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MRC | Cognition and Brain Sciences Unit

# MINDING THE GAPS:
## THE CHALLENGES OF INTERDISCIPLINARY DEVELOPMENTAL SCIENCE

*A British Academy funded workshop hosted at the MRC Cognition & Brain Sciences Unit (Cambridge) on the 19th of September, 2014*

A number of disciplines are converging upon the importance on studying cognition and neuroscience in childhood and adolescence. The result is that the field of developmental science is inherently interdisciplinary, borrowing tools, techniques, aims and approaches from cognitive psychology, education, clinical sciences and neuroscience. Working across the gaps between these disciplines presents a number of challenges. The purpose of this workshop is to share our findings, discuss these challenges and encourage early career researchers developing their own research questions in this area.

## LOCATION

MRC Cognition & Brain Science Unit
15 Chaucer Rd, Cambridge, CB27EF

## SCHEDULE

**09:00** Registration and tea/coffee
**09:30** Welcome and introduction
**09:40** Talk - Courtenay Norbury
**10:20** Talk - Lucy Henry
**11:00** Morning tea
**11:30** Talk - Gaia Scerif
**12:10** Talk - Sarah Durston
**12:50** Lunch and posters
**14:20** Talk - Sarah-Jayne Blakemore
**15:00** Talk - Duncan Astle
**15:40** Afternoon tea
**16:00** Talk - Susan Gathercole
**17:00** End

## TALK ABSTRACTS

**The Surrey Communication and Language in Education Study (SCALES): a population study of risk for language impairment at school entry**
Courtenay Norbury
*Royal Holloway, University of London*

The Surrey Communication and Language in Education Study (SCALES) is the first population study of language development and language impairment (LI) at school entry in the UK. This four-year longitudinal study will trace the development of children's language from Reception to Year 3. Our primary aim is to investigate the associations between language impairment at school entry and other developmental attainments (e.g. behaviour, attention, social skill) and how these relationships change over time.

In 2012 the SCALES screen was completed for 7,267 children in mainstream reception classrooms across more than 160 schools within Surrey. The screen comprised a short form of the Children's Communication Checklist-2 (CCC-S), the Strengths and Difficulties Questionnaire (SDQ) and the new Early Years Foundation Stage Profile (EYFSP), as well as questions regarding the child's home language, special educational needs status, teacher concerns and existing diagnoses. In this talk, I will explore the relationships between language, behaviour and education attainment in our screened sample. I will explain how initial findings influenced our decisions about entry into the second stage of the study, in which detailed assessments of language, cognition and behaviour were undertaken on 600 of the children in Year 1. I will also outline the practical challenges we've faced and the issues that arise at the crossroads of theory, policy and practice.

***abstracts continue next page***

**Working memory in children with developmental disorders**

Lucy Henry
*City University, London*

The working memory model (Baddeley, 2000) attempts to capture how current mental workspace / capacity functions in day-to-day life during demanding cognitive activities. The model includes two 'slave' subsystems for immediate storage of verbal and visuospatial information, a multimodal system that integrates information from different sources / modalities and allows long-term memory support, and a high level executive organiser that focuses, divides and switches attention as necessary. The current talk considers working memory profiles across these components in children with developmental disorders. Children with a range of developmental disorders will be considered (specific language impairment, intellectual disabilities, Down syndrome, Williams syndrome), and the educational implications of working memory strengths and limitations will be discussed.

**Genetic disorders at the crossroads: Diverse developmental mechanisms of ADHD risk**

Gaia Scerif
*Attention, Brain and Cognitive Development (ABCD), Department of Experimental Psychology, Oxford University*

Disorders of identified genetic aetiology have long offered a bridge across disciplines (e.g., genetics, basic neuroscience and developmental psychopathology). Developmental scientists have been central in highlighting how any mapping across levels of description (genes, brain, cognition and behaviour) is inherently complex.

Today, I will focus on a particular set of behaviours for which children with some genetic disorders are at very high risk, hyperactivity and inattention. This focus will help me illustrate both the exciting interdisciplinary findings and the many outstanding puzzles for developmentalists working in this area. On the one hand, many problems are immediately obvious: What tools do we have available to study developing attention as it unfolds? Are the inattention and hyperactivity measured in genetic disorders like ADHD, or "ADHD-like"? Is the high level of comorbidity with other dimensions of psychopathology (e.g., autistic spectrum disorders) a foe or a friend? On a positive note, collaborators in genetics and cognitive neuroscience have pushed us developmentalists to think about how distinguishable developmental mechanisms of risk can be studied by contrasting neurocognitive development across genetic disorders. At the same time, clinical geneticists, affected individuals and their families have drawn us to focus on the high variability and comorbidity in outcomes across children with the same genetic disorder, and their implications for prognosis and disclosure.

I hope to cover some of the basic science and practical implications emerging from these interdisciplinary efforts and, through them, raise discussion. Regardless of the open questions, one conclusion seems sound: genes affected across genetic disorders at high risk for ADHD have cascading effects on neuroplasticity and many are variably expressed through development, so understanding their influence ultimately entails a developmental perspective.

With special thanks to: Kate Baker, Dorothy Bishop, Victoria Cole, Kim Cornish, Nikki Gratton, Elena Longhi, Annette Karmiloff-Smith, Ann Steele, The Downs Syndrome Educational Trust, The Fragile X Society, The Williams Syndrome Foundation, Unique

**Developmental profiles in ADHD and ASD**

Sarah Durston
*University of Utrecht*

At the NICHE-lab in Utrecht, we study brain development in developmental disorders, such as ADHD and autism. We combine brain-imaging techniques assessing brain structure, function and connectivity with other approaches, including genetics, cognitive psychology and developmental psychology. Recently, we have started to use data-driven statistical techniques to inform theoretical models of these disorders. In my talk, I will discuss recent results on the impact of behavioural symptoms on brain development in ASD, studies investigating differences in psychological developmental profiles in ASD and ADHD and, finally, the effect of measurement method on findings on brain development and their potential implications for interpreting data.

**Adolescence: a sensitive period for social development?**

Sarah-Jayne Blakemore
*University College London*

Social cognitive processes involved in navigating an increasingly complex social world continue to develop throughout adolescence. Areas of the social brain undergo both structural changes and functional reorganisation and this possibly reflects a sensitive period for adapting to one's social environment. The changes in social environment that occur during adolescence might interact with increasing executive functions and heightened social sensitivity to influence a number of adolescent behaviours. I will discuss research involving neuroscientists, psychologists, paediatric endocrinologists, the Science Museum, schools, teachers and - most importantly - adolescents themselves, who are often involved in the design of our experimental paradigms and protocols.

**Studying the neural mechanisms of attention and memory in childhood**

Duncan Astle
*MRC Cognition & Brain Sciences Unit*

Attentional or cognitive control enables us to regulate and optimise our cognition and behaviour. These mechanisms are critical in childhood, because they support children's ability to learn and are impaired in neurodevelopmental disorders. These control mechanisms are heavily dependent upon co-ordinated activity across distributed brain areas (termed functional connectivity), that integrates information about evolving task goals with relevant sensory input or motor output. It is fundamentally important that we understand how dynamic patterns of neural activity are coordinated across brain areas, because of its critical role in cognition. As yet, however, we know little about these underlying neural mechanisms or their developmental courses. We know even less about the sources of variation in control mechanisms, the extent to which they can underlie developmental disorders, or the possibilities of their modification through intervention. I will present data in which we use the dynamic electrical activity recorded using MEG to explore the underlying neurophysiological basis of functional connectivity in childhood, the extent to which it underpins differences in working memory capacity across children and whether these mechanisms can be augmented by targeted interventions.

**Understanding developmental impairments of working memory: the challenges of diagnosis, co-morbidity, and intervention**

Susan Gathercole
*MRC Cognition & Brain Sciences Unit*

Working memory (WM) impairments are characteristic of many relatively common developmental disorders including ADHD, reading difficulties, and dyscalculia, and are widely viewed as contributing to the cognitive problems of affected children. Within diagnostic categories, though, the nature of WM impairments is not highly consistent and there can be high degrees of overlap across diagnoses, which are often themselves highly comorbid. It will be argued that a transdiagnostic approach that focuses on dimensions of WM disorder and their likely causes is preferable to classification by diagnosis, and may provide a more reliable means of predicting responses to intervention. An even greater challenge for intervention is to find methods of improving WM function that generalise to practical everyday contexts and boost the child's learning and well-being. Principles from other fields of intervention research including education and neurorehabilitation appear to provide some obvious explanations of why transfer is so limited with current methods of WM intervention.

# POSTER ABSTRACTS

### Executive Function Training Improves Preschool Working Memory

**Emma Blakey** and Daniel J. Carroll

*Department of Psychology, The University of Sheffield*

Executive functions (EFs) allow us to maintain and update information (working memory), flexibly adjust our attention (cognitive flexibility), and suppress irrelevant responses (Inhibition; Jurado & Rosselli, 2007). A recent body of research has reported improvements in various EFs after cognitive training during infancy (Wass, Porayska-Pomsta & Johnson, 2011), middle childhood (Dunning, Holmes & Gathercole, 2013) and adulthood (e.g. Jaeggi et al., 2008). However, there is still debate over the extent to which training transfers to structurally different tasks and domains, and how long improvements last for (Shipstead, Redick & Engle, 2012). Furthermore, few training studies have targeted the preschool years – a time when there are dramatic improvements in EFs (e.g. Zelazo et al., 2003). The current study compared an EF-training group with an active control group. Fifty-four 4-year-olds (*M* age= 4-years; 4-months) completed four sessions of computerised tasks over one month. Importantly, baseline and outcome cognitive tasks were different to the training tasks. The training group significantly improved their working memory from pre-training relative to the control group ($p$= 0.045). Notably, this effect was maintained three months later ($p$= 0.04). There was also a borderline significant effect of training on inhibitory control ($p$= 0.06). However, there were no significant effects of training on cognitive flexibility or processing speed (all *ps* > 0.05). Children with poor working memory were more likely to improve after training, and furthermore, were more likely to maintain this improvement after 3-months.

### Using real-time fMRI to modify cortical emotion regulation during adolescence

**Kathrin Cohen Kadosh**

*University of Oxford/King's College London*

A negative side-effect of the substantial social and cognitive changes during adolescence, along with the ongoing brain development, is an increased vulnerability to psychological problems. Anxiety, which affects up to 1 in 4 adolescents, is a particular common problem, which is further exacerbated by less efficient emotion regulation abilities during this period. This study used fMRI-based neurofeedback (NF) to teach 17 participants (aged 7-17, 9 female) to self-regulate the response patterns in the anterior insula, a key emotion regulation region. During scanning, participants were shown an online-analysis of the brain signal in the anterior insula via a thermometer display. They then practiced to increase its response by thinking happy thoughts. We found that while female participants successfully learned to up-regulate insula activation during the first 8 trials (20 sec each), the boys did not. However, this increase was not sustained in either group for the last 8 trials, possibly due to emotion adaptation effects and subject tiredness. We are now working on improving the longevity of these effects by combining NF with an established cognitive regulation strategy, such as attention/cognitive bias modification (A/CBM). In turn, NF could be used to help boost the efficiency of A/CBM at the brain level.

### Visual recognition memory relates positively to stress related arousal, and negatively to endogenous attention tasks, in typical 12-month-old infants.

**Kaya de Barbaro**, K. Clackson, Sam V. Wass

*Medical Research Council Cognition and Brain Sciences Unit, Cambridge UK*

Previous work indicates that novelty preference in the visual paired comparison task associates with enhanced IQ and executive functioning in later childhood (Colombo et al 2004). Here, we were interested in distinguishing between two putative mechanisms that might underlie this association. According to the first, higher novelty preferences indicate superior early recognition memory, thought to be related to endogenous attention or more cortically-based functioning (Rose et al., 2005; Colombo & Mitchell, 2009). According to the second, rapid habituation and novelty preference might reflect lower-level attentional differences such as increased occulomotor reaction times (e.g. Frick & Colombo,1999). We investigate this by considering relationships between task performance and stress, as follows. During mild to moderate stress, the brain

upregulates subcortically-based, lower-level attentional processes to quickly reduce uncertainty, while *downregulating* prefrontal activity (Arnsten et al, 2009).

To distinguish between these putative mechanisms we recorded three measures in 23 typically developing 12-month-old infants: a) a visual paired comparison task (VPC), b) a reversal learning (RL) task thought to be a relatively 'pure' measure of endogenous attentional control in infants (Wass et al., 2011) and c) an infant stress reactivity measure. Higher stress reactivity was found to associate with *worse* RL performance ($r=-.56$, $p<.05$), but with *better* performance on the VPC ($r=.48$, $p<.05$). Performance on the RL task was also found to be inversely correlated with novelty preferences, although this was marginally non-significant given the small sample size ($r=-.39$, $p<.1$). Our findings appear consistent with the second mechanism, suggesting that the VPC task may reflect arousal-related upregulation of low-level attentional processes.

**Using passive neuroimaging measures to characterise functional brain networks in dyslexia and ADHD**

**Lauren Gascoyne,** Joel Talcott & Mable Nakubulwa

*Aston Brain Centre, Aston University*

Both genetic and environmental factors play an important role in the aetiology of developmental disorders. Although developmental disorders are usually characterised and diagnosed using behavioural and cognitive measures, neuroimaging studies have indicated that there are underlying differences in brain structure and function when compared to typically developing children. Children with developmental disorders are not always able to complete cognitive tasks reliably, so studying the brain during rest (a. k. a. resting-state) is one current area of interest in the field of neuroimaging. Magnetoencephalography (MEG) is one technique that allows characterisation of the resting brain networks without the need for cognitive input, providing valuable information about the functions of the human brain from a network perspective. Using the MEG technique, we explored the brain's intrinsic connections in Dyslexia, ADHD and typically developing children. Preliminary results indicate a reduction in long and short-range network efficiency in children with Dyslexia and ADHD when compared to typically developing children, particularly in lower oscillatory frequency bands. Differences in network properties have potential for utilisation as biomarkers of both behavioural and functional deficits.

**Individual Differences in Working Memory and Mathematical Ability in Primary School Children**

**Rebecca Gordon**

*Arts and Human Sciences / Psychology, London South Bank University*

Over the past two decades research evidence has consistently demonstrated working memory (WM) to be a major contributor to the development of mathematical ability in primary school children. In addition studies suggest that WM capacity increases as a function of age with some arguing this is due, in part, to the development of WM maintenance strategies (i.e. refreshing information held in WM whilst concurrent processing is underway, e.g. verbal rehearsal). The aim of this study was to further explore WM capacity by identifying individual differences in the development of maintenance strategies in primary school children. Any contribution of such maintenance strategy or indeed of pure (i.e. unaided by maintenance strategy) WM capacity to future mathematical ability was examined. Ninety-two Year Three children (7 to 8 years old) were assessed. Mathematical skill was assessed using one standardised measure, along with the individual mathematical grades assigned to each child by the school. WM capacity was assessed using two sets of tasks. One set was designed to manipulate the processing component based on individual processing speeds with the purpose of restricting the ability to apply maintenance strategies. The other set was designed to allow unrestricted processing time, and therefore permit maintenance strategy use. It is postulated that mature maintenance strategies contribute to superior mathematical ability in primary school children. Potential application of such findings is discussed.

**A cognitive approach to understanding pain-related vulnerability in adolescents: Attention biases, attention control, and pain catastrophising**

**Lauren C Heathcote***, Elaine Fox, Tine Vervoort, Christopher Eccleston, Jennifer Y F Lau

**University of Oxford and Action Medical Research*

**AIM:** Children and adolescents frequently report pain, however a clinically significant minority experience recurrent or chronic pain which substantially impairs physical, social, and psychological functioning. Catastrophising has emerged as a salient risk factor for the development and maintenance of chronic pain and disability in youth, and key definitions and theoretical models highlight a role for attentional mechanisms in the catastrophising process. However, little research has taken a cognitive approach to investigate how attentional factors underlie catastrophising in youth. Moreover, no studies have yet tested a dual process model of pain and attention by investigating the interaction of rapid attention biases and more regulatory attention control processes in explaining pain catastrophising. This is despite catastrophising being seemingly characterised by both attention capture by pain and an inability to make controlled shifts away from pain. Taking a dual process approach may be especially important in examining developmental factors of chronic pain, as not only do different stages of attention contribute to many forms of learning, thereby shaping developing cognitive representations from the earliest years, but attention control is still developing during adolescence, and may therefore have a different effect or impact on biases and cognitions than in adulthood.

**METHOD:** Eighty pain-free adolescents (16-18 years) performed a dot-probe task with pictorial stimuli displaying pain or neutral facial expressions, presented for 100ms and 1250ms, thought to reflect early and later stages of processing respectively. Participants also completed pain catastrophising, trait anxiety, and attention control measures.

**RESULTS:** Results of a regression analysis showed that the interaction between attentional control and attentional biases for pain faces significantly explained pain-related anxiety levels at early stages of processing only. Specifically, attention bias for pain faces predicted higher pain-related anxiety only for participants with low levels of attention control. Attention control did not, however, moderate the relationship between attentional biases and general anxiety, suggesting specificity for pain-related anxiety.

### My School: A real-life measure of working memory

**Agnieszka Jaroslawska**

*MRC Cognition & Brain Sciences Unit, Cambridge*

This research illustrates the interdisciplinary nature of developing cognitive assessments for children. Here we aimed to bring cognitive assessment close to classroom learning by embedding it in educational activities that depend on working memory.

Working memory provides crucial support for classroom learning and deficits in working memory represent a high risk factor for poor educational progress. In this study, forty-two children were assessed on standardised measures of working memory and tasked with remembering and performing sequences of spoken action commands. They followed the commands in real life and on a computer using newly developed software called My School.

My School allows the user to navigate through a virtual school and simulates some of the memory demands of the real classroom. In the single room scenario a child is placed in a virtual classroom filled with items of stationery. Their task is to follow verbal instructions to find and manipulate sequences of objects located in the room. The multi room scenario places higher demands on both processing and storage by introducing a variety of locations to the experimental design. In this version of the task, a child begins each trial in the headteacher's office where he/she listens to an instruction. To carry out the instruction the child has to navigate around the virtual school.

We found that performance scores from My School correlated highly with the original following instruction task and with existing measures of verbal working memory. We concluded that My School can be used as a concrete, ecologically valid measure of working memory.

### Combining cognitive measures, eye-tracking and EEG to assess attention development

**Louisa Kulke**[1], Megan Gawryszewski[1], John Wattam-Bell[1], Janette Atkinson[1] and Oliver Braddick[2]

[1]*Department of Developmental Science, UCL.*
[2]*Department of Experimental Psychology, Oxford University.*

Infants' ability to switch attention from a central fixation stimulus to a peripheral visual target, measured in the Fixation Shift Paradigm (FSP), is a reliable measure of attention development in infancy (cf. Atkinson, J., & Braddick, O., 2012. Dev Med Child Neurol, 54, 589-595.). Attention shifts improve with age, most likely as a result of emerging cortical control of attention. However, to our knowledge, behavioural measures and functional measures of brain potentials have never been directly combined to investigate the neural basis of fixation shifts in early infancy.

We have developed an automated approach using remote eye-tracking (Tobii X120) which offers improved accuracy and shorter testing times in comparison to former methods. This allows combination with electroencephalography (EEG) to investigate underlying neural mechanisms.

Our results from 43 infants between 1 and 7 months and adult subjects confirm a developing ability to disengage. Patterns of brain potentials in response to the paradigm differed between adults and infants, suggesting a restructuring of the neural mechanisms of attention with age.

The new method is suitable for fine-grained assessment of typical and atypical development of attention and its underlying brain mechanisms and can be used to identify early brain markers of attention development.

**Neurocognitive memory-related phenotypes of infants with Down syndrome may predict protective/risk markers for Alzheimer's disease.**

**Esha Massand**[1,2], **George Ball**[1,2] & Annette Karmiloff-Smith[1,2]

[1] *Birkbeck Centre for Brain & Cognitive Development, University of London*
[2] *LondDownS Consortium*

Although not all individuals with Down syndrome (DS) go on to develop the clinical features of Alzheimer's disease (AD), virtually all will present with the common histopathological brain features of the disease (including the build-up of amyloid plaques) by middle age. However, it is still unclear why some individuals with DS go on to develop AD dementia whilst others do not.

The specific aims of the current project are to understand early individual differences in memory ability of infants with DS that may be predictive of subsequent cognitive phenotypes of AD. We will present our pilot data from infants with DS aged 6-60 months, from a series of eye-tracking tasks designed to test the precursors of episodic memory. This memory system is one of the first to decline in Alzheimer's.

A specific focus of the current research will be on outliers as a *meaningful* source of variation. We aim to identify individual differences in *inter alia* episodic memory in early development that may point to potential clinical markers (endophenotypes) for the cognitive variation in individuals with DS. Our findings should provide evidence to support early intervention for individuals with DS at high risk for AD.

**Symbolic estrangement in young children's representations of small numbers**

**Rebecca Merkley,** Stephanie Bugden, Daniel Ansari and Gaia Scerif

*University of Oxford*

The association of distinct representations (e.g., the digit "3", number word "three", nonsymbolic three-item sets) to the same semantic referent is a central problem in cognitive science. As developmentalists, we questioned a common assumption shared by cognitive, evolutionary psychologists and neuroscientists: the idea that numerical symbols are mapped onto core nonsymbolic representations of number. Recent evidence has shown symbolic numbers are not tightly linked to approximate nonsymbolic representations in adulthood, nor do they seem to be strongly related even in young children who have only recently acquired the semantics of number symbol. These findings suggest that, at least in adults, there may instead be separate systems for processing exact numbers and approximate nonsymbolic quantities. We assessed young children's ability to map between symbolic and nonsymbolic representations of small numbers (1-9) in order to test specific associations between core nonsymbolic systems of number and numerical symbols. Eighty-nine children between the ages of four and six-years performed four computerized forced-choice tasks assessing their ability to map between three formats of number: words, digits, and nonsymbolic arrays. Critically, all participants had demonstrated that they understood the counting principles, indicating an understanding of exact, symbolic number. Results showed that children were most accurate at mapping between the two symbolic formats. However, when the tasks required mapping between symbolic and nonsymbolic representations of number, children were significantly more accurate at mapping across formats for numbers less than five than for larger numbers. These results suggest that even just after children have learned the cardinality principles, their symbolic representations of numbers larger than four are not strongly related to corresponding approximate nonsymbolic representations. In turn, these findings point to the earliest evidence of symbolic estrangement and to a distinction between associations for small and larger

representations of single digit numbers. In broader terms, they require cognitive psychologists and neuroscientists to suggest alternative mapping mechanisms.

### Improving measures of Cognitive Biases for Children under age 8: The Why and the How

**Suzannah Ravenscroft***, Dr. Helen Dodd, Prof. Shirley Reynolds

**School of Psychology and Clinical Language Sciences, University of Reading*

Threat-related biases in attention and interpretation have been implicated in the cause and maintenance of anxiety disorders in adults, but very little is known about the relationship between such biases and disorders in children below age eight. Existing tasks used to assess attention bias (reaction time tasks) and interpretation bias (e.g. ambiguous scenarios) rely on motor, reflective and linguistic skills that make them inappropriate for young children. If we are to gain a better understanding of the relationship between these biases and psychological disorders in childhood we need novel, creative tasks that do not rely on cognitive, motor and linguistic skills. This research investigates the use of objective measures including facial electromyography (fEMG), eye-tracking and electroencephalography (EEG) to capture cognitive biases in children under eight. A novel interpretation bias task has been developed, which uses fEMG alongside behavioural responses to sounds. In addition, two new tasks have been developed to investigate attention bias in children, one using eye-tracking and one using EEG alongside behavioural responses. These tasks allow for the investigation of the association between cognitive biases and anxiety in young children. Such understanding would inform the content of interventions, such as cognitive bias modification, targeted to this age group.

### Attending to narrative and detecting mispronunciations with Auditory Processing Disorder (APD)

**Hettie Roebuck** and Johanna G. Barry

*MRC Institute of Hearing Research, University Park, Nottingham, UK*

Recent research has suggested that APD may reflect an underlying deficit in sustained attention [1]. However, the assumptions are based on auditory processing tasks that bear little relationship to everyday listening. In this study, we assess the role of sustained attention using a story task designed to mimic everyday listening.

Participants were children with and without a referral for APD, or listening difficulties identified using the ECLIPS [2]. Participants were asked to press a button when they heard a mispronounced word in a story. To assess the role of language in listening difficulties, these words were either more or less predicted by the preceding context. Research has shown that children detect more mispronunciations of words predicted by context [3]. If listeners with APD had a primary difficulty was sustaining attention, we predicted they would detect fewer mispronunciations and show an effect for context. If underlying language deficits impact task performance, we would expect the effect for linguistic context to disappear.

The APD group missed more mispronunciations than the controls, but both groups detected more mispronunciations of words predicted by contexts suggesting their primary problems with the task reflected difficulties sustaining attention.

**Acknowledgements**
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**References**

1. Moore, D.R., Ferguson, M.A., Edmondson-Jones, A.M., Ratib, S., & Riley, A. (2010). The nature of auditory processing disorder in children. Pediatrics, 126, e382-390.
2. Cole, R.A., & Perfetti, C.A. (1980). Listening for mispronunciations in a children's story: The use of context by children and adults. J Verb Learn Verb Beh, 19, 297-315.
3. Barry, J.G. and Moore, D.R. (2014). Evaluation of Children's Listening and Processing (ECLiPS) Manual edition 1.

**Automatic Orienting toward Protofacial Stimuli in Early Childhood**

**Punit Shah**[1], **Sophie Sowden**[1], Francesca Happé[1], Richard Cook[2], & Geoff Bird[1,3]

[1]*Social, Genetic and Developmental Psychiatry Centre (MRC), Institute of Psychiatry, Kings College London, University of London*
[2]*Department of Psychology, City University London*
[3]*Institute of Cognitive Neuroscience, University College London*

Newborns exhibit a tendency to orient to faces, thought to be mediated by a subcortical mechanism tuned to the protoface; a face-like configuration comprising three dark areas on a lighter background. This orienting response biases input into the developing visual system, thereby supporting the emergence of cortical circuitry required for more sophisticated face representation. It has been suggested that deficits of face perception associated with developmental disorders may be underpinned by abnormalities with this orienting mechanism. However, little is known about the developmental course of facial orienting. We developed a novel attentional-cueing procedure to measure protofacial orienting – amenable for use in (genetically sensitive) longitudinal designs. 5- to 6-year old children were required to indicate which of two letter arrays, presented either side of fixation, contains a target letter. Immediately preceding the onset of the letter arrays, the protoface and an inverted control pattern are presented at peripheral left and right locations. In line with previous research in newborns, children responded significantly faster when the protoface cued the correct location of the target letter, indicative of robust orienting response towards protofacial stimuli. Applications of this procedure to investigate the aetiology and development of face perception and related social cognitive abilities are discussed.

**Effect of congenital heart defects on cognitive and adaptive skills in children with Down syndrome**

**Faye Smith*,** Hannah Nash, Emma Hayiou-Thomas, Eve Roman and Margaret Snowling

**Department of Psychology, University of York*

Children with Down syndrome are at increased risk of many health concerns, including congenital heart defects (Roizen et al, 2014). Previous research suggests that language and motor skills are weaker in infants and toddlers with Down syndrome who are born with a heart defect (Visootsak et al., 2011, 2014). The present study examined whether heart defects have an impact on broader adaptive and cognitive skills in older children with Down syndrome (aged 4- to 5- years). This study followed 22 children with Down syndrome (aged 4- to 5-years old at the start) over the course of 15 months. Children underwent a cognitive assessment examining nonverbal and language ability and parents were interviewed using the Vineland Adaptive Behaviour Scales. The results showed that children born with a congenital heart defect (N=11) had weaker cognitive and adaptive skills, particularly in the language domain, although the magnitude of these impairments decreased over the course of the study. Understanding the interactions between health and cognition could help to identify children at risk of the greatest cognitive difficulties and enable effective early interventions to be implemented.

**Exploring language in a preterm sample: responding to joint attention influences the relation between gestational age and expressive vocabulary.**

**Rebecca G. Sperotto**[1], Alice Winstanley[2], Marc H. Bornstein[3], Merideth Gattis[1]

[1]*Cardiff University*
[2]*University of Cambridge*
[3]*Eunice Kennedy Shriver National Institute of Child Health and Human Development*

The development of expressive language (Kern & Gayraud, 2007) and responding to joint attention (RJA) (Garner, Landry, & Richardson, 1991) are delayed in preterm infants (born < 37 weeks of gestation). In healthy infants, RJA strongly predicts expressive language (Morales et al., 2000). In preterm infants, this relation has mainly been studied through mother-infant interactions.

We investigated the relations between gestational age (GA), RJA and language development in preterm ($n$ = 33) and term ($n$ = 60) infants. At 13 months we measured RJA through experimenter-infant interactions with the Early Social Communication Scales (Mundy et al., 2003). At 18 months expressive vocabulary was assessed with the Oxford Communicative Development Inventory (Hamilton, Plunkett, & Schafer, 2000).

Preterm infants showed less RJA ($t$ (91) = -4.16, $p$ < .001) and smaller expressive vocabulary ($t$ (91) = -3.14, $p$ < .005). GA was a significant predictor of expressive vocabulary ($\beta$ = .333, $p$ < .001, $R^2$ = .111). Adding RJA to the model explained more variability (GA: $\beta$ = .224, $p$ < .05; RJA: $\beta$ = .290, $p$ < .010; $R^2$ = .183).

In the second year of life, at lower gestational ages, a compromised ability to follow pointing increases word production difficulties.

**Evaluating cognitive and neural endophenotypes of ADHD in a non-clinical sample: Response variability, impulsivity and attentional modulation of ERPs**

**Jennifer Tellett**[1], Maddie Groom[1], Samantha Johnson[2], Chris Hollis[1], Helen Budge[1] and Lucy Cragg[1]

*[1]University of Nottingham, UK; [2]University of Leicester, UK*

**Introduction and Objectives:** Response variability and impulsivity have been proposed as cognitive endophenotypes of Attention-Deficit/Hyperactivity Disorder (ADHD). In order to investigate whether these markers meet the endophenotype criteria of being continuous (seen within the general population) and probabilistically predictive (correlated with ADHD symptoms), this study explored response variability and impulsivity in a non-clinical sample. It has also been argued that endophenotype research should be closely grounded in neuroscience, therefore this study sought to identify markers of attentional modulation that may act as neural endophenotypes of ADHD using electroencephalography (EEG).
**Methods:** Thirty-one children aged 8-10 years with varying levels of inattention and hyperactivity, as measured by the Conners Parent Rating Scale, completed a CPT-AX task while EEG recordings were taken. Standard deviation of reaction time was used to measure response variability, commission errors were summed to measure impulsivity, and attentional modulation Event-Related Potential (ERP) waves were created by calculating the difference between ERPs elicited by visually identical cued and uncued targets.
**Results:** Symptoms of both inattention and hyperactivity were significantly correlated with response variability and commission errors, as well as with the amplitude of the attentional modulation wave for P2 and P3 ERP components.
**Discussion:** The significant relationships between ADHD symptoms and both response variability and impulsivity within this non-clinical sample support their use as cognitive endophenotypes. In addition, the correlation of P2 and P3 components of the attentional modulation ERP wave with ADHD symptoms suggests that these ERP components representing attentional modulation of visual processing might be useful neural endophenotypes.
**References:** Castellanos, F., X., & Tannock, R. (2002) Neuroscience of attention-deficit/hyperactivity disorder: the search for endophenotypes. *Nature Reviews Neuroscience, 3,* 617-628