys and playing Jenga; an eye-tracking project where two objects appear on a screen and children were asked to look at one by a little character; and finally the three-year long study involving home visits and visits to the lab for a NIRS task, play sessions and the much-loved gift-wrap task! The best thing about my time here has been watching the children grow. Often a child will come in shy and dubious of what’s going to happen and seeing them open up and be chatty by the end of an experiment is lovely. My favourite moments include talking with a child and realising how spontaneous they can be. For example, in the middle of an experiment a child once decided to declare their love of eating sweetcorn (mum later informed me they had never actually eaten sweetcorn!).”

**Jeevun Grewal**
“I have thoroughly enjoyed working in the Developmental Dynamics Lab on projects involving neuroimaging, eyetracking, sleep, language and motor assessments. Perhaps most memorable are the times I have ‘sib-sitted’, looking after the siblings of participants in our studies. One particularly memorable occasion springs to mind where one child I was attempting to look after took great delight in running around the waiting room, rolling on the floor and laughing hysterically!”
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Or find us: https://www.uea.ac.uk/developmental-dynamics-lab/home

Dr. Laura Colosimo

Developmental Dynamics Lab PhD student Laura Colosimo recently completed a successful viva here in the School of Psychology and has achieved her doctorate to become Dr. Laura Colosimo. Here is what she had to say about her time working within the Developmental Dynamics Labs.

“I moved to Norwich in 2016 and have been with the DDLab before it even opened its doors. I have seen the rooms built, the walls painted, and the studies developed. I have gone to preschools, baby bump shows, and baby classes to meet with families and recruit participants for our studies. I have developed and ran 6 studies, with over hundreds of families with children ranging from 3 months to 3 years.

And after three years and one PhD degree here is what I learned as an official doctor of developmental science from working in the DDLab at UEA.

Babies are incredibly smart and they love learning. Infants as young as three months have begun building the foundation for word learning. By mouthing objects, they are learning about object properties. By crawling they are starting to explore their world and engage with new objects to be labels. By looking and listening they are starting to learn the labels to the objects they have explored.

I have learned all this because of families who have come to the DD Lab and let us learn from their children. I have been lucky to see families grow and come back in for studies once their child was old enough or even when a new addition came along. And for this I am so grateful. Lastly I wanted to share some things I have learned from British families I have met along the way. 1) Norwich is a wonderful “fine” city to raise a family live in, 2) once the BBC convinced Brits that spaghetti was a vegetable that grew on trees, and 3) there is one week of summer here, so do go out and enjoy it.”

Editor’s note: Laura is originally from southern California and thus doesn’t think it is summer unless the temperature is above 35 degrees. We are proud to say she has secured a job testing early preschool (Nursery) programs in the states and will be putting all she learned from Norwich families to good use. We wish her the best.

Thanks for partnering with us!

Thanks to all the families who have given up their time to take part in our studies. We are sincerely grateful to you and for giving us the opportunity to continue with our research here in the Developmental Dynamics Laboratory.

Do you have any friends or relatives interested in their children taking part in our studies?

At the Developmental Dynamics Laboratory, we research how children think, remember and pay attention to things and how these abilities change in early development.

For more information please contact us at:

child.scientist@uea.ac.uk or telephone 01603 597376

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