Campbell, C., Horlin, C., Reid, C. , McMichael, J., Forrest, L., Brydges, C.R. , French, N. and Anderson, M. (2015) How do you think she feels? Vulnerability in empathy and the role of attention in school-aged children born extremely preterm. British Journal of Developmental Psychology, In Press .

Abstract

The aim of this study was to examine empathic competence in children born extremely preterm (EP, <28 weeks) given vulnerabilities in social relationships. Empathy in typically developing children is mediated by executive functions. Executive functioning is also impaired in preterm children. Of particular interest in this paper are the attentional components of executive functioning as mediators of empathic development. Thirty-two 7 year-old EP children and 40 age-matched term children participated in the Project K.I.D.S program and completed the K.I.D.S Empathy Development Scale (KEDS), Wechsler Intelligence Scale for Children (WISC-IV) and Test of Everyday Attention for Children (TEA-Ch). Children born extremely preterm exhibited poorer performance on all measures. The mediating role of attention in empathy competence was not supported by mediation modeling when FSIQ was controlled. As predicted, the EP group showed weaker empathic development relative to typically developing children. They also shower poorer attentional abilities. However, the effect of preterm birth on empathy was not mediated by executive-level attention. The cognitive mechanisms underpinning poor empathy competence in EP children remain unclear. Future research needs to examine the role of inhibition, social-emotional recognition and regulation.

The social development of children born extremely preterm is problematic (Gardner, Johnson, Yudkin, & al., 2004; Msall & Park, 2008). Problems in affective and behavioural regulation as well as impoverished social skills are common. Indeed, frank social pathology in this group is evidenced with high risk of autism spectrum features and up to 8% of children born extremely preterm are expected to meet the diagnostic criteria for Autism Spectrum Disorder (ASD), relative to 1% in the general population (CDC, 2006; Meyer, Yee, & Feldon, 2007; Movas & Paneth, 2012). Children born extremely preterm are also reported to have a 2.64 fold risk of receiving an ADHD diagnosis (Bhutta, Cleves, Casey, Cradock, & Anand, 2002). More broadly though, the social difficulties experienced by children born extremely preterm are more prevalent than the incidence of social-communication disorders per se. For example, gaze aversion, poor attention to social cues, and fewer social initiation behaviours have been noted in infants as young as four months of age and through their toddler years (Assel et al., 2002; De Schuymer, De Groote, Desoete, & Roeyers, 2011; Farooqi, Hagglof, Sedin, & al., 2007; Landry, Smith, Miller-Loncar, & Swank, 1997; Spittle, Orton, Doyle, & Boyd, 2009). School-aged children born extremely preterm are more likely to exhibit immature social skills with higher incidence of peer problems, difficulty initiating and maintaining friendships, and difficulties interpreting group dynamics and social cues (Anderson & Doyle, 2003; Bhutta et al., 2002; Chapieski & Evankovich, 1997; Hack, 2009; Hille et al., 2001; Msall & Park, 2008; Nadeau, Tessier, Boivin, Lefebvre, & Robaey, 2003; Samara, Marlow, Wolke, & Group, 2008; Wolke, 2011).

The role of empathy in vulnerable social development of children born extremely preterm (i.e. gestation less than or equal to 28 weeks) has received little attention in clinical outcome research (Msall & Park, 2008) and are the primary focus of this paper. Empathy is integral to socio-emotional development and forms the basis of an individual’s ability to understand and engage in social interaction, regulate behaviour and act pro-socially (Decety & Jackson, 2004; Reid et al., 2013). The development of empathy is also likely to be influenced by preterm birth via a pathway from vulnerabilities in high-order cognitive processes. In addition, despite a paucity of previous research that has examined the specific role of empathy in preterm children's social development, its centrality is perhaps suggested in the prevalence of attention deficit and autism spectrum disorders. The current study, to the best of our knowledge, is one of very few to examine empathy competence in children born extremely preterm and the only published study to examine the potential neurocognitive processes that may underpin these vulnerabilities.

Recent social and developmental neuroscience models illuminate the neural circuitry that instantiate empathy as a construct of different component processes (Cacioppo & Decety, 2011). The assumptions underlying the developmental neuroscience model, is that children need to apply cognitive abilities, such as inhibiting impulsive responses, cognitive flexibility and self-regulatory skills in order to take the perspective of the 'other' (Marton, Wiener, Rogers, Moore, & Tannock, 2009). Empathy is a response that follows from both the *anticipation* and *comprehension* of the emotional state of another (Eisenberg, Spinrad, & Sadovsky, 2006; Marton et al., 2009). Ideally empathy leads to prosocial action. Higher order cognitive processes, such as language, attention, and theory of mind, are thought to be layered upon the phylogenetically older, or more basic social and emotional capacities in an evolutionary drive toward reaching social potential (Cacioppo & Decety, 2011). Poor empathic competence and social-perspective taking in children with attention-deficit hyperactivity disorder (ADHD) for example, is thought to involve disruption to various components of these executive systems that regulate the social-cognitive processing (Barkley, 2006). Given that being born extremely preterm poses considerable risk to the development of many cognitive processes (including attention dysregulation and subtle features consistent with sub-clinical presentations of autism), it is not unexpected that these children are also vulnerable in the cognitive processes that underpin the development of empathic competence, which behaviourally may be seen as immature social development.

Cognitive and learning difficulties following extremely preterm birth are consistently found in longitudinal follow-up outcomes. Impaired executive functions including attention, working memory, inhibition and goal maintenance are consistently reported (Aarnoudse-Moens, Weisglas-Kuperuse, van Gourdoever, & Oosterlaan, 2009; Anderson et al., 2011; Anderson & Doyle, 2008; Anderson, Doyle, & Group, 2004; Dupin, Laurent, Stauder, & Saliba, 2000; Mulder, Pitchford, Hagger, & Marlow, 2009). Of particular interest in this paper, is attention. According to Posner’s influential model, attention can be deconstructed into three interrelated neural networks responsible for: (i) *orienting* attention toward environmental stimuli, which underpins selective attention in the presence of distraction; (ii) *alert arousal* or the ability to sustain attention required for effortful processing of information; and (iii) *executive attentional control*, which allows attention to shift between stimuli in the processing of multiple sources of information while executing inhibitory control (Posner & Petersen, 1990; Posner & Raichle, 1994). Indeed, children born extremely preterm show poorer performance in all aspects of their attention relative to age-matched term peers (Anderson et al., 2011). These differences coalesce with both poorer performance on measures of general intelligence (IQ) as well as on measures of executive function .

Heeding the direction of a neurosciences paradigm, we draw together the cognitive and social development of children born extremely preterm to examine common and distinct pathways involved in the development of empathy. First, we expected that our extremely preterm participants would show poorer competence in empathy relative to their peers. Mindful of cognitive co-variation, we expected that poorer performance on empathy tasks would be mediated by the compromised attention seen in the development of the extremely preterm child when general cognitive ability (FSIQ), age, ADHD symptoms, and language concerns are controlled for.

Method

Participants

A total of 72 children participated in the study. *Extremely Preterm Group (EP):* Thirty-two children born extremely preterm (EP) at less than or equal to 28 weeks gestation were recruited from the local Neonatal Follow-up Program. The mean chronological age of EP children was 7.09 (SD 0.17) years and corrected age of 6.83 (SD 0.16) years. The median gestational age of the EP groups was 26 weeks (range = 24–28 weeks). Neonatal Follow-up records confirmed that no children in the EP group had a diagnosis of either ASD or ADHD. Early developmental delay concerns were raised for three children (including language delay), language delay was noted in an additional seven participating children and attention problems noted in one additional child. *Control Group:* Forty peers of the EP children (classmates) were recruited as a control group. Every attempt was made to ensure that all control participants were typically developing, as determined by information provided by their parent or guardian. Children with any developmental pathology identified at intake or subsequently were excluded from analysis. No developmental pathology was thus identified in this resultant peer-control group. The mean age of the control sample was 7.09 (SD 0.42) years. An independent-samples t-test confirmed there was no significant difference in the chorological age between groups. As expected, an independent samples t-test also confirmed a significant differences in full scale IQ between the groups, $t(63)=5.14$, $p<.001$.

Procedures and Measures

All participants were recruited and assessed in compliance the local Health Service Ethics Committee and the University Human Research Ethics Committee. All participants attended the Project KIDS neurodevelopmental research program which is run in a holiday activity day format to make the experience enjoyable for children who are often hyper-sensitized to medical assessment and intervention (Reid & Anderson, 2012). Project KIDS operates with a maximum of 24 children in attendance on two consecutive days, half of whom are age matched controls for clinical samples of children. All activities are embedded in a thematic story and tests are interspersed with games and social play time. Completion of tasks is rewarded with stickers and tokens that can be exchanged for play materials. Children and parents report that the experience is a positive one for children and this is further evidenced by a return rate of more than 95% for the second testing day.

Measures utilized for this study were a subset of measures undertaken as part of the Project KIDS battery, specifically: The Kids Empathic Development Scale (KEDS), Test of Everyday Attention for Children (TEA-Ch) and Wechsler Intelligence Scale for Children, 4th Ed (WISC-IV) were administered with children individually in accordance with standardised test administration procedures. Two parent-report questionnaires were also administered to screen for developmental issues related to attention problems: The Conners-3 ADHD Index (Parent Form) and the Hyperactivity subscale of the Strengths and Difficulties Questionnaire.

The Kids Empathy Development Scale (KEDS; (Reid et al., 2013)). The KEDS is a standardised multidimensional measure of the cognitive, affective and behavioural components of empathy that has established reliability and validity for primary school aged samples (Reid et al., 2013). Children are presented with 12 picture-based scenarios and asked to make affective inferences about faceless characters. Children are asked to infer or ascribe one of six pre-identified emotions to characters depicted in each image, by pointing to a picture of the relevant facial expression or by verbally labeling the associated emotion (e.g.

"tell me/show me how this boy feels"). Once the affective inference is made, children are asked a series of test questions about their cognitive inference (e.g. "why you think this boy feels happy?") and a behavioural inference (e.g. "what would you do if you were that boy"). Children are also asked to take the perspective of both victims and protagonist characters in scenarios and extrapolate about what their own behavioural response to scenarios would be. The multi-dimensionality of the KEDS is intended to allow richer evaluation of the depth, breadth and inter-relatedness of understanding situations, beliefs and actions. Picture-scenarios vary in complexity and are scored according to appropriateness and pro-social behavioural justification. Scores are summed and higher total scores reflect greater empathic competence. Internal consistency as reported with Cronbach's alpha for the Affect scale was .63, Cognitive scale was .82 and the behavioural scale .84. Rasch modeling was used to evaluate internal consistency and scale dimensions and are reported in Reid et al. (2013).

The Test of Everyday Attention for Children: (TEA-Ch; (Manly et al., 2001)): The TEA-Ch is a standardised measure of attention. The test-retest reliability correlations of each of the subtests are reported below along with what each is thought to measure: These three subtests were used in the current study to measure:

(i) *selective attention*, the ability to discriminate simple stimuli while ignoring distraction, was measured using the subtest 'Sky Search' (r=.09). Children were required to visually discriminate (put a circle around) target space-ship pairs (identical pairs) while ignoring similar space-ship pairs (non-identical pairs) under time pressure;

(ii) *sustained attention*, the ability to maintain attention during a task deliberately long and dull, was measured using the subtest 'Score!' (r=.64). Children were asked to count a series of space-ship firing sounds presented at intermittent intervals on CD; and

(iii) *attentional shifting*, the ability command of attention resources to switch focus from one stimuli to the next, was measured by the subtest ‘Creature Counting’ (timing score; *r=.73)*. Children were asked to count alien creatures hiding in their burrows while alternating their counting from forwards to backwards on the presentation of a visual cue (arrows up and down).

Wechsler Intelligence Scale for Children (WISC-IV; (Wechsler, 2005)). The WISC-IV is a gold-standard measure of intelligence, which provides an estimate of children’s general intellectual functioning (full scale IQ) as well as appraisal of their performance in verbal reasoning, perceptual reasoning, working memory and speed of information process. The WISC-IV was included to help differentiate between global cognitive deficits or delays; and the composite domains were submitted for mediation analysis to differentiate these different cognitive processes on children’s performance on the KEDS. Full Scale IQ was derived from either ten subtests of the WSIC-IV or four subtests from the Wechsler Abbreviated Scale of Intelligence (WASI), which were supplemented by the Working Memory and Processing Speed Index from the WISC-IV under standardised conditions. From the WISC-IV Similarities, Vocabulary, Information comprised the Verbal Reasoning Index; Block Design, Matrix Reasoning and Picture Completion made up the Perceptual Reasoning Index; Digit Span and Letter Number Sequencing the Working Memory index. A sub-sample of our EP group (13) participated in another linked study that included the WASI. These children completed Similarities, Vocabulary, Block Design and Matrix Reasoning from the WASI to avoid repeating the WISC-IV and associated practice effects. The inter-test reliability of IQ estimates between the WISC-IV and WASI is reported to fall within the range of 0.83-0.86 (Prifitera, Saklofske, & Weiss, 2005).

Conners ADHD Index Parent-Form (Conners, 2008): The Conners ADHD Index (Parent form) is a 10-item parent-report screening questionnaire suitable for children from 6 years of age through 18 years. The internal consistency across the scales ranges from .77 to .97, and test-retest reliability coefficients (Cronbach's alpha) range from .71 to .98 (Conners, 2008).

Data Screening

Prior to analysis, all scores from the KEDS, TEA-Ch, WISC-IV, and Conners were screened for univariate and multivariate outliers. The criterion of standardised *z* scores greater than 3.29 standard deviations away from the mean was used to determine any univariate outliers. These scores were removed and treated as missing data. No more than two cases were removed from any variable. Multivariate outliers were investigated using Mahalanobis distance with a critical chi- square value of 32.91 ($df = 12$, $p < .001$). No multivariate outliers were present. Distributions were checked for normality through examination of skewness and kurtosis values for each variable. All values were within the required ranges for normality. Little's MCAR test for missing data was not significant, χ^2 (94) = 100.35 $p = .31$, indicating that this data was missing completely at random. Missing data was imputed during the path analysis using the inbuilt full information maximum likelihood technique through AMOS 20 software.

As suggested by Hu and Bentler (1999), the goodness-of-fit measures reported for the model are the chi-square (χ^2) statistic, the Root Mean Square Error of Approximation (RMSEA) and the Comparative Fit Index (CFI). The χ^2 statistic is commonly used in latent variable analysis to measure goodness of fit; a non-significant χ^2 indicates that data entered into a theorised model does not significantly deviate from the model, inferring good model fit. The criteria for excellent model fit for RMSEA and CFI are less than .05 and greater than .95 respectively. However, models are acceptable with respective values of .10 and .85. The mediation analysis was submitted to a maximum likelihood estimation procedure through AMOS 20 software.

Results

Prematurity Differences

In order to examine differences in performance between the extremely preterm and typically-developing participants, independent-samples *t*-tests were conducted on the scores from each measure. Results of these *t*-tests as well as means, standard deviations, and effect sizes for the extremely preterm and typically-developing participants on every measure are presented in Table 1. Significant differences in performance between the two groups were found for every measure (with the exception of TEA-Ch Score!), with the extremely preterm participants exhibiting lower performance than the typically-developing participants. Effect sizes for these significant differences ranged from medium to very large.

Insert table 1 about here

Correlational Analysis

The relationship between preterm birth and performance on the KEDS, TEA-Ch, Connors ADHD and the four WISC-IV variables were assessed using bivariate Pearson correlations and are presented in Table 2. As expected, performance on all measures was significantly and negatively related to being born preterm (i.e. being born preterm was associated with worse performance). Performance on the KEDS and TEA-Ch was also significantly correlated with a variety of the control variables (age, Conners ADHD, and the

Table 1

Descriptive and group differences in performance on the KEDS, TEA-Ch and WISC-IV.

	N		*M (SD)*				
	EP	Control	EP	Control	*t*	*df*	Effect Size
KEDS	32	38	58.13 (8.75)	79.26 (11.05)	8.75**	68	2.12
TEA-Ch Dual Task	30	39	30.49 (39.37)	14.88 (20.92)	1.97*	41.48	0.61
TEA-Ch Score!	32	40	6.03 (2.93)	6.98 (2.47)	1.48	70	0.35
TEA-Ch Creature Counting Timing	13	26	7.04 (1.54)	6.00 (1.65)	1.89*	37	0.62
TEA-Ch Sky Search Attention	31	39	7.89 (3.39)	5.29 (2.01)	3.78**	46.18	1.11
Conners ADHD	31	32	67.71 (21.37)	39.13 (30.17)	4.35**	55.92	1.16
WISC-IV Verbal Reasoning	32	40	93.50 (11.38)	104.45 (10.90)	4.15**	70	0.99
WISC-IV Performance Reasoning	30	40	97.50 (9.91)	109.63 (13.85)	4.08**	68	0.99
WISC-IV Working Memory	31	38	89.35 (10.32)	99.05 (11.06)	3.73**	67	0.91
WISC-IV Processing Speed	32	39	92.88 (14.01)	102.33 (14.41)	2.79*	69	0.67

Notes. Positive *t* values indicate a higher group mean; **p* < .05; ***p* < .001; standard scores were computed using corrected age for the EP group. KEDS = K.I.D.S Empathy Development Scale; TEA-Ch = Test of Everyday Attention for Children; WISC-IV = Wechsler Intelligence Scale for Children (4th ed.).

four WISC-IV variables) further supporting the need to account for this relationship in the path analysis.

Insert Table 2 about here.

Mediation Analysis

Having found associations between premature birth, KEDS, and TEA-Ch performance, a mediation analysis was conducted, where the four TEA-Ch variables mediated the relationship between preterm birth and KEDS performance. Additionally, the four WISC-IV variables, age, Conners ADHD, and whether any language concerns were raised early in development were covaried in order to account for the potential influences of intelligence, ADHD, and language problems in extremely preterm children. The model proposed that prematurity would predict TEA-Ch performance, which in turn would predict performance on the KEDS, when controlling for the influence of age and intelligence. However, the direct association between preterm birth and KEDS performance (which was significant in the correlational analyses) would drop to non-significance due to this indirect association through TEA-Ch performance.

The model is presented in Figure 1, and produced marginal fit indices: $\chi^2(30)$ = 63.68, $p < .001$; RMSEA = .13; CFI = .82. Although there was a significant negative relationship between preterm birth and performance on the Creature Counting, Dual Task and Sky Search Attention subtests of the TEA-Ch ($p < .001$, $p = .030$, and $p = .019$, respectively), only the relationship between the Creature Counting subtest and the KEDS remained significant ($p = .005$). Unexpectedly, the significant negative relationship between preterm birth and performance on the KEDS remained, even when FSIQ, age, Conners ADHD, and language concerns were accounted for. None of these factors significantly predicted KEDS performance ($p = .07$ to $p = .99$). The path from preterm birth to KEDS performance was then constrained to $r = -.48$ (i.e. the correlation value

Table 2

Correlations between all study and control variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. Age (CA/ChA)	-											
2. KEDS	.26*	-										
3. TEA-Ch Sky Search Attention	-.20	-.21	-									
4. TEA-Ch Score!	.19	.16	-.21	-								
5. TEA-Ch Creature Counting Timing	-.29	-.06	.25	.04	-							
6. TEA-Ch Dual Task	-.12	.02	.27*	-.23	.07	-						
7. Conners ADHD	-.15	-.19	.03	-.30*	.21	.35**	-					
8. WISC-IV Verbal Reasoning	.12	.23	-.39**	.13	-.03	-.27*	-.04	-				
9. WISC-IV Performance Reasoning	.16	.25*	-.31*	.10	-.10	-.23	-.15	.64**	-			
10. WISC-IV Working Memory	.08	.12	-.23	.12	-.20	-.32**	-.31*	.40**	.60**	-		
11. WISC-IV Processing Speed	.06	.19	-.07	.22	-.21	-.25*	-.39**	.27*	.43**	.46**	-	
12. Preterm birth	-.37**	-.48**	.25*	-.18	.20	.27*	.26*	-.45**	-.44**	-.42**	-.32**	-

Notes. Preterm birth was coded as 1 and term birth as 0 in analysis; Early language concerns were coded as 1 if concerns were raised and 0 if not; * $p < .05$; ** $p < .01$.

between the two variables), to test whether the TEA-Ch variables mediated the relationship at all. A χ^2-difference test found that model fit did not become significantly worse when the path was constrained to this value [$\chi^2(1) = 0.34$, $p = .56$], indicating that the relationship between preterm birth and empathy was not mediated by attention at all.

Insert figure 1 about here

Discussion

The current study investigated empathic development of primary school aged children born extremely preterm. As expected extremely preterm birth was associated with reduced performance on our empathy task that measured cognitive, affective and behavioural aspects of empathy. Although the control children had higher than average mean IQ and their mean IQ was significantly higher than the preterm group, the path analysis (see Figure 1) sought to statistically control for these differences. So, while IQ, ADHD, and language problems were all significant covariates of preterm birth, being born preterm still made a significant and sizeable ($r = -.48$) unique contribution to empathy (as measured using the KEDS). Moreover, this contribution is clearly independent of the unique contribution that being born preterm makes to attention competency (as measured by the TEA-Ch). This primary finding supports previous research with toddlers in which parents provide lower ratings on the empathy subscale of the Infant Toddler Social-Emotional Assessment in their toddlers born very preterm (Spittle et al., 2009). This primary outcome also supports previous research that has reported poorer social skills in this group at school age (Msall & Park, 2008). It seems then, that empathy has a role to play in explaining these persistent social difficulties.

The current study also took a neurocognitive approach to trying to unpack the causes of poorer empathic development in preterm children, given the range of cognitive delays and deficits reported in this population. In particular, this study investigated the mediating

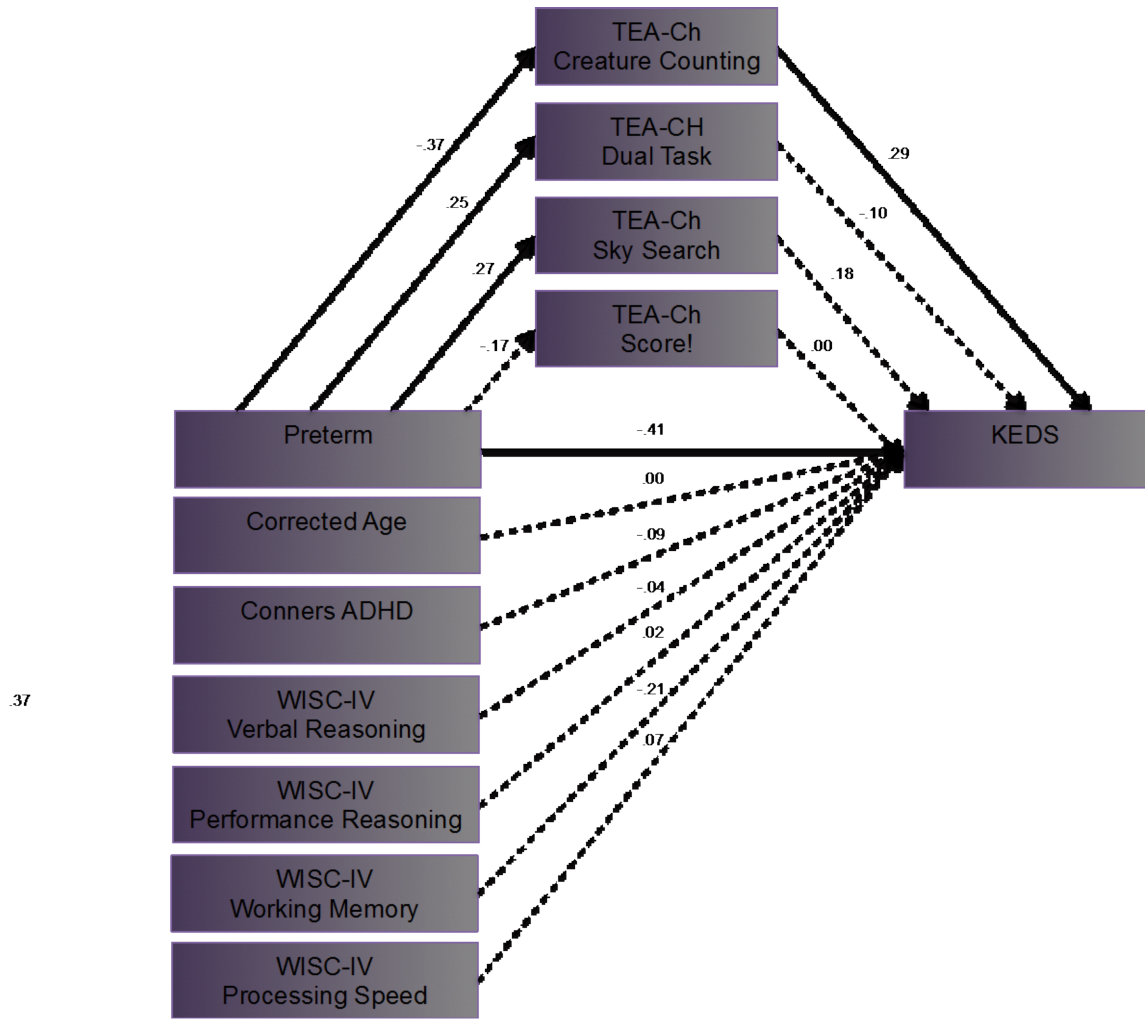

Figure 1. Path analysis for preterm birth predicting KEDS score, mediated by the TEA-Ch and controlling for IQ, age, ADHD, and language concerns. Dotted lines indicate non-significant coefficients. All other coefficients are significant to α = .05.

role of attention in compromised empathic ability. As expected, and as previously reported, children born extremely preterm showed poorer performance on all cognitive tasks including tasks of executive-level attention relative to their term-matched peers (Anderson et al., 2011). However, unlike previous research that had linked inhibitory control with performance on tasks of empathy (Marton et al., 2009), our second hypothesis, that empathy competence would be mediated by selective, sustained and shifting attention, was not supported.

In sum, it seems that understanding the developmental trajectory of empathic development in preterm children is a fruitful path for understanding the nature of persistent social difficulties and higher rates of diagnosis for ASD and ADHD in this population. It also seems clear that emerging neuro-scientific models of empathy would suggest that there are a number of cognitive deficits or delays associated with prematurity that have a likely connection with areas of the brain implicated in empathic functioning. The current study would suggest that executive level attention is not the cognitive mediator of this relationship but there are other likely candidates such as working memory, inhibition and goal maintenance. Additionally there may be some limitations in the assessment of attention in this study as the TEA-Ch, while widely accepted as a gold standard clinical assessment tool, has some limitations in its norming sample, with small samples and wide age bands that may limit its sensitivity for this kind of research. Biological measures of attention and other executive functions may afford a stronger platform for exploring a neurocognitive framework for empathy. Computer-based paradigms may also afford greater sensitivity and specificity of measurement.

Quality of life, including long-term social and emotional adjustment in children born extremely preterm is arguably as important as medical recovery given improving survival rates to adulthood. Understanding the factors that contribute to interpersonal adjustment for these children is a priority given vulnerabilities identified in both toddlers and school aged children. The current study provides evidence that interruptions to the development of empathy may be a contributor to these difficulties. Further, it provides a model for how a neurocognitive framework offers strong potential to guide further investigation into the nature, cause, trajectory, and potentially, remediation, of these deficits.

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