Sensitive periods for the effect of child maltreatment on psychopathology symptoms in adolescence

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Short title: Sensitive periods and child maltreatment

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Number of Tables: 3

Number of Figures: 2

Word Count: 3964 manuscript; 247 abstract

Keywords: maltreatment, neglect, sensitive periods, accumulation of risk, psychopathology

Abstract

Introduction: Child maltreatment is among the strongest risk factors for mental disorders. However, little is known about whether there are ages when children may be especially vulnerable to its effects. We sought to identify potential sensitive periods when exposure to the 2 most common types of maltreatment (neglect and harsh physical discipline) had a particularly detrimental effect on youth mental health.

Methods: Data came from the Future of Families and Child Wellbeing Study (FFCWS), a birth cohort oversampled from "fragile families" (n=3,474). Maltreatment was assessed at 3, 5, and 9 years using an adapted version of the Parent-Child Conflict Tactics Scales (CTS-PC). Using least angle regression, we examined the relationship between repeated measures of exposure to maltreatment on psychopathology symptoms at age 15 (Child Behavior Checklist; CBCL/6-18). For comparison, we evaluated the strength of evidence to support the existence of sensitive periods in relation to an accumulation of risk model.

Results: We identified sensitive periods for harsh physical discipline, whereby psychopathology symptom scores were highest among girls exposed at age 9 (r^2=0.67 internalizing symptoms; r^2=1% externalizing) and among boys exposed at age 5 (r^2=0.41%). However, for neglect, the accumulation of risk model explained more variability in psychopathology symptoms for both boys and girls.

Conclusion: Child maltreatment may have differential effects based on the child's sex, type of exposure, and the age it occurs. These findings provide additional evidence for clinicians

assessing the benefits and drawbacks of screening efforts and point towards mechanisms driving increased vulnerability to psychopathology.

Introduction

Childhood maltreatment is one of the most potent though preventable risk factors for psychopathology throughout the lifespan [1]. One of the dominant approaches to operationalizing this relationship is the cumulative risk model, which assumes that the number of exposures to any risk factor will determine its impact above and beyond the intensity or type of risk factor [2]. However, there are mixed findings in support of this additive assumption of risk because current research has not fully explored if the cumulative effect of multiple instances of maltreatment, for example, could be explained by a single, more intense experience out of many or the context of when and how the maltreatment occurred in the child's life [2, 3]. Emerging research, particularly from animal studies, suggests maltreatment may not have consistent effects throughout childhood, but rather there are sensitive periods when the developing brain is particularly vulnerable to adversity [4]. The sensitive period model presumes the developmental timing of exposure is most important for determining the effect the exposure will have on later outcomes such as psychopathology symptoms. This could be a result of time-dependent maturation or plasticity in the brain that coincides with exposure to maltreatment in childhood to produce a greater effect than that of the same exposure occurring at a different time [5-8]. Yet, in humans, such sensitive periods have been largely unidentified, due to a scarcity of research and mixed results (for a comprehensive review of this literature, refer to Schaefer, Chen, & Dunn, in press [9]). Some prospective studies have found early maltreatment (before age 5) is more strongly associated with psychopathology risk [10-12]. Prospective studies have found later maltreatment (after age 10 [13] or during adolescence [14]) is most harmful. Some find no developmental timing differences [15-17]. Well-powered prospective research in large and diverse samples is needed to determine if and when sensitive periods occur. Such research can

increase understanding of the processes linking maltreatment to mental health problems and suggest optimal time points for screening and prevention efforts to reduce the negative consequences of adversity exposure [4].

The current study addresses this need by analyzing data on child maltreatment from a population-based cohort of high-risk children followed from birth through adolescence. Children from fragile families, defined as unmarried parents, were oversampled. This dataset contained repeated measures of children's exposure to neglect and harsh physical discipline, the 2 most common types of child maltreatment [18, 19], and measures of child internalizing and externalizing symptoms. Although the effects of more extreme forms of physical abuse on psychopathology risk are well established, numerous studies suggest physical discipline practices, such as spanking, slapping, and hitting [20], are associated with various negative developmental outcomes, including increased child aggression [21], slower cognitive development [22], and poor mental health in childhood [23] and adolescence [20]. Indeed, informed by this considerable body of research, the American Academy of Pediatrics released a policy statement urging parents to desist from physical and harsh verbal discipline [24, 25].

We brought three key innovations to these analyses. First, we examined psychopathology outcomes during adolescence, which allowed us to evaluate the longer-term impacts of maltreatment on psychopathology in youth. If there was a latency or time-lag between the onset of maltreatment to presentation of behavioral symptoms, studies like ours, which follow children for longer, are likely to detect sensitive periods, as compared to studies of shorter duration. Second, among prospective studies examining the role of child maltreatment

timing on psychopathology risk [10-17], the size of this study (n=3474) was considerably larger (average for prior studies was n=826). Thus, we had greater statistical power to detect potential sensitive period effects, if they existed. Third, we evaluated the strength of evidence to support the existence of sensitive periods compared to an accumulation of risk model [2], in which the effect of maltreatment on psychopathology symptoms is presumed to increase with the number of occasions exposed, regardless of timing. Few prior studies [26] have compared the sensitive period model to alternative life-course models to determine which better explains risk for psychopathology. This dearth of comparison is a major limitation, as it could explain mixed results among prior studies.

Methods

Participants and Procedures

Data came from the Future of Families and Child Wellbeing Study (FFCWS) formerly known as the Fragile Families and Child Wellbeing Study, a birth cohort study following a random sample of nearly 5000 families in 20 large cities (populations over 200,000) [27] in the United States. FFCWS oversampled families with unmarried parents, in an attempt to capture a nationally representative sample of fragile families who may be vulnerable to risk factors associated with nonmarital childbearing, such as poverty. Between 1998 and 2000, mothers and fathers in 75 hospitals were interviewed after their child's birth, referencing approximately 4898 births to 3711 unmarried and 1187 married parents; nonmarital births and families who were socioeconomically disadvantaged were oversampled. A description of sociodemographic characteristics of the sample and key study variables is presented in Table S1, available online. Families were interviewed again when the child was 1, 3, 5, 9, and 15 years of age. Follow-up

interview completion rates were excellent (89% of mothers at age 1, 86% at age 3, 85% at age 5, 76% at age 9, and 73% at age 15).

Ethical Considerations

Informed consent was obtained for each family at each interview. The institutional review boards at Columbia University and Princeton University approved the FFCWS. Additional details on participation, including attrition at each wave of assessment, are publicly available online [28].

Measures

Predictors: Exposure to childhood maltreatment

Assessments of neglect and harsh physical discipline were derived from the Parent-Child Conflict Tactics Scales (CTS-PC), a frequently-used measure to assess child maltreatment in population-based samples [19, 29, 30]. The CTS-PC was reported by primary caregivers (most often mothers) at child ages 3, 5 and 9, and collected mostly via computer-based in-home assessments with an interviewer and sometimes by telephone.

The FFCWS CTS-PC measure included a subset of items from the CTS-PC and its supplemental scale on neglect, designed to capture mild and moderate maltreatment (5 neglect items ($\alpha = .22$) and 5 harsh physical discipline items; see Supplement 1, available online). Items asking about severe physical maltreatment (e.g., "burned or scalded him/her on purpose," "grabbed him/her around the neck and choked him/her") were omitted by FFCWS to avoid potentially implicating parents and necessitate involvement of child protective services. Items capturing more mild forms of corporal punishment [31] (e.g., "spanked him/her on the bottom

with a hand") were not included in our measure of harsh physical discipline. Consistent with prior studies using the CTS-PC in FFCWS [32], harsh physical discipline was coded as a dichotomous variable indicating presence vs absence of the following: (1) the parent had shaken the child at any point in the past year; and/or (2) the parent had hit the child with an object on 3 or more occasions in the past year. See Supplemental Materials for details on the specific items included.

Children were coded as having been exposed to neglect if their primary caregiver reported at least 1 of these events in the past year at any frequency: (1) parent had to leave child home alone even when adult was needed; (2) parent was so caught up in own problems that they were not able to express love to child; (3) parent not able to make sure child got food when needed; (4) parent was not able to make sure child got to the doctor or hospital when needed; and (5) parent was so drunk or high that they had problem taking care of child. These items were also chosen to be consistent with prior studies in the FFCWS [33-35].

Outcome: Child Behavior Problems

At age 15, child behavior problems were assessed using items from the Child Behavior Checklist (CBCL/6-18), one of the most commonly-used measures of psychopathology symptoms in children [36]. Primary caregivers rated their child's behavior on 34 items using a 3-point scale (0=not true; 1=sometimes true; 2=very true or often true). We analyzed raw total scores from the internalizing (analytic sample α=0.88; 8 items) and externalizing subscales (analytic sample α=0.91; 20 items), which were square-root transformed prior to analyses to

improve univariate normality, and then converted to z-scores to aid interpretability. Parent report of psychopathology was analyzed, as it was far more comprehensive than child self-reports (which only focused on measuring depressive symptoms). As we have described elsewhere [37, 38], the occurrence, predictors of, and consequences for discrepancies between parental and child reports are important to study in their own right and could be in a future investigation.

Covariates

We adjusted for the following covariates, measured at the time of the child's birth, to rule-out the effects of baseline sociodemographic factors: maternal age; maternal race/ethnicity; maternal marital status; mother-reported receipt of public assistance, welfare, or food stamps; and maternal education. We also adjusted for maternal depression or substance use when her child was 3 years of age, because parent psychopathology symptoms were associated with both child psychopathology and maltreatment in our sample, and could lead to maternal bias in both the reporting of child abuse exposure and psychopathology symptoms [39, 40] (see Covariate section in Supplement 1, available online). For comparison, we also conducted analyses without adjustment for maternal psychopathology (see Table S4 and Table S5, available online).

All analyses were stratified by sex, because stress exposure [30] and psychopathology [41-43] vary between boys and girls and may lead to differences in the effects of these life-course theoretical models [2]. We used sex stratification rather than tests of statistical interaction, because interaction terms can only capture differences in magnitude of the exposure effect in the same life-course model, while stratification can capture differences in the structure of the life-course model as well as the magnitude of exposure effects.

Analyses

To minimize loss of power and reduce potential bias due to attrition, we performed multiple imputation among children with complete outcome data on psychopathology symptoms measured at year 15 (n=3474; see Data Analysis section in Supplement 1, available online).

We used an innovative two-stage structured life course modeling approach (SLCMA) [44, 45] to test the strength of evidence for sensitive periods. The SLCMA was originally developed by Mishra [46] and later extended by Smith [44] to analyze repeated binary exposure data across the life course. The SLCMA allows researchers to compare competing life-course theoretical models simultaneously and identify the most parsimonious explanation for variation in the outcome of interest. Details about the SLCMA are in Supplement 1.

We considered the sensitive-period theoretical model (assessed at ages 3, 5 and 9 years) and compared it with a second model – the accumulation of risk model – in which the outcome varies with the number of occasions exposed regardless of timing (i.e., under the accumulation model there are no sensitive periods). The SLCMA uses least-angle regression (LARS) to identify which theoretical model (or set of theoretical models working in combination) is most supported by the data. When LARS identifies the accumulation model alone, it indicates no sensitive periods are supported by the data; when LARS identifies a sensitive-period model, it indicates the specific period when exposure to maltreatment has the greatest effect on the outcome.

A total of 8 LARS models were conducted, corresponding to each type of maltreatment (neglect and harsh physical discipline) and outcome (internalizing and externalizing psychopathology), separately for boys and girls. We regressed the exposures on the covariates and then implemented LARS on the regression residuals to adjust for possible confounding [45]. We used the covariance test [47] to determine whether a set of theoretical models working in combination explained sufficiently more of the outcome variation than a single theoretical model, applying a Bonferroni significance threshold of 0.05/8=0.00625. No combination of models met this threshold, hence all results are reported as the single best fitting theoretical model. Compared with other variable selection procedures, such as stepwise regression, the LARS has multiple benefits including greater statistical power [44], not overinflating effect size estimates [48] nor introducing bias in hypothesis tests [47].

Having selected a theoretical model using LARS, we then estimated the coefficients of the selected model for each type of maltreatment, outcome, and sex, enabling us to determine the magnitude of effect for a selected theoretical model, while continuing to adjust for covariates. We calculated confidence intervals (CIs) for the effect estimates that have 95% coverage while adjusting for the selection made by LARS [44].

Although researchers have grouped adversity exposures into clusters – such as deprivation and threat, as a means to characterize the distinct neural pathways they might influence – we analyzed these exposures separately, because we wanted to determine if there were unique timing-outcome effects for each form of maltreatment and preserve statistical power

(a multiple prediction model with multiple exposures and lifecourse hypotheses would both reduce power and complicate interpretation of results).

Results

Sample Characteristics

The analytic sample was nearly sex-balanced (48% female) and diverse by race/ethnicity (21.9% White; 50.3% Black; 24.4% Hispanic; 3.5% other) and socioeconomic background, though skewed towards more disadvantaged families, as indicated by levels of maternal education (11.2% of mothers were college educated or higher), and receipt of public assistance/welfare (36.2%) (see Table S1, available online).

Exposure to childhood maltreatment was common, with 988 children exposed to neglect at any time point (28.4%), 1214 exposed to harsh physical discipline (34.9%) (Table 1), and 334 children (9.6%) exposed to both types of maltreatment at any time point. Reports of child exposure to neglect increased with age, more than doubling between ages 5 and 9, whereas reports of harsh physical discipline were stable across time.

Exposures were somewhat correlated across time (average correlation across time points for neglect: r=0.33; harsh physical discipline: r=0.51; see Table S2, available online). Children exposed to harsh physical discipline at any time point were also slightly more likely to be exposed to neglect at any time point (r=0.28). These correlation values are well below the correlation of 0.80 observed to limit the ability of the SLCMA to identify the correct life-course model [44].

Internalizing and externalizing symptoms were moderately correlated (Pearson r=0.51). Boys had, on average, greater levels of externalizing psychopathology at age 15 than girls

(*P*<.001) (see Table S3, available online). Girls, in comparison, had greater levels of internalizing problems at age 15 (*P*=.006). Children of mothers with less than a high school education who received public assistance, used substances, or had periods of depression were also more likely to show higher levels of internalizing and externalizing problems at age 15 (all *P*<.05). Children born to younger and unmarried mothers showed higher levels of externalizing problems in particular (*P*<.001) compared to their peers.

Model Selection and Effect Estimates

Tables 2 and 3 display the life-course theoretical models selected by the LARS procedure, separately for each type of childhood maltreatment exposure, psychopathology outcome, and sex. These tables also show the effect estimates and 95% CIs for these selected models, adjusted for covariates.

Internalizing Symptom Results

As shown in Table 2 and Figure 1, an accumulation model best explained the relationship between neglect and internalizing symptoms in both girls (r^2=0.6%) and boys (r^2=0.9%). For exposure to harsh physical discipline, a sensitive period at age 9 best explained the association with internalizing symptoms in girls (r^2=0.7%; see Fig. 2). A sensitive period at age 5 best explained the association in boys (r^2=0.4%; see Fig. 2). The same life-course theoretical models were chosen in the analyses omitting the maternal psychopathology variables (see Table S4 and Table S5, available online).

Externalizing Symptom Results

As shown in Table 3, the accumulation model best explained the relationship between neglect and externalizing symptoms in girls, although this was the only model in which the confidence interval for the regression coefficient included zero. Similar to the internalizing symptom findings, a sensitive period at age 9 was again selected as the best fitting model for explaining the relationship between harsh physical discipline and externalizing symptoms in girls (r^2=1.0%; see Fig. 2). In boys, however, an accumulation model explained the most variation in externalizing symptoms following both neglect exposure (r^2=0.7%) and harsh physical discipline (r^2=1.4%; see Fig. 1). These findings were also consistent when maternal psychopathology variables were removed (see Supplement 1, Table S4 and Table S5, available online).

Discussion

Two primary findings emerged from this study. First, we identified sensitive periods for harsh physical discipline: both internalizing and externalizing symptoms were elevated in girls exposed to harsh physical discipline at age 9; internalizing symptom scores were elevated among boys exposed at age 5. These findings are consistent with work by Teicher and colleagues [49, 50] in showing that physical abuse and neglect may not only have different sensitive periods for psychopathology symptoms, but also the timing of these sensitive periods may be sex-dependent. Our ability to detect these sensitive-period effects was notable, because reports of harsh physical discipline were moderately correlated over time in this sample, making sensitive periods harder to discern. The large sample size of FFCWS and the statistical power it therefore afforded enabled us to differentiate sensitive-period from accumulation effects.

Second, with neglect, we saw stronger and consistent evidence for the accumulation of risk model for both boys and girls. For each additional time period of exposure to neglect, the z-score for psychopathology increased by one-tenth, on average. Though not a fully direct comparison, these findings align with the Bucharest Early Intervention Project (BEIP), which found that children randomly assigned to remain in institutional care had greater psychopathology symptoms in adolescence than children who were never institutionalized or randomized to high-quality foster care [51]. However, in the BEIP, sex differences in this accumulation effect have been observed, with girls being somewhat protected from the effects of severe early deprivation [51]. Reports of neglect were weakly correlated across time in our FFCWS analytic sample, suggesting parental reporting was either inconsistent or experiences of neglect were intermittent, perhaps due to changes in work, childcare, and neighborhood conditions [52]. To our knowledge, this is the largest study to test the sensitive-period hypothesis for neglect in children or adolescents.

These findings provide important clues for researchers to consider in narrowing the search space to identify mechanisms underlying psychopathology risk. If sensitive periods begin after children reach specific maturational goals, as has been found [53], then our findings hint at what domains to study and when. Our results can also guide clinicians in the assessment of adversity exposure, particularly in pediatric care settings [54]. Experts have discussed *which* screening measures to use [55], *how* to address patient- and provider-level barriers to implementation [56], and general challenges of screening [57]. This study sheds light on *when* these tools should be deployed, if universal screening (the ideal scenario) is not an option.

This study had four major limitations. First, there were limitations in the measurement of child maltreatment. We were unable to triangulate data from multiple sources (e.g., child self-report; administrative records) as such data were not available in this study. Further, FFCWS investigators did not ask caregivers about their children's exposure to maltreatment before age 3. Children younger than 3 have the highest rates of reported maltreatment, comprising one-quarter of all documented cases of child maltreatment [58]. Thus, we are likely underestimating the amount of maltreatment and also including children who were maltreated in unexposed group. Assuming that people are unlikely to self-report abuse if there is none, our estimates are likely underestimates of the effects due to this misclassification of maltreated children. Consistent with our findings, however, a 2018 paper using data from ALSPAC found evidence for sensitive periods during middle childhood (defined in ALSPAC as age 6.75) associated with sexual and physical abuse. This finding is striking because the ALSPAC study used the same analytic approach as ours, but had maltreatment measures available as early as age 1.5 [26]. Nevertheless, analyses of secondary data are always limited by the measures originally collected by the primary study investigators, and for us the timing of those measurements might not be fully optimized to detect sensitive periods. Second, as with most longitudinal studies, there was nonresponse and attrition over waves, which could bias the results (i.e. 89%, 86%, 85%, 76%, and 73% of baseline families participated at age 1, 3, 5, 9 and 15, respectively). However, it is notable that a small percentage of the sample appear to permanently attrite, or leave, the study; most families missing a wave return in the following wave [59-61]. More importantly there is little evidence that nonresponse in FFCWS for any given wave is predicted by social-demographic factors, including marital status, education, race, health status, and poverty (see attrition tables here

https://ffcws.princeton.edu/sites/g/files/toruqf4356/files/documents/attrition_table_1.pdf). These findings imply that the missing may be mostly at random and therefore not significantly biasing the results [62]. Nevertheless, we addressed this attrition through multiple imputation, though some bias from unobserved variables is still likely. Third, the SLCMA does not accommodate time-varying covariates. Thus, we were unable to account for macro-level shocks associated with the Great Recession or other factors. Future studies should investigate these additional risk factors – as well as promotive (and protective) factors in the etiology of psychopathology. Fourth, as with the measure of maltreatment, psychopathology relied on caregiver reports, which may cause lower reported severity of symptoms.

In summary, these findings suggest more nuanced work is needed to assess early exposure to maltreatment, which could lay the groundwork for research, policy, and intervention.

Acknowledgements

The authors thank Janine Cerutti, Stephanie Gomez, Thomas Soare, and Nitasha Siddique for their assistance in preparing this manuscript for publication. The authors also thank Susan T. Landry for her assistance in copy-editing this manuscript.

Statement of Ethics

Informed consent was obtained for each family at each interview. The Institutional Review Boards at Columbia University and Princeton University approved the FFCWS (Approval #5767).

Conflict of Interest

Colter Mitchell received grants R01MD011716 and R01HD076592 to support research on FFCWS. Erin Dunn, Daniel Busso, Kathryn Davis, Andrew Smith, Henning Tiemeier, and Ezra Susser report no conflicts of interest.

Funding Sources

This research was specifically funded by grants K01MH102403 and R01MH113930 (Dunn). FFCWS is funded by grants R01HD36916, R01HD39135, and R01HD40421 and a consortium of private foundations. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health, the U.S. Department of Veterans Affairs, or the United States Government. The funding sources had no role in the design or conduct of the study.

Author Contributions

All authors made substantive contributions to the work presented in this paper. Erin C. Dunn led the concept and design for this paper. Erin C. Dunn, Daniel S. Busso, Kathryn A. Davis, Andrew D.A.C. Smith, Colter Mitchell, Henning Tiemeier, and Ezra S. Susser were involved in the acquisition, analysis, and/or interpretation of data. Daniel S. Busso and Kathryn A. Davis conducted statistical analysis. Erin C. Dunn drafted the manuscript along with Daniel S. Busso and Kathryn A. Davis. Erin C. Dunn, Daniel S. Busso, Kathryn A. Davis, Andrew D.A.C. Smith, Colter Mitchell, Henning Tiemeier, and Ezra S. Susser provided critical revision of the manuscript for important intellectual content. Daniel S. Busso provided administrative, technical, and/or material support, and Erin C. Dunn provided supervision. Erin C. Dunn, Daniel S. Busso,

Kathryn A. Davis, Andrew D.A.C. Smith, Colter Mitchell, Henning Tiemeier, and Ezra S. Susser had full access to all the data in the study and accept responsibility to submit for publication.

Data Availability Statement

The data that support the findings of this study are not publicly available due to the inclusion of confidential information that could compromise the privacy of the research participants. Access can be granted via a Contract Data Use License to faculty and research personnel at institutions with an institutional review board (IRB) or human subjects review committee registered with the US Office for Human Research Protections (OHRP) or the National Institutes of Health (NIH), once they obtain IRB approval for their research purposes. To submit an application, you can contact ffdata@princeton.edu with the required documents listed at https://ffcws.princeton.edu/restricted. Further enquiries can be directed to ffdata@princeton.edu.

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Figure Legends

Fig. 1. Effect of accumulation of exposure to neglect on child psychopathology symptoms (N=3474)

Note: The accumulation model identified for externalizing symptoms in girls was non-significant.

Fig. 2. Effect of developmental timing of exposure to harsh physical discipline on child psychopathology symptoms (N=3474)

Note: No sensitive period was identified for externalizing symptoms in boys; the accumulation model was identified instead. Standard errors are indicated with standard error bars.

Table 1. Exposure to childhood maltreatment in the total sample and by age at exposure (N=3474)

	Childhood Maltreatment							
	Harsh Physical Discipline				Neglect			
	Female		Male		Female		Male	
	N	(%)	N	(%)	N	(%)	N	(%)
Unexposed	1143	68.4	1117	62.0	1209	72.4	1277	70.8
Exposed	528	31.6	686	38.0	462	27.7	526	29.2
Timing of Exposure								
Year 3	233	13.9	319	17.7	135	8.1	160	8.9
Year 5	287	17.8	364	20.2	139	8.3	140	7.8
Year 9	260	15.6	346	19.2	305	18.3	345	19.1

Note: Percentages for each age indicate the proportion of children exposed among children with complete outcome data, separately for males (N=1803) and females (N=1671)

Table 2. Life course theoretical models identified by the LARS as explaining the most variation in child internalizing symptoms (N=3474)

Maltreatment	Model(s) Selected	R^2	Regression coefficient	SE	LCI	UCI
		Girls (n=1671)				
Harsh Physical Discipline	Sensitive Period Year 9	0.67%	0.13	0.04	0.05	0.21
Neglect	Accumulation	0.57%	0.09	0.03	0.05	0.14
		Boys (n=1803)				
Harsh Physical Discipline	Sensitive Period Year 5	0.41%	0.10	0.04	0.03	0.17
Neglect	Accumulation	0.85%	0.08	0.02	0.04	0.12

Note: Models adjust for the presence vs. absence at child 3 years of maternal depression and substance use at child 3 years of age. For sensitive periods models, the regression coefficient is the difference in the z-score for internalizing symptoms for exposed vs unexposed during the sensitive period; for the accumulation model, the regression coefficient is the difference in the z-score for each additional occasion exposed. Confidence intervals are adjusted for model selection; this can cause the intervals to become asymmetrical while maintaining 95% coverage.

LCI: Lower Confidence Interval; UCI: Upper Confidence Interval

LARS: Least Angle Regression variable selection procedure

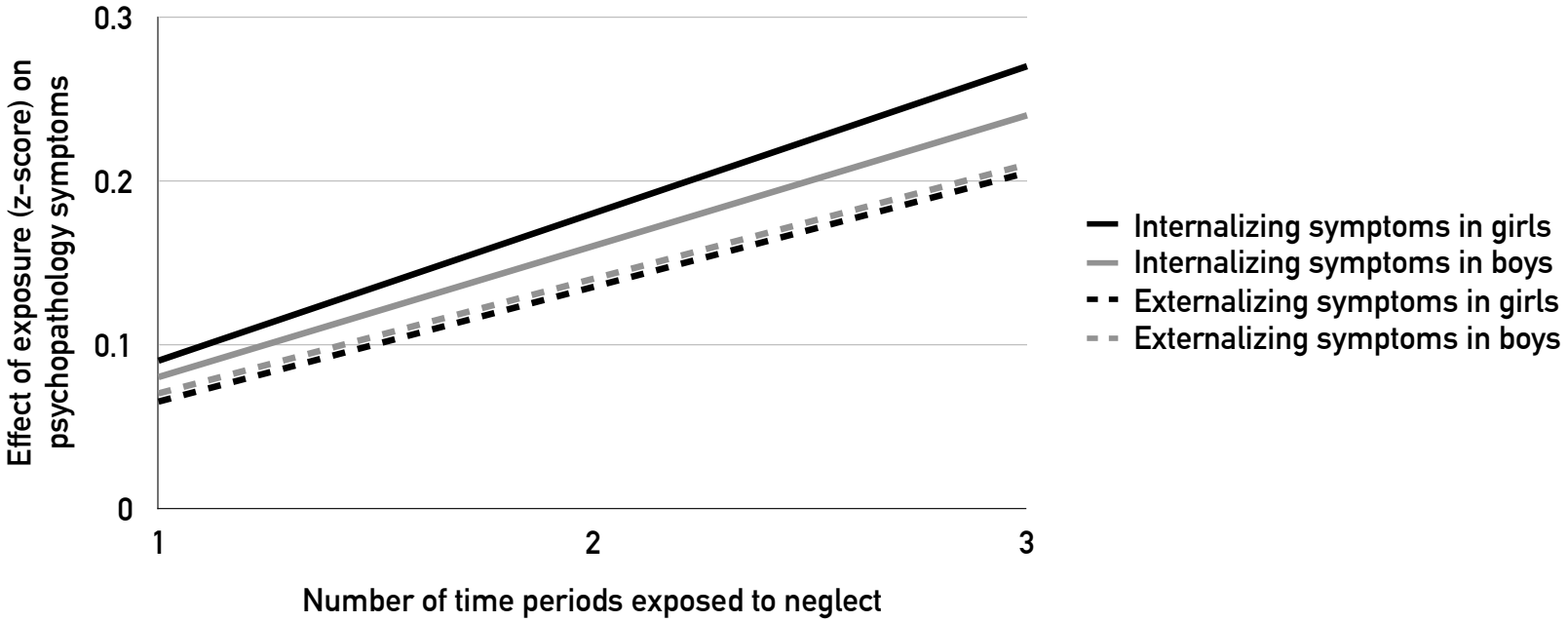
Table 3. Life course theoretical models identified by the LARS as explaining the most variation in child externalizing symptoms (N=3474)

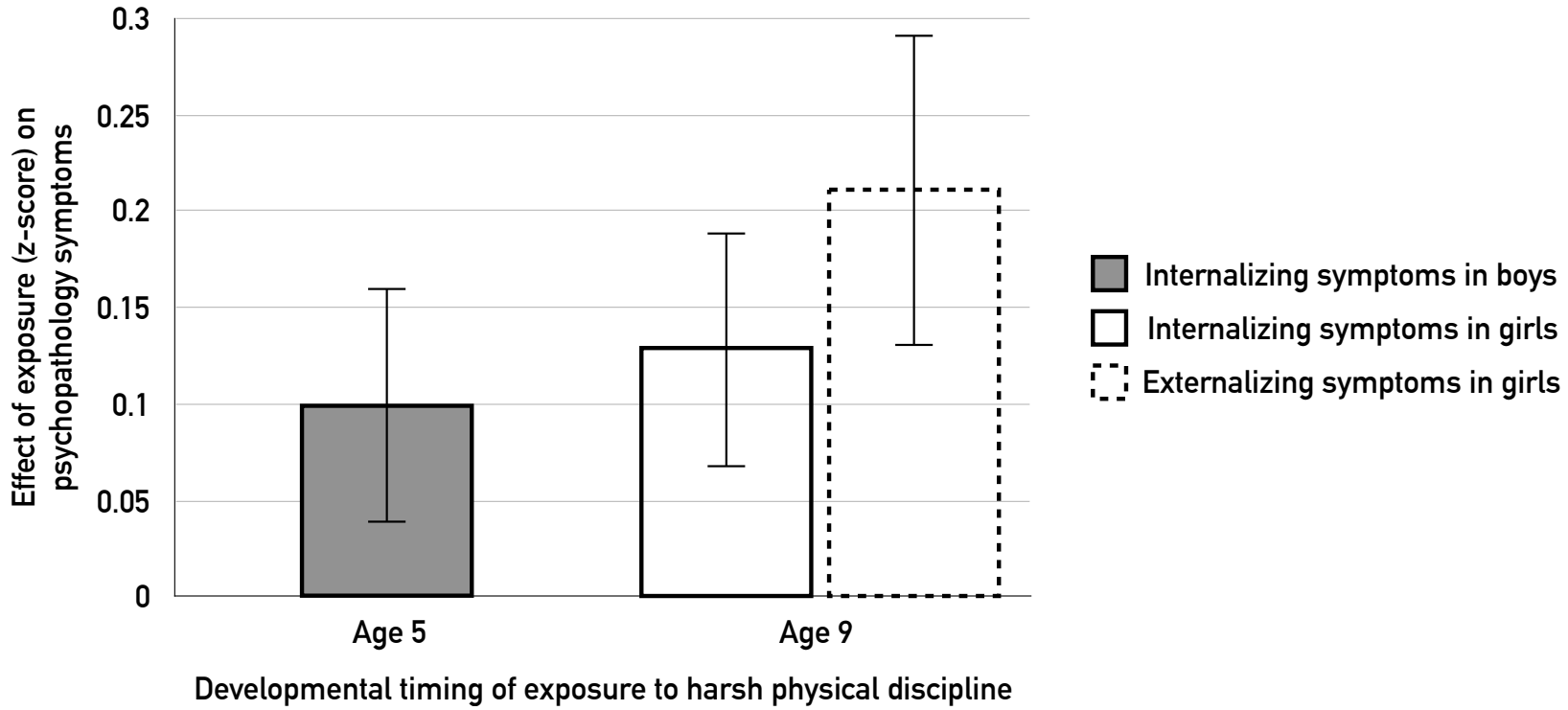
Maltreatment	Model(s) Selected	R^2	Regression coefficient	SE	LCI	UCI
		Girls (n=1671)				
Harsh Physical Discipline	Sensitive Period Year 9	1.0%	0.21	0.03	0.13	0.28
Neglect	Accumulation	0.06%	0.07	0.02	-0.43	0.10
		Boys (n=1803)				
Harsh Physical Discipline	Accumulation	1.37%	0.08	0.01	0.05	0.11
Neglect	Accumulation	0.70%	0.07	0.02	0.03	0.11

Note: Models adjust for the presence vs. absence at child 3 years of maternal depression and substance use at child 3 years of age. For sensitive periods models, the regression coefficient is the difference in the z-score for externalizing symptoms for exposed vs unexposed during the sensitive period; for the accumulation model, the regression coefficient is the difference in the z-score for each additional occasion exposed. Confidence intervals are adjusted for model selection, this can cause the intervals to become asymmetrical while maintaining 95% coverage.

LCI: Lower Confidence Interval; UCI: Upper Confidence Interval

LARS: Least Angle Regression variable selection procedure


0.3
0.2
0.1
0
Effect of exposure (z-score) on psychopathology symptoms
1
2
3
Number of time periods exposed to neglect
Internalizing symptoms in girls
Internalizing symptoms in boys
Externalizing symptoms in girls
Externalizing symptoms in boys


0.3
0.25
0.2
0.15
0.1
0.05
0
Effect of exposure (z-score) on psychopathology symptoms
Age 5
Age 9
Developmental timing of exposure to harsh physical discipline
Internalizing symptoms in boys
Internalizing symptoms in girls
Externalizing symptoms in girls