Exposure to childhood adversity and deficits in emotion recognition: Results from a large, population-based sample

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Abstract

Background: Emotion recognition skills are essential for social communication. Deficits in these skills have been implicated in mental disorders. Prior studies of clinical and high-risk samples have consistently shown that children exposed to adversity are more likely than their unexposed peers to have emotion recognition skills deficits. However, only one population-based study has examined this association.

Methods: We analyzed data from children participating in the Avon Longitudinal Study of Parents and Children, a prospective birth cohort (n=6,506). We examined the association between eight adversities, assessed repeatedly from birth to age 8 (caregiver physical or emotional abuse; sexual or physical abuse; maternal psychopathology; one adult in the household; family instability; financial stress; parent legal problems; neighborhood disadvantage) and the ability to recognize facial displays of emotion measured using the faces subtest of the Diagnostic Assessment of Non-Verbal Accuracy (DANVA) at age 8.5 years. In addition to examining the role of exposure (vs. non-exposure) to each type of adversity, we also evaluated the role of the timing, duration, and recency of each adversity using a Least Angle Regression variable selection procedure.

Results: Over three-quarters of the sample experienced at least one adversity. We found no evidence to support an association between emotion recognition deficits and previous exposure to adversity, either in terms of total lifetime exposure, timing, duration, or recency, or when stratifying by sex.

Conclusions: Results from the largest population-based sample suggest that even extreme forms of adversity are unrelated to emotion recognition deficits as measured by the DANVA, suggesting the possible immutability of emotion recognition in the general population. These findings emphasize the importance of population-based studies to generate generalizable results.

Keywords: sensitive periods; children; emotion recognition; ALSPAC; adversity

Abbreviations: Avon Longitudinal Study of Parents and Children (ALSPAC), Diagnostic Assessment of Non-Verbal Accuracy (DANVA), Least Angle Regression (LARs)

Introduction

Numerous studies have documented the consequences of exposure to child adversity, including poverty (Brooks-Gunn and Duncan, 1997), abuse or maltreatment (Slopen et al., 2014, Widom et al., 2007), and family disruption or dysfunction (Gilman et al., 2003) on mental health outcomes. Overall, the effects of childhood adversity persist across the lifespan, at least doubling the risk of youth- and adult-onset mental disorders (Gilman et al., 2015, McLaughlin et al., 2010, McLaughlin et al., 2012). Given the strong evidence that childhood adversities are common, affecting upwards of 60% of the US (Koenen et al., 2010, Gilbert et al., 2009) and global populations (McLaughlin et al., 2012, Kessler et al., 2010), their associated mental health problems could affect large segments of the population. Yet, despite the ubiquity of adversity worldwide, the mechanisms linking adversity to psychopathology remain poorly characterized.

Here, we examined whether deficits in emotion recognition could be one pathway linking adversity to subsequent mental health problems. Emotion recognition skills, or the ability to recognize facial displays of emotion, are essential for navigating social interactions and interpreting communication signals indicating trustworthiness, intent, and empathy (Frith, 2009). Deficits in emotion recognition abilities have been linked to the etiology, course, and treatment of a wide range of psychiatric disorders including, depression, anxiety, autism, and schizophrenia (Bourke et al., 2010, Button et al., 2013, Boraston et al., 2007, Kohler et al., 2003). Many studies have also shown that children exposed to severe adversity – especially cases of abuse and maltreatment that come to the attention of authorities – are more likely than their unexposed peers to experience both biases and inaccuracies in detecting emotions (Cicchetti and Toth, 2005, Perlman et al., 2008, Pollak and Tolley-Schell, 2003, Striano et al., 2002). A smaller number of studies have also linked exposure to other types of adversity, including maternal depression, poverty, and institutional rearing, to emotion recognition difficulties (Bornstein et al., 2011, Evans, 2004, Parker et al., 2005)

Yet, prior work on the relationship between childhood adversity and emotion recognition deficits is limited in four important ways. First, most studies examine the effect of a single adversity, rather than multiple types, thus failing to account for a holistic set of experiences that might be driving emotion recognition (see a recent exception by: (Germine et al., 2015)). Second, few prior studies have examined how the developmental timing and duration of adversity influences emotion recognition deficits, even though emotion recognition skills are fine-tuned into adolescence in response to one's unique social experiences. Third, only a handful of longitudinal studies exist; among these tend to be small-scale studies ($n \leq \sim 100$ children) that have almost exclusively focused on clinical samples (e.g., children with autism or at risk for schizophrenia), or high-risk samples of children exposed to extreme adversity (e.g., children in institutional care or with documented cases of child abuse and neglect) (Bouhuys et al., 1999, Kohler et al., 2000). Relatedly, there is a shortage of population-based studies, making the generalizability of prior findings unclear. To our knowledge, the only population-based study completed found no association between adversity and face emotion discrimination impairments (Germine et al., 2015); this cross-sectional study was conducted in a sample of over 5,000 adults where participants completed an emotion-recognition test anonymously through a website and retrospectively reported about their exposure to childhood adversity. Efforts to bring a population perspective to the fields of social, cognitive, and developmental neuroscience are needed as part of the movement towards "population neuroscience" (Falk et al., 2013).

In the current study, we addressed these limitations by examining whether exposure to a comprehensive set of childhood adversities predicted subsequent emotion recognition deficits

within a large, population-based sample that prospectively followed children from infancy through middle childhood. Our primary aim was to determine if exposure to adversity at any point between birth and age 8 was associated with emotion recognition skills deficits at age 8.5. As a secondary aim, we sought to determine the extent to which the characteristics of adversity, including its timing and accumulation, could affect emotion recognition skills; to our knowledge, no other prior studies have examined such associations. We therefore tested three of the most popular models from lifecourse theory, each of which describes the association between an exposure and health outcome (Ben-Shlomo and Kuh, 2002), to determine which one (or more) models best fit with the data. The three models examined were: (a) a *sensitive period model* (Knudsen, 2004) in which the effect of adversity depends on the developmental time period of the exposure; (b) *an accumulation model* (Evans et al., 2013), in which the effect of adversity increases with the number of occasions exposed, regardless of timing; and (c) *a recency model* (Shanahan et al., 2011), in which the effect of adversity is stronger for more proximal events.

Methods

Sample and Procedures

Data came from the Avon Longitudinal Study of Parents and Children (ALSPAC), a prospective, longitudinal birth-cohort of children born to mothers who were living in the county of Avon England (120 miles west of London) with estimated delivery dates between April 1991 and December 1992 (Boyd et al., 2013). ALSPAC was designed to increase knowledge of the pathways to health across the lifespan, with an emphasis on genetic and environmental determinants. Approximately 85 percent of eligible pregnant women agreed to participate (n=14,541), and 76% of eligible live births who were alive at 12 months of age (n=13,988 children) were enrolled. Response rates to data collection have been good (75% have completed at least one follow-up). Ethics approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committee. More details are available on the ALSPAC website (www.bristol.ac.uk/alspac) including a fully searchable data dictionary.

There were 7,303 children who began the emotion recognition task, described below. We excluded from our analysis 797 children (10.9% of those who began the task) because the interviewer noted at the end of the task that the child had: (1) completed fewer than 23 out of the 24 emotion recognition trials (n=501); (2) appeared confused (n=40), dishonest (n=36), or bored with the task (n=139); or (3) did not seem to make a good attempt at the task (n=88). Children included in our analytic sample (n=6,506; 89.1% of the total sample who participated in the age 8 clinic assessment) did not differ from those who were excluded (n=797) with respect to age, race, sex, poverty level, parental educational status, previous pregnancies, or geographic location (all p-values >0.05).

Measures

Exposure to Adversity

We examined eight types of adversity, measured using parent mailed questionnaires. These adversities are commonly used to define early life adversity (Felitti et al., 1998, Slopen et al., 2014). Each adversity was measured on at least five occasions before age 8 years (**Table 1**).

Caregiver physical or emotional abuse. Children were coded as having been exposed to physical or emotional abuse if the mother, partner, or both responded affirmatively to any of the following items: (1) Your partner was physically cruel to your children; (2) You were physically cruel to your children; (3) Your partner was emotionally cruel to your children; (4) You were emotionally cruel to your children.

Sexual or physical abuse. Exposure to sexual or physical abuse was determined through an item asking the mother to indicate whether or not the child had been exposed to either sexual or physical abuse from anyone.

Maternal psychopathology. Maternal psychopathology was determined using data from: (1) the Crown-Crisp Experiential Index (CCEI), which includes separate subscales for anxiety and depression (Crown and Crisp, 1979); (2) the Edinburgh Postnatal Depression Scale (EPDS) (Cox et al., 1987); and (3) a question asking about suicide attempts in the past 18 months. Consistent with prior ALSPAC studies (Enoch et al., 2010) and previous cut-points established in the literature (see below), we coded children as exposed to maternal psychopathology if one or more of the following criteria occurred: (1) the mother had a CCEI depression score greater than 9 (Crown and Crisp, 1979); (2) the mother had a CCEI anxiety score greater than 10 (Crown and Crisp, 1979); (3) the mother had an EPDS score greater than 12 (Cox et al., 1987); or (4) the mother reported a suicide attempt since the time of the last interview.

One adult in the household. Mothers indicated the number of adults (>18 years of age) living in the household. Children were coded as exposed if there were fewer than two adults in the household.

Family instability. Mothers indicated whether the child had been: (1) taken into care; (2) separated from their mother for two or more weeks; (3) separated from their father for two or more weeks; or (4) acquired a new parent. Children were coded as exposed if any of these events occurred.

Financial stress. Mothers indicated using a Likert-type scale (1=not difficult; 2=slightly difficult; 3=fairly difficult; 4=very difficult) the extent to which the family had difficulty affording the following: (1) items for the child; (2) rent or mortgage; (3) heating; (4) clothing; (5) food. Children were coded as exposed if their mothers reported at least slight difficulty for three or more items; this cut-point roughly corresponded to the top quartile.

Parent legal problems. Mothers indicated whether or not the child's parents had experienced any encounters with the legal system. Children were coded as exposed if either or both parents had legal problems.

Neighborhood disadvantage. Mothers indicated the degree to which the following were problems in their neighborhood: (1) noise from other homes; (2) noise from the street; (3) garbage on the street; (4) dog dirt; (5) vandalism; (6) worry about burglary; (7) mugging; and (8) disturbance from youth. Response options to each item were: 2=serious problem, 1=minor problem, 0=not a problem or no opinion. Items were summed, yielding scores ranging from 0-16. Children with scores of eight or greater, which generally corresponded to the 95th percentile, were classified as exposed to neighborhood disadvantage.

Recognizing Facial Affect

The ability to recognize facial displays of emotion was measured using the faces subtest of the Diagnostic Assessment of Non-Verbal Accuracy (DANVA) at age 8.5 (Norwicki and Duke, 1994). In this computer-based task, the faces subtest consists of 24 colored photos of child faces (both male and female children who were primary school age). Each face displays one of four emotions: (a) happiness; (b) sadness; (c) anger; or (d) fear. Half of the photos were presented at a high intensity (e.g., extreme anger); the other half at a low intensity (e.g., mild anger). Following a two-second presentation, the child was asked to indicate the emotion displayed by the photo. The DANVA has been shown in studies of typically developmentally children to have good internal consistency reliability across age groups (α=0.77-0.88) and to

correlate highly with indices of personal and social adjustment (e.g., self-esteem; relationship to peers) (Norwicki and Duke, 1994).

Consistent with prior literature (Barona et al., 2015, Kothari et al., 2013, Pollak et al., 2000, Gollan et al., 2008, Buhlmann et al., 2011, Sato et al., 2009, Surguladze et al., 2004, Gibb et al., 2009), we derived two sets of variables from these data. First, we examined the number of emotion-specific misattributions, meaning the total number of faces incorrectly identified as a specific emotion. For instance, children could have incorrectly identified a happy face as sad; this error would be classified as a misattribution of sad. We therefore summed the total number of faces misattributed as happy (range=0-13), sad (range=0-11), angry (range=0-7), or fearful (range=0-8). Second, we examined the incorrect identification of emotions generally, meaning a global measure indicating the total number of misattributions across all emotions. This variable was derived by summing across the emotion-specific misattributions (range=0-22).

Covariates

We controlled for the following covariates, measured at child birth: singleton v. multiple birth; number of previous pregnancies; maternal marital status; highest level of maternal education; maternal age; homeownership; and parent social class (see **Supplemental Materials**). These measures were shown here and elsewhere to correlate strongly with exposure to adversity and/or emotion recognition skills (Edwards et al., 2002, Schmidt et al., 2010).

Analyses

We began by running univariate and bivariate analyses to examine the distribution of covariates and exposure to adversity in the total analytic sample. Next, we used multiple linear regression to examine the association between exposure to each type of adversity (0=unexposed; 1=exposed at any time point) on the emotion recognition outcomes as well as a total adversity score indicating the total number of times exposed to each type of adversity (range 0-27). We then used a novel two-stage structured lifecourse modeling approach (SLCMA; Smith et al., 2015, Smith et al., 2016) to evaluate which of the three lifecourse theoretical models (sensitive period, accumulation, recency) could best explained this relationship. The major advantage of the SLCMA relative to other methods (e.g., standard multiple regression; structural equation modeling) is that it provides an unbiased way to compare multiple competing theoretical models simultaneously and identify the most parsimonious explanation for the observed outcome variation (see **Supplemental Materials**).

We also conducted two secondary analyses. First, we reran the primary analyses (described above) stratified by sex, given that prior studies have found sex differences in the prevalence of adversity (Koenen et al., 2010) as well as emotion recognition development and abilities (McClure, 2000). Second, building from the SLCMA, we fitted a linear regression model containing all possible theoretical models; this saturated model allowed us to determine if any hypothesized association (or combination of hypothesized associations) was present in the data.

To reduce potential bias and minimize loss of power due to attrition, we conducted all analyses using a multiply imputed dataset (see **Supplemental Materials**).

We also performed two sensitivity analyses to assess the robustness of our findings. First, we reran our analysis to modify our inclusion criteria, so that children were included in the analysis if they had completed at least 23 of the 24 trials and were reported by the interviewer to be bored, confused, dishonest, or gave a poor attempt at the task. Including these children

(n=303) eliminated the possibility that children who had impairments in recognizing emotional faces were inappropriately excluded from the analysis. Second, given that prior literature has focused on both misattributions (where a face is incorrectly identified as expressing another emotion) as well as errors in recognizing a specific emotion, we also reran our primary analyses focusing on errors made in recognizing each of the four emotions and errors made across all emotions. These variables were derived by summing the total number of errors made in recognizing happy (range=0-6), sad (range=0-6), angry (range=0-6), or fearful faces (range=0-6) as well as the total number of errors made across all emotions (range=0-24).

Results

Sample Characteristics

The analytic sample was gender-balanced (50.5% female) and comprised of predominately White (96.1%) children from families whose parents were married and owned their home (**Supplemental Table 1**).

Distribution of Exposure to Adversity and Emotion Recognition Skills

Most children (78%; n=5,063) experienced at least one adversity at some point in their life. Family instability (46%), financial stress (37%), and maternal psychopathology (28%) were the three most reported adversities (**Table 1**). Parent legal problems was the least reported adversity (6%). Age at exposure to adversity varied by type (**Table 1**). Within each adversity type, exposures were correlated over time (**Supplemental Table 1**), with neighboring time points being generally more highly correlated than distant time points.

Children made the most emotion-specific misattributions in recognizing faces as happy (mean errors=2.13, median=2, SD=1.39), followed by sad (mean errors=1.24, median=1, SD=1.31) and fearful faces (mean errors=0.80, median=0, SD=1.09). The fewest misattributions were made in recognizing faces as angry (mean errors= 0.49, median=0, SD=.91). On average, children made 4.69 misattributions across all four emotions (median= 4, SD=2.74)

Exposure to any adversity was patterned by socio-demographic factors, though emotion recognition deficits were not (**Supplemental Table 2**).

Association between Adversity and Emotion Recognition Models

Results of the linear regression yielded little evidence of an association between exposure to each type of adversity (ever vs. never exposed) as well as the total adversity score on number of emotion recognition errors (all p-values >0.07; **Table 2**), with even extreme levels of adversity being unassociated (**Figure 1**).

In the SLCMA analysis all lifecourse theoretical models were weak and inconclusive predictors of emotion recognition (p>0.17; **Table 3**).

These results were robust to stratification by sex. Lifetime exposure to adversity was unassociated with emotion recognition deficits in both boys and girls (**Supplemental Table 3**). The lifecourse theoretical models did not explain substantial variability (**Supplemental Table 4**), even when all theoretical models were considered simultaneously in the saturated model (**Supplemental Table 5).**

Sensitivity Analysis

Results with the more inclusive sample (n=6694), which included children who were initially excluded, were nearly identical to the results from the smaller, less inclusive sample (n=6506). Specifically, no significant associations were detected between lifetime exposure to

adversity and emotion specific misattributions in the inclusive sample (**Supplemental Table 6**). Further, the SLCMA analysis showed no significant associations between any of the lifecourse theoretical models and misattributions (**Supplemental Table 7**).

Furthermore, there was little evidence of an association between exposure to each type of adversity whether in errors made un recognizing each emotion or all emotions combined. Only 2 out of 45 significant associations were detected, which showed an increased risk of making errors in recognizing happy faces among children exposed to sexual or physical abuse (β= 0.09; p=0.001; OR= 0.04-0.14) and an increased risk of making errors in recognizing fearful faces among children who experienced neighborhood disadvantage (β= -0.13; p= 0.036; OR = -0.22- -0.01) (**Supplemental Table 8**). However, all lifecourse theoretical models were weak and inconclusive predictors of the total number of emotion recognition errors (**Supplemental Table 9).**

Discussion

The major finding of this study is that exposure to adversity appears unassociated with emotion recognition deficits in this population-based sample of children. This lack of association was observed regardless of how we characterized adversity (e.g., focusing on its timing, duration, recency or severe forms), whether we examined adversities individually or all together, and whether we conducted the analyses in the total sample or stratified by sex. Our results are consistent with the one other population-based study conducted, which also found no association between adversity and face emotion discrimination impairments (Germine et al., 2015). Our study differed from this prior study (Germine et al., 2015) in that our work uses prospective data collection, making the reports of timing and adversity more likely to be accurate; furthermore, our study uses a validated clinical measure administered by trained testers as opposed to an internet questionnaire. However, our results differ from dozens of studies using more selective samples, which have generally found robust associations between exposure to adversity and emotion recognition deficits (Pollak and Tolley-Schell, 2003, Pollak, 2008).

What could explain such discrepancies between our study and the prior literature? First, the faces subtest of the DANVA could have been unable to detect subtle differences in facial emotion recognition, even though both high and low intensity of emotions were presented. More recent emotion recognition tasks capture both subtle and dramatic changes in emotional states and the social context in which the child was reporting (e.g., through vignettes, either read aloud or acted out, that are matched to emotional faces) (Button et al., 2013). Additionally, the limited number of trials in the DANVA, which were 24 in total (6 for each emotion), could not have resulted in enough between-subject variation. Nevertheless, the measure should have been sensitive to capture meaningful differences, if they existed, given that there was a range of scores in our sample (though scores were skewed towards lower values), and the DANVA has been used successfully in other population-based samples, including ALSPAC, to differentiate children who are at risk for eating disorders, have social communication difficulties, and are at risk for autism or ADHD (Kothari et al., 2015, Kothari et al., 2013, Ingersoll and Lalonde, 2010, McKown et al., 2013).

Second, our measurement of emotion recognition skills (at 8.5 years of age) could be poorly timed. Prior studies have focused on children outside of this age, namely toddlers (3-5 years) (Pollak et al., 2000, Perlman et al., 2008), or teenagers (10 years and up) (Joormann et al., 2010, Dadds et al., 2012). However, research in the development of emotion recognition suggests that emotion recognition skills develop and change not only in early childhood, but well

through the teenage years (Thomas et al., 2007). Thus, our study appears to capture an understudied, but relevant, developmental stage.

Lastly, it is possible that emotion recognition deficits are not observed following exposure to adversity among typically developing children. Our sample was comprised of predominately white families who were married and owned their own home; children growing-up in this type of traditional family likely have very different social and other experiences as compared to children growing-up in less stable environments. Adversity may only affect emotion recognition abilities in very extreme samples. It is also possible that methodological limitations led prior studies to identify associations that were explained by other factors including current mental health problems. Indeed, among the two longitudinal studies we identified, neither controlled for prior mental health problems, which could result in residual confounding.

Notably, our study was powered to detect even small effect estimates. A post-hoc power calculation suggested our analytic sample size was capable of detecting between group differences of at least small effect (Cohen's d=0.07-0.11) given at least 80% power and with our observed lifetime prevalence of adversity at 6-46%. As most prior studies have found effect estimates an order of magnitude larger than ours, our results do not appear attributable to low power, especially given the narrow confidence intervals observed, rather they suggest the association between adversity and emotion recognition is inconclusive.

Several limitations are noted. Our adversity measures came primarily from parent-reported questionnaires, which prior studies suggest may lead to under-reporting (Goodman and Goodman, 2011). Some measures of adversity were also derived from single items, which could affect the precision of these estimates. However, the prevalence of exposure to each adversity in ALSPAC, which ranged from 6-46%, were similar to prevalence estimates derived from nationally-representative epidemiological samples in the United States, which have found that close to 40% of adolescents have experienced some type of childhood adversity (McLaughlin et al., 2012, Gilbert et al., 2009). Although experiences of adversity may be less well-characterized in our sample compared to others, as some of our measures were derived from single-item questionnaires rather than more in-depth assessments, the use of these questionnaires allowed for a significantly larger sample size than has been previously used. We were also unable to examine the effect of exposure to multiple types of adversity during the same developmental period, as each adversity was measured at a different time point. We were also limited by how the adversities were originally collected. Notably, the variables caregiver physically and emotional abuse and sexual or physical abuse were derived from different surveys and question sets, thus creating overlap between the two variables in children who were physically abused by a caregiver. Additionally, as with any longitudinal study, there was attrition over time, which we attempted to address using multiple imputation. Finally, our inability to capture perceptions of neutral faces, which are omitted from the DANVA, is also a limitation, though the DANVA has been well validated without neutral faces.

In summary, our results suggest that exposure to childhood adversity does not impair emotion recognition abilities among children in the general population. The results highlight the importance of generating and triangulating results across multiple study samples to identify general versus specific effects of adversity on emotion recognition.

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Key Points

- Emotion recognition skills are essential for effective social communication, and deficits in these skills have been implicated in mental health problems.
- Prior studies of clinical and high-risk samples have consistently shown that children exposed to adversity are more likely than their unexposed peers to have emotion recognition skills deficits.
- However, only one population-based study has examined this association.
- In this large-population-based sample, we found no evidence to support an association between emotion recognition deficits and previous exposure to adversity.
- These findings underscore the need for population-based studies to generate generalizable results.

Table 1. Exposure to childhood adversity in the total sample and by the age at exposure

	Physical or emotional abuse		Sexual or physical abuse (by anyone)		Maternal psychopathology		One adult in the household		Family instability		Financial stress		Parent legal problems		Neighborhood Disadvantage	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Unexposed	5517	85	5733	88	4651	72	5459	84	3534	54	4088	63	6131	94	5623	86
Exposed	989	15	773	12	1855	28	1047	16	2972	46	2418	37	375	6	883	14
Age at Exposure																
Infancy																
Age 8 mo.	217	3.7	---	---	593	10.2	235	4.1	---	---	715	12.3	72	1.2	---	---
Age 1.5/1.75	240	4.2	139	2.4	583	10.4	279	5	1157	19.8	705	15.5	82	1.5	489	8.8
Age 2.5/2.75	335	6.1	227	4.1	802	14.8	340	6.2	1168	20.9	653	11.9	99	1.8	405	7.5
Preschool																
Age 3.5	---	---	183	3.3	749	14.1	---	---	1095	19.6	1255	20.1	---	---	---	---
Age 4/4.75	279	5	201	3.7	---	---	389	7.2	729	13.3	---	---	96	1.8	---	---
Age 5/5.75	378	7	174	3.3	---	---	---	---	599	11.3	---	---	83	1.6	303	5.7
Middle Childhood																
Age 6/6.75	307	5.8	162	3	825	15.7	---	---	487	9.1	---	---	85	1.6	---	---
Age 7	---	---	---	---	---	---	487	9.1	---	---	1137	18.3	---	---	242	4.5
Age 8	---	---	---	---	---	---	505	9.4	467	8.4	---	---	---	---	---	---

Percentages for each age represent proportions of those exposed out of the total population.

--- indicates that the variable was not assessed at the corresponding time point

Table 2. Results of linear regression models examining ever vs. never exposed on multiply imputed data for each type of misattribution of a face as that emotion (N=6506)

	Happy			Sad			Angry			Fear			All Emotions		
	Beta	95% CI	p-value	Beta	95% CI	p-value	Beta	95% CI	p-value	Beta	95% CI	p-value	Beta	95% CI	p-value
Exposed (vs. unexposed)															
Physical or emotional abuse	0.05	-0.04, 0.15	0.27	0.02	-0.07, 0.11	0.69	0.02	-0.04, 0.09	0.49	-0.04	-0.12, 0.03	0.27	0.05	-0.15, 0.24	0.62
Sexual or physical abuse	-0.10	-0.20, 0.01	0.07	-0.02	-0.10, 0.09	0.97	-0.01	-0.07, 0.07	0.97	0.06	-0.02, 0.15	0.15	-0.04	-0.25, 0.17	0.72
Maternal psychopathology	< 0.01	-0.07, 0.08	0.96	-0.02	-0.10, 0.05	0.53	-0.01	-0.06, 0.04	0.75	-0.04	-0.10, 0.02	0.20	-0.07	-0.22, 0.08	0.37
One adult in the household	0.05	-0.05, 0.15	0.32	-0.07	-0.16, 0.02	0.15	0.01	-0.05, 0.08	0.70	0.01	-0.08, 0.09	0.87	< 0.01	-0.20, 0.20	0.99
Family instability	-0.01	-0.09, 0.06	0.72	-0.05	-0.12, 0.01	0.12	-0.04	-0.09, 0.01	0.08	-0.02	-0.07, 0.04	0.57	-0.12	-0.27, 0.02	0.09
Financial stress	-0.04	-0.12, 0.03	0.28	-0.04	-0.11, 0.03	0.24	-0.02	-0.07, 0.03	0.44	0.01	-0.05, 0.07	0.75	-0.09	-0.24, 0.05	0.22
Parent legal problems	0.04	-0.11, 0.18	0.60	-0.09	-0.23, 0.05	0.19	-0.02	-0.12, 0.08	0.69	0.01	-0.11, 0.13	0.89	-0.07	-0.36, 0.23	0.66
Neighborhood disadvantage	-0.05	-0.15, 0.05	0.31	0.01	-0.08, 0.10	0.84	< 0.01	-0.07, 0.07	0.95	0.05	-0.03, 0.13	0.26	< 0.01	-0.19, 0.20	0.96
Cumulative exposure	-0.04	-0.13, 0.05	0.38	-0.02	-0.11, 0.07	0.64	<0.01	-0.06, 0.07	0.88	0.05	0.03, 0.12	0.23	-0.01	-0.19, 0.17	0.90

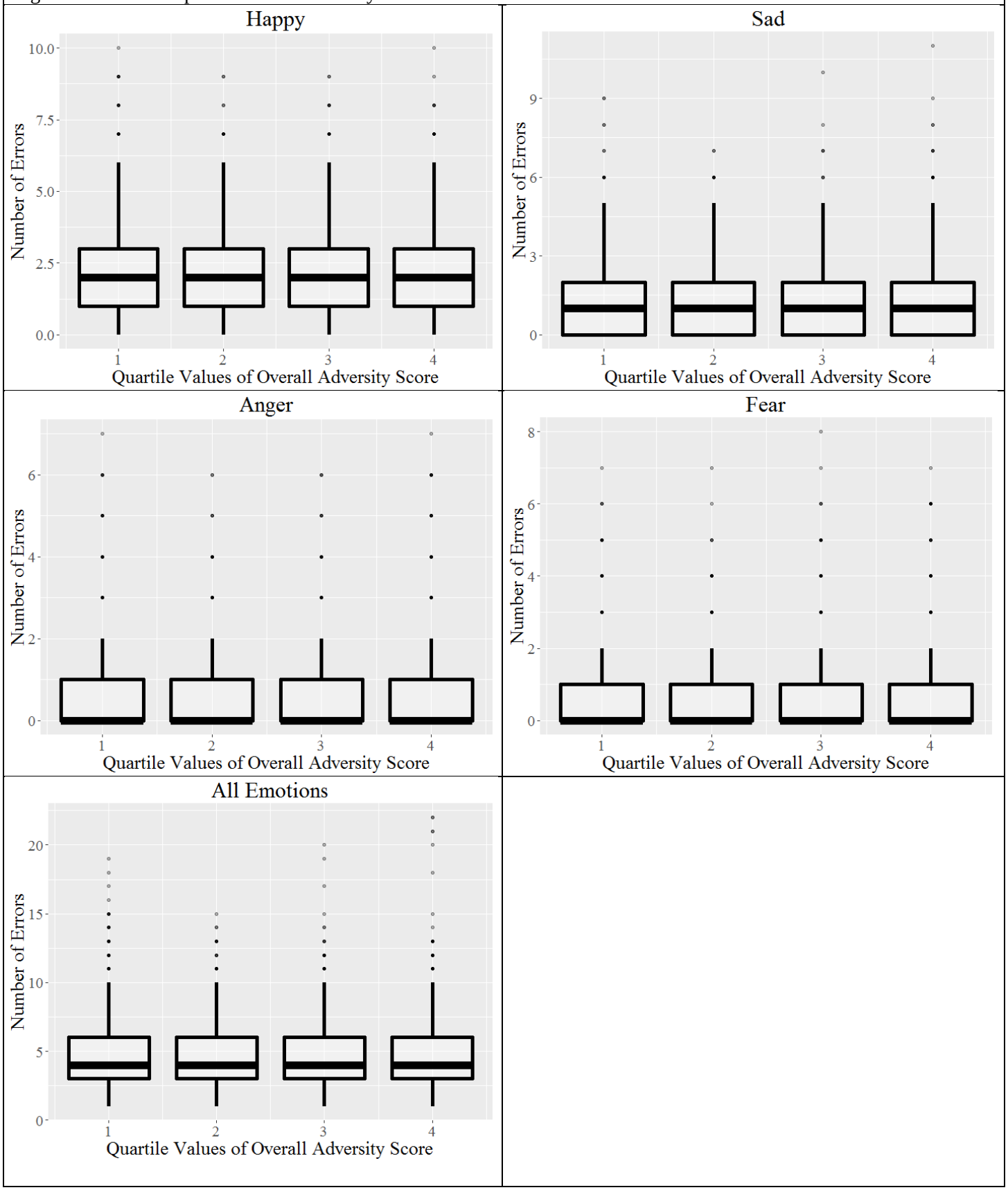
Cell entries are betas, 95% confidence intervals, and p-values derived from nine multiple linear regression (one for each type of adversity plus a model for cumulative exposure). Cumulative exposure was defined as a total of all adversity exposures over all time periods.

Table 3. Results of LARS models on multiply imputed data for each type of misattribution of a face as that emotion (N=6506)

	Happy		Sad		Fear		Anger		All Emotions	
	Model(s) selected	p-value	Model(s) selected	p-value	Model(s) selected	p-value	Model(s) selected	p-value	Model(s) selected	p-value
Physical or emotional abuse	2.75 Years	0.31	2.75 Years	0.73	5 Years	0.96	8 Months	0.61	6 Years	0.95
Sexual or physical abuse	1.5 Years	0.74	1.5 Years	0.75	2.5 Years	0.17	Recency	0.88	4.75 Years	0.36
Maternal psychopathology	1.75 Years	0.48	6 Years	0.75	1.75 Years	0.21	5 Years	0.97	6 Years	0.45
One adult in the household	6 Years	0.19	7 Years	0.43	8 Months	0.54	2.75 Years	0.78	6 Years	0.83
Family instability	3.5 Years	0.79	2.5 Years	0.40	4.75 Years	0.96	Accumulation	0.57	3.5 Years	0.85
Financial stress	2.75 Years	0.75	7 Years	0.54	2.75 Years	0.59	7 Years	0.93	7 Years	0.99
Parent legal problems	8 Months	0.98	6 Years	0.65	5 Years	0.94	4 Years	0.83	5 Years	0.51
Neighborhood disadvantage	5 Years	0.81	5 Years	0.86	2.75 Years	0.78	1.75 Years	0.89	2.75 Years	0.76

The table indicates the set of theoretical models chosen by LARS, after adjusting for covariates.

Figure 1. Relationship between the adversity score and misattribution of a face as each emotion



Supplemental Methods

Measures

We controlled for the following covariates, measured at child birth: *child race/ethnicity* (0=non-White; 1=White); *pregnancy size* (0=single; 1=multiple); *number of previous pregnancies* (between 0-3+); *maternal marital status* (0=never married; 1=widowed/divorced/separated; 2=married); *highest level of maternal education* (1=less than O-level, 2=O-level, 3=A-level, 4=Degree or above); *maternal age* (0=ages 15-19, 1=ages 20-35, 2=age>35); *homeownership* (0=mortgage/own home; 1=rent home; 2=other); and *parent social class* (i.e. the highest social class of either parent: 1=foreman; 2=manager; 3=supervisor; 4=lending hand; 5=self-employed; 6=none of these)(Chen et al., 2013, Adkins et al., 2011, Anney et al., 2010, Wood et al., 2008).

Multiple Imputation

There were 6,506 children with complete outcome data in our primary analysis. However, a small proportion of these 6,506 children had missing exposure or covariate data; rates of missingness for exposure or covariate data ranged per variable from 4.3% (n=279; for maternal birth age) to 19.1% (n=1244; for presence versus absence if maternal psychopathology at 6 years).

To reduce potential bias and minimize loss of power due to attrition, we performed multiple imputation, separately for each exposure, using logistic regression in 20 datasets with 25 iterations each among all children with complete outcome data. In addition to imputing exposures, we also imputed covariates as described here. Of note, variables were included in the imputation models following the guidance of van Buuren and colleagues (van Buuren et al., 1999, van Buuren and Groothuis-Oudshoorn, 2011) as well as prior research with imputation in the ALSPAC dataset (Ramchandani et al., 2008, Evans et al., 2012). The following variables were allowed to enter the imputation models: all covariates, later exposures to the same adversity (if available, measured through age 8.5), exposure to the other adversities, later outcomes (behavior symptoms and internalizing symptoms measured at ages 10, 11, 13, 16, and 18), and other maternal behavior measures (i.e., alcohol intake and smoking behavior). Variables uncorrelated with the missing variable ($r<0.10$) were excluded from the imputation model (van Buuren et al., 1999, van Buuren and Groothuis-Oudshoorn, 2011). Imputation was performed with chained equations (Azur et al., 2011) with the *mice* package in R (van Buuren and Groothuis-Oudshoorn, 2011). To reduce noise in estimation of effect estimates, we did not impute the outcome (White et al., 2011). For each adversity, we assessed the convergence of the imputation model and the distribution of imputed data as compared to the observed data.

LARs Regression Modeling

We achieved a single dataset for analysis by implementing LARs on the covariance structure among all variables, estimated by averaging the covariance structure across all multiply imputed datasets. This allowed us to avoid potential problems arising from different model selections across multiply imputed datasets (Wood et al., 2008).

For each type of adversity, we generated three sets of encoded variables: (1) a single variable denoting the total number of time periods of exposure to a given adversity, to test the accumulation hypothesis (coded as 0-6); (2) a set of variables indicating presence vs. absence of the exposure to adversity at a specific developmental stage, to test the sensitive period hypothesis; and (3) a single variable denoting the total number of developmental periods of

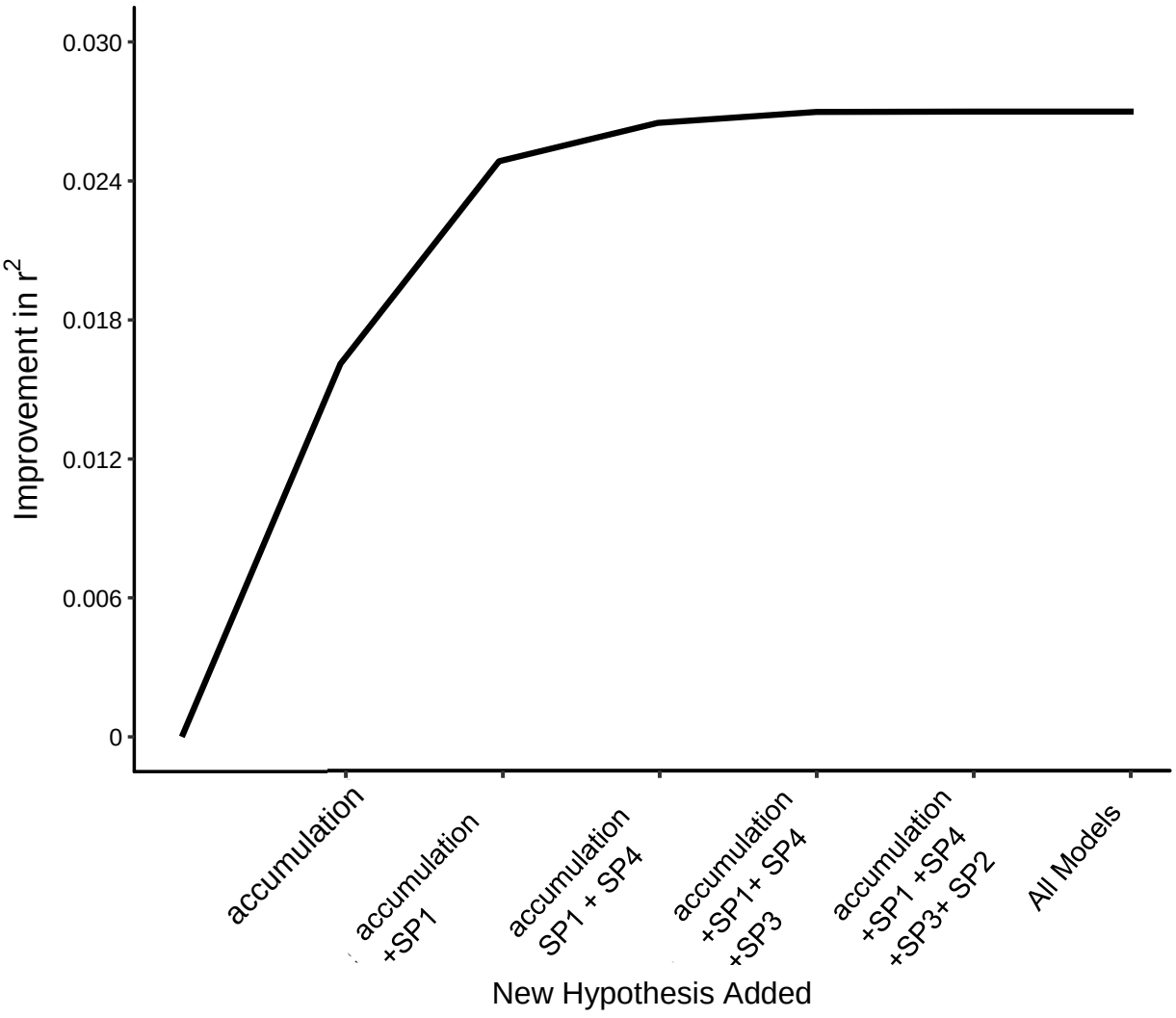
exposure, with each exposure linearly weighted by the age (in months) of the child during the measurement time period, to test the recency hypothesis; this variable assumed a linear increase in the effect of exposure over time and weighted more recent exposures more heavily than distally-occurring ones, allowing us to determine whether more recent exposures were more impactful. This weighted recency variable is distinguished from the last sensitive period model, which captures only the most recent exposure.

We then evaluated the relative importance of these variables using a two-stage structured lifecourse modeling approach (SLCMA) originally developed by Mishra (Mishra et al., 2009) for analyzing repeated, binary exposure data across the lifecourse. Relative to a more traditional regression model, the main advantage of the SLCMA is that it provides a structured and unbiased way to compare multiple competing theoretical models simultaneously and identify the most parsimonious explanation for the observed outcome variation.

In the first stage, we followed the approach of Smith (Smith et al., 2015) and entered the set of variables described previously into a Least Angle Regression (LARs) procedure (Efron et al., 2004) in order to identify, separately for each type of adversity, the single theoretical model (or potentially more than one models working in combination) that explained the most variability in child emotion recognition difficulties. We used a covariance test (Lockhart et al., 2014) and examined elbow plots (**Figure 1**) to determine whether the selected models were supported by the ALSPAC data. Compared to other variable selection procedures, including stepwise regression, the SLCMA has been shown to not over-inflate effect size estimates (Efron et al., 2004) or bias hypothesis tests (Lockhart et al., 2014). Compared to other methods for the structured approach, LARS has been shown to have greater statistical power and not bias subsequent stages of analysis (Smith et al., 2015). To adjust for potential confounding, we regressed each encoded variable on the covariates and implemented LARs on the regression residuals (Smith et al., 2016).

In the second stage, the theoretical models determined by a covariance test p-value threshold of 0.05 in the first stage (which appeared before the elbow; see **Figure 1**) would have been carried forward to a single multiple regression framework, where measures of effect would have been estimated for all selected hypotheses. The goal of this second stage would have been to determine the contribution of a selected theoretical model after adjustment for covariates as well as other selected theoretical models, in instances where more than one theoretical model was chosen in the first stage.

Figure 1. Elbow plot illustrating LARs variable selection procedure testing two life course models: accumulation and sensitive periods



LARs begins by first identifying the single variable with the strongest association to the outcome; it then identifies the combination of two variables with the strongest association, followed by three variables, and so on, until all variables are included. LARs therefore achieves parsimony by identifying the smallest combination of encoded variables that explain the most amount of outcome variation. In addition to a covariance test, which is calculated at each stage of the LARs procedure and tests the null hypothesis that adding the next encoded variable does not improve r^2, results can also be summarized in an "elbow plot," showing the increase in overall model r^2 as additional predictors are added to the model. The point where this plot levels off indicates the point of diminishing marginal improvement to the model goodness-of-fit from adding additional predictors, suggesting that the predictors included in the model at this point represent an optimal balance of parsimony and thoroughness. In this example, both accumulation and sensitive period 1 were selected in the best fitting models. SP =Sensitive Period.

Supplemental Table 1. Distribution of covariates in the total sample and by exposure to any childhood adversity and by levels of emotion recognition error(N=6506)

	Total Sample		Exposure to any adversity				Emotion Recognition Error		
	%	N	%	N	χ^2	*p*-value	Mean	SD	*p*-value
Gender					0.13	0.71			<0.01
Males	49.52	3222	78.02	2514			4.86	2.78	
Females	50.48	3284	77.62	2549			4.45	2.62	
Race					15.13	<0.01			0.04
White	96.11	5683	79.78	4534			4.31	2.52	
Non-White	3.89	230	90.43	208			4.68	2.7	
Maternal Education					19.55	<0.01			<0.01
less than O-level	21.63	1301	84.63	1101			4.96	2.85	
O-level	34.73	2089	78.75	1645			4.67	2.76	
A-level	26.85	1615	79.44	1283			4.53	2.56	
Degree or Above	16.78	1009	79.78	805			4.51	2.55	
Pregnancy Size					2.35	0.13			0.39
Single	97.31	6331	77.68	4918			4.64	2.7	
Multiple (2+)	2.69	175	82.86	145			4.83	2.88	
Maternal Marital Status					87.32	<0.01			0.82
Never Married	13.57	827	90.68	750			4.62	2.68	
Widowed/Divorced/Separated	4.82	294	90.13	265			4.69	2.79	
Married	81.6	4973	78.32	3895			4.68	2.71	
Home Ownership					119.34	<0.01			0.04
Mortgage/own home	83.51	5049	78.11	3944			4.64	2.68	
Rent home	14.08	851	93.3	794			4.8	2.82	
Other	2.41	146	91.78	134			5.09	2.78	
Age of Mother at child birth					22.81	<0.01			0.16
Ages 15-19	1.83	114	98.24	112			5.03	2.84	
Ages 20-35	89.67	5584	80.69	4500			4.68	2.71	
Age >35	8.5	529	79.96	423			4.52	2.66	
Parental Social Class					44.36	<0.01			0.10
Foreman	13.31	866	77.25	669			4.58	2.71	
Manager	36.4	2368	80.45	1905			4.59	2.62	
Supervisor	19.57	1273	77.38	985			4.75	2.66	
Lending Hand	5.5	358	83.8	300			4.68	2.72	
Self-Employed	1.75	114	84.21	96			5.26	3.27	
None of these	23.47	1527	72.56	1108			4.66	2.82	
Number of previous pregnancies					23.85	<0.01			0.16
0	46.54	2797	79.73	2230			4.73	2.69	
1	35.77	2150	79.3	1705			4.56	2.67	
2	13.03	783	83.14	651			4.65	2.79	
3+	4.67	280	90.36	253			4.78	2.82	

Emotion recognition error refers to the total number of errors (min=1; max=22; mean=4.65; sd=2.71)

Supplemental Table 2. Tetrachoric correlations between childhood adversities

Physical or emotional abuse (N=4503)

Age	8mo	1.75	2.75	4	5	6
8mo	1	--	--	--	--	--
1.75	0.7	1	--	--	--	--
2.75	0.57	0.71	1	--	--	--
4	0.47	0.61	0.72	1	--	--
5	0.49	0.52	0.62	0.66	1	--
6	0.5	0.57	0.6	0.66	0.73	1
Average:	0.61					

Parent legal problems (N=4397)

Age	8mo	1.75	2.75	4	5	6
8mo	1	--	--	--	--	--
1.75	0.68	1	--	--	--	--
2.75	0.44	0.6	1	--	--	--
4	0.44	0.47	0.7	1	--	--
5	0.22	0.29	0.35	0.54	1	--
6	0.43	0.32	0.31	0.44	0.6	1
Average:	0.46					

Sexual or physical abuse (by anyone) (N=4514)

Age	1.5	2.5	3.5	4.75	5.75	6.75
1.5	1	--	--	--	--	--
2.5	0.49	1	--	--	--	--
3.5	0.41	0.44	1	--	--	--
4.75	0.32	0.42	0.44	1	--	--
5.75	0.36	0.38	0.41	0.45	1	--
6.75	0.31	0.42	0.34	0.51	0.59	1
Average:	0.42					

Family instability (N=4216)

Age	1.5	2.5	3.5	4.75	5.75	6.75	8
1.5	1	--	--	--	--	--	--
2.5	0.57	1	--	--	--	--	--
3.5	0.46	0.61	1	--	--	--	--
4.75	0.15	0.25	0.42	1	--	--	--
5.75	0.28	0.31	0.3	0.53	1	--	--
6.75	0.19	0.2	0.23	0.43	0.64	1	--
8	0.11	0.25	0.21	0.29	0.39	0.43	1
Average:	0.35						

Maternal psychopathology (N=4380)

Age	8mo	1.75	2.75	5	6
8mo	1	--	--	--	--
1.75	0.72	1	--	--	--
2.75	0.66	0.71	1	--	--
5	0.57	0.57	0.65	1	--
6	0.59	0.58	0.6	0.71	1
Average:	0.64				

Financial stress (N=5120)

Age	8mo	1.75	2.75	5	7
8mo	1	--	--	--	--
1.75	0.69	1	--	--	--
2.75	0.66	0.73	1	--	--
5	0.48	0.48	0.53	1	--
7	0.37	0.42	0.4	0.6	1
Average:	0.54				

One adult in the household (N=4162)

Age	8mo	1.75	2.75	4	7	8
8mo	1	--	--	--	--	--
1.75	0.87	1	--	--	--	--
2.75	0.77	0.9	1	--	--	--
4	0.69	0.81	0.92	1	--	--
7	0.58	0.71	0.76	0.81	1	--
8	0.58	0.69	0.73	0.8	0.94	1
Average:	0.77					

Neighborhood disadvantage (N=4446)

Age	1.75	2.75	5	7
1.75	--	--	--	--
2.75	0.77	--	--	--
5	0.69	0.75	1	--
7	0.65	0.68	0.77	1
Average:	0.72			

Supplemental Table 3. Results of linear regression models examining ever vs. never exposed to adversity on multiply imputed data for each type of emotion misattribution

	Happy			Sad			Angry			Fear			All Emotions		
	Beta	95% CI	p-value	Beta	95% CI	p-value	Beta	95% CI	p-value	Beta	95% CI	p-value	Beta	95% CI	p-value
Exposed (vs. unexposed)															
Females (N=3284)															
Physical or emotional abuse	0.08	-0.05, 0.20	0.25	-0.01	-0.13, 0.11	0.88	0.05	-0.04, 0.14	0.24	-0.04	-0.14, 0.07	0.49	0.08	-0.18, 0.35	0.53
Sexual or physical abuse	-0.17	-0.32, 0.00	0.03	-0.05	-0.19, 0.09	0.47	-0.01	-0.10, 0.10	0.82	0.10	0.00, 0.23	0.08	-0.13	-0.40, 0.20	0.39
Maternal psychopathology	0.02	-0.08, 0.13	0.71	-0.05	-0.14, 0.05	0.32	-0.03	-0.09, 0.06	0.61	< 0.01	-0.07, 0.09	0.91	-0.05	-0.23, 0.18	0.61
One adult in the household	0.07	-0.07, 0.20	0.32	-0.03	-0.16, 0.09	0.59	0.04	-0.05, 0.14	0.36	0.01	-0.10, 0.11	0.90	0.08	-0.19, 0.35	0.54
Family instability	0.06	-0.04, 0.16	0.23	-0.03	-0.12, 0.06	0.59	-0.04	-0.10, 0.03	0.30	-0.02	-0.10, 0.06	0.68	-0.02	-0.21, 0.17	0.86
Financial Stress	-0.05	-0.16, 0.05	0.35	-0.04	-0.13, 0.05	0.41	-0.03	-0.10, 0.04	0.41	-0.01	-0.09, 0.07	0.76	-0.13	-0.33, 0.06	0.20
Parent legal problems	0.09	-0.13, 0.27	0.33	-0.10	-0.28, 0.07	0.25	-0.06	-0.18, 0.08	0.34	-0.07	-0.22, 0.10	0.34	-0.15	-0.52, 0.24	0.44
Neighborhood disadvantage	-0.01	-0.15, 0.13	0.98	-0.02	-0.15, 0.11	0.75	< 0.01	-0.09, 0.10	0.99	0.08	-0.03, 0.19	0.19	0.05	-0.22, 0.32	0.69
Males (N=3222)															
Physical or emotional abuse	0.04	-0.10, 0.17	0.58	0.01	-0.13, 0.14	0.90	-0.01	-0.10, 0.08	0.84	-0.06	-0.16, 0.04	0.29	-0.02	-0.28, 0.25	0.89
Sexual or physical abuse	-0.05	-0.19, 0.09	0.48	-0.01	-0.16, 0.13	0.84	0.00	-0.09, 0.09	0.95	0.02	-0.10, 0.13	0.75	-0.05	-0.34, 0.16	0.73
Maternal psychopathology	-0.01	-0.12, 0.10	0.85	< 0.01	-0.11, 0.11	0.97	< 0.01	-0.07, 0.07	0.96	-0.08	-0.17, 0.01	0.08	-0.10	-0.31, 0.12	0.38
One adult in the household	0.02	-0.13, 0.16	0.83	-0.10	-0.25, 0.04	0.15	-0.02	-0.11, 0.08	0.74	< 0.01	-0.11, 0.11	0.99	-0.10	-0.39, 0.18	0.48
Family instability	-0.08	-0.18, 0.03	0.15	-0.07	-0.18, 0.03	0.17	-0.05	-0.12, 0.02	0.16	< 0.01	-0.09, 0.08	0.93	-0.20	-0.42, 0.01	0.06
Financial Stress	-0.02	-0.13, 0.08	0.66	-0.05	-0.16, 0.06	0.39	-0.01	-0.08, 0.06	0.76	0.03	-0.06, 0.11	0.55	-0.06	-0.28, 0.16	0.61
Parent legal problems	-0.03	-0.25, 0.20	0.80	-0.02	-0.25, 0.21	0.88	0.01	-0.13, 0.16	0.84	0.06	-0.12, 0.24	0.49	0.03	-0.43, 0.49	0.90
Neighborhood disadvantage	-0.07	-0.21, 0.08	0.37	0.04	-0.11, 0.19	0.59	-0.01	-0.10, 0.08	0.83	-0.01	-0.13, 0.11	0.89	-0.04	-0.34, 0.25	0.77

Cell entries are betas, 95 % confidence intervals, and p-values derived from eight multiple linear regression (one for each type of adversity).

Supplemental Table 4. Results of the LARs models on multiply imputed data for each type of emotion stratified by sex (N=6506)

	Happy			Sad			Fear			Anger		
	Model(s) selected	p-value	r2 explained	Model(s) selected	p-value	r2 explained	Model(s) selected	p-value	r2 explained	Model(s) selected	p-value	r2 explained
Females (N=3284)												
Physical or emotional abuse	8 Months	0.70		2.75 Years	0.87		6 Years	0.74		1.75 Years	0.62	
Sexual or physical abuse	Accumulation	0.94		1.5 Years	0.98		1.5 Years	0.43		6 Years	0.12	
Maternal psychopathology	1.75 Years	0.84		6 Years	0.65		1.75 Years	0.42		6 Years	0.68	
One adult in the household	Accumulation	0.77		2.75 Years	0.68		8 Months	0.39		7 Years	0.77	
Family instability	5.75 Years	0.94		3.5 Years	0.19		8 Years	0.12		4.75 Years	0.88	
Financial Stress	8 Months	0.69		1.75 Years	0.20		2.75 Years	0.03	0.13	2.75 Years	0.99	
Parent legal problems	8 Months	0.99		1.75 Years	0.83		4 Years	0.66		2.75 Years	0.96	
Neighborhood disadvantage	4.75 Years	0.95		7 Years	0.41		2.75 Years	0.09	0.09	5 Years	0.90	
Males (N=3222)												
Physical or emotional abuse	2.75 Years	0.53		2.75 Years	0.89		8 Months	0.94		8 Months	0.97	
Sexual or physical abuse	4 Years	0.66		4 Years	0.79		5 Years	0.50		4 Years	0.53	
Maternal psychopathology	2.75 Years	0.64		3.5 Years	0.57		2.75 Years	0.10		1.75 Years	0.90	
One adult in the household	1.75 Years	0.87		7 Years	0.08	0.12	8 Months	0.87		2.75 Years	0.50	
Family instability	1.5 Years	0.34		2.5 Years	0.73		2.5 Years	0.87		Accumulation	0.76	
Financial Stress	2.75 Years	0.16		1.75 Years	0.50		Recency	0.36		1.75 Years	0.94	
Parent legal problems	4 Years	0.60		8 Months	1.00		6 Years	0.72		4 Years	0.92	
Neighborhood disadvantage	5 Years	0.90		1.75 Years	0.97		7 Years	0.35		7 Years	0.89	

The table indicates the set of theoretical models chosen by the LARs, after adjusting for covariates.

Supplemental Table 5. Results of saturated linear regression models of all encoded variables on multiply imputed data for each type of emotion misattribution (N=6506)

	Happy		Sad		Angry		Fear		All Emotions	
	p-value	r^2 explained	p-value	r^2 explained	p-value	r^2 explained	p-value	r^2 explained	p-value	r^2 explained
Physical or emotional abuse	0.16	0.17	0.98	0.03	0.95	0.04	0.74	0.08	0.86	0.06
Sexual or physical abuse	0.26	0.17	0.56	0.12	0.99	0.04	0.36	0.17	0.25	0.18
Maternal psychopathology	0.38	0.10	0.80	0.06	0.80	0.06	0.23	0.14	0.86	0.04
One adult in the household	0.71	0.09	0.55	0.11	0.76	0.08	0.67	0.10	0.95	0.05
Family instability	0.91	0.06	0.53	0.13	0.72	0.09	0.76	0.08	0.86	0.07
Financial Stress	0.38	0.11	0.75	0.06	0.99	0.02	0.71	0.07	0.84	0.05
Parent legal problems	0.87	0.06	0.10	0.67	0.99	0.04	0.79	0.08	0.83	0.07
Neighborhood disadvantage	0.70	0.06	0.99	0.02	0.99	0.02	0.10	0.15	0.92	0.03

Cell entries are percentage of r^2 explained and p-values derived from eight multiple linear regression (one for each type of adversity).

Supplemental Table 6. Results of linear regression models examining ever vs. never exposed to adversity on multiply imputed data including excluded children for each type of emotion misattribution (N=6802)

	Happy			Sad			Angry			Fear			All Emotions		
	Beta	SE	P	Beta	SE	P	Beta	SE	P	Beta	SE	P	Beta	SE	P
Caregiver physical or emotional abuse	0.07	0.05	0.16	0.03	0.05	0.54	0.03	0.03	0.40	-0.03	0.04	0.47	0.09	0.10	0.34
Sexual or physical abuse	-0.08	0.05	0.15	-0.01	0.05	0.83	0.00	0.03	0.89	0.06	0.04	0.15	-0.02	0.11	0.85
Maternal psychopathology	0.01	0.04	0.76	-0.03	0.04	0.39	-0.02	0.03	0.55	-0.04	0.03	0.16	-0.08	0.08	0.31
One adult in the household	0.06	0.05	0.28	-0.08	0.05	0.10	0.00	0.03	0.91	0.00	0.04	0.98	-0.02	0.10	0.86
Family instability	0.06	0.05	0.23	-0.01	0.04	0.89	-0.03	0.04	0.41	-0.02	0.04	0.68	0.01	0.10	0.93
Financial Stress	-0.03	0.04	0.44	-0.05	0.04	0.19	-0.03	0.03	0.19	0.01	0.03	0.84	-0.10	0.08	0.18
Parent legal problems	0.03	0.08	0.69	-0.08	0.07	0.23	-0.03	0.05	0.46	-0.01	0.06	0.85	-0.12	0.14	0.38
Neighborhood disadvantage	-0.05	0.05	0.30	0.01	0.05	0.79	0.00	0.03	0.99	0.04	0.04	0.36	0.00	0.10	0.97

Cell entries are betas, standard errors, and p-values derived from nine multiple linear regression (one for each type of adversity).

Supplemental Table 7. Results of LASSO models on multiply imputed data for each type of emotion (N=6802)

	Happy		Sad		Fear		Anger		All Emotions	
	Model(s) selected	P-value	Model(s) selected	P-value	Model(s) selected	P-value	Model(s) selected	P-Value	Model(s) selected	P-Value
Physical or emotional abuse	2.75 Years	0.17	2.75 Years	0.89	5 Years	0.23	5 Years	0.97	Recency	0.82
Sexual or physical abuse	Recency	0.61	3.5 Years	0.83	3.5 Years	0.06	4.75 Years	0.94	4.75 Years	0.24
Maternal psychopathology	1.75 Years	0.70	6 Years	0.69	5 Years	0.83	5 Years	0.78	Recency	0.84
One adult in the household	7 years	0.23	7 Years	0.79	8 Months	0.46	1.75 Years	0.86	8 Months	1.00
Family instability	5.75 Years	0.83	2.5 Years	0.10	2.5 Years	0.95	Accumulation	0.55	Accumulation	0.91
Financial Stress	2.75 Years	0.45	7 Years	0.10	2.75 Years	0.61	7 Years	0.17	7 Years	0.35
Parent legal problems	8 Months	0.95	5 Years	0.46	1.75 Years	0.92	4 Years	0.41	5 Years	0.73
Neighborhood disadvantage	7 Years	0.94	7 Years	0.78	1.75 Years	0.83	2.75 Years	0.91	2.75 Years	0.80

The table indicates the set of theoretical models chosen by LARs, after adjusting for covariates.

Supplemental Table 8. Results of linear regression models examining ever vs. never exposed to adversity on multiply imputed data for each type of error recognizing emotion (N=6506)

	Happy			Sad			Angry			Fearful			All Emotions		
	Beta	95% CI	P	Beta	95% CI	P	Beta	95% CI	P	Beta	95% CI	P	Beta	95% CI	P
Exposed (vs. unexposed)															
Physical or emotional abuse	0.01	-0.03, 0.06	0.54	-0.03	-0.09, 0.03	0.38	-0.01	-0.10, 0.09	0.85	0.07	-0.03, 0.17	0.16	0.04	-0.15, 0.24	0.65
Sexual or physical abuse	0.09	0.04, 0.14	< 0.01	-0.01	-0.08, 0.06	0.85	-0.05	-0.15, 0.05	0.35	-0.08	-0.19, 0.03	0.15	-0.04	-0.24, 0.16	0.67
Maternal psychopathology	< 0.01	-0.03, 0.04	0.92	-0.02	-0.07, 0.03	0.37	-0.03	-0.10, 0.05	0.49	-0.03	-0.11, 0.04	0.37	-0.08	-0.23, 0.06	0.28
One adult in the household	-0.02	-0.06, 0.02	0.38	0.05	-0.02, 0.12	0.18	-0.06	-0.16, 0.04	0.22	0.04	-0.06, 0.14	0.43	< 0.01	-0.20, 0.20	0.97
Family instability	-0.02	-0.05, 0.02	0.34	-0.03	-0.08, 0.01	0.16	-0.06	-0.13, 0.01	0.09	-0.02	-0.09, 0.06	0.69	-0.13	-0.27, 0.02	0.08
Financial Stress	-0.01	-0.04, 0.02	0.55	0.01	-0.04, 0.06	0.73	-0.03	-0.11, 0.04	0.36	-0.06	-0.13, 0.01	0.10	-0.10	-0.24, 0.05	0.20
Parent legal problems	-0.02	-0.09, 0.05	0.60	0.04	-0.06, 0.13	0.44	-0.09	-0.23, 0.05	0.19	0.04	-0.11, 0.18	0.61	-0.04	-0.31, 0.24	0.80
Neighborhood disadvantage	0.04	-0.02, 0.09	0.16	0.04	-0.04, 0.12	0.27	0.08	-0.04, 0.19	0.18	-0.13	-0.22, -0.01	0.04	< 0.01	-0.20, 0.20	0.99
Cumulative exposure	0.01	-0.03, 0.05	0.58	0.02	-0.04, 0.08	0.53	-0.02	-0.11, 0.07	0.67	-0.03	-0.12, 0.06	0.49	-0.02	-0.20, 0.16	0.82

Cell entries are betas, 95% confidence intervals, and p-values derived from nine multiple linear regression (one for each type of adversity plus a model for cumulative exposure). Cumulative exposure was defined as a total of all adversity exposures over all time periods.

Supplemental Table 9. Results of Variables Significant in Linear Regression LARs models on multiply imputed data for each type of emotion stratified (N=6506

Significant Variable	P- Value	r2 explained
Sexual or Physical Abuse at 3.5 Years	0.77	0.01
Neighborhood Disadvantage at 1.75 Years	0.91	<0.01

The table indicates the set of theoretical models chosen by LARS, after adjusting for covariates.

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