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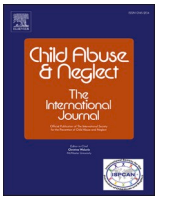

Adversity in early childhood: Long-term effects on early academic skills

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ABSTRACT

Background: The dimensional adversity model (McLaughlin & Sheridan, 2016) proposes that deprivation and threat affect child development differently. However, empirical support for the dimensional adversity model stems predominately from adolescent samples.
Objective: We aimed to examine if deprivation and threat experiences in infancy have differential effects on pre-academic skills in early childhood. Furthermore, we addressed the effect of chronic vs. temporary adversity exposure in infancy.
Participants and Setting: The population-based sample consisted of 3481 infants (49% girls). Newborns and their families were followed longitudinally (6 months to 6 years of age).
Methods: Based on parental information, we computed four deprivation variables and three threat variables. Pre-academic cognitive and social-emotional skills were measured with a math and a vocabulary test and parental questionnaires on emotion regulation and behavioral problems.
Results: Results showed that infant deprivation (but not threat) is negatively associated with math scores ($\beta = -0.06$) and language skills ($\beta = -0.04$) in kindergarten. However, infant threat and deprivation were both associated with behavioral problems ($\beta = 0.06$; $\beta = 0.04$) and emotion-regulation difficulties ($\beta = 0.04$; $\beta = 0.03$) in kindergarten. Analyses comparing chronic vs. temporary adversity exposure showed that chronic exposure was strongly related to all cognitive and social-emotional outcomes.
Conclusions: We found partial support for the differential effects of deprivation and threat on pre-academic skills. Furthermore, the results suggest that particularly chronic adversity poses a potential risk for development - across domains of cognition and emotions.

Adverse experiences can have lasting imprints on child development. Mounting research has shown that adverse experiences in early childhood (e.g., poverty, neglect, or violence) are related to poorer health outcomes (e.g., Edwards, Holden, Felitti, & Anda, 2003; Green et al., 2010) as well as to impaired cognitive and social-emotional development (e.g., Cicchetti, 2016; Noble, McCandliss, & Farah, 2007; Spratt et al., 2012). The majority of research has focused on severe adversity experiences during childhood and adolescence. Aspects that have gained less attention are (a) adversity exposure during infancy and (b) subtle types of adversity experiences common in the general population (McKelvey, Selig, & Whiteside-Mansell, 2017; Vogel, Perry, Brandes-Aitken, Braren, & Blair, 2021). Because of the rapid brain growth and heightened plasticity during infancy and toddlerhood (Shonkoff et al., 2012), it is crucial to understand the effects of subtle and chronic adversity experiences very early in life. Based on the dimensional adversity framework proposed by McLaughlin, Sheridan, and Lambert (2014), McLaughlin and Sheridan (2016), we addressed the prospective

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relation between adversity exposure during infancy and pre-academic skills in early childhood.

1.1. Childhood adversity and early academic skills

Adverse childhood experiences (ACE) refer to environmental circumstances in a child's life that deviate substantially from the expectable environment. According to McLaughlin et al. (2016), such deviations occur primarily in two distinct forms. Either the deviation is characterized by the absence of an expectable input, including all forms of deprivation experiences. Or the deviation is characterized by the presence of unexpected input that threatens the overall well-being of a child. Research has shown that ACE not only increase the risk for poorer health and cognitive development (e.g., Cicchetti, 2016; Edwards et al., 2003; Noble et al., 2007; Spratt et al., 2012), but can also jeopardize the development of emerging academic skills (Blair, Granger, & Peters Razza, 2005; Jimenez, Wade, Lin, Morrow, & Reichman, 2016). Growing up in poverty has been one of the most frequently studied developmental risks in relation to academic skills. Research has shown that the risk of poverty is related to lower academic achievement from a very early age, to more academic problems throughout the educational trajectory, and early school dropout (Blair & Raver, 2016; Duncan & Brooks-Gunn, 1997; Evans, 2004; Raver, Blair, & Willoughby, 2013). More recently, other forms of adversity have been studied in relation to educational achievement, revealing similar relationships. ACE seem to be related to poorer academic outcomes and school-readiness skills (Jimenez et al., 2016; Suntheimer & Wolf, 2020). Conceptually, school-readiness skills include academic skills such as vocabulary, math, and social-emotional skills and can be assessed before school enrollment. A longitudinal study has shown that ACE during infancy and toddlerhood were associated with poorer cognitive skills and language skills at the age of three (McKelvey et al., 2017). In addition, the number of adverse experiences also increased the odds of having below-average performance on all school readiness skills, including social-behavioral skills (Jimenez et al., 2016). In a similar vein, Suntheimer and Wolf (2020) reported that adversity in early childhood was associated with poorer executive functions and pre-academic skills at the age of five. Such early educational gaps at school entry are particularly alarming as they tend to persist or increase over time (Bradbury, Corak, Waldfogel, & Washbrook, 2015).

1.2. Models of childhood adversity

Different theoretical frameworks have addressed the pervasive relation between ACE and childhood outcomes. One of the prevailing approaches to examining adversity effects is the cumulative risk approach (Evans, Li, & Whipple, 2013). The cumulative risk approach focuses on the number of adverse experiences and assumes a positive relationship between the number of adverse experiences and the negative impact on childhood outcomes. Thus, with an increasing number of adverse experiences, the detrimental effects on development increase too. Although the authors of the cumulative risk model state the specific theoretical rationale explaining the predictive power of the cumulative risk approach is still lacking, they propose the disruptions in stress response systems and accumulated stress exposure facilitating long-term wear and tear on physiological regulatory systems as potential explanatory pathways (Evans et al., 2013). Overall, the cumulative risk model assumes additive effects of different adversity experiences but does not distinguish between different types of adverse experiences.

An alternative model, the dimensional model of adversity and psychopathology (DMAP; McLaughlin et al., 2014; McLaughlin & Sheridan, 2016), proposes two core dimensions of adverse environmental experiences; deprivation and threat. The dimensional understanding of adversity is based on the idea that essential underlying dimensions of environmental experience can be identified across a wide range of adversities that share similar characteristics. One core assumption of the DMAP is that the experience of deprivation and threat will influence child development in ways that are at least partially distinct (see McLaughlin, 2016; McLaughlin et al., 2014). More precisely, the two dimensions of experience are assumed to have differential effects on experience-expectant and experience-depended learning processes and affect neurobiological development and the development of cognition and emotion in partially different ways (McLaughlin, DeCross, Jovanovic, & Tottenham, 2019).

Within this model, deprivation refers to a lack of stimulating input from the environment and includes poverty, neglect, institutional rearing, and more broadly, the lack of stimulating material to engage with. Such depriving experiences have in common that they constrain primary forms of learning that demand sensory input of any sort. Thus, the development of learning processes such as associated learning, implicit learning, and higher-order learning processes are at risk when exposed to deprivation. According to the model, especially the development of cognitive skills such as executive functions, language, and academic skills will be negatively affected when exposed to deprivation experiences (Sheridan et al., 2018; Sheridan & McLaughlin, 2016). Empirical support for such a hypothesis can be found across different studies (e.g., Raver et al., 2013; Sheridan, Peverill, Finn, & McLaughlin, 2017; Smyke et al., 2007). For example, studies comparing children growing up in non-risk environments to children growing up in poverty or children from low SES backgrounds showed lower executive functions and worse academic performance (Duncan, Yeung, Brooks-Gunn, & Smith, 1998; Evans, 2004; Raver et al., 2013).

Experiences of threat, in contrast to deprivation, encompass experiences that are harmful or potentially harmful and include all forms of violence and abuse. The DMAP proposes that exposure to threat affects the development of fear learning processes and emotional learning processes (McLaughlin & Sheridan, 2016). The absence of a safe environment in childhood limits opportunities to learn to distinguish between safe and threatening cues and thus may also affect the development of emotion regulation. For example, a study showed that maltreatment during childhood was related to poor discrimination between threat and safety cues during a fear

conditioning task (McLaughlin et al., 2016). Thus, threat exposure seems to alter the sensitivity to threat-related information in the environment.

To wrap up, the DMAP model moves beyond the notion that stress pathways are the only mechanism explaining the risks of adversity on childhood development. Instead, the model assumes that features of the environment will be associated with some shared pathways (i.e., disruptions in stress response systems) and some that are unique to deprivation or threat, respectively (i.e., divergent associations with neural structures and different learning processes). Empirical support for DMAP stems predominately from studies with adolescents. For example, Sheridan et al. (2017) examined executive functions in adolescents. Results showed that neglect and low parental education (i.e., deprivation risks) but not abuse nor violence (i.e., threat risks) were related to impaired executive functions. Another study with an adolescent sample showed that exposure to threat but not deprivation was associated with changes in physiological reactivity, mediating the link between threat and externalizing behavioral problems (Busso, McLaughlin, & Sheridan, 2017; Lambert, King, Monahan, & McLaughlin, 2017). However, empirical support for the DMAP model in early childhood is limited. To our knowledge, there are only very few studies that examined the dimensional assumptions in preschool samples. Whereas one study with preschoolers found similar relations as reported in adolescent samples (Machlin, Miller, Snyder, McLaughlin, & Sheridan, 2019), another study only found partial support for the theoretically assumed relations. More precisely, Wolf and Suntheimer (2019) found only partial support for the effect of deprivation on cognitive skills: Whereas inhibition was negatively associated with deprivation and threat, working memory and switching were not associated with either of the two dimensions. Threat exposure was negatively related to emotional skills and enhanced externalization behaviors.

Furthermore, Vogel et al. (2021) applied the DMAP to a poverty sample. They found the theoretically proposed relations: Deprivation but not threat during toddlerhood was associated with poorer executive functions in early childhood. Altogether, there seems to be support for the differential effects of deprivation and threat in early childhood. However, longitudinal research is still needed to examine these differential effects of deprivation and threat when looking at the entire developmental period of early childhood.

1.3. Current knowledge gaps in adversity research

In the adversity literature, two aspects remain understudied. First, there is very little research on the duration of ACE, which is primarily due to methodological reasons: Most studies assess ACE retrospectively by asking parents or children about their previous experiences earlier in life. Through such an approach, the duration of ACE cannot be precisely captured. However, with a longitudinal research design, it is possible to assess ACE consecutively and capture the durational aspects of ACE exposure (McKelvey et al., 2017). Second, most research on early ACE focuses either on specific adverse samples (e.g., poverty, parental mental illness, or institutionalization) or high-risk samples. These findings have put forward compelling evidence of the pronounced risk of ACE for child development. However, studies with population-based samples examining more subtle adversity experiences in the general population are scarce. When aiming to understand the mechanisms underlying ACE, research with population-based samples, including children potentially not exposed to any ACE, are needed, too. Findings from a cross-sectional, population-based cohort study, including children exposed to ACE and not exposed to any ACE at all, reported poorer cognitive and affective development in 18-months infants exposed to ACE (Nilsson, Landorph, Houmann, Olsen, & Skovgaard, 2019). However, the duration of ACE was not considered in that study. ACE were assessed at a single time point. Research including chronicity in a population-based sample would be an important step to gain further insights into the associations between infant adversity and early childhood development. The current study is set out to address those knowledge gaps.

1.4. The present study

Based on the DMPA, we examine if deprivation and threat experiences in infancy have differential effects on early childhood outcomes. Furthermore, we address the effect of chronic vs. temporary adversity exposure. To address those research questions, we used data from a population-based, longitudinal cohort study. Adversity experiences were assessed at six months and 24 months of age. Pre-academic skills such as vocabulary and math but also social-emotional skills were assessed during kindergarten. Based on the core assumptions of the DMPA, the hypotheses are the following: Firstly, we expect that deprivation but not threat would negatively predict early cognitive academic skills such as math and vocabulary. Secondly, we expect that threat, but not deprivation would negatively predict early socio-emotional skills. Thirdly, we expect that to compared temporary exposure, chronic exposure would be more negatively related to pre-academic cognitive and social-emotional skills.

2. Methods

2.1. Participants

We used data from a longitudinal panel study to address our research questions (German National Educational Panel Study (NEPS), newborn cohort; Blossfeld, Rossbach, & von Maurice, 2011; Blossfeld & Roßbach, 2019). A German, population-based sample of 3481 infants (49% girls) born between February and June 2012 and their families were recruited and followed longitudinally (Weinert et al., 2016). A two-stage procedure was implemented to warrant sample representativity. Eighty-four German municipalities were used as primary sampling units, explicitly stratified according to three strata of urbanization (i.e., the number of inhabitants). We used data from wave one and wave three to seven. Data from wave two was not included as only half of the sample (approx. 1500 families) were

interviewed. For an overview of the sample and measurement time-points, see Table 1.

At every wave, a trained interviewer visited the families at home. The primary caretaker was interviewed with a computer-assisted, standardized interview. The parent was interviewed on parenting practices, child and personal well-being, economic situation, family experiences, and the child's social and emotional competence. Data of direct assessments of the child's development were obtained from wave four (3-years-old) onwards.

2.2. Measures

2.2.1. Adversity variables

The parent interview at wave one and wave three was used to generate deprivation and threat indices. Based on the definition of deprivation and threat put forward by McLaughlin and Sheridan (2016) and empirical operationalization of the adversity dimensions by Wolf and Suntheimer (2019), we examined all interview questions. We created four deprivation variables and three threat variables from the parental interview. All risk variables were dichotomized (present or not) and summed within each adversity dimension. Two different variables were computed to distinguish between chronic adversity exposure and temporary adversity exposure. If the adverse event was present at wave one *and* wave three, it was coded as a chronic exposure. If the adverse event was present at wave one or wave three, it was coded as temporary (i.e., temporal occurrence). A definition of each risk variable and sample prevalence are presented in Table 2.

2.2.2. Covariates

2.2.2.1. Vocabulary. The child's vocabulary was assessed with the German version of the Peabody Picture Vocabulary Test-Revision IV (Dunn & Dunn, 2007; Lenhard, Lenhard, Segerer, & Suggare, 2015). The test was administered twice (wave four and wave six). Data from wave four was included as a covariate to account for prior vocabulary knowledge predicting language as an outcome. The tests consisted of 19 sets with 12 items per set and were administered to the child. The sum score of correctly answered items was used as a dependent variable.

2.2.2.2. Executive functions. The three subcomponents of executive functions, i.e., inhibition, switching, and working memory (Miyake et al., 2000), were administered individually to the child. The digit span task was used to assess working memory. The task version of the "Kaufman Assessment Battery for Children" (K-ABC; internal consistency: $\alpha = 0.86$; Melchers & Preuss, 2009) was applied. The total score of all correctly solved items was used as a dependent variable. A child-adapted version of the flanker task (Oeri, Buttelmann, Voelke, & Roebers, 2019) was used to assess inhibition and switching. In the inhibition-flanker task, children had to respond to the central fish while ignoring the two flanking fish on either side. The task consisted of a step-by-step practice and a test phase with 30 items. The dependent variable for inhibition was accuracy performance in the incongruent trials. If children completed the task I, then the switching-flanker task was introduced. The switching task (i.e., task II) consisted of three practice trails and 16 test trails. The task entailed a rule switch. Children were instructed to respond to the outer fish while ignoring the central fish. The dependent variable was the accuracy mean value of all congruent and incongruent trials.

2.2.2.3. Peer problems. Parents reported on the child's peer problems. The subscale *peer problems* from the Strength and Difficulty Questionnaire (SDQ; internal consistency: $\alpha = 0.60$; Goodman, 1997; Woerner, Becker, & Rothenberger, 2004) was administered. Higher scores indicate more peer-related problems.

2.2.2.4. Maternal education. Maternal education was used as a covariate in the analysis. Education level was classified using the International Standard Classification of Education (ISCED, 2011; ranging from none to doctoral degree or equivalent).

2.2.3. Pre-academic outcome variables

2.2.3.1. Math skills. Mathematical competence was administered to the child with a standardized mathematics test (Grüßing et al., 2013). Five different mathematical competencies were captured with the test: I. sets, numbers, and operations; II. units and measuring; III. space and shape; IV. change and relationships; and V. data and chance. The test consists of 20 items. As dependent variable, we used

Table 1
Overview of the assessed variables across measurement points.

	Waves					
	Wave I	Wave III	Wave IV	Wave V	Wave VI	Wave VII
Age	6 months	24 months	3 yrs.	4 yrs.	5 yrs.	6 yrs.
Assessed variables	Deprivation, threat	Deprivation, threat	Vocabulary, digit span, peer problems	Flanker task, math skills	Vocabulary, behavioral problems	Emotion regulation
Dropout (%)	17	5.0	3.9	7.2	4.2	–

Note. $N = 3481$. Panel stability = 63%. Data from wave II was not included in the analysis.

Table 2
Definitions and sample prevalences for deprivation and threat variables.

Adversity dimension	Definition	Prevalence chronic exposure	Prevalence temporary exposure
Deprivation			
Maternal depression	The mother reported being in a depressed mood regularly or always.	13.7%	33.6%
Single parenthood	Only one adult is living with the child.	3.0%	4.9%
Poverty	OECD definition of poverty. Income below 60% of the median was coded as poor.	6.8%	15.4%
Minimal cognitive stimulation	The parent indicated never or less than once a month to read books, engage in pretend play games, or read poems or children's songs.	0.2%	4.0%
Threat			
Substance use	The parent indicates regular nicotine use during pregnancy and breastfeeding.	0%	0.1%
Harsh discipline	The parent indicated to use at least 2 out of 3 harsh discipline practices regularly.	1.2%	30.5%
High parental stress	Parent indicates to agree or totally agree with to at least 2 out of three parental stress items.	0.1%	2.4%

Note. $N = 3481$. Chronic exposure refers to occurrence between wave one and wave three; temporary exposure refers to temporary occurrence at wave one and at wave three.

the weighted maximum likelihood estimates (M = 0.08, SD = 1.00). (For details on the theoretical background and validity-analyses, see Neumann et al. 2013).

2.2.3.2. Vocabulary. The child's vocabulary was re-assessed at wave six with the German version of the Peabody Picture Vocabulary Test-Revision IV (internal consistency: α = 0.97; Dunn & Dunn, 2007; Lenhard et al., 2015).

2.2.3.3. Emotion regulation. Parents reported on the child's emotion regulation skills on three items (internal consistency: α = 0.82). Items were developed for the BiKS-3-13 Study and described in Rose, Weinert, and Ebert (2018). Higher scores indicate more difficulties in emotion regulation.

2.2.3.4. Behavioral problems. Parents reported on the child's behavioral problems. The subscale *behavioral problems* from the German version of the Strength and Difficulty Questionnaire (SDQ; subscale behavioral problems, internal consistency: α = 0.60; Goodman, 1997; Woerner et al., 2004) was administered. Higher scores indicate more peer-related problems.

2.3. Statistical analysis

Panel stability across the seven waves was 63%. Analyses were computed using R (R Core Team, 2016). To deal with missing data in the covariates and outcome variables (38% of the subjects had at least one missing data point), we used the R package missMDA (Josse & Husson, 2016) and FactoMineR (Lê, Josse, & Husson, 2008) to perform multiple imputations with the iterative PCA method (Josse & Husson, 2016). The regularized algorithm avoids overfitting when there are high amounts of missing data. Cross-validation analyses confirmed the accuracy of the imputation. If the information on adversity experiences was missing, information was coded as not available but not imputed. Descriptive statistics for all variables are depicted in Tables 3 & 4.

Bivariate correlations were calculated (see Table 5) to examine possible overlaps across risks. Correlations ranged from non-significant to small in magnitude (range: 0.00–0.23), suggesting that all risk variables can be considered independently. The correlation between the two adversity dimensions, deprivation and threat was $r = 0.04$ ($p < 0.05$).

Next, multivariate regression analyses were computed to examine the differential effects of deprivation and threat on pre-academic cognitive and social-emotional skills. For this set of analyses, chronic exposure variables were used. Thus, deprivation and threat

Table 3
Descriptive statistics: Mean values for all variables (*standard deviations are in parenthesis*).

	n	Covariates					Outcomes	
		Inhibition	WM	Switching	Vocabulary	Maternal education	Math	Vocabulary
Deprivation chronic exposure								
0	2780	69 (20)	2.9 (1.7)	70 (14)	45.6 (22.0)	6.4 (2.8)	−0.06 (0.83)	81.1 (17.9)
1	593	64 (22)	2.6 (1.9)	67 (14)	40.7 (21.8)	5.2 (2.9)	−0.33 (0.91)	76.2 (19.0)
2	96	59 (17)	1.8 (1.3)	66 (13)	36.4 (18.3)	4.0 (2.9)	−0.68 (0.81)	70.8 (19.3)
3	12	64 (18)	2.6 (1.8)	55 (15)	27.5 (14.4)	3.8 (3.0)	−0.61 (0.58)	69.1 (20.3)
Deprivation temporary exposure								
0	1847	69 (21)	3.0 (1.8)	70 (15)	46.5 (22.5)	6.6 (2.7)	−0.03 (0.86)	81.7 (19.1)
1	1297	66 (21)	2.7 (1.6)	69 (14)	42.9 (21.6)	5.8 (2.9)	−0.19 (0.85)	78.7 (18.2)
2	295	64 (20)	2.3 (1.5)	69 (13)	39.2 (18.7)	4.7 (2.9)	−0.36 (0.79)	75.1 (16.3)
3	42	59 (15)	2.1 (1.4)	65 (9)	37.2 (15.0)	3.4 (2.6)	−0.63 (0.75)	73.0 (16.1)

Note. $N = 3481$.

Table 4
Descriptive statistics: Mean values for all variables *(standard deviations are in parenthesis)*.

	n	Covariates					Outcomes	
		Inhibition	WM	Switching	Peer problems	Maternal education	Emotion regulation	Behavioral problems
Threat chronic exposure								
0	3435	68 (21)	2.8 (1.7)	69 (14)	1.3 (1.2)	6.1 (2.9)	6.3 (1.4)	1.9 (1.1)
1	36	65 (26)	2.4 (1.7)	64 (17)	1.7 (1.5)	6.0 (2.8)	7.0 (1.9)	2.6 (1.7)
Threat temporary exposure								
0	2780	68 (21)	2.9 (1.6)	70 (14)	1.3 (1.7)	6.4 (2.7)	6.3 (1.4)	1.9 (1.1)
1	593	65 (21)	2.6 (1.7)	68 (15)	1.4 (1.3)	5.6 (2.8)	6.2 (1.5)	1.9 (1.2)
2	96	64 (19)	2.4 (1.8)	66 (15)	1.3 (1.2)	4.7 (2.8)	6.4 (1.3)	2.2 (1.4)

Note. $N = 3481$.

Table 5
Correlation matrix between all adversity variables (chronic exposure).

	Deprivation				Threat	
	Single parenthood	Poverty	Maternal depression	Min. cognitive stimulation	High parental stress	Harsh discipline
Single parenthood	–					
Poverty	0.22***	–				
Maternal depression	0.08***	0.09***	–			
Minimal cognitive stimulation	0.03*	0.04**	0.00	–		
High parental stress	−0.00	0.09***	−0.09***	0.20***	–	
Harsh discipline	0.01	0.00	0.01	−0.00	−0.00	–

Note. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. Substance was omitted as no child was exposed to chronic parental substance use.

variables consisted of lasting adverse risk exposure between the two measurement points (6- and 24-months of age).

Finally, multivariate regression analyses with a grouping variable distinguishing between chronic and temporary exposure were computed to address the durational effect of adversity exposure.

3. Results

As displayed in Table 2, there are substantial differences in the number of children exposed to chronic and temporal adversity. 17% and 1% of the sample were exposed to chronic deprivation and threat, respectively. 37% and 17% were exposed to temporary deprivation and threat.

3.1. Examining the dimensional adversity model

We tested the first hypothesis with a multivariate regression analysis (see Table 6). As expected, all covariates such as maternal

Table 6
Multivariate regression analysis predicting cognitive pre-academic skills.

	Math			Language		
		CI			CI	
	Final β	Upper	Lower	Final β	Upper	Lower
Covariates						
Maternal education	0.15***	0.12	0.18	0.18***	0.14	0.21
Vocabulary	–	–	–	0.21***	0.17	0.24
Inhibition	0.22***	0.19	0.25	0.06***	0.02	0.10
Switching	0.08***	0.05	0.11	0.07***	0.04	0.10
Working memory	0.35***	0.32	0.38	0.17***	0.14	0.21
Adversity variables						
Deprivation	−0.06***	−0.09	−0.03	−0.04*	−0.07	−0.00
Threat	−0.02	−0.05	0.00	−0.02	−0.05	0.03
Model fit						
Model R^2	0.36			0.24		
Final model, F (df)	F (6, 3474) = 331***			F (7, 3473) = 157***		

Note: $N = 3481$, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. *CI* = confidence interval.

education, executive functions, and language were associated with math and vocabulary. Furthermore, as proposed by the DMAP model, deprivation but not threat was negatively associated with both outcomes, math, and vocabulary. The second hypothesis that threat but not deprivation is related to social-emotional pre-academic skills was partially supported (see Table 7). Overall, the analyses for emotion regulation difficulties and behavioral problems were less consistent. First, not all expected covariates (i.e., maternal education, executive function, and early behavioral problems) were substantially associated with emotion regulation difficulties. Next, whereas the DMAP model would predict that only threat but not deprivation would be related to social-emotional outcomes, our analysis revealed that both threat and deprivation were associated with emotion regulation difficulties and behavioral problems.

3.2. Examining the effect of temporary vs. chronic exposure

To examine the impact of chronic vs. temporary exposure, we computed three groups: no exposure (group 0), temporary exposure (group 1), and chronic exposure (group 2). Multivariate regression analyses with the same covariates and outcome variables were computed. Durational adversity exposure (i.e., deprivation and threat) was entered as a grouping variable in the analysis. Mean-level comparisons revealed a strong association between chronic depriving exposure and pre-academic skills (see Table 8). Effects were even stronger when comparing threatening chronic experiences to threatening temporary experiences (see Table 9).

4. Discussion

The present study examines the effects of adversity exposure during infancy and toddlerhood on pre-academic cognitive and social-emotional skills in kindergarten. The particular strength of this longitudinal study is the consecutive assessment of ACE in a population-based sample. Thus, the results showed that the lasting exposure to deprivation and threat in the early years substantially increases the risk for child development. Compared to infants that have not been chronically exposed to adversity, infants exposed to early deprivation and threat performed lower on all pre-academic measures. Furthermore, the results showed that the effects of adversity are not exclusively found in high-risk samples. Instead, the relation between adversity and early academic outcomes is just as pervasive in a general, population-based sample. Also, the home-based data collection allows examining the effects of deprivation and threat in an ecologically valid way yielding important findings at the population level. Furthermore, whereas most studies assess adversity retrospectively, asking children or parents about their previous experiences, we were able to assess adversity at six months and 24 months of age.

The study's first aim was to examine the differential effects of deprivation and threat as proposed by the dimensional adversity model (McLaughlin & Sheridan, 2016). Overall, we found mixed support for the DMAP. Results for deprivation were in line with the model's proposition: Math and language were negatively associated with depriving experiences. Thus, exposure to deprivation such as maternal depression, poverty, single parenthood, and/or minimal cognitive stimulation during infancy was associated with poorer pre-academic performance in math and vocabulary. It is important to note that this association was significant beyond the general predictors of early academic skills (i.e., maternal education, executive functions, and early vocabulary) *and* threat exposure. However, results for threat were not entirely in line with the model's proposition: Emotion regulation difficulties and behavioral problems were predicted by both deprivation and threat. Thus, we did not find the theoretically proposed differential effect for social-emotional skills. One reason could be that relatively few children met the criterion of being exposed to chronic threatening experiences during infancy and toddlerhood. Less than 2% of the sample were exposed to chronic threat during infancy. In contrast, around 20% of the sample were exposed to some form of chronic deprivation. We assume that the main reason why there were relatively few subjects who met the criterion for chronic threat exposure is because we relied exclusively on parental information. In general, questions on deprivation variables are easier to answer candidly (e.g., income, household size, single parenthood, toys, books in the household, and family activities). However, it takes more courage to admit the use of corporal punishment, substance use, or discontentment with being a parent. Although the consecutive assessment of adversity is an advantage in terms of precise “window of occurrence,” it comes with other difficulties such as relying entirely on parental reports, most certainly for that age range. Overall, the reported results for threat have to be interpreted cautiously.

The DMAP model suggests that deprivation and threat have differential effects on childhood development because those qualities of experiences disrupt experience-expectant and experience-depended learning processes. Whereas deprivation disrupts higher-order learning processes, threat disrupts emotional learning processes (McLaughlin et al., 2019; McLaughlin & Sheridan, 2016). However, the present results and results reported by Wolf and Suntheimer (2019) only show partial support for the proposed differential effects. From a broader lens, children in the present study were still at an early stage of their development. It is possible that if similar measures were obtained at later stages in their development that the differential effects would be similar to the previously reported adolescent samples (Busso et al., 2017; Lambert et al., 2017; Sheridan et al., 2017). However, this is speculative, and further research, particularly on early learning mechanisms, is needed to clarify such a hypothesis.

The second set of analyses aimed to examine the durational aspect of adversity exposure. Within the dimensions of deprivation and threat, we computed three groups: No depriving experience, temporary depriving experiences, and chronic depriving experiences. And the same for threat: no threatening experiences, temporary threatening experiences, and chronic threatening experiences. Thus, deprivation and threat were computed as a grouping variable, differentiating between none, temporary, and chronic exposure. Across all outcomes variables, results showed that chronic exposure seems strongly related to pre-academic cognitive and social-emotional skills regardless of the dimension. Particularly in terms of the standardized beta values, the increase in effect size between temporary exposure and chronic exposure ranged between (0.10–0.50) across outcomes. The high beta values across the dimensions of deprivation and threat indicate that the durational aspect of adversity exposure poses a substantial risk for child development. The

Table 7
Multivariate analysis predicting social-emotional pre-academic skills.

	Emotion regulation difficulties			Behavioral problems		
		CI			CI	
	Final β	Upper	Lower	Final β	Upper	Lower
Covariates						
Maternal education	0.03	−0.00	0.07	−0.06***	−0.10	−0.03
Peer problems (SDQ)	0.08***	0.04	0.11	0.06***	0.03	0.09
Inhibition	0.00	−0.03	0.04	−0.04*	−0.07	−0.00
Switching	−0.24***	−0.27	−0.20	−0.25***	−0.29	−0.22
Working memory	0.01	−0.02	0.05	0.00	−0.03	0.04
Adversity variables						
Threat	0.04**	0.01	0.08	0.06***	0.02	0.09
Deprivation	0.03*	0.00	0.07	0.04*	0.01	0.07
Model fit						
Model R^2	0.07			0.10		
Final model, F (df)	F (7, 3473) = 38.9***			F (7, 3473) = 56.3***		

Note: $N = 3481$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. CI = confidence interval.

Table 8
Multivariate regression analysis with grouping variable predicting cognitive pre-academic skills.

	Math			Language		
		CI			CI	
	Final β	Upper	Lower	Final β	Upper	Lower
Covariates						
Maternal education	0.16***	0.13	0.19	0.17***	0.13	0.20
Vocabulary	–	–	–	0.20***	0.17	0.24
Inhibition	0.14***	0.11	0.18	0.06***	0.03	0.09
Switching	0.05**	0.02	0.08	0.07***	0.04	0.10
Working memory	0.40***	0.37	0.43	0.17***	0.14	0.21
Adversity variables						
Deprivation						
0–1	−0.04	−0.11	−0.02	−0.06	−0.13	−0.01
0–2	−0.14***	−0.23	−0.07	−0.11*	−0.20	−0.02
Threat						
0–1	−0.10***	−0.16	−0.04	−0.11***	−0.17	−0.05
0–2	−0.23	−0.48	−0.00	−0.26*	−0.51	−0.00
Model fit						
Model R^2	0.34			0.24		
Final model, F (df)	F (8, 3472) = 227***			F (9, 3471) = 124***		

Note: $N = 3481$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. CI = confidence interval.

results suggest that chronic adverse exposure is strongly related to both developmental domains, cognition, and emotion.

4.1. Limitations

Whereas numbers for depriving experiences were about the size we would expect (i.e., numbers are comparable to a UNICEF report published in 2019; UNICEF, 2019), numbers for threat were very low. We ought to assume that more infants were exposed to threatening experiences, but parents just did not report that in the interview. Substance use and harsh parental practices are likely to be higher than reported in the present study (see, e.g., UNICEF, 2019). This has an important implication. It might be that due to the relatively low numbers of chronic threatening experiences, the association for threat with the respective outcomes was underestimated. And maybe results would have been different with more children classifying for the threat exposure group. Thus, it would be fruitful to include multi-informant sources to classify children in future research. However, multi-informant approaches are difficult to obtain during infancy. Despite the difficulty of assessing adversity in the general population, it must be kept in mind that it is not very likely that parents would have given exaggerated answers. We can thus be relatively confident that those children classified within the corresponding groups most likely were experiencing such situations.

Furthermore, dichotomous indicators for the dimension of deprivation and threat were used. Thus, children would either fall into the category of being exposed to deprivation or threat or not. The reality, however, is more nuanced, and such dichotomizations do not account for the severity of the experience. Studies with at-risk samples have started applying continuous adversity indicators (e.g., Goetschius et al., 2020; Hein et al., 2020; Machlin et al., 2019). Similar to studies with at-risk samples, future research should also

Table 9
Multivariate regression analysis with grouping variable predicting social-emotional pre-academic skills.

	Emotion regulation difficulties			Behavioral problems		
		CI			CI	
	Final β	Upper	Lower	Final β	Upper	Lower
Covariates						
Maternal education	0.04*	0.00	0.08	−0.05**	−0.08	−0.01
Peer problems (SDQ)	0.07***	0.04	0.10	0.05**	0.02	0.09
Inhibition	0.00	−0.03	0.04	−0.04	−0.07	−0.00
Switching	−0.24***	−0.27	−0.20	−0.25***	−0.29	−0.22
Working memory	0.01	−0.02	0.05	0.01	−0.03	0.04
Adversity variables						
Threat						
0–1	0.04	−0.12	0.02	−0.02	−0.09	0.05
0–2	0.37*	0.08	0.65	0.50***	0.22	0.78
Deprivation						
0–1	0.12**	0.04	0.19	0.16***	0.09	0.24
0–2	0.15**	0.06	0.25	0.21***	0.11	0.31
Model fit						
Model R^2	0.08			0.10		
Final model, F (df)	F (9, 3471) = 31.4***			F (7, 3473) = 56.3***		

Note: $N = 3481$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. *CI* = confidence interval.

apply continuous indicators in population-based samples to capture the severity of the experiences.

4.2. Conclusion

To wrap up, in the population-based, longitudinal study, we examined the effect of deprivation and threat exposure during infancy on pre-academic skills in early childhood. We extended prior work by assessing adversity consecutively and examining the durational effect of adversity. We found partial support for the differential effects of deprivation and threat on pre-academic cognitive and social-emotional skills. Overall, the results suggest that compared to temporary adverse exposure, chronic adverse exposure poses a potential risk for later development - across domains of cognition and emotions.

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