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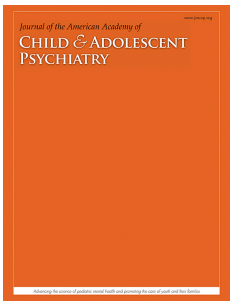

Cross-domain Symptom Development Typologies and Their Antecedents: Results From the UK Millennium Cohort Study

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Cross-Domain Symptom Development Typologies and Their Antecedents: Results From the UK Millennium Cohort Study

RH = Childhood Symptom Development

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ABSTRACT

Objective. Typologies of symptom development have been used to identify individuals with different symptom development in the externalising and internalising domains of child psychopathology separately – albeit the domains' high comorbidity and shared common aetiological risk. This study identifies typologies of development across both symptom domains in childhood, investigates their associated antecedents with a specific focus on the comparisons between overall severity of symptoms, and symptom expression in one or the other domain.

Method. Latent class analysis identified groups based on **e**motional and behavioural symptoms assessed at ages 3,5,7, and 11 in the UK Millennium Cohort Study (N=15,439). A range of socio-demographic, family structure and environment, birth, infancy, and early childhood antecedents are examined.

Results. Five groups were identified: 1. low symptoms (57%), 2. moderate behavioural (21%), 3. moderate emotional (12.5%), 4. high emotional-moderate behavioural (5.5%), and 5. high behavioural-moderate emotional (4%). Higher symptoms are predicted by greater numbers of antecedents and risk factors, both when compared to the low symptom group and when comparing groups with moderate and high levels of symptoms in either domain (groups 5v2 and 4v3). Comparisons of groups with similar overall symptom levels but different dominant symptom domain (groups 2v3 and 4v5) indicate that apart from gender and ethnicity, there are few unique antecedents of whether children mainly internalise or externalise their symptoms.

Conclusion. It is possible and useful to define groupings or typologies jointly across both externalising and internalising symptom development in childhood. Although numerous antecedents predict the experience of symptoms, there are few unique antecedents that differentiate between individuals with similarly high levels of overall symptoms expressed in

internalising or externalising domains. Identification of at-risk children and delivery of early intervention might benefit from a reduced focus on symptom domain with possible downstream effects through the lifecourse for most common psychiatric disorders.

Key words. Trajectories, internalizing, externalizing, comorbidity, correlates

INTRODUCTION

The development of mental illness through childhood is complex, and population average estimates of symptom development over time can obscure subgroups with different patterns of symptom development. Externalising and internalising symptoms have been successfully employed as the two broad domains representing common childhood psychiatric disorders, and there has been much research examining heterogeneous person-centred typologies in symptom development, especially for externalising symptoms.[1-5] These approaches that focus on identifying developmental typologies based on differences in symptom development have led to uncovering more information about aetiology, longitudinal risk, mechanisms, and consequences of symptom development.[1-6]

However, comorbidity is high between symptoms in these two domains, both concurrently and sequentially. Cross-sectional correlations of symptoms range up to 0.6, and 29-45% of young people in community-based samples with clinical levels of emotional or behavioural symptoms concurrently experience high levels of symptoms in the other domain.[7-9] Longitudinal co-development in symptoms, estimated using latent growth models, indicates that these two domains are not only associated cross-sectionally, but also that changes in one domain are positively associated with changes in the other.[10,11] To understand the longitudinal associations and symptom development in these two domains, many studies have focused on the longitudinal relationship in terms of which symptoms are precursors to which,[12] or the cascading nature of symptom development.[13] Studies attempting to take a person-centred approach have identified groups of children based on internalising,

externalising, or comorbid groupings at cross-sections in development,[14,15] and some studies have estimated the probabilities of transitioning between these groups over time.[16,17] This body of research suggests that to a greater extent, behavioural symptoms precede emotional symptoms,[11,12] a probably unsurprising finding given the former is more prevalent in childhood and the latter in adolescence.[18] Although there has been much focus on understanding longitudinal "which-comes-first" relationships between these domains, there have been no identified studies jointly identifying heterogeneous typologies of symptom development across both these domains longitudinally.

Investigations of antecedents and risk factors for internalising and externalising domains mostly identify common risk factors (e.g. dysregulation, socioeconomic deprivation).[19] In light of these findings, we examine whether different developmental typologies of symptoms across these domains have any unique antecedents. In addition to comparing groups with symptoms to a group with no/low symptoms,[4,6] we propose planned comparisons between groups of theoretical interest based on overall levels of symptoms and the dominant domain of symptoms. For example, by directly comparing risk factors for groups that have similar overall levels of symptoms but have greater emotional or behavioural symptoms, we understand from a person-centred approach whether the antecedents are indeed more similar than different for these symptom domains and, if different, which risk factors uniquely predict externalising or internalising symptomatology. This information, if better understood at the population level, would have implications for screening, identification, and intervention earlier in the lifecourse.

In summary, a tradition of examining heterogeneous typologies of symptom development in population-based longitudinal studies has led to greater understanding of developmental heterogeneity and associated risk factors for both externalising and internalising symptoms. Nevertheless, the high cross-sectional and longitudinal associations

between these domains suggest considering developmental typologies in one domain while ignoring symptom development in the other might not be optimal. The current study aims to examine whether distinct heterogeneous typologies of symptom development across both emotional and conduct problem symptoms can be identified in childhood (from ages 3-11 years). Subsequently, we investigate a wide range of socio-demographic, family, and early childhood antecedents of the different symptom development groupings.

METHOD

Participants

Participants are from the Millennium Cohort Study (MCS), a UK birth cohort study of individuals born at the start of the millennium (September 2000 – January 2002) who have been assessed at five waves through childhood – at ages 9 months, 3, 5, 7, and 11 years. The study uses a stratified cluster design and includes all regions and countries of the UK. Cohort members were identified from child benefit (a universal benefit) records, and includes children born between September 2000 and January 2002. Greater details of the study design, variables, and attrition can be found at www.cls.ioe.ac.uk.[20] For the purposes of this research, the sample consisted of 15,439 children (48.9% girls) with mental illness symptom data available for at least two of the four waves where symptoms were assessed (waves 2-5, ages 3-11 years).

Compared to the full MCS sample at sweep 1 (age 9 months, N=18,818), weighted proportions indicate that the analysed sample has slightly fewer children from lower income households (18% in analysed sample compared to 18.9% in original sample) and fewer children from ethnic minorities (11.3% in analysed sample compared to 12.6% in original sample).

Measures

Emotional and behavioural symptoms. The two main outcomes, emotional and

behavioural difficulties, are measured at each wave using the Strengths and Difficulties Questionnaire (SDQ)[21] reported by a parent or guardian (>95% mothers). Both the SDQ emotional symptoms scale (e.g. often seems worried) and conduct problems scale (e.g. often has temper tantrums) consist of five items. Items in each of the scales are summed to create an overall score ranging from 0-10, with a higher score indicating greater difficulties. A score of 5 (4 at age 3) or higher on the emotional subscale and 4 (6 at age 3) or higher on the conduct subscale is indicative of high levels of symptoms (www.sdqinfo.com).

Antecedents. With the aim of investigating a range of distinct antecedents, variables predicting childhood symptom development typologies in this study are considered under four broad headings: 1) socio-demographic, 2) family structure and environment, 3) birth and infancy factors, and 4) early childhood factors. Antecedents were assessed at Sweeps 1 and 2 (9 months and 3 years). Measure details, reporter, and sweep for each variable are included in Supplement 1, available online, and Table 1 presents the full list of predictors and their descriptive statistics (% for categorical and means for continuous variables).

Analysis

Identifying typologies of childhood symptom development. Typologies of emotion and behaviour symptom development over childhood were identified using latent class analysis[22] in Mplus7.[23] Models with 2 to 8 classes were estimated to identify the model with the best solution/optimum number of classes. Criteria used to assess and select a k-trajectory model for further analysis included model comparisons, model fit, neatness of classification and interpretability.[24] Model selection was based on comparing log likelihood estimates of k-trajectory model with k-1 trajectory model using log-likelihood difference test. Model fit was estimated using the sample-adjusted Bayesian information criterion (A-BIC), neatness of classification was assessed using entropy, and posterior probabilities and interpretability were assessed based on theoretical relevance and proportions in identified groups.[24]

Participants with a minimum of two timepoints available were included in analysis (N=15,439), with Full Information Maximum Likelihood in Mplus accounting for missing data under the Missing At Random (MAR) assumption, which in this stage of the analysis implies that missing responses depend on the observed values of emotional and behavioural symptoms. Survey design (strata, clusters, and weighting) were incorporated into these models using the cluster and weight options in Mplus.

Antecedents of identified groups. We examine the predictors of identified typologies in two ways. We first conduct a multinomial logistic regression analysis, where the full set of antecedents are included as predictors in the model when comparing belonging to a certain group of symptom development with the reference group (the group with the largest proportion of children: low symptom group). We subsequently conduct planned comparisons of predictors between pairs of trajectory groups (using logistic regression) based on theoretical interest in differences between them, adjusting for multiple pair-wise comparisons using a Bonferroni correction. All coefficients presented for the multinomial and logistic regressions are adjusted for the other predictors in the model.

In this stage of analysis, multiple imputation with chained equations *(n=25)* was carried out to impute values on missing predictors. Demographic characteristics such as sex, ethnicity, number of siblings, and month of birth had no missing values. Overall missing cells were at 7.9% of the total, with missing-ness varying from as low as n=1 for parent education (0.006%) to highs of 18.2% for maternal and 32.9% for paternal psychological distress. Given the stratified clustered sample design of the MCS and to account for subgroup oversampling and attrition over waves, all analyses were conducted accounting for the survey design and applying weights using the *svy* commands in STATA.[25]

In terms of the correlations between the predictor variables, given variables were chosen to represent distinct aspects of the child's environment and development, and the

majority of correlations were below +/-0.3. The exceptions were the family socioeconomic factors (correlations ~0.5), maternal age at birth correlated ~0.33 with the socio-economic variables, parent–child conflict correlated 0.4 with emotional dysregulation, and lastly cognitive ability and school readiness, correlated 0.45. The low correlations between the predictor variables limit concerns regarding collinearity in the models.

RESULTS

Typologies of Emotional and Behavioural Difficulties Through Childhood

Based on the latent class analyses, the 5-class model was selected due to its relative better fit with respect to a range of criteria. Log-likelihood differences indicated the 5-trajectory model was significantly better than the 4-trajectory model (LRT[9] = 2469.54, $p <$ .001), with the 6-trajectory model not being identified. The A-BIC was significantly lower on a steep trajectory compared to smaller class models, indicating improved model fit (A-BIC difference = 2411.34). The selected 5-class model also had good classification fuzziness (entropy = 0.84), which was similar to the 4-class model (0.847) and slightly lower than the 2-class model (0.87), which was, however, less useful as it simply classified the sample into high and low symptom groups, whereas the groups derived from the 5-class model were theoretically/clinically more meaningful. The high entropy (>0.80) permitted the use of most likely class membership directly in all further analysis.[26]

< Figure 1 around here>

Figure 1 demonstrates the mean emotional and behaviour symptoms scores for the sample in each identified group. The age standardised scores across the entire analysed sample are also presented for each group. As can be seen from the figure, the largest group of children (group 1) had low symptoms in both domains across all of childhood (57% of the sample, n=8,763). Groups 2 and 3 include children with low symptoms in one domain and moderate symptoms in the other – 21% of the sample experiences moderate levels of

behaviour difficulties and 12.5% of children demonstrated moderate emotional symptoms. Group 4 included 854 children (5.5%) with high levels of emotional symptoms and moderate behavioural symptoms, which seem to peak at age 5 and then take a downward trajectory. The smallest identified group included 4% of the sample (group 5, n=627) with clinical levels of behavioural symptoms and moderate levels of emotional symptoms. The average level of symptoms across the two domains and the four time points for each of the groups were as follows: group 1, low symptoms (M=0.93, SD=0.48), group 2, moderate behavioural (M=2.23, SD=0.55), group 3, moderate emotional (M=2.34, SD=0.51), group 4, high emotional, moderate behavioural (M=4.16, SD=0.75), and group 5, high behavioural, moderate emotional (M=4.07, SD=0.89). As can be seen from these averages, mean overall level of symptoms in groups 2 vs. 3 (moderate behavioural and emotional groups) and groups 4 vs. 5 (high emotional and behavioural groups) were almost identical, forming the basis for the first set of planned comparisons that are presented later in the article. Table 1 includes descriptive statistics for the emotional and behavioural symptoms and the predictors included in analysis both for the overall sample and for each of the identified groups.

<Table 1 around here>

Antecedents of Identified Groups

Table 2 presents results of a multinomial logistic regression, with the largest group (group 1) consisting of children with low symptoms in both domains across childhood used as the reference category in analysis.

Sex was not a particularly strong predictor of group membership across all the groupings identified. Boys were more likely to have moderate behavioural and high behavioural symptoms (groups 2 and 5) compared to girls. Asian children were less likely to have moderate or high behaviour problems, and Black African children were less likely to have any of the higher symptom trajectories compared to White children in the sample.

Children from lower income households were more likely to belong to all the higher symptom trajectory groups when compared to children from high income households, with indications of a gradient of risk from low to higher income quintiles. Parents having no or low educational qualifications and being unemployed predicted higher likelihood of some high symptoms groups, especially the moderate emotional symptoms group, compared to children from higher educated households and parents in higher occupational categories. Children with 1 or 2 siblings were more likely to have moderate behavioural symptoms compared to children with no siblings. Greater maternal mental ill-health predicted higher likelihood of belonging to all the higher symptom classes compared to the low symptom group. Greater paternal psychological distress was associated with a lower likelihood of moderate behavioural difficulties (group 2). Poorer parental relationship state and greater parent–child conflict predicted children being in all the higher symptom classes compared to in the low symptom group.

< Table 2. around here>

In terms of the birth and infancy factors, greater maternal age predicted lower likelihood of a child being in the group with high behavioural and moderate emotional symptoms. Maternal smoking during pregnancy predicted children having moderate and high behavioural symptoms. Birthweight significantly predicted membership to group 5 (high behaviour and moderate emotional symptoms) whereby higher birthweights predicted lower likelihood of belonging to this group. Withdrawal/apprehension and poor adaptability in infancy predicted a higher likelihood of belonging to the group with moderate emotional and low behavioural symptoms across childhood. Higher infant regularity predicted lower likelihood of belonging to the groups with moderate levels of either emotional or behavioural symptoms.

Concerning early childhood factors, poor health increased the likelihood of belonging

to all the higher symptom groupings compared to the low symptom group. Cognitive ability did not predict group membership, and greater school readiness was associated with a lower likelihood of experiencing high behavioural and moderate emotional symptoms (group 5). Self-regulation and dysregulation in early childhood predicted group membership to all the higher symptoms groups to different degrees.

Planned comparisons. To further understand the differences between these groups of children, two sets of planned comparisons were undertaken. The first set focuses on comparing groups with similar levels of overall symptoms but with higher expression in contrasting domains – between groups with moderate symptoms in one and low symptoms in the other domain (groups 2v3) and high overall symptoms with high symptoms in one and moderate in the other domain (groups 4v5).

The second set of planned comparisons are between groups with similar developmental trajectories, albeit to different severity (so comparing groups with moderate and high symptoms in the same domain), emotional (groups 3v4) and behavioural (groups 2v5). Given the multiple pairwise planned comparisons, a Bonferroni correction is applied to the p value of .05 resulting in an alpha value of 0.0125 (=0.05/4).

<Table 3 around here>

Planned Comparisons 1, Groups With Similar Overall Symptom Levels. In the comparison of the two groups with moderate symptoms (Table 3), girls were more likely to belong to group 3 (moderate emotional symptoms) compared to group 2 (moderate behavioural symptoms). Apart from sex, the main predictors of membership to one of these groups compared to the other were: Ethnicity (Pakistani and Bangladeshi children more likely to be in group 3), children with 2 or more siblings less likely to be in the moderate emotional symptom group, greater maternal psychological distress predicted moderate emotional symptoms and maternal smoking during pregnancy predicted moderate behavioural

symptoms, infant apprehension predicted a greater likelihood of having moderate emotional symptoms (group 3), and higher dysregulation predicted having moderate behavioural symptoms (group 2).

Comparing groups with severe symptoms (groups 4v5), girls and Asian children were less likely to be in the group with higher behavioural problems. Only two other predictors in the model differentially predicted group membership: children with older mothers at birth were less likely to be in the group with higher behavioural symptoms, while infant withdrawal/apprehension predicted higher likelihood of having higher emotional symptoms.

Planned comparisons 2, groups with identical dominant symptom domain, differing severity. Comparing the groups with higher emotional symptoms but to different degrees of severity (groups 3 and 4), we see that no socio-demographic characteristics predicted group membership. Greater maternal psychological distress, parent–child conflict, relative younger age, poorer physical health, and higher emotional dysregulation predicted belonging to the higher symptom group (group 4).

Comparing the groups with higher behavioural symptoms but differing severity levels (group 2 and 5), girls were less likely to be in the higher behavioural problems group. Maternal psychological distress, parent–child conflict, and lower maternal age at birth predict higher odds of belonging to the higher behavioural symptom group with accompanying emotional symptoms (group 5), compared to the moderate behavioural symptoms group (group 2).

DISCUSSION

The current study explored typologies of symptom development across both the internalising and externalising domains in childhood. This advancement contributes to a large literature where person-centred typologies in symptom development have so far been explored separately in these domains, albeit the acknowledged presence of moderate levels of

co-morbidity in symptoms. The results of this study indicate that it is possible to derive meaningful groupings of children based on symptom development across both these domains from ages 3 to 11 years. Five groups of children were robustly identified: the majority group with low symptoms across both domains (57% of the sample), groups with moderate emotional or behavioural symptoms and low symptoms in the other domain, and two groups with high symptoms in one domain and moderate symptoms in the other domain.

Examining a range of socio-demographic and early childhood antecedents clarifies the factors that predict children will belong to any of the four higher symptom groupings when compared to the majority low symptom group. In line with existing literature, a range of risk factors are identified for most of the higher symptom trajectory groups including sex, income, occupation, maternal psychological distress, parent–child conflict, parental relationship state, relative age, infant adaptation and apprehension withdrawal, and early childhood independence and emotional dysregulation. Some other risk factors were specific to certain groups such as maternal smoking during pregnancy and lower parent education (higher likelihood of behavioural symptom groups), Asian ethnicity and higher school readiness (lower likelihood of higher behavioural symptom groups), parent–child closeness, greater home safety, having one sibling and higher cognitive ability (lower likelihood of high emotional, moderate behavioural symptom group). Similarly, the planned comparisons between groups with the same main symptom group (planned comparisons 2) highlight that the overall level of symptoms are sensitive to some childhood predictors, whereby higher levels of symptoms are predicted by a greater number of risk factors that might predispose children to expressing symptoms in either or both of these domains.

Notably, the planned comparisons between groups with similar overall levels of symptoms, but with greater symptoms in one or the other domain (planned comparisons 1) demonstrate that apart from sex and ethnicity, very little predicts whether children internalise

or externalise their symptoms, especially in the high overall symptom groups. This is a revealing finding, suggesting that ultimately the risk factors mainly predict the overall level of psychological distress experienced by children. This lends support to the hypothesis that common aetiological factors mainly underlie most forms of common mental health disorders. This is corroborated by recent advances in understanding the structure of psychopathology whereby general psychopathology is statistically represented by the common variance across all disorders,[27,28] emerging findings from behavioural genetic models where the shared genetic risk associated with internalising and externalising disorders seem to be more similar than distinct,[29] and neuroimaging studies indicating similar brain structure deficits across multiple common psychiatric disorders.[30] The two antecedents that predicted higher emotional symptoms when overall levels of symptoms were high included maternal age at birth and infant apprehension. At moderate symptom levels, maternal psychological distress and infant apprehension predicted greater likelihood of emotional symptom expression and maternal smoking, parent–child conflict, having two or more siblings, and childhood dysregulation predicted expressing moderate behavioural symptoms. These unique predictors would benefit from further investigation to assess if they replicate and to understand the specific pathways through which they operate.

It is important to recognise that although not many unique risk factors of moderate or high symptoms in one domain compared to the other were identified, it is possible that the outcomes of these different developmental paths and the treatments that are most effective vary. With regards to outcomes, for instance, heterogeneous trajectory-based approaches have demonstrated that children with higher internalising and externalising symptom trajectories have poorer academic outcomes[6,31]; however, the negative impact seems larger and more consistent for externalising problems.[6,31] Given that we have identified childhood symptom development trajectories in an ongoing longitudinal study, future research can

investigate whether these identified symptom typologies are associated with differential future outcomes in a range of domains (economic, social, education, etc.).

A key strength of this study is the use of the MCS, a current, nationally representative sample of thousands of children in the UK, allowing generalisability of findings to the population. The sample also provides the opportunity to investigate short- and long-term outcomes of the identified typologies as the cohort moves through adolescence and adulthood. The main limitation is the brief parent-reported symptom checklist used in the study; however, more detailed instruments or clinical interviews were not feasible as part of data collection in such a large, multidisciplinary study. Moreover, research indicates the SDQ is a valid proxy for symptom levels in community samples and corresponds to levels of clinical disorder.[32] A key limitation of this study is shared method variance, whereby both the main outcomes and a substantial proportion of the antecedents were based on maternal report (in the majority of individuals in the sample). This is likely to have biased some of the findings, in particular the influence of maternal psychological distress on children's symptoms.[33] Although there was limited multicollinearity in the predictors and they were selected to represent different aspects of a child's environment and development, given the multivariate approach used in the study, a causal interpretation cannot be made, and some variables might be important but have small or insignificant effects in the models as their effect might be mediated by other variables. Furthermore, there may be unmeasured confounding from variables, especially related to genetic influences on these symptoms, which were not included as risk factors in our model. Although all known pathways through which genes might affect the findings were accounted for in the models, this assumption is not testable. However, for the main findings of the study to be overturned, a strong negative confounding or suppression would be necessary.

In conclusion, the study illustrates that it is possible and useful to define groupings or

typologies jointly across both internalising and externalising symptom development in childhood. The findings highlight that, apart from some gender and ethnic differences, there are mainly common risk factors for groups with similar overall levels of symptoms, irrespective of how the symptoms are manifested. These findings suggest that identification of at-risk children can be more streamlined, focussing more on overall risk and severity, rather than symptom domain. This has implications for both how we understand clinical symptom development and comorbidity in mental health and for interventions and policy development, whereby it might be possible and useful for screening and support to be targeted across most common risk factors for both disorders.

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Figure caption:

Figure 1. Mean symptom and age standardised emotional and behaviour symptom scores at ages 3,5,7, and 11 years in the identified groups. Note: SDQ = Strengths and Difficulties Questionnaire.

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Supplement 1

Measures

Details of the antecedents included as predictors in the models are presented below (under the four broad headings of socio-demographic factors, family structure and environment, birth and infancy related variables and early childhood factors) and in Table S1.

Socio-demographic. Gender, ethnicity, and different markers of family socioeconomic status are included. Ethnicity is recorded using the Office for National Statistics 8-categories, White, Mixed, Asian-Indian, Asian-Pakistani, Asian-Bangladeshi, Black-Caribbean, Black-African, and other ethnic group. Household income was represented in Organisation for Economic Co-operation and Development (OECD) UK equivalised quintiles (1= lowest, 5= highest income quintile). Parent education is represented by the highest National Vocational Qualifications (NVQ) level in the household (NVQ levels 1-5, where NVQ level 1 represents General Certificate of Secondary Education grade D-G and level 5 represents having a higher degree/diploma,[1] with a separate category for other/overseas qualifications/no qualifications. Employment status and occupational class is represented using the National Statistics Socio-economic Classification (NS-SEC) three class coding of higher managerial and professional occupations, intermediate occupations, and routine and manual occupations,[2] and a separate fourth category denoting a workless household.

Family structure and environment. Family structure variables included in the analysis are lone parent and number of siblings (none, 1, 2, or 3+). Family environment variables assessed in early childhood (age 3) are: maternal and paternal psychological distress measured using the Kessler K6 scale,[3] where higher scores are indicative of greater psychological distress; parent–child conflict and closeness were assessed using the Pianta Child-Parent Relationship Scale, 15-item short form.[4] Relationship between parents in household was measured using a 7-item version of the Golombok-Rust Inventory of Marital State averaged across both respondents at waves 1 and 3, where higher scores reflect greater discord.[5] Home safety was assessed via smoking in household (any respondent smokes=1) and an interviewer-rated home safety measure at wave 2 using 6 items from the Observation for Measurement of the Environment scale[6] that assessed elements of the cleanliness, safety, and environment of the home.

Birth and Infancy. Variables relating to the birth of the child are maternal age at birth, planned or unplanned pregnancy, whether mother smoked during pregnancy, birthweight of child in kilograms and month of birth (as a reflection of relative age throughout childhood). Infant development variables included motor delay at 9 months and infant temperament assessed using four subscales of the Carey Infant temperament scale: infant mood (5-items), approach-withdrawal (3 items), adaptability (2 items), and regularity (4 items).[7,8]

Early childhood. Poor physical health in early childhood was assessed based on parents reporting that their child suffered from a major chronic or longstanding illness (e.g. asthma, eczema) in childhood. Cognitive ability, school readiness, and regulation assessed at age 3 years were examined as predictors of symptom development over childhood. Cognitive

ability and functioning were measured using the British Ability Scales Naming Vocabulary task[9] and the Bracken School Readiness score reflecting basic concept development in children using six subtests (colours, letters, numbers, sizes, comparisons and shapes) of the Bracken Basic Concept Scale – Revised.[10] Items from the Child Social Behaviour Questionnaire assessing Independence, Self-Regulation (e.g. likes to work things out for self) and Emotional Dysregulation (e.g. shows mood swings) were completed by a parent.[7]

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Cross-domain Symptom Development Typologies and Their Antecedents: Results From the UK Millennium Cohort Study

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Table 1. Descriptive Statistics for Symptom Levels at Different Ages and the Predictors Included in Analysis for the Overall Sample and the Identified Groups

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	Overall Sample	Group 1 Low symptoms	Group 2 Moderate behavioral	Group 3 Moderate emotional	Group 4 High emotional, moderate behavioral	Group 5 High behavioral, moderate emotional
	Mean or % (95% CI)	Mean or % (95% CI)	Mean or % (95% CI)	Mean or % (95% CI)	Mean or % (95% CI)	Mean or % (95% CI)
N	*15,439*	*8,763*	*3,264*	*1,931*	*854*	*627*
Emotional symptoms						
at 3	1.37 (±0.03)	0.87 (±0.03)	1.28 (±0.05)	2.26 (±0.07)	3.82 (±0.10)	1.79 (±0.12)
at 5	1.39 (±0.03)	0.74 (±0.03)	1.14 (±0.05)	2.84 (±0.06)	4.66 (±0.09)	2.10 (±0.11)
at 7	1.54 (±0.03)	0.75 (±0.03)	1.26 (±0.05)	3.32 (±0.07)	5.23 (±0.10)	3.31 (±0.12)
at 11	1.87 (±0.03)	1.02 (±0.05)	1.98 (±0.09)	3.39 (±0.11)	4.87 (±0.17)	4.25 (±0.20)
Behavioral symptoms						
at 3	2.82 (±0.03)	1.91 (±0.06)	4.00 (±0.10)	2.78 (±0.13)	5.15 (±0.19)	5.63 (±0.22)
at 5	1.52 (±0.02)	0.74 (±0.02)	2.57 (±0.04)	1.27 (±0.05)	3.28 (±0.07)	4.61 (±0.09)
at 7	1.40 (±0.02)	0.56 (±0.02)	2.54 (±0.03)	1.10 (±0.04)	3.13 (±0.06)	5.22 (±0.07)
at 11	1.38 (±0.03)	0.64 (±0.03)	2.48 (±0.04)	1.11 (±0.06)	2.72 (±0.08)	5.19 (±0.10)
Socio-demographic characteristics						
Sex (% female)	48.87 (±0.96)	50.82 (±1.21)	43.14 (±2.07)	53.26 (±2.65)	48.51 (±3.9)	35.6 (±4.07)
Ethnicity						
White	88.73 (±1.95)	89.26 (±1.91)	90.05 (±2.04)	86.09 (±3.14)	81.97 (±4.05)	90.82 (±2.62)
Mixed	3.04 (±0.46)	3.03 (±0.58)	2.77 (±0.71)	2.96 (±0.88)	4 (±1.62)	3.72 (±1.69)
Indian	1.69 (±0.47)	1.82 (±0.57)	1.25 (±0.47)	1.91 (±0.82)	2.31 (±1.16)	0.49 (±0.52)
Pakistani	2.51 (±1.11)	1.83 (±0.8)	2.75 (±1.29)	4.28 (±2.09)	5.65 (±2.76)	2.01 (±1.26)
Bangladeshi	0.78 (±0.38)	0.71 (±0.34)	0.54 (±0.33)	1.18 (±0.69)	1.85 (±1.16)	0.41 (±0.41)
Caribbean	0.87 (±0.38)	0.84 (±0.4)	0.89 (±0.43)	0.7 (±0.45)	1.34 (±1.08)	1.2 (±0.98)
African	1.26 (±0.49)	1.51 (±0.58)	0.86 (±0.41)	1.05 (±0.69)	0.94 (±0.75)	0.71 (±0.78)
Other	1.12 (±0.36)	1.00 (±0.3)	0.9 (±0.42)	1.85 (±1.03)	1.94 (±1.08)	0.65 (±0.77)
Income						
Lowest quintile	17.98 (±1.23)	12.5 (±1.01)	23.77 (±1.95)	19.71 (±2.33)	38.64 (±3.74)	39.28 (±3.95)
2nd quintile	18.54 (±1.15)	15.51 (±1.22)	23.07 (±1.88)	18.97 (±2.16)	27.32 (±3.36)	28.4 (±3.93)
3rd quintile	20.31 (±1.11)	20.51 (±1.34)	20.10 (±1.73)	22.63 (±2.31)	15.4 (±2.82)	17.12 (±3.16)
4th quintile	21.18 (±1.02)	23.71 (±1.28)	18.68 (±1.76)	20.22 (±2.31)	12.09 (±3.04)	10.43 (±3.0)
Highest quintile	21.98 (±2.15)	27.76 (±2.48)	14.38 (±2.34)	18.46 (±2.68)	6.54 (±2.11)	4.78 (±2.16)
Parent education						
None/other	7.93 (±0.79)	4.92 (±0.62)	10.15 (±1.35)	9.23 (±1.61)	19.32 (±2.9)	23.59 (±3.87)
NVQ 1	5.01 (±0.49)	3.46 (±0.49)	7.41 (±1.12)	4.83 (±1.08)	9.63 (±2.2)	10.7 (±2.78)
NVQ 2	24.11 (±1.34)	21.25 (±1.47)	28.59 (±2.15)	25.04 (±2.6)	31.21 (±4.34)	32.00 (±3.88)
NVQ 3	15.7 (±0.89)	15.78 (±1.17)	15.98 (±1.64)	15.12 (±1.96)	16.15 (±2.77)	14.07 (±3.4)
NVQ 4	39 (±1.77)	44.21 (±1.9)	32.78 (±2.53)	37.97 (±3.05)	21.25 (±3.94)	17.99 (±3.86)
NVQ 5	8.27 (±1.06)	10.38 (±1.25)	5.09 (±1.19)	7.80 (±1.75)	2.43 (±1.28)	1.65 (±1.13)
Occupation						
Higher managerial	48.75 (±2.17)	56.7 (±2.21)	38.39 (±2.78)	46.35 (±3.29)	24.69 (±4.29)	20.22 (±3.81)
Intermediate	21.28 (±0.96)	21.46 (±1.24)	21.86 (±1.87)	21.36 (±2.39)	20.01 (±2.98)	16.71 (±3.23)
Routine/manual	27.51 (±1.71)	20.6 (±1.59)	36 (±2.49)	30.05 (±2.91)	47.84 (±4.54)	54.19 (±4.47)
Workless household	2.47 (±0.36)	1.24 (±0.26)	3.74 (±0.73)	2.24 (±0.75)	7.47 (±2.21)	8.88 (±2.42)
Family Structure and environment						
Lone parent	13.7 (±0.92)	10.07 (±0.82)	17.76 (±1.58)	13.79 (±2.11)	24.83 (±3.56)	33.5 (±4.95)
Siblings (0)	26.2 (±0.94)	26.43 (±1.28)	24.14 (±1.71)	26.73 (±2.5)	28.92 (±3.65)	28.5 (±3.9)
Siblings (1)	46.88 (±1.08)	47.74 (±1.36)	46.99 (±2.02)	48.25 (±2.7)	37.96 (±3.64)	39.84 (±3.94)
Siblings (2)	18.27 (±0.76)	17.98 (±0.97)	19.26 (±1.61)	16.96 (±2.01)	19.78 (±3.29)	19.7 (±3.72)
Siblings (3+)	8.65 (±0.56)	7.85 (±0.69)	9.61 (±1.18)	8.05 (±1.36)	13.33 (±2.76)	11.95 (±2.69)
Maternal psych. distress	3.23 (±0.09)	2.51 (±0.09)	3.78 (±0.17)	3.93 (±0.2)	6.03 (±0.4)	5.61 (±0.48)
Paternal psych. distress	2.98 (±0.1)	2.65 (±0.1)	3.31 (±0.17)	3.22 (±0.21)	4.09 (±0.37)	4.13 (±0.44)
Parent relationship	1.94 (±0.01)	1.85 (±0.01)	2.06 (±0.02)	2 (±0.03)	2.19 (±0.06)	2.24 (±0.07)
Parent–child conflict	17.72 (±0.11)	16.29 (±0.11)	19.72 (±0.21)	18.29 (±0.26)	21.71 (±0.5)	22.04 (±0.59)
Parent–child closeness	33.08 (±0.05)	33.4 (±0.05)	32.72 (±0.1)	32.93 (±0.12)	32.03 (±0.25)	31.94 (±0.29)
Smoking household	39.41 (±1.28)	33.41 (±1.38)	49.11 (±2.37)	38.4 (±2.59)	52.64 (±4.2)	66.24 (±4.62)
Home safety	0.93 (±0)	0.94 (±0)	0.92 (±0.01)	0.93 (±0.01)	0.87 (±0.02)	0.87 (±0.02)
Birth and infancy factors						
Maternal age at birth	29.07 (±0.24)	29.86 (±0.23)	28.19 (±0.36)	28.74 (±0.38)	27 (±0.49)	25.33 (±0.6)
Unplanned pregnancy	40.95 (±1.27)	36.27 (±1.48)	46.72 (±2.16)	41.54 (±2.78)	54.43 (±4.21)	62.97 (±4.64)
Smoked during pregnancy	22.87 (±1.19)	17.36 (±1.16)	32.27 (±2.15)	19.51 (±2.26)	36.77 (±4.29)	50.56 (±4.81)
Birthweight	3.37 (±0.01)	3.40 (±0.01)	3.36 (±0.03)	3.35 (±0.04)	3.25 (±0.05)	3.25 (±0.06)

Gross motor delay	10.61 (±0.66)	9.52 (±0.8)	11.1 (±1.34)	12.25 (±1.7)	16.08 (±2.89)	12.44 (±2.93)
Relative age	5.4 (±0.07)	5.31 (±0.09)	5.56 (±0.16)	5.32 (±0.19)	5.71 (±0.27)	5.79 (±0.3)
Mood	3.84 (±0.02)	3.89 (±0.02)	3.8 (±0.03)	3.78 (±0.04)	3.74 (±0.06)	3.75 (±0.07)
Apprehension-withdrawal	1.83 (±0.02)	1.77 (±0.02)	1.84 (±0.04)	1.96 (±0.05)	2.11 (±0.07)	1.86 (±0.08)
Adaptation	2.15 (±0.02)	2.08 (±0.02)	2.16 (±0.04)	2.31 (±0.06)	2.43 (±0.09)	2.22 (±0.1)
Regularity	4.3 (±0.02)	4.37 (±0.02)	4.23 (±0.03)	4.25 (±0.04)	4.03 (±0.08)	4.08 (±0.08)
Early childhood factors						
Poor physical health	58.27 (±1.1)	54.77 (±1.31)	61.86 (±1.97)	62.01 (±2.69)	69.52 (±4.1)	66.42 (±4.72)
Cognitive ability	5.04 (±0.1)	5.42 (±0.1)	4.59 (±0.15)	4.88 (±0.2)	3.69 (±0.25)	3.7 (±0.3)
Bracken School readiness	25.89 (±0.61)	27.89 (±0.61)	23.41 (±0.77)	24.97 (±1.03)	20.09 (±1.35)	18.87 (±1.31)
Self-regulation: independence	2.46 (±0.01)	2.5 (±0.01)	2.42 (±0.02)	2.42 (±0.02)	2.34 (±0.03)	2.37 (±0.04)
Emotional dysregulation	1.49 (±0.01)	1.35 (±0.01)	1.69 (±0.02)	1.57 (±0.03)	1.83 (±0.04)	1.86 (±0.04)

Note: NVQ=National Vocational Qualifications.

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Table 2. Multinomial Logistic Regression Predicting Group Membership Compared to A Reference Group (Bars Indicate Size of Coefficients, Dark Grey-Negative Coefficient and Light Grey-Positive Coefficient)

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	Group 1 Low	Group 2 Mod beh		Group 3 Mod emo		Group 4 High emo, mod beh		Group 5 High beh, mod emo	
		Bar chart	Coef (95% CI)	Bar chart	Coef (95% CI)	Bar chart	Coef (95% CI)	Bar chart	Coef (95% CI)
Socio-demographic characteristics									
Sex (female)			**-0.24 (±0.1)**		**0.13 (±0.13)**		-0.02 (±0.19)		**-0.55 (±0.22)**
Ethnicity (Mixed)[a]			-0.27 (±0.31)		-0.12 (±0.37)		0.02 (±0.45)		-0.21 (±0.57)
Ethnicity (Asian, Indian)[a]			**-0.51 (±0.34)**		-0.26 (±0.44)		-0.14 (±0.59)		**-1.46 (±0.97)**
Ethnicity (Asian, Pakistani)[a]			-0.15 (±0.24)		0.27 (±0.31)		-0.01 (±0.40)		**-0.90 (±0.56)**
Ethnicity (Asian, Bangladeshi)[a]			**-0.89 (±0.48)**		-0.08 (±0.40)		-0.28 (±0.48)		**-1.64 (±1.05)**
Ethnicity (Black Caribbean)[a]			-0.2 (±0.49)		-0.38 (±0.39)		0.04 (±0.68)		-0.06 (±0.90)
Ethnicity (Black African)[a]			**-0.85 (±0.43)**		**-0.71 (±0.60)**		**-1.43 (±0.66)**		**-1.51 (±1.19)**
Ethnicity (Other)[a]			-0.37 (±0.50)		0.31 (±0.49)		0.03 (±0.74)		-0.97 (±1.42)
Income (lowest quintile)[b]			**0.49 (±0.22)**		**0.37 (±0.28)**		**1.03 (±0.47)**		**0.78 (±0.57)**
Income (2nd quintile)[b]			**0.45 (±0.21)**		**0.28 (±0.24)**		**0.92 (±0.44)**		**0.87 (±0.56)**
Income (3rd quintile)[b]			**0.26 (±0.20)**		**0.34 (±0.23)**		**0.51 (±0.39)**		**0.69 (±0.59)**
Income (4th quintile)[b]			**0.26 (±0.19)**		0.18 (±0.18)		**0.49 (±0.41)**		0.58 (±0.65)
Parent Education (none/other)[c]			0.27 (±0.32)		0.21 (±0.32)		**0.90 (±0.61)**		**0.99 (±0.76)**
Parent education (NVQ 1)[c]			**0.42 (±0.35)**		0.01 (±0.37)		**0.82 (±0.66)**		0.61 (±0.84)
Parent education (NVQ 2)[c]			0.24 (±0.27)		0.04 (±0.26)		**0.72 (±0.57)**		0.50 (±0.74)
Parent education (NVQ 3)[c]	r		0.12 (±0.29)		-0.10 (±0.29)		0.56 (±0.59)		0.26 (±0.81)
Parent education (NVQ 4)[c]	e		0.13 (±0.24)		-0.02 (±0.24)		0.34 (±0.58)		0.21 (±0.77)
Occupation (intermediate)[d]	f		0.06 (±0.16)		-0.04 (±0.20)		0.03 (±0.29)		0.00 (±0.33)
Occupation (routine/manual)[d]	e		**0.23 (±0.17)**		0.09 (±0.20)		0.28 (±0.31)		**0.43 (±0.30)**
Workless household[d]	r		**0.65 (±0.38)**		0.10 (±0.44)		**0.78 (±0.56)**		**0.85 (±0.55)**
Family Structure and environment	e								
Lone parent	n		0.03 (±0.16)		0.03 (±0.23)		-0.08 (±0.26)		0.16 (±0.31)
Siblings (1)[e]	c		**0.14 (±0.14)**		0.01 (±0.17)		**-0.26 (±0.23)**		0.01 (±0.23)
Siblings (2)[e]	e		**0.20 (±0.17)**		-0.11 (±0.21)		-0.10 (±0.30)		0.24 (±0.32)
Siblings (3+)[e]			0.16 (±0.21)		-0.18 (±0.25)		-0.11 (±0.36)		0.26 (±0.40)
Maternal psychological distress	g		**0.09 (±0.07)**		**0.25 (±0.07)**		**0.39 (±0.09)**		**0.29 (±0.11)**
Paternal psychological distress	r		**-0.07 (±0.07)**		0.01 (±0.08)		-0.05 (±0.11)		-0.06 (±0.13)
Parent-relationship state	o		**0.21 (±0.06)**		0.13 (±0.07)		**0.22 (±0.1)**		**0.32 (±0.12)**
Parent-child conflict	u		**0.55 (±0.06)**		0.23 (±0.08)		**0.72 (±0.12)**		**0.77 (±0.15)**
Parent-child closeness	p		-0.04 (±0.06)		-0.05 (±0.07)		**-0.10 (±0.08)**		-0.09 (±0.10)
Smoking household			0.07 (±0.13)		0.00 (±0.15)		-0.09 (±0.24)		0.14 (±0.28)
Home safety			-0.03 (±0.06)		-0.01 (±0.07)		**-0.15 (±0.09)**		-0.06 (±0.10)
Birth and infancy factors									
Maternal age at birth			-0.03 (±0.07)		-0.04 (±0.08)		0.00 (±0.11)		**-0.28 (±0.14)**
Unplanned pregnancy			-0.01 (±0.11)		-0.03 (±0.15)		-0.15 (±0.20)		0.04 (±0.25)
Smoked during pregnancy			**0.26 (±0.15)**		-0.17 (±0.20)		0.21 (±0.26)		**0.39 (±0.26)**
Birthweight			-0.01 (±0.06)		-0.03 (±0.07)		-0.07 (±0.10)		**-0.11 (±0.11)**
Gross motor delay			0.05 (±0.18)		0.18 (±0.20)		0.25 (±0.28)		-0.05 (±0.34)
Relative age			**0.03 (±0.02)**		0.00 (±0.02)		**0.05 (±0.03)**		**0.05 (±0.03)**
Mood			-0.03 (±0.06)		-0.06 (±0.07)		-0.05 (±0.09)		-0.09 (±0.11)
Apprehension-withdrawal			-0.01 (±0.06)		**0.10 (±0.08)**		**0.12 (±0.10)**		-0.09 (±0.13)
Adaptation			0.02 (±0.06)		**0.12 (±0.07)**		**0.16 (±0.10)**		0.08 (±0.12)
Regularity			**-0.07 (±0.05)**		-0.06 (±0.07)		**-0.16 (±0.09)**		-0.10 (±0.10)
Early childhood factors									
Poor physical health			**0.17 (±0.10)**		**0.24 (±0.13)**		**0.51 (±0.22)**		**0.22 (±0.22)**
Cognitive ability			-0.01 (±0.02)		0.00 (±0.02)		**-0.04 (±0.04)**		-0.03 (±0.05)
Bracken School readiness			**-0.07 (±0.07)**		-0.07 (±0.09)		-0.06 (±0.16)		**-0.18 (±0.17)**
Self regulation- independence			**-0.11 (±0.06)**		**-0.13 (±0.07)**		**-0.24 (±0.09)**		**-0.18 (±0.11)**
Emotional Dysregulation			**0.39 (±0.06)**		**0.27 (±0.07)**		**0.53 (±0.12)**		**0.56 (±0.15)**

Note: Coefficients in bold are significant at at least the p<.05 level. Reference group: a. White ethnicity, b. highest income quintile, c. National Vocational Qualifications (NVQ)5, d. Higher managerial occupations, e. No siblings. Beh = behavior; emo = emotional; mod = moderate.

Table 3. Odds Ratios for Planned Comparisons Between Pairs of Groups

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	Planned comparisons 1		Planned comparisons 2	
	Group 2 (mod beh) vs. 3 (mod emo)	Group 4 (high emo, mod beh) vs. 5 (high beh, mod emo)	Group 3 (mod emo) vs. 4 (high emo, mod beh)	Group 2 (high beh) vs. 5 (high beh, mod emo)
	OR (±95CI)	*OR* (±95CI)	*OR* (±95CI)	*OR* (±95CI)
Socio-demographic characteristics				
Sex (female)	**1.50 (±0.21)**	**0.59 (±0.17)**	0.87 (±0.23)	**0.72 (±0.18)**
Ethnicity				
Mixed[a]	1.19 (±0.56)	0.91 (±0.98)	1.26 (±0.83)	1.05 (±0.76)
Asian, Indian[a]	1.38 (±0.74)	0.33 (±0.52)	0.87 (±0.94)	0.47 (±0.76)
Asian, Pakistani[a]	**1.64 (±0.69)**	**0.42 (±0.30)**	0.71 (±0.32)	0.54 (±0.39)
Asian, Bangladeshi[a]	**2.19 (±1.29)**	0.25 (±0.54)	0.95 (±0.51)	0.57 (±1.01)
Black Caribbean[a]	0.92 (±0.84)	0.91 (±1.63)	1.92 (±1.72)	1.10 (±1.40)
Black African[a]	1.23 (±1.02)	0.91 (±2.37)	0.51 (±1.02)	0.56 (±1.21)
Other[a]	2.01 (±1.67)	0.45 (±1.27)	0.85 (±1.12)	0.67 (±2.18)
Income				
Lowest quintile[b]	0.86 (±0.30)	0.65 (±0.68)	1.74 (±1.35)	1.39 (±1.11)
2nd quintile[b]	0.82 (±0.28)	0.78 (±0.76)	1.63 (±1.12)	1.55 (±1.17)
3rd quintile[b]	1.09 (±0.30)	1.11 (±1.18)	1.12 (±0.65)	1.53 (±1.19)
4th quintile[b]	0.90 (±0.24)	0.97 (±1.2)	1.24 (±0.73)	1.39 (±1.28)
Parent Education				
None/other[c]	0.97 (±0.48)	1.42 (±2.41)	2.22 (±2.12)	2.04 (±2.47)
NVQ 1[c]	0.68 (±0.39)	1.01 (±1.86)	2.31 (±2.33)	1.19 (±1.63)
NVQ 2[c]	0.87 (±0.39)	1.00 (±1.57)	2.09 (±1.79)	1.27 (±1.49)
NVQ 3[c]	0.85 (±0.35)	0.88 (±1.54)	2.01 (±1.73)	1.16 (±1.53)
NVQ 4[c]	0.91 (±0.36)	1.02 (±1.65)	1.44 (±1.2)	1.12 (±1.29)
Occupation				
Intermediate[d]	0.87 (±0.22)	0.97 (±0.5)	1.12 (±0.39)	0.94 (±0.4)
Routine/manual[d]	0.86 (±0.2)	1.14 (±0.64)	1.23 (±0.46)	1.22 (±0.45)
Workless household[d]	0.59 (±0.37)	0.95 (±0.91)	1.91 (±1.72)	1.18 (±0.8)
Family Structure and environment				
Lone parent	0.96 (±0.28)	1.28 (±0.51)	0.93 (±0.4)	1.13 (±0.42)
Siblings (1)[e]	0.88 (±0.18)	1.27 (±0.47)	0.72 (±0.22)	0.87 (±0.23)
Siblings (2)[e]	**0.73 (±0.19)**	1.45 (±0.76)	1.08 (±0.53)	0.96 (±0.38)
Siblings (3+)[e]	0.73 (±0.25)	1.52 (±0.97)	1.05 (±0.54)	1.04 (±0.51)
Maternal psychological distress	**1.17 (±0.10)**	0.91 (±0.1)	**1.21 (±0.13)**	**1.21 (±0.13)**
Paternal psychological distress	1.08 (±0.09)	0.98 (±0.17)	0.95 (±0.12)	1.01 (±0.14)
Parent relationship state	0.91 (±0.08)	1.10 (±0.17)	1.11 (±0.15)	1.13 (±0.15)
Parent–child conflict	**0.71 (±0.07)**	1.03 (±0.16)	**1.58 (±0.22)**	**1.29 (±0.20)**
Parent–child closeness	0.98 (±0.08)	1.00 (±0.12)	0.91 (±0.1)	0.96 (±0.1)
Smoking household	0.96 (±0.19)	1.32 (±0.53)	0.93 (±0.29)	1.06 (±0.35)
Home safety	1.02 (±0.08)	1.09 (±0.13)	0.90 (±0.08)	0.96 (±0.11)
Birth and infancy factors				
Maternal age at birth	1.00 (±0.09)	**0.76 (±0.13)**	0.99 (±0.13)	**0.80 (±0.13)**
Unplanned pregnancy	1.01 (±0.17)	1.28 (±0.43)	0.87 (±0.23)	1.09 (±0.3)
Smoked during pregnancy	**0.64 (±0.16)**	1.18 (±0.44)	1.38 (±0.51)	1.17 (±0.36)
Birthweight	0.99 (±0.08)	0.97 (±0.13)	0.95 (±0.12)	0.91 (±0.11)
Gross motor delay	1.13 (±0.27)	0.83 (±0.35)	1.07 (±0.35)	0.9 (±0.37)
Relative age	0.98 (±0.02)	1.00 (±0.04)	**1.05 (±0.03)**	1.02 (±0.03)
Mood	0.97 (±0.08)	0.98 (±0.13)	1.01 (±0.12)	0.93 (±0.11)
Apprehension-withdrawal	**1.13 (±0.10)**	**0.82 (±0.13)**	1.03 (±0.13)	0.9 (±0.13)
Adaptation	1.09 (±0.09)	0.93 (±0.12)	1.08 (±0.14)	1.05 (±0.13)
Regularity	1.02 (±0.08)	1.07 (±0.13)	0.91 (±0.1)	0.96 (±0.11)
Early childhood factors				
Poor physical health	1.09 (±0.16)	0.75 (±0.27)	**1.39 (±0.39)**	1.01 (±0.28)
Cognitive ability	1.01 (±0.03)	1.02 (±0.07)	0.96 (±0.05)	0.98 (±0.05)

Bracken School readiness	1.01 (±0.11)	0.94 (±0.19)	1.04 (±0.2)	0.89 (±0.16)
Self-regulation: independence	0.97 (±0.08)	1.06 (±0.13)	0.89 (±0.1)	0.96 (±0.12)
Emotional dysregulation	**0.90 (±0.07)**	1.07 (±0.22)	**1.31 (±0.17)**	1.20 (±0.19)
N	*5195*	*1481*	*2785*	*3891*

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Note. Bold indicates significant at p<.0125 (Bonferroni-corrected p value). Reference group: a. White ethnicity, b. highest income quintile, c. National Vocational Qualifications (NVQ) 5, d. Higher managerial occupations, e. No siblings. Beh = behavior; emo = emotional; mod = moderate.

Supplementary Table 1. Outline of the Measures, Source, and Age at Which the Predictors Included in This Study Were Assessed.

Predictor	***Measure***	***Source***	***Age (study wave)***
<u>*Socio-demographic characteristics*</u>			
Sex	Male/Female	Multiple	9 months (1)
Ethnicity	ONS 8-category measure	Multiple	9 months (1)[a]
Income	OECD UK equivilised quintiles	Main and partner respondents	3 years (2) [a]
Parent Education	Highest NVQ level in household	Composite from highest main and partner respondents	3 years (2) [a]
Occupation	NS-SEC 3 category coded based on occupation	Composite from main and partner respondents	3 years (2) [a]
<u>*Family Structure and environment*</u>			
Lone parent	Yes/No	Main respondent (mainly mother)	9 months (1)
Siblings	Number	Main respondent (mainly mother)	3 years (2) [a]
Maternal psychological distress	Kessler K-6	Maternal report	3 years (2)
Paternal psychological distress	Kessler K-6	Paternal report	3 years (2)
Parent-relationship state	Golombok-Rust Inventory of Marital State	Composite of maternal and paternal reports	9 months (1) and 5 years (3)
Parent-child conflict	Pianta Child-Parent Relationship Scale	Main respondent (mainly mother)	3 years (2)
Parent-child closeness	Pianta Child-Parent Relationship Scale	Main respondent (mainly mother)	3 years (2)
Smoking household	Yes/No	Composite of main and partner respondent	3 years (2)
Home safety	6-items, Home-SF scale	Interviewer assessment	3 years (2)
<u>*Birth and infancy factors*</u>			
Maternal age at birth	In years	Main reporter (checked against child health records where possible)	9 months (1)
Unplanned pregnancy	Yes/No	Maternal report	9 months (1)
Smoked during pregnancy	Yes/No	Maternal report	9 months (1)
Birthweight	In kilograms	Main reporter (checked against child health records where possible)	9 months (1)
Gross motor delay	Delay in moving, sitting or standing	Main respondent (mainly mother)	9 months (1)
Relative age	Scaled month of birth	Multiple	9 months (1)
Mood	Carey Infant temperament scale	Main respondent (mainly mother)	9 months (1)
Apprehension-withdrawal	Carey Infant temperament scale	Main respondent (mainly mother)	9 months (1)
Adaptation	Carey Infant temperament scale	Main respondent (mainly mother)	9 months (1)
Regularity	Carey Infant temperament scale	Main respondent (mainly mother)	9 months (1)
<u>*Early childhood factors*</u>			
Poor physical health	Any longstanding or chronic	Main respondent (mainly	3 years (2)

	illness	mother)	
Cognitive ability	British ability scales	Cognitive assessment	3 years (2)
School readiness	Bracken School Readiness questionnaire	Main respondent (mainly mother)	3 years (2)
Self-regulation: independence	Child Social Behaviour Questionnaire	Main respondent (mainly mother)	3 years (2)
Emotional Dysregulation	Child Social Behaviour Questionnaire	Main respondent (mainly mother)	3 years (2)

Note: NS-SEC = National Statistics Socio-economic Classification; NVQ = National Vocational Qualifications; OECD = Organisation for Economic Co-operation and Development; ONS = Office for National Statistics; SF = short form.

[a] Where missing at particular sweep, data from adjacent sweep was used.

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roblems scale score

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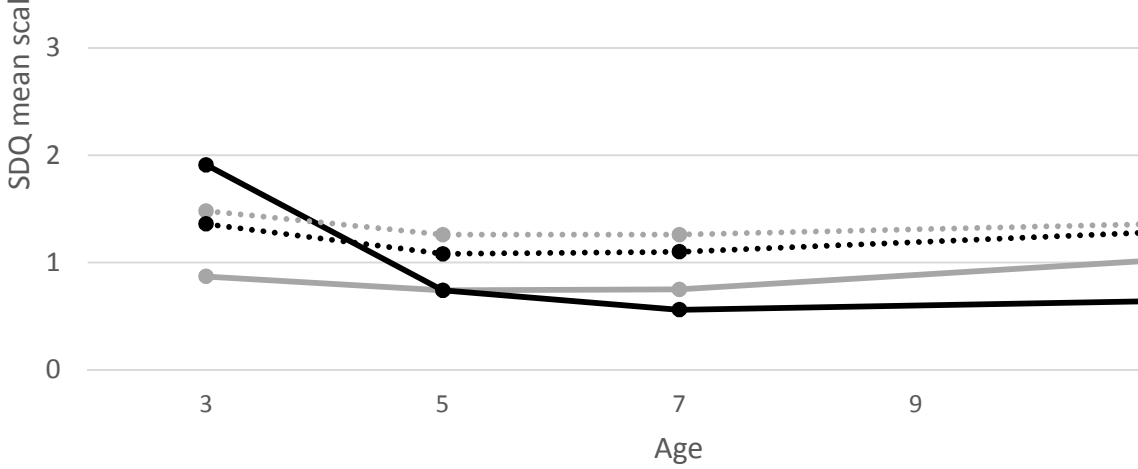
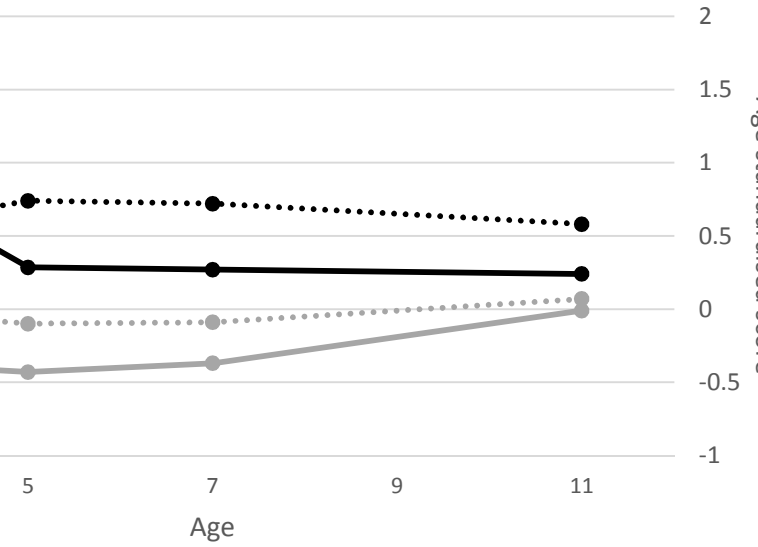
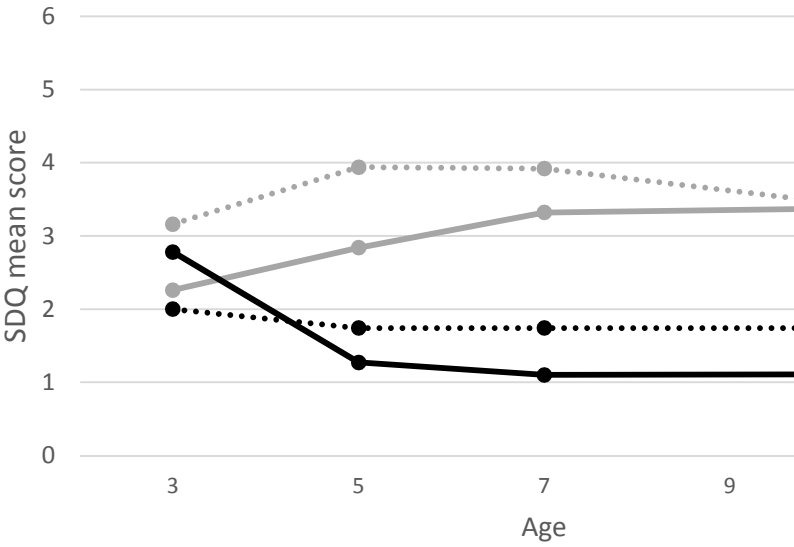
roblems age standardised



derate behaviour, low emotional symptoms;
21% (n=3264)

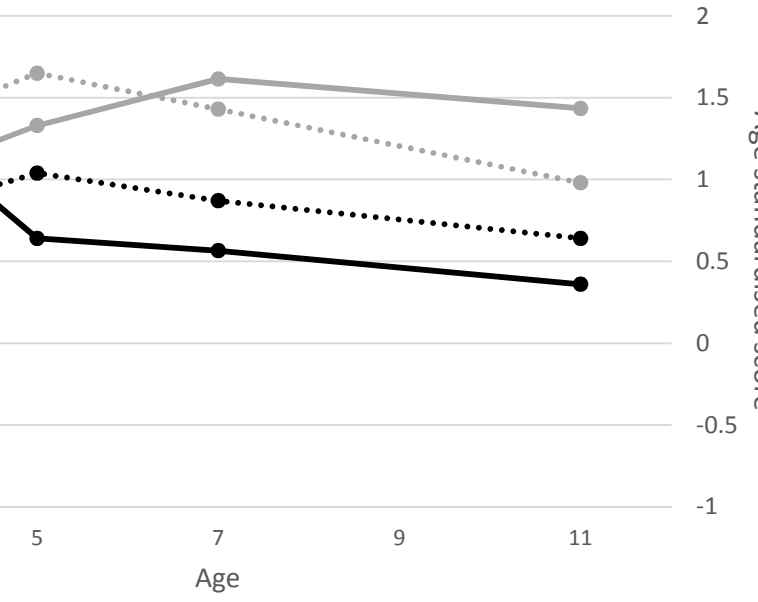
Group 3: Moderate emotional, low behavio
12.5% (n=1931)

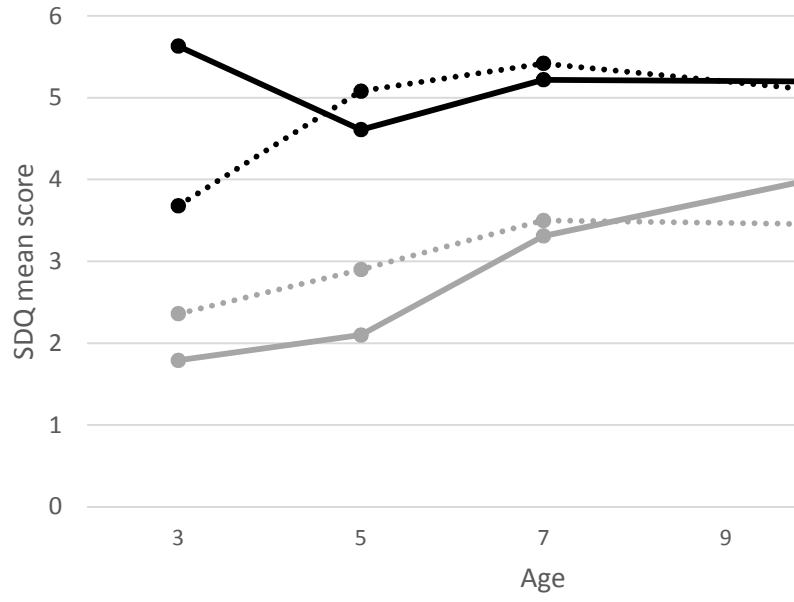




emotional, moderate behaviour symptoms;
5.5% (n=854)

Group 5: High behaviour, moderate emotiona
4% (n=627)





roblems scale score

ymptoms age standardised

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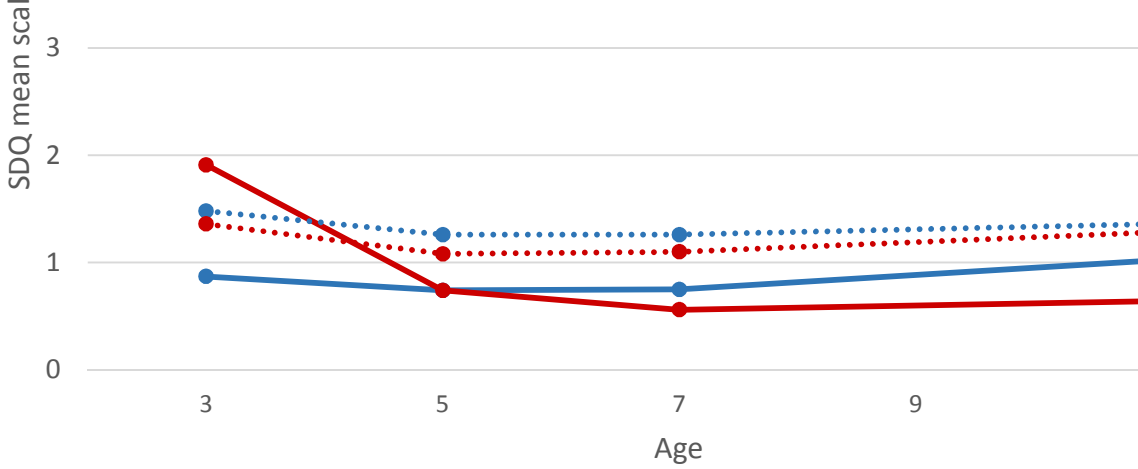
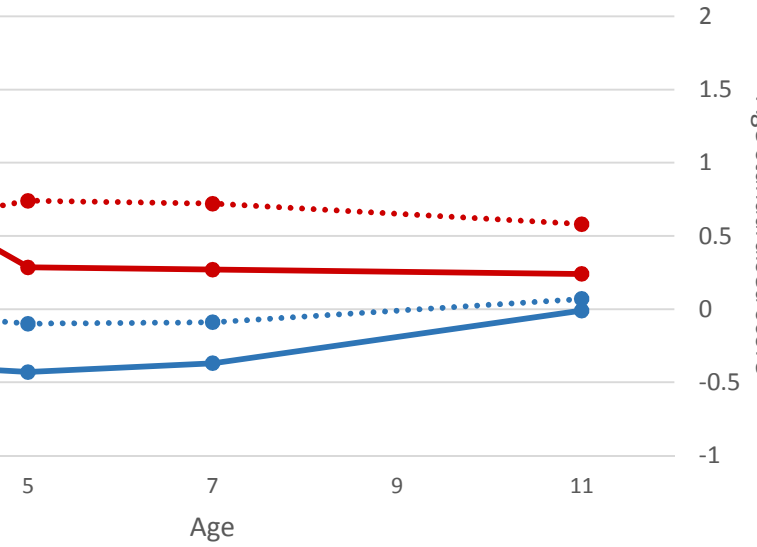
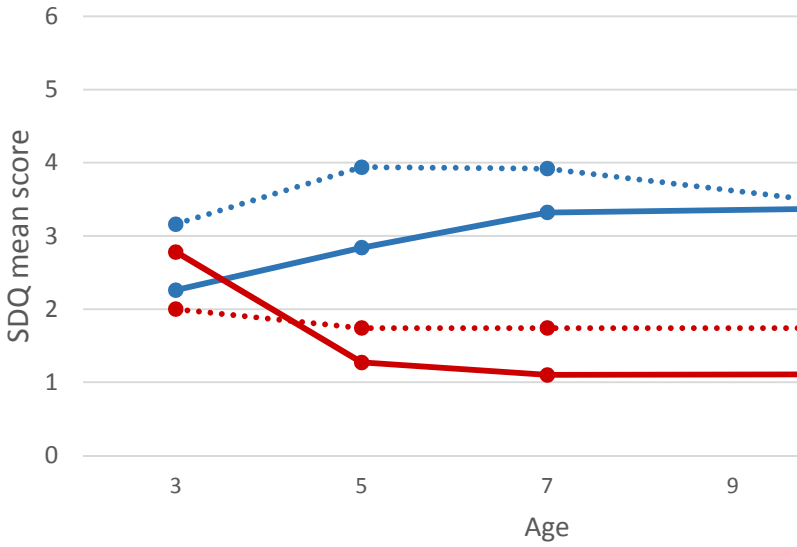


derate behaviour, low emotional symptoms;
21% (n=3264)



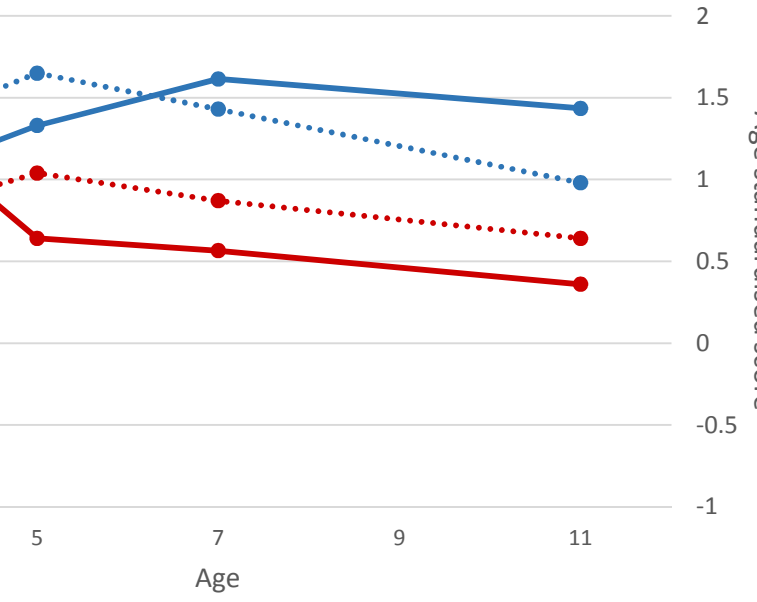
Group 3: Moderate emotional, low behavio
12.5% (n=1931)



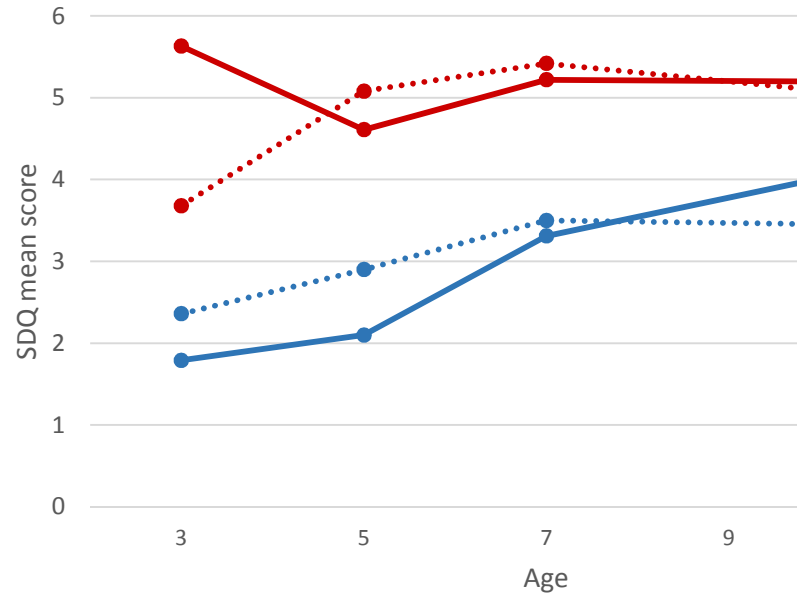
Age standardised score

SDQ mean score

emotional, moderate behaviour symptoms;
5.5% (n=854)



Group 5: High behaviour, moderate emotion
4% (n=627)



Age standardised score

SDQ mean score