Transitions between socio-emotional and cognitive vulnerability profiles from early to middle childhood: a population study using multi-agency administrative records

**Running title:** Developmental profile transitions

**Authors/affiliations:**

*Piotrowska P.J, Neuroscience Research Australia (NeuRA) p.piotrowska@neura.edu.au
*Whitten, T., UNSW, Sydney t.whitten@unsw.edu.au
Tzoumakis S., Griffith University/UNSW, Sydney s.tzoumakis@griffith.edu.au
Laurens K.R., Queensland University of Technology/UNSW, Sydney kristin.laurens@qut.edu.au
Katz I., UNSW, Sydney ilan.katz@unsw.edu.au
Carr V.J., UNSW, Sydney/NeuRA/Monash University v.carr@unsw.edu.au
Harris F., UNSW, Sydney felicity.harris@unsw.edu.au
Green M.J., UNSW, Sydney/NeuRA melissa.green@unsw.edu.au

*Denotes shared first authorship

**Acknowledgements**

This research used population data owned by the NSW Education Standards Authority; NSW Department of Family and Community Services and Justice; NSW Ministry of Health; NSW Registry of Births, Deaths and Marriages; and, the NSW Bureau of Crime Statistics and Research. This paper uses data from the Australian Early Development Census (AEDC). The AEDC is funded by the Australian Government Department of Education and Training. The findings and views reported are those of the author and should not be attributed to these Departments or the NSW and Australian Government. The record linkage was conducted by the Centre for Health and Record Linkage.

**Correspondence** to Melissa J. Green, School of Psychiatry, AGSM Building, UNSW, Sydney, NSW 2033, Australia; email: melissa.green@unsw.edu.au

**Funding**

This research was conducted by the University of New South Wales with financial support from the Australian Research Council Linkage Project (LP110100150, with the NSW Ministry of Health, NSW Department of Education, and the NSW Department of Family and Community Services representing the Linkage Project Partners) and Future Fellowship awarded to KRL (FT170100294); the National Health and Medical Research Council (NHMRC) Project Grants (APP1058652 and APP1048055) and Partnership Project (APP1133833), and; the Australian Rotary Health (Mental Health of Young Australians Research Grants 104090 and 162302).
Abstract

Adult psychosocial difficulties, including psychiatric disorders, are often preceded by childhood psychosocial vulnerabilities, presenting critical windows of opportunity for preventative intervention. The present study aimed to identify longitudinal patterns (representing transitions between profiles) of childhood socio-emotional and cognitive vulnerability in the general population from early to middle childhood, in relation to key risk factors (e.g., parental mental illness and offending). Data were drawn from the New South Wales Child Development Study, which combines intergenerational multi-agency administrative records with cross-sectional assessments using data linkage methods. We analysed data from childhood assessments of socio-emotional and cognitive functioning at two time points (ages 5-6 and 10-11 years) that were linked with administrative data from government departments of health, child protection, and education for 19,087 children and their parents. Latent profile analyses were used to identify socio-emotional and cognitive profiles at each time point, and latent transition analyses were used to determine the probability and potential moderators of transition between profiles at each age. Three developmental profiles were identified in early childhood, reflecting typically developing, emotionally vulnerable, and cognitively vulnerable children, respectively; two profiles were identified in middle childhood, reflecting typically developing and vulnerable children. Child’s sex, child protection services contact, parental mental illness, and parental offending influenced children’s transitions between different vulnerability profiles, with the strongest effects for parental mental illness and child protection contact. Early detection of vulnerable children and factors promoting resilience are important steps in directing future health and social policy, and service planning for vulnerable children.

Key Words: latent profile analysis; psychopathology; resilience; developmental transition; record linkage
Adult psychiatric disorders are often preceded by childhood psychopathology [1]. The detection of children showing early signs of risk for mental disorders may therefore be critical for implementing interventions that could mitigate a trajectory of life-long mental ill-health [2]. A range of social, behavioural, emotional and cognitive problems during childhood have been associated with poor outcomes later in life. For example, lower social competence at age 4 years uniquely predicts externalising and internalising behaviours in adolescence [3], and elevated aggression and emotion dysregulation at school entry predicts conduct problems and mood dysregulation in late adolescence [4]. Early socio-emotional skills are also associated with poor young adult outcomes across a range of domains such as education, employment, criminal activity, and mental health [5]. The same is true for early indicators of cognitive impairment, which have been associated with later psychosocial problems [6,7] and academic under-achievement [8], with early cognitive competence influencing learning trajectories and later educational outcomes [9]. However, the majority of research examining relationships between psychosocial difficulties experienced in childhood and adult psychopathology has typically focused on categories of ‘impairment’ (e.g., according to standardised scores on a given clinical scale) representing clinical populations or psychiatric outcomes rather than continuous indices of developmental functioning. Person-centered approaches, such as latent profile analysis (LPA), to identify subpopulations that share particular characteristics, may be better suited to modelling patterns in the development of psychopathology in the general population. These methods facilitate the delineation of children who share particular patterns of vulnerability over time, which may lead to better understanding of the developmental origins of mental illness to improve the efficacy of early intervention efforts [10].

Using a person-centred approach to characterise patterns of early child development, Thomson and colleagues [11] reported six profiles of children with varying patterns of socio-emotional development in a large population sample (n=35 818), based on analysis of a restricted set of eight subdomain items that comprise the Social Competence and Emotional Maturity domains from the Canadian Early Development Instrument. Another recent study using the Australian version of this instrument (the Australian Early Development Census; AEDC) identified four profiles of early developmental vulnerability among ~69 000 children using all 16 subdomain items, spanning all five AEDC domains [12]. The particular subdomains of the AEDC that most prominently discriminated a highly vulnerable subgroup of children (labelled ‘misconduct risk’) were those related to aggressive and hyperactive behaviours, whereas other groups showing ‘mild’ or more severe ‘pervasive’ generalised risk showed vulnerabilities on all AEDC subdomains. These studies did not address the continuity of
early childhood vulnerabilities through early to middle childhood. Other longitudinal studies have shown that socio-emotional problems such as antisocial behaviour or depression persist from early childhood into adolescence [13,14], and may lead to different outcomes in adulthood. For example, Althoff and colleagues [15] reported 7 classes of children with various patterns of internalising, externalising, and attention problems (as rated on the Child Behavior Checklist), and showed the relative stability of these profiles across early and middle childhood; interestingly, the same groups showed heterotypic diagnostic patterns between childhood psychopathology and adult mental disorder diagnoses.

The paths between childhood profiles of risk or resilience across early and middle stages of childhood are yet to be explored in relation to individual or familial risk factors that may influence psychosocial and cognitive development. The Canadian study introduced above [11] showed that profiles of lower socio-emotional functioning in early childhood were associated with male sex, English as a second language, and lower household income. Poverty has also been strongly associated with children’s cognitive development [16], and a systematic review by Reiss [17] showed that socioeconomically disadvantaged children are two to three times more likely to develop mental health problems. Another important risk factor for offspring development is parental mental illness, which has been linked to behavioural development and adjustment [16,18]. Similarly, childhood maltreatment has been shown to have longstanding effects on mental health [19], and is associated with adverse cognitive and socio-emotional development, as well as multiple health risks in childhood and adolescence [20,21], including violence, drug use, binge drinking, depression, and suicide attempts [22,23]. Meta-analytic evidence demonstrates consistent associations between parental offending/incarceration and offspring antisocial behaviour [24], and a more recent prospective population-based study showed that parental offending was associated with early childhood developmental vulnerabilities [25].

The present study therefore explored transitions between developmental vulnerability profiles across early and middle childhood, comprising both socio-emotional and cognitive domains, and examined the influence of familial risk factors, traditionally associated with poor mental health outcomes, on patterns of developmental transitions among children in the general population. The aims of the study were to (1) identify latent profiles of childhood socio-emotional and cognitive vulnerability in the general population of children at ages 5-6 and 10-11 years, (2) determine the probabilities of transition between such profiles in early and middle childhood, and (3)
determine the extent to which the child’s sex, exposure to childhood maltreatment, and parental mental illness and criminal offending influenced the transitions between different vulnerability profiles across time.

Method

Participants

Data for this study were drawn from the New South Wales Child Development Study [NSW-CDS; 26,27]. The NSW-CDS involves 87,037 children for whom teachers completed the Australian Government Department of Education and Training’s Australian Early Development Census [AEDC; 28] in 2009 during their first year of formal schooling (when the children were 5-6 years old); subsequently, the NSW-CDS investigator-led Middle Childhood Survey [MCS; 29] of psychosocial and behavioural functioning was administered in 2015 to 27,808 children within the same school year-group (aged approximately 11 years), among whom 83.4% (n=23,194) were represented in the original 2009 AEDC cohort (i.e., 26.6% of the original AEDC-defined cohort were also assessed by the MCS). Child data from these two cross-sectional assessments were linked with administrative health, education, and child protection records for children and their parents [see 27 for detailed procedures of data collections and linkage rates]. In the current study, socio-emotional functioning was assessed using the AEDC at age 5-6 years (T1) and MCS data at age 11 years (T2), while indices of cognitive functioning (literacy and numeracy) were obtained from the AEDC (T1) and the NSW Education Standards Authority’s 2014 National Assessment Program – Literacy and Numeracy assessment [NAPLAN; 30] at age 10 years (T2). Analyses were conducted on a sub-cohort of 19,087 NSW-CDS children who had completed the AEDC, NAPLAN, and MCS, and also had linked parental records.

Measures

Socio-emotional and cognitive assessments

Age-appropriate assessments of socio-emotional and cognitive functioning at T1 (from the AEDC) and T2 (from the MCS and NAPLAN) measured five domains of children’s socio-emotional health and two domains of cognitive skills (i.e., 7 domains in total), including (1) social competence, (2) prosocial and helping behaviour, (3) anxious and fearful behaviour, (4) aggressive behaviour, (5) hyperactivity and inattention, (6) literacy, and (7) numeracy. The reliability and validity of the instruments employed have been established elsewhere [28, 29, 30], and the specific items used to assess these constructs at T1 and T2 are provided in online Supplementary Materials; reliability estimates for each scale are presented in Table 1.
All seven scales were standardised and the resulting z-scores used in analyses. The socio-emotional items were ordinal (scored 0, 1, 2 by the teacher at T1 and by self-report at T2) and coded so that higher scores indicated higher level of functioning (i.e., more prosocial/positive behaviour and fewer behavioural/emotional problems); the items were summed to create continuous scales representing five socio-emotional domains: social competence (ability to get along with peers, playing/working cooperatively with other children), prosocial and helping behaviour (helping others when hurt or in difficulty, stopping a quarrel, comforting others who are upset), anxious and fearful behaviour (worried, unhappy, crying a lot, nervous, indecisive); aggressive behaviour (getting into fights, bullying, disobedience, stealing, temper tantrums), and hyperactivity and inattention (restless, distractible, impulsive, inattentive, difficulty awaiting turns). Cognitive skills were measured by two continuous scales assessing children’s basic literacy and basic numeracy as part of the AEDC at T1, and using the NAPLAN reading and numeracy scales at T2 with higher scores indicating higher level of literacy and numeracy. The teacher-assessments of cognitive ability at T1 were focused on basic age-relevant abilities, while the NAPLAN represents the results of a standardised individual pencil-and-paper test that aims to index competencies in literacy and numeracy that should be achieved by the age at which the test is administered. Theoretically, NAPLAN scaled scores range between 0-1000, but in reality, scores do not always cover this full range. In the NSW-CDS child population, the scaled scores ranged between 86.9 - 811.4 for reading, and 122.0 - 814.3 for numeracy.

Demographics
A binary indicator for the child’s sex was obtained from the AEDC data collection. Socioeconomic status (based on residential postcode) was obtained at both time points: at T1 from the AEDC data collection and at T2 from the MCS data. The binary indicator of socioeconomic disadvantage was computed using the Socio-Economic Index for Area [SEIFA; 31]: families in quintile 1 were regarded as ‘most disadvantaged’, and those in quintiles 2-5 were regarded as ‘least-disadvantaged’. Approximately half of the sample was male (48.9%), and just over a quarter of the sample (25.4%) were considered to be socioeconomically disadvantaged at T1, and 18.1% at T2.

Child protection contact
Binary indicators of contact with child protection services were derived from records in the NSW Department of Family and Community Services (FACS) Case Management System - Key information Directory System (CMS-KiDS; 2001-2016). Two separate indicators of contact with child protection services were derived: the first (T1)
represented any child protection report received at any time up to the year before the AEDC data collection (i.e., 2008), and the second (T2) indicated contacts that occurred in the years 2009 to 2015 (i.e., up to the year of the MCS assessment). Both indicators represented children with any type of child protection report (including all reports to FACS, whether or not they were found to meet the risk of significant harm threshold, were followed up, or substantiated by FACS case workers) including children who had been placed in Out-of-Home-Care. Approximately one-sixth of children had at least one FACS report (14.5% at T1 and 14.7% at T2).

**Parental mental illness**

Binary indicators of parental mental illness were determined using the International Classification of Disease (ICD-10) codes representing any type of psychiatric disorder recorded in hospital admissions and/or ambulatory service records provided by the NSW Ministry of Health (including the Admitted Patients Data Collection [2001-2016], the Emergency Department Data Collection [2005-2016], and the Mental Health Ambulatory Data Collection [2001-2015]). Two separate indicators of parental mental illness were derived for the purpose of examining parental mental illness as a potential moderator of the initial profiles established at age 5 years, and the probability of transition between early and middle childhood profiles, with consideration of the timing of this risk factor within particular developmental periods. We thus derived one index of parental diagnoses evident in health data available prior to the child’s birth and up to the year before the AEDC data collection (i.e., 2001-2008) for entry as a covariate in the Latent Profile Analysis of data collected at age 5 years (T1); the second index of parental mental illness was restricted to diagnoses evident in health data available from the year of the AEDC data collection to the year of the MCS assessment (i.e., 2009-2015), relevant to the second stage of analyses where the probability of transitioning between profiles established at age 5 and age 11 years (T2) was of primary interest. Less than one-sixth of the children had a parent with a diagnosed mental disorder (14.6% at T1 and 12.5% at T2).

**Parental criminal offending**

Binary indicators of finalised criminal charges - for any type of criminal offence - for either parent, were derived from data contained in the NSW Bureau of Crime Statistics and Research Reoffending Database (1994-2015). Each individual in the database had at least one proven offence. As per the derivation of parental mental health indices, there were two indices of parental criminal offending in relation to analyses of data up to T1 (representing any parental criminal records evident from 1994-2008) and between T1 and T2 (2009-2015). Around one-in-
seven children had a parent with a criminal record before T1 (14.3%), and around one-in-eight between T1-T2 (12.2%).

**Statistical analyses**

Analyses were conducted using *Mplus* 8.0 [32] and IBM SPSS 25.0 [33]. To identify the optimal latent profile transition analysis (LPTA) solution, the analysis plan followed an established three-step model estimation procedure [34]. Firstly, latent profile models for standardised socio-emotional and cognitive indices were fit separately at the two cross-sectional time points (T1, T2), to determine the optimal number of profiles at each time point. The LPA models at T1 were regressed on several covariates known to be associated with early childhood developmental vulnerabilities: family socioeconomic disadvantage, parental offending, parental mental illness, and child protection services contact. These covariates were all measured prior to the AEDC socio-emotional and cognitive indicators. At T2, the LPA models were regressed only on family socioeconomic disadvantage measured at T2, given our aim to determine the role of other covariates in potentially moderating transition between developmental profiles derived in early and middle childhood. The remaining covariates indexing risk factors occurring between T1 and T2 were examined as potential moderators in subsequent latent transition models.

All LPA models were conducted with all available data points, using the maximum likelihood estimation with robust standard errors (MLR), and 100 random starts (10 iterations) to allow thorough investigation of multiple solutions and to ensure loglikelihood replicability [35]. The optimal number of profiles was determined at each time point by taking into account fit indices [including Akaike (AIC) and Bayesian Information Criterion (BIC), the Sample-Size-Adjusted BIC, and estimated entropy value], as well as theoretical justification, parsimony and interpretability [36]; solutions with one to five distinct profiles were fitted to the data and compared on these features. While lower values of the model fit statistics such as AIC and BIC represent better-fitting models, the entropy criterion measures the ability of a mixture model to provide well-separated classes, and entropy values approaching 1 indicate clear distinction of classes [37]. The final LPA models were then interpreted using the item scale means and probabilities.

In the second step, a latent profile membership value was assigned to each child based on their most likely predicted profile membership, and saved as a nominal variable. The average latent class probabilities were then
used to calculate log ratios to account for the prefixed measurement error rates. The nominal variable of most likely class membership with measurement error rates prefixed at the misclassification rate of the initial LPA models was used as an indicator for the latent class variable in the latent transition analysis (LTA). Finally, in the third step, a series of longitudinal LTA models were fitted to estimate latent probabilities of children moving between profiles at the two time points. An initial baseline LTA model was established first, and then examined further to determine whether profile membership changed from T1 to T2 as a function of child’s sex, parental offending, parental mental illness, and child protection record occurring between the two time points. Each of the potential moderators was tested separately in a multi-group model where parameters were either free or fixed to be equal across moderator groups (e.g., transition probabilities across time points were initially free between males and females, and later constrained to be equal). The competing models were compared using the chi-square difference test based on model loglikelihood values.

Results

Latent profile analyses

Table 2 summarises the resulting model fit indices for the 1- through 5-profile solutions, at each time point separately. At T1, the most substantial decreases in AIC and BIC indices were evident up to the model with three latent profiles, after which changes in fit indices were smaller. Given the smaller changes in model fit and the high entropy value (.97), indicating good distinction between classes, the three-profile solution was chosen as the most parsimonious model at T1. This model included four covariates (family socioeconomic disadvantage, child protection contact, parental mental illness, and parental criminal offending) that indexed information available prior to AEDC assessments and which might therefore affect a child’s latent profile membership. When compared to the typically developing profile group (reference category), children identified as emotionally vulnerable were more likely to be living in an area of socioeconomic disadvantage [Exp(B)=1.20; 95% CI 1.07-1.34], have at least one parent with a diagnosed mental illness [Exp(B)=1.41; 95% CI 1.23-1.61], have a child protection record [Exp(B)=2.11; 95% CI 1.83-2.42], and have at least one parent with a history of offending [Exp(B)=1.28; 95% CI 1.11-1.48]. The same covariates predicted children’s cognitive vulnerability: family’s socioeconomic disadvantage [Exp(B)=1.98; 95% CI 1.77-2.22], parental mental illness [Exp(B)=1.24; 95% CI 1.07-1.43], child protection contact [Exp(B)=2.10; 95% CI 1.81-2.43], and parental offending [Exp(B)=1.62; 95% CI 1.40-1.88].
At T2, a somewhat different pattern of latent profile results was observed, where the most substantial model fit improvement was observed between models 2 and 1, with a good entropy value for the two-profile solution (.82). The addition of the third profile did not produce substantial changes in fit indices and resulted in a substantially lower entropy value. Given these results, the two-profile model was chosen to represent children’s socio-emotional and cognitive functioning at T2. Children from socioeconomically disadvantaged families were more likely to be in the vulnerable than typically developing profile [Exp(B)=1.81; 95% CI 1.67-1.95]. The two latent profile models (T1 and T2) are illustrated in Figure 1.

Detailed item means, and the proportion of children represented in each profile, are presented in Table 3. At T1, within the selected three-profile model solution, the majority of children (84.0%) did not show any signs of socio-emotional or cognitive difficulties and were therefore described as ‘typically developing’ (profile 1: typically developing). The remaining two T1 profiles were of similar size, with 8.6% and 7.4% of children identified with emotional (profile 2: vulnerable emotionally) or cognitive (profile 3: vulnerable cognitively) difficulties, respectively. Children in profile 2 at T1 showed some difficulties across all socio-emotional and cognitive domains; however, the most pronounced difficulties were associated with aggression and hyperactivity/inattention scores. In contrast, children in profile 3 at T1 demonstrated the opposite pattern, with the most pronounced difficulties in the cognitive domain (basic literacy and numeracy), and the remaining scores lower than for typically developing children. At T2, two profiles of social-emotional and cognitive functioning were identified. The largest proportion of children at T2 were identified as typically developing (profile 1; 74.4%) with good scores evident across all developmental domains. Profile 2 (25.6%) represented globally vulnerable children showing difficulties across all socio-emotional and cognitive domains.

**Latent transition analyses**

After ascertaining the best-fitting latent profile models at T1 and T2, a series of latent transition analyses were performed to characterise movement between the social-emotional and cognitive profiles established at two time points; these models further examined the extent to which potential moderators were associated with transitions between profiles. Figure 2 presents the initial baseline LTA model with no moderators (LogL -21127.58; AIC=42265.15; BIC= 42288.55). The majority of children (78%) who were in the typically developing profile at T1 remained in the same profile and did not show vulnerability at T2. Over half of children in profile 2 (emotionally vulnerable) at T1 (58%) moved to profile 1 (typically developing) at T2, suggesting that emotional problems
resolved over time for the majority of this group of children. However, a substantial proportion of children from profile 2 (42%) at T1 remained vulnerable at T2 showing continuing emotional difficulties in this subgroup. A similar pattern of results was found for children identified as cognitively vulnerable at T1, with 41% remaining vulnerable and 59% moving to the typically developing group at T2. A relatively small proportion of children in the typically developing profile at T1 (22%) showed vulnerability at T2.

These initial findings were considered in the light of potential moderators, namely child’s sex, child protection contact, parental mental illness, and parental criminal offending. The potential influence of each moderator was analysed separately in a series of multi-group LTA analyses. Detailed comparisons between free and fixed models are presented in Table 4. The chi-square comparisons tests for all four potential moderators were significant, suggesting that models that allowed the latent transition probabilities to differ across the levels of a moderator fit the data significantly better. Specific latent transition probabilities for all moderator levels and the baseline model are presented in Table 5. The most substantial sex difference in latent transition probabilities was observed for children initially described as cognitively vulnerable (T1), with 64% of girls (vs. 55% of boys) later moving to the typically developing profile at T2, and a higher proportion of boys staying in the vulnerable profile at T2 (45%). Similarly, among the children identified as emotionally vulnerable at T1, girls were less likely to show these difficulties at T2 (i.e., 61% of girls vs. 56% of boys moved to the typically developing profile at T2). When child protection records were considered, children with a child protection contact were more likely to show vulnerability at T2 regardless of their initial profile at T1. Over half of the children remained vulnerable at both time points when a child protection record was present. These children were also less likely than children with no child protection record to be in the typically developing profile at T2. Notably, typically developing children at T1 who had a child protection contact between T1 and T2 had a doubled latent probability of being identified as vulnerable at T2, compared to children with no child protection contact.

Similarly, parental mental illness had a large effect on the patterns of child socio-emotional and cognitive difficulties, with children of parents diagnosed with a mental illness more likely to show vulnerability at T2, and less likely to move to, or remain in, the typically developing profile at T2. Parental mental illness also increased children’s probability of developing emotional difficulties at T2 even if they were typically developing at T1. Finally, parental criminal offending seemed to have an impact on typically developing children (T1), who were more likely to show vulnerability at T2 compared to those with no record of parental criminal offending. Parental
offending also increased the probability of children identified as emotionally vulnerable at T1 being identified as vulnerable at T2. However, parental offending appeared to have little impact on the probability that children identified as cognitively vulnerable at T1 were identified as vulnerable at T2, as indicated by the similar latent transition probabilities for vulnerable children at T2, regardless of the presence of a parental criminal record.

Given the relative differences in latent transition probabilities across moderator levels and multi-group model results, child protection contact appeared to be the strongest moderator of children’s developmental transitions, followed by parental mental illness and parental offending. In general, children who had records of contact with child protection services, parental mental health problems, or parental criminal offending, were more likely to be vulnerable at both time points, and less likely to improve over time (i.e., more likely to remain in vulnerable groups). These children also showed a higher probability of transitioning from the typically developing group at T1 to the vulnerable group at T2.

Discussion

We identified three profiles of socio-emotional and cognitive vulnerability in early childhood (aged 5-6 years) reflecting ‘typically developing’, ‘emotionally vulnerable’, and ‘cognitively vulnerable’ groups of children, and two profiles in middle childhood (aged 10-11 years), reflecting ‘typically developing’ and ‘vulnerable’ children. Aggressive and hyperactive behaviours uniquely characterised the ‘emotionally vulnerable’ profile, and represented 8.6% of children at the first assessment, while 7.4% of children were identified as ‘cognitively vulnerable’ at T1, reflecting specific difficulties in literacy and numeracy. At T2, 25.6% of children were identified as vulnerable across all subdomains of socio-emotional and cognitive functioning, representing a substantial increase in the proportion of children deemed developmentally vulnerable in comparison to the two vulnerable groups derived at T1; this may reflect an increase in problem behaviours in later childhood as has been previously established [38]. In general, children showed substantial stability in vulnerability profiles across time, in line with existing literature on the stability of socio-emotional problems across various stages of childhood [15,13,14]. However, the use of self-report measures indexing socio-emotional vulnerabilities at age 10-11 years, relative to the teacher-reported AEDC assessment conducted at age 5-6 years, must be considered when interpreting these findings. Discrepancies between parent and child reports of depressive and disruptive symptoms [39], and between parent and teacher reports have previously been described [40].
With regard to the moderators of transition between particular socio-emotional and cognitive profiles, all of the risk factors that were examined (i.e., male sex, child protection contacts, parental mental illness and criminal offending) significantly influenced developmental transitions from early to middle childhood, with the strongest effects observed for child protection contacts. This is not surprising given the known pervasive effects of childhood maltreatment on early developmental vulnerabilities [20, 21], and later psychopathology [22, 23]. In particular, a previous study that focused on the impact of childhood maltreatment on developmental trajectories from early to middle childhood [20] showed that, while early effects of maltreatment were often seen immediately, ongoing effects of newly occurring maltreatment were evident in socio-emotional and cognitive functioning over time. In the present study, children who were emotionally or cognitively vulnerable in early childhood (age 5 years) were less likely to move to the typically developing profile in middle childhood (age 10-11 years) when child protection contacts had been recorded in the time between the two assessments. Male sex was also a strong risk factor for persistent developmental vulnerability in this study: boys were more likely than girls to be classified as vulnerable at age 10-11 years, regardless of their initial socio-emotional and cognitive profile, consistent with considerable evidence of sex differences in behavioural problems, with boys having higher prevalence rates or symptom levels than girls [41,42]. Future studies might further explore the role of child’s sex in combination with other potential moderators of socio-emotional and cognitive development across multiple time points.

The two parental risk factors (mental illness and offending) that were considered in this study also influenced the transition to socio-emotional and cognitive difficulties in middle childhood (age 10-11 years) among children who had previously been classified in the typically developing group in early childhood (age 5 years). However, these parental risk factors had different effects with respect to the persistence of vulnerability across early and middle childhood. That is, only parental mental illness was linked to persistent vulnerability in middle childhood (T2) following classification in either the socio-emotional or cognitively vulnerable groups at T1; in contrast parental offending influenced the persistence of vulnerability in middle childhood only among children originally classed as emotionally (but not cognitively) vulnerable at T1. These effects may also reflect the timing of exposures during particular developmental periods (restricted here to the years prior to each of the socio-emotional and cognitive assessments). Several previous studies have also shown that parental mental illness is associated with offspring cognitive difficulties and socio-emotional and behavioural problems in both cross-sectional studies of early and middle childhood, and longitudinal studies of developmental transitions over time [16,18]. Similarly, parental offending is an established risk factor for offspring emotional and conduct problems, with some evidence of
association with poor cognitive and educational outcomes in childhood and adolescence [24,25,43]. These findings suggest that children exposed to one or more of these risk factors are more likely to develop socio-emotional and cognitive problems very early in life, and are less likely to improve over time. Parental risk factors should thus be considered key indicators of the need for preventative interventions that could be implemented via school-based programs, or earlier, when vulnerable families come into contact with other government agencies (i.e., health, child protection, and/or criminal justice agencies).

Despite the strengths of the current study, including a large representative sample, and use of person-centred modelling of socio-emotional and cognitive skills with consideration of time-sensitive risk factors, some limitations deserve mention. We were limited to investigating transitions between only two time points in early and middle childhood. It is possible that different patterns of transitions may be observed with more frequent measurements during child development, and at later stages of development. It is also possible that the current results may have been affected by different instruments assessing socio-emotional and cognitive constructs at T1 and T2. The measures used, however, represented age-appropriate item versions assessing the same constructs. Available research has often used clinical assessments of children’s development or focused on later developmental periods (e.g., from middle childhood to adolescence) when children are able to provide self-report. The current study investigated children’s transition from early to middle childhood and used the non-clinical indices of socio-emotional and cognitive development which necessitated the use of age-appropriate measures at T1 and T2.

In sum, this study provides evidence of substantial stability across multiple socio-emotional and cognitive domains from early to middle childhood in a population-based sample. The study is among the first to show that the risk factors traditionally linked with poor mental health outcomes – such as being of male sex, in contact with child protection services, or exposed to parental mental illness or criminal offending – are associated with socio-emotional and cognitive difficulties that begin early in childhood and persist into middle childhood. These risk factors may prove useful for targeting childhood interventions early in the life course, for which there is emerging evidence of their efficacy and economic value [44-46] for improving long term outcomes for vulnerable children.
Table 1. Descriptive statistics (n=19 087) at times 1 and 2 (T1 and T2)

|                              | T1          | T2          | Reliability Indices* |
|------------------------------|-------------|-------------|-----------------------|
| **SCALES (RAW SCORES)**      |             |             |                       |
| Social competence            | m (sd)      | m (sd)      | T1        | T2        |
|                              | range       | range       |           |           |
|                              | 6.74 (1.76) | 6.58 (1.45) | .96       | .64       |
|                              | 0-8         | 0-8         |           |           |
| Prosocial and helping behaviour | 11.00 (4.52)| 12.45 (2.66)| .97       | .86       |
|                              | 0-16        | 0-16        |           |           |
| Anxious and fearful behaviour | 9.30 (1.39) | 6.86 (2.36) | .90       | .84       |
|                              | 0-10        | 0-10        |           |           |
| Aggressive behaviour         | 11.35 (1.55)| 9.06 (2.70) | .94       | .89       |
|                              | 0-12        | 0-12        |           |           |
| Hyperactivity and inattention | 10.54 (2.46)| 7.29 (2.80) | .96       | .81       |
|                              | 0-12        | 0-12        |           |           |
| Literacy                     | 9.49 (1.15) | 507.62 (80.40)| .69     | .88       |
|                              | 0-10        | 86.9 – 811.4|           |           |
| Numeracy                     | 9.35 (1.58) | 495.60 (72.74)| .79     | .88       |
|                              | 0-10        | 122.0 – 814.3|           |           |
| **COVARIATES**               | n (%)       | n (%)       |           |           |
| Child gender – male          | 9334 (48.9%)| -           | -         | -         |
| SEIFA Q1 most disadvantaged  | 4854 (25.4%)| 3454 (18.1%)| -         | -         |
| Child protection services contact | 2773 (14.5%)| 2801 (14.7%)| -         | -         |
| Parental mental illness      | 2781 (14.6%)| 2390 (12.5%)| -         | -         |
| Parental criminal offending   | 2725 (14.3%)| 2339 (12.2%)| -         | -         |

Note: Higher scale scores correspond to better functioning

*Reliability Indices are represented as Ordinal α for the socio-emotional scales derived from the Australian Early Development Census (T1) [28] and the Middle Childhood Survey (T2) [29] items; Cronbach’s α are presented for literacy and numeracy scales from the Australian Early Development Census (T1) [28] and National Assessment Program - Literacy and Numeracy assessment (T2) [30].
Table 2. Model fit statistics for identifying the baseline latent profile models at times one and two (T1 and T2; n=19,087).

| # of latent profiles | Log Likelihood | # of free parameters | AIC     | ΔAIC   | BIC     | ΔBIC   | Adjusted BIC | Δ Adjusted BIC | Entropy |
|----------------------|----------------|----------------------|---------|--------|---------|--------|---------------|----------------|---------|
| **Latent profiles at T1** |                |                      |         |        |         |        |               |                |         |
| 1                    | -222,202.53    | 22                   | 444,449.06 | -      | 444,621.91 | -      | 444,551.99  | -              | -       |
| 2                    | -173,061.42    | 26                   | 346,174.83 | -98274.23 | 346,379.11 | -98242.80 | 346,296.48 | -98255.51 | 0.951 |
| 3                    | -163,049.91    | 38                   | 326,175.83 | -19999.00 | 326,474.39 | -19904.72 | 326,353.62 | -19942.86 | 0.974 |
| 4                    | -158,179.94    | 50                   | 316,459.87 | -9715.96 | 316,852.71 | -9621.68 | 316,693.81 | -9659.81 | 0.973 |
| 5                    | -154,585.73    | 62                   | 309,395.46 | -7064.41 | 309,782.58 | -7070.13 | 309,585.55 | -7108.26 | 0.939 |
| **Latent profiles at T2** |                |                      |         |        |         |        |               |                |         |
| 1                    | -198,766.41    | 16                   | 397,564.82 | -      | 397,690.55 | -      | 397,639.70  | -              | -       |
| 2                    | -181,482.37    | 23                   | 363,010.73 | -34554.09 | 363,191.47 | -34499.08 | 363,118.38 | -34521.32 | 0.823 |
| 3                    | -178,780.93    | 32                   | 357,625.86 | -5384.87 | 357,877.33 | -5314.14 | 357,775.64 | -5342.74 | 0.717 |
| 4                    | -177,106.51    | 41                   | 354,295.02 | -3330.84 | 354,617.21 | -3260.12 | 354,486.92 | -3288.72 | 0.748 |
| 5                    | -175,648.63    | 50                   | 351,397.26 | -2897.74 | 351,790.18 | -2827.02 | 351,631.28 | -2855.64 | 0.742 |

AIC: Akaike Information Criteria; BIC: Bayesian Information Criterion
Table 3. Characteristics/item means of the best fitting 3-group and 2-group latent profile models at T1 and T2.

|                      | PROFILE 1 |          | PROFILE 2 |          | PROFILE 3 |          |
|----------------------|-----------|----------|-----------|----------|-----------|----------|
|                      | Typically developing |          | Emotionally vulnerable (T1) / Vulnerable (T2) |          | Cognitively vulnerable |          |
|                      | T1        | T2       | T1        | T2       | T1        |          |
| n (%)                | 16031 (84.0%) | 14205 (74.4%) | 1640 (8.6%) | 4882 (25.6%) | 1416 (7.4%) |          |
| Mean (sd) z scores   |           |          |           |          |           |          |
| Social competence    | 0.24 (0.77) | 0.25 (0.81) | -1.55 (1.01) | -0.72 (1.14) | -0.87 (1.16) |          |
| Prosocial and helping behaviour | 0.17 (0.92) | 0.23 (0.84) | -0.98 (0.92) | -0.67 (1.12) | -0.73 (1.01) |          |
| Anxious and fearful behaviour | 0.14 (0.80) | 0.25 (0.84) | -0.84 (1.61) | -0.73 (1.08) | -0.57 (1.38) |          |
| Aggressive behaviour | 0.27 (0.40) | 0.46 (0.53) | -2.50 (1.55) | -1.32 (0.85) | -0.14 (0.93) |          |
| Hyperactivity and inattention | 0.27 (0.61) | 0.30 (0.87) | -2.04 (1.15) | -0.88 (0.82) | -0.69 (1.23) |          |
| Basic literacy       | 0.22 (0.59) | 0.13 (0.97) | -0.20 (1.05) | -0.38 (0.99) | -2.19 (1.71) |          |
| Basic numeracy       | 0.26 (0.43) | 0.12 (0.98) | -0.02 (0.77) | -0.36 (0.97) | -2.91 (1.23) |          |
Table 4. Multi-group model fit statistics and chi-square difference test comparisons against the fixed models.

| COVARIATE                | Model  | LogLikelihood | AIC     | BIC     | Adjusted BIC | Entropy | $\chi^2$ (df) |
|--------------------------|--------|---------------|---------|---------|--------------|---------|---------------|
| Child’s sex              | Free   | -34 100.56    | 68 223.12 | 68 309.54 | 68 274.59    | 0.889   | 521.68 (5)    |
|                          | Fixed  | -34 361.40    | 68 734.80 | 68 781.94 | 68 762.87    | 0.885   |               |
| Child protection services contact | Free   | -28 708.35    | 57 438.70 | 57 525.12 | 58 490.16    | 0.890   | 785.66 (5)    |
|                          | Fixed  | -29 101.18    | 58 214.35 | 58 261.49 | 58 242.42    | 0.886   |               |
| Parental mental illness  | Free   | -28 196.21    | 56 414.42 | 56 500.84 | 56 465.89    | 0.888   | 571.28 (5)    |
|                          | Fixed  | -28 481.85    | 56 975.71 | 57 022.85 | 57 003.78    | 0.885   |               |
| Parental criminal offending | Free   | -28 016.08    | 56 054.17 | 56 140.59 | 56 105.64    | 0.889   | 671.32 (5)    |
|                          | Fixed  | -28 351.74    | 56 715.47 | 56 762.62 | 56 743.55    | 0.885   |               |

Note: All chi-square difference tests significant at $p<.001$
Table 5. Latent transition probabilities between profiles at T1 and T2 (in parentheses are the proportions of children among T1 profile group that stayed/moved at T2).

| PROFILES AT T1          | Typically developing | Vulnerable  |
|-------------------------|----------------------|-------------|
|                         | Baseline (no moderators) |             |
| Typically developing    | .774 (.78)           | .226 (.22)  |
| Emotionally vulnerable  | .524 (.58)           | .476 (.42)  |
| Cognitively vulnerable  | .476 (.59)           | .524 (.41)  |

| Child’s sex             | Male | Female | Male | Female |
|-------------------------|------|--------|------|--------|
| Typically developing    | .746 (.75) | .798 (.80) | .254 (.25) | .202 (.20) |
| Emotionally vulnerable  | .515 (.56) | .549 (.61) | .485 (.44) | .451 (.39) |
| Cognitively vulnerable  | .442 (.55) | .525 (.64) | .558 (.45) | .475 (.36) |

| Child protection services contact | No contact | Contact | No contact | Contact |
|-----------------------------------|------------|---------|------------|---------|
| Typically developing              | .798 (.80) | .601 (.63) | .202 (.20) | .399 (.37) |
| Emotionally vulnerable            | .583 (.63) | .380 (.44) | .417 (.37) | .620 (.56) |
| Cognitively vulnerable            | .507 (.63) | .416 (.49) | .493 (.37) | .584 (.51) |

| Parental mental illness | No record | Record | No record | Record |
|-------------------------|-----------|--------|-----------|--------|
| Typically developing    | .788 (.79) | .665 (.68) | .212 (.21) | .335 (.32) |
| Emotionally vulnerable  | .546 (.60) | .441 (.50) | .454 (.40) | .559 (.50) |
| Cognitively vulnerable  | .484 (.61) | .450 (.47) | .516 (.39) | .550 (.53) |

| Parental criminal offending | No record | Record | No record | Record |
|-----------------------------|-----------|--------|-----------|--------|
| Typically developing        | .793 (.79) | .615 (.64) | .207 (.21) | .385 (.36) |
| Emotionally vulnerable      | .552 (.60) | .407 (.47) | .448 (.40) | .593 (.53) |
| Cognitively vulnerable      | .477 (.61) | .474 (.53) | .523 (.39) | .526 (.47) |
Figure 1. Latent profile solutions at time 1 (T1; upper panel) and time two (T2; lower panel).
Figure 2. Latent transition probabilities between profiles at times one and two (T1, T2).
Ethical standards

The research was conducted with ethical approval from the NSW Population and Health Services Research Ethics Committee (HREC/15/CIPHS/21), and data custodian approvals granted by the relevant government departments.

Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.
1. Kim-Cohen J, Caspi A, Moffitt TE, Harrington H, Milne BJ, Poulton R (2003) Prior juvenile diagnoses in adults with mental disorder: developmental follow-back of a prospective-longitudinal cohort. Arch Gen Psychiatry 60 (7):709-717

2. Marin O (2016) Developmental timing and critical windows for the treatment of psychiatric disorders. Nat Med 22 (11):1229-1238. doi:http://dx.doi.org/10.1038/nm.4225

3. Bornstein MH, Hahn C-S, Haynes OM (2010) Social competence, externalizing, and internalizing behavioral adjustment from early childhood through early adolescence: Developmental cascades. Development and psychopathology 22 (4):717-735

4. Okado Y, Bierman KL (2015) Differential risk for late adolescent conduct problems and mood dysregulation among children with early externalizing behavior problems. Journal of Abnormal Child Psychology 43 (4):735-747

5. Jones DE, Greenberg M, Crowley M (2015) Early social-emotional functioning and public health: The relationship between kindergarten social competence and future wellness. American journal of public health 105 (11):2283-2290

6. Beitchman JH, Wilson B, Brownie E, Walters H, Inglis A, Lancee W (1996) Long-term consistency in speech/language profiles: II. Behavioral, emotional, and social outcomes. Journal of the American Academy of Child & Adolescent Psychiatry 35 (6):815-825

7. Snowling MJ, Bishop D, Stothard SE, Chipchase B, Kaplan C (2006) Psychosocial outcomes at 15 years of children with a preschool history of speech-language impairment. Journal of Child Psychology and Psychiatry 47 (8):759-765

8. Zhang X, Räsänen P, Koponen T, Aunola K, Lerkkanen MK, Nurmi JE (2018) Early Cognitive Precursors of Children's Mathematics Learning Disability and Persistent Low Achievement: A 5-Year Longitudinal Study. Child development

9. Jordan NC, Kaplan D, Ramineni C, Locuniak MN (2009) Early math matters: Kindergarten number competence and later mathematics outcomes. Developmental psychology 45 (3):850

10. Laursen BP, Hoff E (2006) Person-centered and variable-centered approaches to longitudinal data. Merrill-Palmer Quarterly 52 (3):377-389

11. Thomson KC, Guhn M, Richardson CG, Ark TK, Shoveller J (2017) Profiles of children's social–emotional health at school entry and associated income, gender and language inequalities: a cross-sectional population-based study in British Columbia, Canada. BMJ open 7 (7):e015353

12. Green MJ, Tzoumakis S, Laurens KR, Dean K, Kariuki M, Harris F, O'Reilly N, Chilvers M, Brinkman SA, Carr VJ (2017) Latent profiles of early developmental vulnerabilities in a New South Wales child population at age 5 years. Australian & New Zealand Journal of Psychiatry https://doi.org/10.1177/0004867417740208. doi:10.1177/0004867417740208

13. Broidy LM, Nagin DS, Tremblay RE, Bates JE, Brame B, Dodge KA, Fergusson D, Horwood JL, Loeber R, Laird R, Lynam DR, Moffitt TE, Petitt GS, Vitaro F (2003) Developmental trajectories of childhood disruptive behaviors and adolescent delinquency: a six-site, cross-national study. Dev Psychol 39 (2):222-245

14. Luby JL, Gaffrey MS, Tillman R, April LM, Belden AC (2014) Trajectories of preschool disorders to full DSM depression at school age and early adolescence: continuity of preschool depression. Am J Psychiatry 171 (7):768-776

15. Althoff RR, Verhulst FC, Rettew DC, Hudziak JJ, van der Ende J (2010) Adult outcomes of childhood dysregulation: a 14-year follow-up study. J Am Acad Child Adolesc Psychiatry 49 (11):1105-1116. e1101

16. Kiernan KE, Mensah FK (2009) Poverty, maternal depression, family status and children's cognitive and behavioural development in early childhood: A longitudinal study. J Soc Policy 38 (04):569-588

17. Reiss F (2013) Socioeconomic inequalities and mental health problems in children and adolescents: a systematic review. Soc Sci Med 90:24-31
18. Leinonen JA, Solantaus TS, Punamäki RL (2003) Parental mental health and children's adjustment: The quality of marital interaction and parenting as mediating factors. Journal of Child Psychology and Psychiatry 44 (2):227-241

19. Gilbert R, Widom CS, Browne K, Fergusson D, Webb E, Janson S (2009) Burden and consequences of child maltreatment in high-income countries. The Lancet 373 (9657):68-81

20. Font SA, Berger LM (2015) Child maltreatment and children's developmental trajectories in early to middle childhood. Child Dev 86 (2):536-556

21. Green MJ, Tzoumakis S, McIntyre B, Kariuki M, Laurens KR, Dean K, Chilvers M, Harris F, Butler M, Brinkman SA (2017) Childhood maltreatment and early developmental vulnerabilities at age 5 years. Child Dev

22. Hussey JM, Chang JJ, Kotch JB (2006) Child maltreatment in the United States: prevalence, risk factors, and adolescent health consequences. Pediatrics 118 (3):933-942

23. Norman RE, Byambaa M, De R, Butchart A, Scott J, Vos T (2012) The long-term health consequences of child physical abuse, emotional abuse, and neglect: a systematic review and meta-analysis. PLoS Med 9 (11):e1001349

24. Murray J, Farrington DP, Sekol I (2012) Children's antisocial behavior, mental health, drug use, and educational performance after parental incarceration: a systematic review and meta-analysis. Psychol Bull 138 (2):175

25. Laurens KR, Tzoumakis S, Kariuki M, Green MJ, Hamde M, Harris F, Carr VJ, Dean K (2017) Pervasive influence of maternal and paternal criminal offending on early childhood development: A population data linkage study. Psychol Med 47 (5):889-901

26. Carr VJ, Harris F, Raudino A, Luo L, Kariuki M, Liu E, Tzoumakis S, Smith M, Holbrook A, Bore M, Brinkman S, Lenroot R, Dix K, Dean K, Laurens KR, Green MJ (2016) New South Wales Child Development Study (NSW-CDS): an Australian multiagency, multigenerational, longitudinal record linkage study. BMJ Open 6 (2). doi:10.1136/bmjopen-2015-009023

27. Green MJ, Harris F, Laurens KR, Tzoumakis S, Dean K, Brinkman S, Chilvers M, Sprague T, Stevens R, Carr VJ (2018) Cohort Profile: The New South Wales Child Development Study (NSW-CDS) – Wave 2 (Child age 13 years). Int J Epidemiol

28. Janus, M., Brinkman, S., Duka, E.K., (2011). Validity and psychometric properties of the Early Development Instrument in Canada, Australia, United States, and Jamaica. Social Indic Research, 103, 283-297.

29. Laurens KR, Tzoumakis S, Dean K, Brinkman SA, Bore M, Lenroot RK, Smith M, Holbrook A, Robinson KM, Stevens R, Harris F, Carr VJ, Green MJ (2017) The 2015 Middle Childhood Survey (MCS) of mental health and well-being at age 11 years in an Australian population cohort. BMJ Open 7 (6):e016244. doi:https://dx.doi.org/10.1136/bmjopen-2017-016244

30. Australian Curriculum, Assessment and Reporting Authority 2014, National Assessment Program – Literacy and Numeracy 2013: Technical Report, ACARA, Sydney. https://www.nap.edu.au/_resources/NAPLAN_2013_technical_report.pdf

31. Pink B (2013) Socio-Economic Indexes for Areas (SEIFA) 2011: Technical Paper. Accessed 15 May 2015. edn. Australian Bureau of Statistics Commonwealth of Australia: Canberra.,

32. Muthén LK, Muthén BO (1998-2017) Mplus User's Guide. Eighth Edition. Muthén & Muthén, Los Angeles, CA

33. IBM Corp (2017). IBM SPSS for Macintosh, Version 25.0. Armonk, New York: IBM Corp.

34. Asparouhov T, Muthén B (2014) Auxiliary variables in mixture modeling: Three-step approaches using M plus. Structural Equation Modeling: A Multidisciplinary Journal 21 (3):329-341
35. Berlin KS, Williams NA, Parra GR (2014) An introduction to latent variable mixture modeling (part 1): Overview and cross-sectional latent class and latent profile analyses. Journal of Pediatric Psychology 39 (2):174-187

36. Jung T, Wickrama AS (2008) An introduction to latent class growth analysis and growth mixture modeling. Soc Personal Psychol Compass 2 (1):302-317

37. Celeux G, Soromenho G (1996) An entropy criterion for assessing the number of clusters in a mixture model. Journal of classification 13 (2):195-212

38. Moffitt T (2003) Life-course-persistent and adolescence-limited antisocial behavior: a 10-year research review and a research agenda. Causes of conduct disorder and juvenile delinquency:49-75

39. Rubio-Stipec M, Fitzmaurice G, Murphy J, Walker A (2003) The use of multiple informants in identifying the risk factors of depressive and disruptive disorders - Are they interchangeable? Soc Psychiatry Psychiatr Epidemiol 38 (2):51-58. doi:10.1007/s00127-003-0600-0

40. Lederberg Stone S, Speltz ML, Collett B, Werler MM (2013) Socioeconomic Factors in Relation to Discrepancy in Parent versus Teacher Ratings of Child Behavior. Journal of Psychopathology and Behavioral Assessment 35 (3):314-320. doi:10.1007/s10862-013-9348-3

41. Lahey BB, Schwab-Stone M, Goodman SH, Waldman ID, Canino G, Rathouz PJ, Miller TL, Dennis KD, Bird H, Jensen PS (2000) Age and gender differences in oppositional behavior and conduct problems: A cross-sectional household study of middle childhood and adolescence. J Abnorm Psychol 109 (3):488-503. doi:10.1037//0021-843x.109.3.488

42. Odgers CL, Moffitt TE, Broadbent JM, Dickson N, Hancox RJ, Harrington H, Poulton R, Sears MR, Thomson WM, Caspi A (2008) Female and male antisocial trajectories: From childhood origins to adult outcomes. Dev Psychopathol 20 (2):673-716. doi:10.1017/s0954579408000333

43. Whitten T, Laurens KR, Tzoumakis S, Kaggodaarachchi S, Green MJ, Harris F, Carr VJ, Dean K (2019) The influence of parental offending on the continuity and discontinuity of children's internalizing and externalizing difficulties from early to middle childhood. Social Psychiatry and Psychiatric Epidemiology 54 (8):965-975. doi: 10.1007/s00127-019-01670-5

44. Conti, G., Heckman, J. J. & Pinto, R. (2016) The effects of two influential early childhood interventions on health and healthy behaviour. Econ J 126, F28-F65, doi:10.1111/ecoj.12420.

45. Garcia, J. L., Heckman, J. J., Leaf, D. E. & Prados, M. J. (in press). Quantifying the life-cycle benefits of an influential early childhood program. J Polit Econ, doi:10.1086/705718 (2019).

46. Rohacek, M., Greenberg, E. & Massey, M. The State of the Science on Early Childhood Interventions: Pay for success early childhood education toolkit report #1. (Urban Institute, Washington DC, 2016).