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The impact of childhood social stressors on the stress system

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PEERS GETTING UNDER THE SKIN

The impact of childhood social stressors on the stress system

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Chapter 1.

General Introduction

The concept of a carefree childhood is widely accepted, while stress might be part of even the youngest students' life. When children enter elementary school, they are exposed to a whole new social world. For the first time, children are confronted with a large peer group and a classroom setting with social agendas that ebb and flow throughout the day. Within the social context of the school, opportunities that foster or hamper the development of children are provided.

The forming of close, well-functioning relationships with other children is one of children's most significant tasks in a child's socialization (Hartup, 1989). The belongingness hypothesis describes the human drive to form and maintain meaningful and positive relationships with others (Baumeister and Leary, 1995). The human drive to form social connections was characterized as an evolutionary adaptation aimed at assuring resources such as safety and other benefits. Humans need and seek their sense of belonging (Baumeister & Leary, 1995). The need of acceptance and belonging already develops in elementary school, as peer relationships become more important (Baumeister & Leary, 1995; Coie et al., 1990; Ryan & Shim, 2008; Williams, 2007). Starting with primary school, children learn social norms and adapting their behavior from their peers. Peers constantly provide feedback for another and thus teach children to adapt to the social environment (Bukowski et al., 2015). During puberty, with the transition to secondary school, adolescents spend increasingly more time with their peers compared to less time with their parents (Nickerson & Nagle, 2005). Hence, during ongoing interactions with peers, children learn how to become competent members of their social peer world, while peers provide an important social context for healthy socio-emotional and behavioral development.

So, what could children possibly worry about in a classroom setting? Parents and teachers tend to view the world of children as carefree and happy. Most children are accepted in the classroom hierarchy and easily make friends. However, peer

interactions in the school context are complex. Already during elementary school, individual differences in social preference emerge (Bjoerkqvist, 1992). We know that peers facilitate but also hamper healthy development. Some children are confronted with entrenched negative experiences in the peer environment (Hay et al., 2004; Ladd et al., 2003). Negative social experiences can further lead to the genesis of subsequent persistent levels of internalizing symptoms, such as depression or anxiety, in children and adolescents (Deater- Deckard, 2001; Gooren et al., 2011; Ladd et al., 2003; van Lier & Koot, 2010; Zwierzynska et al., 2013) and long-term feelings of social isolation, loneliness and impaired social competence (Veenstra et al., 2005; Kochel & Rudolph, 2012).

However, the pathway of how negative peer relations are linked to psychopathology is unknown. More recent studies focused on physiological and health consequences of social stressors (Gruenewald et al., 2004). Social stress has been broadly defined as a social situation that threatens one's self-esteem and mental health via stress system activation (Kiecolt-Glaser et. al., 2020). It has been hypothesized that negative social experiences in the peer environment result are social stressors (Rubin et al., 2006). The stress system has been suggested to play a crucial role in how negative social experiences in the peer context are linked to the onset of internalizing symptoms (Gunnar, 2000; Shirtcliff and Essex, 2008; Saridjan et al., 2014). However, how the peer environment shapes the stress system remains unclear.

In the classroom the peer environment might shape the stress system via social evaluation. With the placement in the classroom peer group, children start to socially evaluate each other. Children evaluate each other based on personality characteristics and behaviors and decide who they like or dislike. Receiving a negative social evaluation may indicate that the need to belong is not fulfilled (Baumeister & Leary, 1995; Williams, 2001). If an individual endures long-term ostracism, failure of attempts to

regain a sense of belonging might give way to despair and helplessness (Kiecolt-Glaser et. al., 2020). Stress system activation to negative experiences in the peer context are thought to function as an alarm system to initiate behaviors that ensure social reconnection (Taylor, 2011).

In addition to their relationships with the broader peer environment, children are confronted with other contextual factors in elementary school. According to Bronfenbrenner's theory of child development (Bronfenbrenner & Morris, 2006), children typically find themselves enmeshed in various contexts, which interact with each other and influence children's social and emotional development. The microsystem describes the most immediate environment in which children live, as the home or school environment. The mesosystem encompasses interactions of the different microsystems, while the macrosystem describes political, economic systems thus more distant influences on children. As such, the classroom landscape may also provide opportunities for other social stressors or social support for children who suffer from negative experiences with peers.

Interactions within this microsystem do not only involve personal relationships with peers but also with teachers in the classroom setting. Teachers are an important attachment figure for elementary school children and having a positive relationship with the teacher can offer emotional support and provide children with a sense of belonging. Therefore, a supportive teacher-student relationship may help children to regulate stress originating from adverse (social) contexts such as negative peer experiences. Thus, a good quality of the relationship with the teacher is related to healthy child outcomes (Huber et al., 2012; Spilt et al., 2014; Wang et al., 2013). However, it remains uncertain whether the teacher-child relationship will indeed influence the impact of peer experiences on stress system activity.

Apart from the immediate school context, the broader environmental context may also affect children indirectly.

According to Bronfenbrenner, the macrosystem is the cultural environment in which the child resides. Thus, in addition to classroom stressors, children differ in the extent to which they are exposed to stress originating from the broader living environment. Chronic stress exposure maintains the stress system and perceived distress constantly activated, which in turn has been linked to increased risk of both physical and emotional disorders (Gunnar, 2000; Dubow et al., 2012).

Worldwide, many children are exposed to chronic stress constituted by for example threats of violent conflicts in their own country (Dubow et al., 2012). While children are not actively involved in violent conflicts in the environment but nonetheless are heavily impacted by the threat of these conflicts. Thus, in times of prolonged stress in the environment, the school is not only about education. Schools can offer a sense of protection or additional stress amid chaos for children. The classroom context allows children to expand their circle of belonging, teachers and peers could assist them or not in times of crises. However, it remains unclear how living under the constant threat of conflict may influence the link between school social stressors, (perceived) stress activity and anxiety symptoms in children.

In the present dissertation we will focus on two main aims: **(1) whether children's peer environmental influences are related to stress system activation (chapter 2 and 3) and (2) the role of the teacher-childhood relationships and environmental threat context in the link between school social stressors, (perceived) stress system activation (chapter 4) and subsequent anxiety symptoms (chapter 5).** In this manner, this current dissertation can add to more complete insights into school social stressors and their link with the stress system, and the development of subsequent internalizing symptoms, including how some school and broader environmental factors may facilitate, or buffer this association. Hence, the role of the stress system in how negative

social experiences are linked to the onset of internalizing symptoms needs to be answered.

In this general introduction, I will first provide a general background on peer environmental influences. In this part, I will also define the physiological stress system and explain aberrant functioning of the two major stress systems. Second, I will provide an overview of the empirical evidence of the association of peer environmental influences and the association with the stress system in children. In this section I will also explain associated research gaps related to our first aim. In the second part of the introduction, I will elaborate on the impact of the teacher-child relationship and the broader environmental context on (perceived) stress and subsequent anxiety symptoms. I will further provide an overview of the empirical basis for the role of the classroom context and the broader environmental context and associated research gaps related to our second aim. Last, I will provide an outline of the addressed research aims in the following chapters.

CHILDREN'S PEER ENVIRONMENTAL INFLUENCES RELATED TO STRESS SYSTEM ACTIVATION

BACKGROUND (CHAPTER 3 AND 4)

NEGATIVE EXPERIENCES IN THE PEER ENVIRONMENT

Several social stressors during childhood were defined. Childhood relational peer victimization is described as deliberate and repeated behaviour intended to actively exclude a child from social activities, or to threaten or damage a victim's relationship or credibility among peers by spreading rumors or gossiping (Crick & Bigbee, 1998). Individual differences in relational victimization typically swiftly emerge during the elementary school period, possibly due to increased social awareness of children (Bjoerkqvist, 1992; Gooren et al., 2011; van Lier & Koot, 2010) and likely become stable across the elementary school years

(Michels et al., 2012). Peer preference, usually measured by sociometric status, captures a child's likability or acceptance/rejection among peers based on liked most and liked least nominations (Cillessen & Bukowski, 2000). Scoring low on peer acceptance does not necessarily mean that a child is actively disliked. The child may be mostly neglected in the social evaluation (Coie et al., 1990). Although low peer acceptance might be less visible in the classroom setting, it might still be a stressful experience and linked to psychopathology. Peer related stressors have been associated with a potential risk for maladjustment (Sontag et al., 2008). Accordingly, poor peer preference and victimization have been linked to mental health problems, such as internalizing or externalizing behaviour problems (e.g Cillessen & Bukowski, 2000; Deater- Deckard, 2001; Ladd, 1999; Parker, 2006; Rudolph & Asher, 2000; van Lier & Koot, 2010).

However, it remains unclear how adverse peer experiences link to psychopathology. Dysregulation of the stress system has previously been linked to the onset of problematic behaviour and emotional problems during childhood (Gunnar, 2000; Shirtcliff and Essex, 2008; El-Sheikh et al., 2008; Saridjan et al., 2014). Therefore, in this present study we focus on adverse peer experiences and their association with physiological stress system activation in order to identify the role of the stress system in the link between adverse peer experiences and psychopathology.

PHYSIOLOGICAL STRESS SYSTEM

The major stress system is composed of the Autonomic Nervous System (ANS) and the Hypothalamus-Pituitary-Adrenocortical (HPA) axis.

AUTONOMIC NERVOUS SYSTEM

The Autonomic Nervous System is composed of two branches: the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). The SNS and PNS operate independently of another and exert reciprocal influences on the heart (Berntson et al., 1991). Activity of the ANS can be measured at rest and in response to a stressor. SNS activity and responses can be measured by for instance the enzyme α-amylase (sAA), while PNS activity, can be measured by heart rate variability. A few seconds after exposure to a stressor, the typical response is the 'fight or flight' reaction (Porges, 1995). This fight or flight response is a quick responding system which reacts to stress-provoking factors. This system aims to prepare the body for action by among others increasing heart rate. Through a withdrawal of the PNS (the vagal break) the SNS is activated to respond to a psychosocial stressor. Psychosocial stressors have been defined as the anticipation, justified or not, that constitute a challenge to homeostasis. Psychosocial stressors typically endanger feelings of lack of control and predictability and a sense of lacking outlets for the frustration caused by the stressor. Typically, heart rate variability (HRV) should decrease in response to a stressor (Porges, 1995), so that heart rate can increase to prepare the body to cope with the stressor. In contrast to HRV, sAA levels typically increase following a stressor (Granger et al. 2007; Porges, 2007; Stroud et al., 2009). This pattern of response to a social stressor was indeed found among children and adolescents (Stroud et al., 2009).

Healthy functioning of the sympathetic and parasympathetic nervous system influences normal social competence and self-regulation (Porges, 2001). Typically, decreases in HRV in response to a stressor correlate with various psychological adjustment outcomes in children and adolescents, including social competence, self- and emotion regulation and behaviour regulation during social challenges (Hastings et al.,

2008; Porges, 2007; Thayer et al., 2009). According to the polyvagal theory (Porges, 2007) individuals with reduced autonomic regulation are thought to have deficits in adaptations to changing environmental demands, have deficits in emotion regulation and have reduced self-regulatory skills (Beauchaine et al., 2015; Hinnant & El-Sheikh, 2009; Porges 2001; Porges, 2007).

HYPOTHALAMIC-PITUITARY-ADRENAL-AXIS

A second stress system that responds to stress provoking factors, is the Hypothalamus-Pituitary-Adrenocortical axis. The end-product of the HPA-axis is the steroid hormone cortisol. Cortisol levels can be measured at rest and in response to a stressor.

Cortisol concentrations typically rise directly following awakening and decline throughout the day, with a slight peak around noon (Cohen et al., 2007). The cortisol awakening curve (CAR) is typically assessed by the change in cortisol concentrations from directly following awakening to 30 minutes after awakening. Two other cortisol measures represent daytime changes in cortisol concentration, namely the daytime cortisol curve and the cortisol slope. The daytime cortisol curve (Area Under the Curve with respect to the Ground; the AUCg) represents an estimation of the total cortisol output during the day. The cortisol slope represents the diurnal change of cortisol concentration (Saxbe, 2008). The CAR represents the preparation of the body to face daily hassles and is therefore linked to overall diurnal cortisol output (Stalder et al., 2011; Adam et al., 2007).

Apart from the diurnal curve, research has also focused on cortisol responses to stress. Indeed, when confronted with a stressful situation such as social evaluative situations or acute experiences of social exclusion, the adaptive bodily response of an individual would be to have a temporary increase in the secretion of cortisol (Dickerson & Zoccola, 2013). The peak level of cortisol is measurable in saliva approximately 20 minutes after

experiencing the stressor (Kudielka & Kirschbaum, 2005; Sapolsky, 2000). Elevated basal cortisol levels and elevated cortisol responses may increase susceptibility to disease incidence such as metabolic syndrome and major depression (O'Connor et al., 2005).

SOCIAL STRESS AND STRESS SYSTEM ACTIVATION

Social stress has provided much of the impetus for describing stress processes. Earlier studies were usually based on primate populations (Sapolsky, 2004). It was suggested that social status has an impact on health of an animal as well as on patterns of stress responses (Sapolsky, 2004). For the current dissertation, it is relevant to discuss some animal research in which low status animals and their stress levels were examined. It has been suggested that chronic stress experienced by low social status animals in a hierarchy is constituted by high rates of physical and psychological harassment of dominant animals, lack of social control and predictability and lack of social support (Sapolsky, 2000). Lower social status individuals experienced higher stress levels, because they suffer from psychological and physical threats from high-ranking individuals and because coping mechanisms, such as affiliative relationships with members of a group, are unavailable (Sapolsky, 2000).

These early social status stress studies in animals have been extended with findings in humans. An excessive and prolonged stress system activation due to social stress has been associated to increased blood pressure, cardiovascular disease and mortality as the stress system becomes overstrained (Porges, 2001; Porges, 2005). It has been suggested that the physiological stress system becomes downregulated when stress exposure is severe or prolonged, in order to counteract the increased risk of disease or mortality (Miller et al., 2007). This downregulation might impact stress system activity and reactivity. Cortisol production might be

downregulated after facing extended stress exposure for several months, as the HPA-axis becomes overstrained. Through the negative feedback circuit this results in suppressed output of CRH and ACTH by acting on glucocorticoid receptors in the brain, ultimately leading to cortisol output rebounds below normal (Miller et al., 2007). However, more recent theories describe that the stress system adapts based on different physiological profiles. Down- but also up-regulation of the stress system can be adaptive with trade-offs as dysregulated stress system activation is also linked to disease and psychopathology (Ellis et al., 2014). Thus, adverse social experiences might change neurobiological systems in order to prepare the body to possible future stressful experiences (McCrory, 2012).

ADRESSING THE FIRST AIM - PEER ENVIRONMENTAL INFLUENCES ARE RELATED TO STRESS SYSTEM ACTIVATION

Several studies have linked individual differences in stress system activity at rest (chronic) to stress exposure in the family context. Although the salience and impact of peer environmental influences during childhood is well established (Parker et al., 2006), most previous studies focused on rather severe adverse social experiences (e.g., abuse or family conflict) and stress system activity at rest in children and adolescent samples (Beauchaine et al., 2015; El-Sheikh et al., 2008; McCrory et al., 2012). Moreover, negative social experiences in the family context were related to lowered and heightened daily cortisol levels in children (DeCaro et al., 2008; Koss et al., 2014; Michels et al., 2012; Gunnar et al., 2000; Peters et al., 2011).

A number of prior studies explored the association of childhood history of peer problems with stress reactivity in response to an acute psychosocial stressor (Chen et al., 2018; DeCaro et al., 2008; Gunnar et al., 2000; Knack et al., 2011; Koss

et al., 2014; Michels et al., 2012; Peters et al., 2011; Vaillancourt et al., 2011). One recent study focused on elementary school children, and found that exposure to elementary school peer-victimization was associated with increased, rather than decreased cortisol responses to a public speaking task (Chen et al., 2018). Previous studies on the association between peer stressors and physiological stress responses focused mostly on (young) adolescent samples. However, poor peer preference is linked to maladaptive outcomes already in the elementary school ages (Ladd, 2006). Thus, although negative peer experiences may represent (prolonged) stressful social experiences (MacDonald & Leary, 2005; Williams, 2001, 2007), our understanding of the association between peer environmental experiences and HPA-axis and ANS activation, in early elementary school children is far from complete.

In chapter 2 and chapter 3 of the dissertation we will add to the existing literature by addressing our first research aim to clarify whether peer environmental influences are related to stress system activation. Important literature gaps pertaining to the link of peer environmental stress and stress system activation and regarding stress system measures can be noted and will be addressed in the present dissertation. It remains unknown whether associations between peer environmental influences and daily cortisol levels exist in childhood. In **chapter two** we associated individual differences in diurnal cortisol concentration in elementary school children with early elementary school classroom peer environmental influences. Related results will provide insights into changes of children's HPA-axis activity levels in and outside of the peer environment throughout the day. It remains unclear how children's prior peer environmental influences shape acute stress responses to a psychosocial stress task. In **chapter three** we explored acute ANS and HPA-axis responses to a psychosocial stress task among children with prolonged negative experiences in the peer context. Related results will provide insights into changes of children's HPA-axis and ANS responses to acute peer

environmental influences. If research results reveal a biological embeddedness of peer environmental stress in children, this would indicate that peer environmental factors associated with stress system activation in children need to be targeted for early prevention of mental health problems (Adam et al., 2007).

CHILDREN'S (PERCEIVED) STRESS ACTIVITY IN THE CLASSROOM - THE ROLE OF THE SCHOOL AND ENVIRONMENTAL CONTEXT

BACKGROUND (CHAPTER 4 AND 5)
SOCIAL CONTEXT AND STRESS

The social context in which children grow up in guide the course of the development of stress (re)activity. Thereby, it is important to consider the mutual exchange between individual children and their social context (Boyce, 1998). The interpersonal culture of the classrooms is not only reflected by peer relationships, but also by student-teacher relationships (Ahnert, 2012). Apart from the immediate school environment, the environment in which children live may have indirect influences on children's development of stress (re)activity and emotion regulation. Numerous children grow up in regions with ongoing conflicts or the threat of conflicts. Early context related experiences set the stage for either adaptive or maladaptive functioning (Bronfenbrenner & Morris, 2006). Stressful experiences in the context in which children live in, may interfere with the achievement of normative developmental tasks, such as the capacity for stress and emotion regulation. According to the cumulative stress hypothesis, the accumulation of stressors in different contexts lead to greater adjustment difficulties, such as increased risk for the development of anxiety problems (Appleyard et al., 2005). A perceived lack of control over environmental stress may result in reduced coping resources in other contexts (Kubiak, 2005; Sapolsky, 2004). High or low levels of interpersonal support

from teachers or peers as well as stress from the environment may overwhelm children's resources and emphasize dysregulated stress activity. On the contrary, high levels of interpersonal support in the classroom or moderate stress from the environment may buffer or emphasize dysregulated stress activity. The role of the teacher and broader environmental threat context in relation to children's stress activity and subsequent internalizing symptoms needs to be addressed in order to make preventive interventions more targeted against the onset of anxiety problems for high-risk children.

CHILDREN'S STRESS ACTIVITY IN THE CLASSROOM CONTEXT- THE ROLE OF TEACHER-STUDENT RELATIONSHIPS

Different social context members in the classroom provide children with different types of social support. Thus, the classroom landscape may also provide opportunities for social support for children who suffer from negative experiences with peers (Ahnert, 2012). Teachers are an important attachment figure for elementary school children. The attachment relationship has been described as an enduring emotional bond a child forms with a particular attachment figure who ideally provides the child with security and comfort. In middle childhood, children develop direct attachment-related behavior to non-parental figures such as teachers in preparation for maturation during adolescence (Mayseless, 2005). Consequently, a supportive teacher-child relationship may help children to regulate stress originating from adverse (social) contexts such as victims from negative peer experiences (Badanes et al., 2012; Sabol & Pianta, 2012). A few recent studies proposed that teacher-child relationships influence the association between negative social experiences in the classroom context and the onset of psychopathology (Huber et al., 2012). Thus, in the context of social experiences in the classroom, the stress-buffering effect would be most relevant for victims of negative peer experiences in

the classroom setting (Spilt et al., 2014; Wang et al., 2012; Yeung & Leadbeater, 2010). However, a (very) close teacher-student relationship might also be an indicator of potential problems such as signaling socio-emotional difficulties in the peer context (Arbeau et al., 2010; Sabol & Pianta, 2012). Thus, a warm teacher-student relationship might in some cases signal underlying socio-emotional problems of the child. Overall, based on the described theory, a supportive teacher-child relationship may buffer or aggravate the detrimental effects of stressful social experiences in the peer context. Whether teachers buffer the relationship between peer stressors and stress system activity is unknown and should therefore be studied. As a result, we could get a comprehensive insight into how dyadic classroom relationships with the teacher might mitigate the negative effects of negative social experiences in the peer context.

CHILDREN'S (PERCEIVED) STRESS ACTIVITY IN THE CLASSROOM CONTEXT- THE ROLE OF LIVING IN A HIGH THREAT REGION

In addition to classroom stressors, children differ in the extent to which they are exposed to stress originating from the broader living environment. The impact of perceived stress originating from classroom related stressors may become amplified due to exposure to other chronic stressors (Sandi & Haller, 2015). Perceived lack of control over the environment may further augment the impact of perceived stress originating from other sources and reduces the ability to cope with social stress (Comer & Kendall, 2007; Sapolsky, 2004 Thabet et al., 2000). Chronic stressors gradually reduce people's coping resources to other daily stressors and thereby tax their mental health making them vulnerable to internalizing problems (Gunnar, 2000; Sapolsky, 2004). Thus, as a consequence of chronic stress, children's capacity to effectively cope with other daily stressors, such as in

the classroom setting, may be diminished (Kubiak, 2005). The relatively high threshold that children experience at the environmental level might render additional stressors in the classroom context more problematic. However, how stress originating from a conflict environment affects the more proximal association of classroom perceived stress and children's anxiety symptoms remains unknown. It is possible that having no "safe haven", that is nowhere to go to for respite in the environment, portends more negative consequences than only having high stress in the classroom context. However, it remains unknown to which extent chronic stress in the form of constant threat of conflict constitutes a risk for the development of anxiety in children in the social context of the classroom (Doeland, 2012; Cohen et al., 2007). Earlier theoretical models describe the impact of chronic stress emotional responses to acute stressors.

THE ROLE OF LIVING IN A HIGH THREAT CONTEXT ON LINKS BETWEEN SCHOOL STRESSORS AND STRESS ACTIVITY- EMPIRICAL EVIDENCE

Recent efforts are directed towards understanding the impact resulting from chronic stress such as living in regions under the threat of conflict on children's socioemotional development. Related literature explores psychosocial consequences of children conflicts, displacement and merely the threat of war (Summerfield, 1995). Feelings of perceived stress and lack of control persist in unpredictable conditions such as under the threat of war or conflict. Accordingly, it was found that direct and indirect exposure to armed conflict gives rise to poor mental health in children in Palestine (Thabet et., 2000). Some responses to threats of conflicts among children are self-directed, such as emotional withdrawal, internalizing symptoms, which may appear adaptive in the short run. As such, a review on war-related research on Israeli children and adults over the past five decades suggests that with the

intractable conflict with Palestinians, members of the population react with varying degrees of perceived distress (Sagi-Schwartz, 2008).

Living in regions that are threatened by conflicts has been linked to heightened anxiety symptoms in children. Accordingly, early studies showed already the influence of the environment, beyond one's control, on the prediction of (perceived) stress and anxiety symptoms (Sagi-Schwartz, 2008). Accordingly, continuous exposure to living in high stress regions has shown to make individuals increasingly vulnerable to anxiety symptoms (Gunnar 2000; Sapolsky, 2004). Indirect exposure to the threat of war has been linked to perceived lack of control, augmented perceived stress and lead to heightened feelings of insecurity and vulnerability (Comer & Kendall, 2007; Thabet et al., 2000). Accordingly, Shamai & Kimhi (2006) showed that Israeli youth living in areas with high risks of conflict showed high levels of perceived stress. Perceived stress when living under the threat of war has also been related to the onset of anxiety symptoms in children (Evans & English, 2002; Kar, 2009; Rasmussen, 2010; Slattery et al. 2012). Perceived stress originating from classroom stressors is another factor associated with childhood anxiety problems (Gini et al., 2018; van der Wal et al., 2003; Veenstra et al., 2005; Zwiersynska et al., 2013). However, the extent to which living in regions under threat of conflict moderates the association between classroom context related stressors and internalizing symptoms among children remains widely unknown. Related insights are crucial to understand what puts children at risk for the development of anxiety problems.

ADRESSING THE SECOND AIM- THE ROLE OF THE CONTEXT IN THE LINK BETWEEN SCHOOL SOCIAL STRESSORS, (PERCEIVED) STRESS SYSTEM ACTIVITY AND SUBSEQUENT ANXIETY SYMPTOMS

The **fourth and fifth chapter** of the dissertation will add to the existing literature by addressing our second research aim to address the role of the context in the link between school social stressors, (perceived) stress system activation and subsequent anxiety symptoms. Current literature lacks a more contextualized approach looking at field-based data of children's social experiences in the school context and inflicted by exposure to the threat of armed conflict. In **chapter 4**, we assessed whether warmth in the teacher-student relationship moderates the association of peer acceptance among classroom peers and daytime HPA axis activity. Related results will examine whether having a supportive teacher-student relationship in the classroom moderates the association of classroom stressors with diurnal stress levels. **In chapter 5**, we examined the moderating effect of living in an area with high threat of armed conflict on the association between perceived stress originating from classroom social stressors and the development of anxiety symptoms in Israeli children. Thus, results will emphasize how and for whom school environmental experiences are related to dysregulated stress activity and subsequent anxiety symptoms by identifying the role of threat context in this link. Understanding the possible processes of how school environmental experiences are related to stress and anxiety symptoms and identifying at-risk children living in and outside of regions under the threat of conflict is important in order to develop effective and specific targeted prevention programs as early as during elementary school.

AIMS

The aims of the present thesis were to examine **(1) whether children's peer environmental influences are related to stress system activation (chapter 2 and 3) and (2) the role of the classroom and environmental context in the link between school social stressors, (perceived) stress system activation (chapter 4) and subsequent anxiety symptoms (chapter 5).**

The specific aims of the present thesis were to examine:

1. whether classroom social experiences in early elementary school relate to diurnal cortisol levels (Chapter 2)
2. whether chronic low peer preference in elementary school associates with ANS and HPA-axis responses to an interpersonal peer stressor in late childhood (Chapter 3)
3. whether warmth in the teacher-student relationship moderates the association of peer acceptance among classroom peers and daytime HPA axis activity (Chapter 4)
4. whether living in an area with high threat of armed conflict moderates the association between perceived stress originating from classroom social stressors and the development of anxiety symptoms in Israeli children (Chapter 5).

SAMPLES AND PROCEDURES

The participants in Chapter 2, 3 and 4 were part of the "happy children, happy adolescents?" sample (vroegsignaleringsproject in Dutch) focused on the impact of social experiences on children's social, emotional, academic and behavioural development. The original study is based on 1500 children from 22 elementary schools in urban and rural areas in the Netherlands. The study was designed to develop an effective stepped prevention system to pinpoint factors that account for the development of problem behaviour at early stage. The majority of children, 97,7% and their

parents were born in the Netherlands. This percentage is somewhat comparable to the Dutch population, 89,3% was born in the Netherlands (Statistics Netherlands 2014). 15.3% of the children were from low socio-economic status families. This percentage is lower than that of the general Dutch population, 29,5% (Statistics Netherlands 2014). The second dataset explored how the impact of everyday school social stressors on children's aggressive behaviour and anxiety is affected by environmental stressors. In a natural experimental design, we studied children from schools in two different geographic regions: (A) high stress environment in Israel (defined as living in a region in which citizens have 20 seconds to get into a bomb shelter when alarm sounds), (B) medium stress environment in Israel (60 seconds to get into a bomb shelter) (Chapter 5). The study was based on 530 children attending 20 mainstream elementary schools and examined children annually starting at ages 9-11 years.

Part 1

The influences of children's peer environment on stress system activation

Chapter 2.

Classroom Social Experiences in Early Elementary School Relate to Diurnal Cortisol Levels

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Abstract

Social stress has been linked to altered hypothalamic-pituitary-adrenocorticol (HPA) axis activation. During elementary school, children can become exposed to negative peer relations, such as poor appraisal among classroom peers, which is considered a social stressor. However, little is known about the association between classroom peer appraisal and the physiological stress system in children. The goal of this study was to examine the association of peer acceptance and peer non-acceptance with diurnal cortisol concentrations in 222 children from 20 mainstream elementary schools (*M*age = 6.97 years, SD = 0.99, 55% boys) in the Netherlands. Saliva samples were collected at awakening, 30 minutes post-awakening, at noon and at 8 pm during a weekend day. From these assessments, the Cortisol Awakening Response (CAR), diurnal cortisol concentration (AUC_g) and diurnal cortisol slope were calculated. Peer nominations of peer acceptance (being liked), and peer non-acceptance (being disliked) were collected across a one year interval. Associations were controlled for peer victimization, age, sex and SES and children's levels of emotional problems and behavioural problems. Results showed that low peer acceptance was associated with heightened diurnal cortisol concentration (i.e., heightened AUG_g), lower cortisol reductions across the day (i.e., less decreasing cortisol slope) and heightened cortisol awakening response (i.e., heightened CAR). Peer non-acceptance and the interaction between peer acceptance and peer non-acceptance (known as peer rejection) were not associated with AUCg, cortisol slope or the CAR. The findings emphasize the association between poor appraisal among classroom peers and children's heightened HPA-axis activation. This underscores the importance of the physiological stress system in studying the consequences of negative peer relations in children.

Introduction

With the transition to formal schooling, children are exposed to potential social stressors such as negative peer appraisal (Rubin et al., 2006). Exposure to social stress may have long-term consequences on hypothalamus-pituitary-adrenal (HPA) axis functioning (Cohen et al., 2007). Social stress, such as constituted by negative experiences in the peer context (peer victimization) are possibly associated with upregulated HPA-axis functioning in elementary school children (Peters et al., 2011). Approximately 10-15% of all children become poorly accepted or rejected by their peers (Woodward & Fergusson, 2000). Yet, little is known about the association of this type of social stress in early elementary school and the physiological stress system in children. The goal of this study is to assess the unique and combined association between peer acceptance and peer non-acceptance with HPA-axis functioning in early elementary school children in the Netherlands. Dysregulation of the HPA-axis functioning has previously been linked to the onset of problematic behaviour and emotional problems during childhood (Gunnar et al., 2000; Shirtcliff & Essex, 2008; El- Sheikh et al., 2008; Saridjan et al., 2014). Thus, if research results reveal a biological embeddedness of social stress in children, this would indicate that social environmental factors associated with altered HPA-axis activation in children need to be targeted for early prevention of mental health problems (Adam et al., 2007).

Both higher and lower than average diurnal levels of cortisol have been suggested to be maladaptive. Elevated and lowered diurnal cortisol levels have been linked to memory, attention problems and failures in coping capacities (Flynn & Rudolph, 2007). Cortisol concentrations typically rise directly following awakening and decline throughout the day, with a slight peak around noon (Cohen et al., 2007). The cortisol awakening curve (CAR) is typically assessed by the change in cortisol

concentrations from directly following awakening to 30 minutes after awakening. Two other cortisol measures represent daytime changes in cortisol concentration, namely the daytime cortisol curve and the cortisol slope. The daytime cortisol curve (Area Under the Curve with respect to the Ground; the AUC_g) represents an estimation of the total cortisol output during the day. The cortisol slope represents the diurnal change of cortisol concentration (Saxbe, 2008).

The CAR represents the preparation of the body to face daily hassles and is therefore linked to overall diurnal cortisol output (Clow et al., 2010; Adam et al., 2007). A larger than usual CAR may signal anticipation to stressful situations and has been associated with frequent arguments at home in children (Michels et al., 2012). Whether associations between (peer) stressors and CAR exist in childhood is unknown as previous studies in childhood samples (e.g., see Gunnar et al., 2003) did not study CAR but focused on cortisol levels instead. However, a larger CAR than average may be expected in children experiencing frequent peer stressors.

Several studies have linked individual differences in daily cortisol output to (chronic) stress exposure. For instance, negative social experiences, such as frequent arguments between parents at home, were related to a more negative cortisol slope in six-year-old children (DeCaro et al., 2008). Cortisol production might be downregulated after facing extended stress exposure for several months, as the HPA-axis becomes overstrained. Through the negative feedback circuit this results in suppressed output of CRH and ACTH by acting on glucocorticoid receptors in the brain, ultimately leading to cortisol output rebounds below normal (Miller et al., 2007). Indeed, lowered diurnal cortisol levels were observed in 3/4-year-old children after facing adverse early child care for two years (Koss et al., 2014). Additionally, active classroom exclusion by peers was related to downregulation of the cortisol diurnal curve and heightened cortisol levels at school in 8-

10 years old children (Peters et al., 2011). Peer rejection was associated with heightened cortisol levels in preschool children (Gunnar et al., 2003). However, in this latter study cortisol levels were only assessed once during the day, thereby impeding studying whether peer rejection was linked to the CAR, cortisol slope and the AUC_g. It needs to be investigated whether the cortisol slope, AUC_g and CAR are similarly influenced by peer appraisal as these indicators of HPA axis functioning have a different connotation (Saxbe et al., 2008). Thus, although negative peer experiences may represent (prolonged) stressful social experiences (MacDonald & Leary, 2005; Williams, 2001, 2007), our understanding of the association between peer relations and the cortisol awakening response as well as diurnal cortisol output in early elementary school children is far from complete.

In this study, we associate individual differences in diurnal cortisol concentration in elementary school children with early elementary school classroom peer acceptance and peer non-acceptance. Peer acceptance is typically assessed by asking classroom peers to nominate who is liked in the classroom (Coie et al., 1982). In contrast, peer non-acceptance indicates who is disliked by their classroom peers (Coie et al.,1982). Scoring low on peer acceptance does not necessarily mean that a child is actively disliked. The child may be mostly neglected in the social evaluation (Coie et al., 1990). However, peer-acceptance and peer non-acceptance may also jointly excerpt their influence. That is, low scores on peer acceptance, combined with high scores on peer non-acceptance is referred to as peer rejection (Deater-Deckard, 2001; Coie et al., 1990). Peer rejection has been previously described as especially troublesome for children (Williams 2001; 2007). Although poor peer appraisal is described as stressful for children, it is important to note that asking children how they like or dislike peers does not necessarily mean that they actively show negative behaviours toward the child. Peer victimization is considered a behavioural manifestation of peer rejection, as it

involves actively trying to harm the victim and their social relations with peers (Olweus 1986, 1993). Previous research suggested that there exists an association between peer victimization and heightened cortisol levels in children (Peters et al., 2011). However, it is still unclear whether mere peer appraisal differences are associated with altered cortisol levels in children. This is important as mere peer appraisal might not always be visible in classroom behavior but might already be associated with altered daily cortisol levels in children as proposed by Gunnar and colleagues (2003).

In the present study, we aimed to explore the unique and possible joint influence of peer acceptance and non-acceptance with diurnal cortisol output in 222 early elementary school children. We expected that especially peer rejection, that is, the combination of low peer acceptance and high peer non-acceptance, is associated with heightened individual differences in daily cortisol levels (Gunnar et al., 2003). Specifically, we expected peer rejection to be linked to heightened CAR, with lower reductions in cortisol across the day, and with higher cortisol levels across the day. In all models, behavioural and emotional problems, as well as peer relational victimization, will be controlled for as such problems in itself have been repeatedly linked to altered HPA axis activity (Bruce et al., 2002; Peters et al., 2011; Rudolph et al., 2010; Saridjan et al., 2014) and coincide with the peer social stressors rejection and poor acceptance (Blackhart et al., 2007; Van Lier & Koot, 2010).

Methods

Participants

Data of this study are part of the Happy Children, Happy Adolescents? (HCHA) project, a longitudinal study among 1624 children on their socio-cognitive and behavioural development in the school context (M age = 6.0 years, SD = 0.46 at the start of the

study; 50% boys). Children were first assessed in fall 2011. The participants lived in the east and center of the Netherlands, had mostly a Dutch-Caucasian background (90%), and the family socioeconomic status (SES) was low in 10% of the sample. For reasons of feasibility, only children of whom we had complete family contact information, and whose primary caregiver actively participated in a parent data collection in 2013 (N = 657) were approached for data collection of cortisol. For the current study, 298 children (M age = 6.97 years, SD = 0.99; 55% boys) of the longitudinal study participated in the cortisol assessments between 2013 and 2014. Ethical approval was obtained from the Medical Ethical Review Board of the VU Medical Centre (protocol number: NL37788.029.1).

Children who did and did not participate in the cortisol collection (N = 298) did not differ on peer acceptance $t(499) = -1.28$, $p = .20$, peer non-acceptance $t(499) = 1.01$, $p = .31$, and age $t(499)= 8.11$, $p = .42$ from the rest of the approached children. Children who participated in the cortisol data collection were equal on peer acceptance $t(1197) = .-.34$, $p =.73$ and non-acceptance $t(1197)= 1.89$, $p = .06$, and age $t(1197) = 2.79$, $p = 0.50$ as compared to the original sample. Of these 298 children, data of three children who had outliers of 3 SDs of the mean on cortisol measures were deleted in order to rule out possible influence of outliers by contamination or by medication. Of the remaining 295 children, 282 children provided valid saliva samples. Valid saliva samples for at least two cortisol measurement points were necessary to calculate at least one of the cortisol indicators. Based on this criterion, N = 222 were included for further analyses. Children who had non-usable cortisol data, did not differ from children with complete data on peer acceptance, $t(209) = -.66$, $p = .44$ or peer non-acceptance, $t(210)= 0.73$, $p = 0.47$.

Design

The current study used data assessed over a one-year period. Children were 5 to 8 years old (grade 1, 2, 3 and 4). Participants completed nominations procedures in the spring of 2013 and 2014. They were supervised by trained interviewers. Cortisol data was obtained at home by the parents between spring of 2013 and spring of 2014. We collected diurnal cortisol levels at home on a Saturday, as a reflection of HPA axis functioning in everyday life (Saxbe, 2008). To avoid confounding by acute experiences of classroom peer rejection, we tested our hypotheses on a weekend day to assess whether stable negative peer appraisal is associated with increases of daily HPA-axis functioning. Daily cortisol concentrations have been shown to be reduced on weekend days in comparison to weekdays in adults (Schlotz et al., 2004). Of children attending day-care, 70 percent showed more typical decline of cortisol on weekend days at home than during a week day in day-care (Watamura et al., 2009). However, studies showed heightened cortisol levels at the weekend after a stressful working week in adults (Berset et al., 2009). This suggests that heightened cortisol levels in the weekend may result of less effective recovery from stress experienced during the week. Averaged peer acceptance, peer non-acceptance and control measure scores (emotional and behavioural problems and relational victimization) were computed to achieve robust measures. An additional advantage of this is that measure captures stability of peer appraisal across a one-year interval. We hypothesized that especially chronic poor peer experiences link to adjustment in daily stress activity.

Methods

Assessment of salivary cortisol levels were sent to the home of the children. Detailed written instructions were sent to the participants, including visual instructions explaining children and their parents how and when to collect the saliva, and how to preserve the tubes. Participants were instructed to provide the first sample directly at awakening (Cortisol 1), the second sample 30 minutes afterwards (Cortisol 2), the third at 12 p.m. (Cortisol 3) and the fourth at 8 p.m (Cortisol 4). The average time of the first sample collection was 7.07 a.m. with a margin of 45 minutes. Compliance was stimulated by calling parents previous to the cortisol collection day to remind them to assist their children with cortisol collection at the specific time points. Cortisol in saliva was collected with the passive drooling method (Schlotz et al., 2004). Parents were instructed to help their children with refraining from brushing their teeth, physical activity, leaving their bed and eating before the first and second cortisol collection time point at 7.00 and 7.30, respectively. They were further asked to not eat directly before collecting saliva at any point and to only drink water directly before the cortisol collection. Children were further instructed to not be physically active two hours before collecting saliva. Parents were instructed to store the cortisol tubes in the freezer before returning them by prepaid mail envelopes. They were asked to send the samples on a weekday and not on a Friday to avoid samples being outside the freezer for more than two days. After receiving the samples, the cortisol tubes were stored at -20°C. After completion of the data collection, samples were sent on dry ice in one batch to the laboratory of the Department of Biological Psychology, Technical University of Dresden for analysis. Salivary cortisol concentrations were measured using a commercial immunoassay with chemiluminescence detection (CLIA; Hamburg, Germany). Intra- and interassay coefficients of variation were below 7% (Saridjan et al., 2014).

We computed three composite variables of the separate cortisol measures within a day: the cortisol awakening response (CAR), the area under the curve with respect to the ground (AUC_g), and the diurnal cortisol slope. These three independent variables represent different aspects of the HPA axis activity. The CAR was computed by substracting Cortisol 1 from Cortisol 2 (Wust et al., 2000). The AUC_g was calculated as the total area under the curve between the four time points (Saxbe, 2008). The AUC_g represents the total cortisol secretion during the day. The AUC_g was calculated for only those children who provided at least three saliva samples. The diurnal cortisol slope was computed by fitting an individual regression line for each child on samples cortisol 1 and cortisol 4, which predicted the change in cortisol values from time since awakening (Saridjan et al., 2014). The second cortisol sample was not included in the measurement to avoid effects of the CAR. Flatter slopes, as indexed by less negative betas, imply a slower cortisol decline during the day.

Peer acceptance and non-acceptance were assessed using peer nominations. All children completed the peer nomination procedure in the spring of 2013 and again in 2014 in their classroom. Children were presented a list of names of their classmates and were asked to nominate an unlimited number of peers in the classroom who they liked (peer acceptance), and who they disliked (non-acceptance) (Coie et al., 1990). Children were not allowed to nominate themselves. To account for differences in class size, the sum scores of peer acceptance and non-acceptance were divided by the number of participating children in the classroom minus one, because self-nomination was not possible. The correlation of peer acceptance and peer non-acceptance across waves was $r = .41$ and $r = .44$, p's $< .01$ respectively.

Control variables

Early morning cortisol differences were represented by individual cortisol intercepts (M = 6.57 cortisol per n/mol, SD =

3.09) at awakening, in order to control for potential cortisol awakening level differences for the diurnal cortisol measures. (Stalder et al., 2011).

Time of first sample was controlled for since differences in time of first cortisol sampling have been shown to influence daily cortisol levels in children (Michels et al., 2012). Relational victimization was assessed using peer nominations of the relational victimization scale of the Social Experiences Questionnaire (SEQ; Crick & Grotpeter, 1996). Children were asked "About which classmates, mean things are said?" The correlations between relational victimization scores across the two waves was $r = 0.30$, $p < 0.01$.

Emotional problems and behavioural problems were assessed by parents in the spring of 2013 and again in the spring of 2014 using the emotional problems and behavioural problems scales of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Parents were asked to indicate on a 5-point scale, ranging from not true (0) to definitely true (4) whether their child is for example "scared a lot" ($M = 1.8$, $SD = 0.77$) or whether their child "often has anger outbursts". The correlation between emotional problems and behavioural problems across the waves was $r = 0.6$ and $r = 0.5$, $p < 0.01$ respectively. Cronbach's alphas were 0.62 and 0.64 for emotional problems, and 0.50 and 0.50 for behavioural problems across waves.

Sex of children was dummy coded with 0 = boys and 1 = girls.

Calendar age of the children was used to control for children's chronological age.

Low Socioeconomic Status was assessed through parental occupation using the Dutch Working Population Classifications of Occupations Scheme (Statistics Netherlands 2001). The highest occupation level (from father or mother) was considered to reflect household socioeconomic status (SES). Low SES was defined as being unemployed of having an elementary job or less. Household

SES was dummy coded as 0 = medium to higher level SES, 1 = unemployed to lower level SES.

Statistical analyses

We tested for unique and possible interaction effects of acceptance and non-acceptance on CAR, AUC_g and cortisol slope. To this end, a model containing all outcomes (CAR, AUC_g, cortisol slope) was fitted, on which main effects of acceptance and non-acceptance and the interaction acceptance x non-acceptance were tested. Paths were controlled for possible effects of relational victimization, behavioural and emotional problems, early morning cortisol differences, time of first sampling, low-SES, age and sex. To account for possible level differences in cortisol, the cortisol intercept was entered as a control variable in all models. To control for possible covariation between the predictors of interest (acceptance, non-acceptance) and emotional and behavioural problems, the predictors were regressed on emotional problems and behavioural problems. Conclusions on best fitting nested models were based on significant prediction effects (main effects and two-way interaction). Mplus version 7 (Muthen & Muthen, 2005) was used for fitting the nested regression models. Standard errors were adjusted for clustering of data at the classroom level using a sandwich estimator (Williams, 2000).

Results

Descriptive statistics

Descriptive statistics for the study variables, and the correlations between the study variables are depicted in Table 1.1. Cortisol concentrations of the four measurement points are presented in Table 1.2. Results in Table 1.1 showed significant negative correlations were found between peer acceptance and AUCg ($r = -0.17$, $p < 0.05$), between peer acceptance and the diurnal cortisol

slope ($r = -0.17$, $p < 0.05$), and between peer non-acceptance and peer acceptance ($r = -0.35$, $p < 0.01$). Relational victimization was positively correlated with non-acceptance ($r = 0.22$, $p < 0.01$). Emotional problems correlated negatively with the cortisol slope ($r = -0.16$, $p < 0.05$). Behavioural problems correlated negatively with the cortisol slope ($r = -0.16$, $p < 0.05$) and peer acceptance ($r = -0.17$, $p < 0.05$) and correlated positively with non-acceptance ($r = 0.21$, $p < 0.01$). The intercept was negatively correlated with the (CAR $r = -0.14$, $p < 0.01$) and positively correlated with the AUCg ($r = 0.25$, $p < 0.01$) and the cortisol slope ($r = 0.72$, $p < 0.01$). Age was positively correlated with victimization ($r = 0.16$, $p < 0.05$). SES was negatively correlated with relational victimization ($r = -0.16$ $p < 0.05$)

Table 1.1 Study Variables

Variable		*M*	*SD*	Range	1	2	3	4	5	6	7	8	9	10	11	12	13
1.	CAR	.94	1.37	-2.28-9.02	-												
2.	AUCg	3.33	0.21	2.72-3.97	.54**	-											
3.	Slope	-5.43	3.77	-14.96-17.87	.34**	.40**	-										
4.	Like	.31	.14	.03-.78	-.18*	-.25**	-.14	-									
5.	Dislike	.15	.13	.00-.63	.16*	.01	.03	-.35**	-								
6.	Emot. prob.	1.80	.79	1.00-5.00	-.01	-.04	-.06*	-.14	-.13	-							
7.	Behav. prob.	2.1	.99	1.00-5.00	.03	-.02	-.16*	-.17*	.21**	.23**	-						
8.	Victimization	0.38	.95	.00-1.00	.06	-.02	-.04	.12	.22**	.06	.05	-					
9.	Intercept	6.57	3.09	2.06-18.73	-.14*	.25**	.72*	-.01	-.19*	.03	-.04	.06	-				

10.	Age	6.97	.99	5.00-10.00	-.70	-.11	-.03	-.01	.06	-.08	-.04	.16*	-.04	-		
11.	Sex	-	-	-	-.01	.03	-.00	.20**	-.27*	.11	-.10	.12	-.05	.02	-	
12.	SES	5.35	1.66	1.00-8.00	.13	-.03	.05	.00	.02	.04	-.07	-.16*	.06	.32	.07	-
13.	Time first sampling	7.02	.74	5.30-9.00	-.08	-.12	-.03	-.15	.12	.04	.16	.05	-.08	-.01	-.0	.13	-

Note. CAR = Cortisol Awakening Response. AUC_g = Area Under the Curve with respect to the ground. Slope = changes of cortisol concentration during the day. Emot. Prob. = Emotional problems, Behav. Prob. = Behavioural problems. Intercept = Early morning cortisol differences. * $p < .05$. ** $p < .05$.

Table 1.2. Cortisol measurements

Variable	Measurement	Mean	Std. Deviation
Cortis. four timepoints	Cort 1 (7.00)	6.57	3.09
	Cort 2 (7.30)	7.51	5.65
	Cort 3 (12.00)	2.63	2.16
	Cort 4 (20.00)	1.48	4.33

Note. CORT = cortisol.

Associations between Peer Social Stressors and cortisol

Multivariate regression models were fitted to test our hypotheses. The outcome variables CAR, AUC_g and diurnal cortisol slope were simultaneously included in the model. Models containing main effects, and two-way interaction term of peer acceptance and peer non-acceptance were fitted. Results are depicted in Table 1.3.

Table 1.3. Associations Between Peer Appraisal and Diurnal Cortisol Outcome Parameters

	CAR				AUCg				Slope			
Step 1: Main effects	*B*	*SE(B)*	*Beta*	*p*	*B*	*SE(B)*	*Beta*	*p*	*B*	*SE(B)*	*Beta*	*p*
Age	-0.06	-0.84	0.07	.40	-0.08	-1.39	0.06	.16	0.03	0.26	0.13	.79
Sex	0.05	0.29	0.16	.76	0.09	0.59	0.16	.55	0.13	0.30	0.44	.76
SES	0.47	1.05	0.44	.29	0.31	0.84	0.36	.39	0.53	0.69	0.76	.48
Emotional prob.	-0.04	-0.61	0.07	.54	-0.11	-1.79	0.06	.07	-0.38	-2.69	0.14	.01
Behavioural prob.	0.13	1.16	0.11	.25	0.13	1.46	0.09	.14	0.37	1.57	0.23	.12
Victimization	0.39	0.42	0.95	.67	0.93	1.07	0.87	.28	2.12	1.16	0.84	.25
Intercept	-0.06	-0.96	0.07	.34	0.15	2.52	0.06	.01	-0.03	-0.18	0.14	.86
Time first sampling	-0.22	-0.95	0.23	.34	-0.21	-1.14	0.18	.25	-0.24	-0.71	0.34	.47
Like	-1.24*	-2.02	0.61	.04	-2.09**	-3.28	0.63	.00	-3.43*	-2.31	1.49	.02
Dislike	0.49	0.46	1.06	.64	-0.37	-0.58	0.65	.65	-1.50	-1.16	-1.29	.25
R^2	.06				.23				.04			
Step 2: 2-way interaction												
Age	-0.07	-1.05	0.07	0.28	-0.08	-1.42	0.06	.15	0.04	0.31	0.13	.75

Sex	0.03	0.16	0.16	0.87	0.09	0.57	0.17	.44	0.15	0.33	0.44	.74
SES	0.48	1.07	0.45	0.28	0.31	0.84	0.36	.39	0.52	0.68	0.76	.49
Emotional prob.	-0.05	-0.66	0.07	0.51	-0.12	-1.79	0.06	.07	-0.37**	-2.70	0.14	.01
Behavioural prob.	0.13	1.14	0.12	0.26	0.13	1.45	0.09	.15	0.34	1.56	0.24	.12
Victimization	0.23	0.23	0.99	0.82	0.90	1.02	0.88	.31	2.23	1.21	1.84	.23
Intercept	-0.06	-0.93	0.07	0.35	0.16	2.51	0.06	.01	-0.03	-0.18	0.14	.89
Time first sampling	-0.20	-0.87	0.23	0.38	-0.19	-1.09	0.18	.27	-0.24	-0.69	0.34	.49
Like	-0.32	-0.38	0.84	0.70	-1.79	-2.48	0.72	.01	-3.87	-2.19	1.76	.03
Dislike	2.59	1.27	2.04	0.70	0.30	0.21	-2.22	.80	-2.51	-1.26	1.99	.21
Like * Dislike	-8.73	-1.62	5.38	0.10	-2.84	-0.88	3.19	.37	4.09	0.83	4.90	.40
R^2		.08				.25				.07		

Note. CAR = Cortisol Awakening Response. AUC_g = Area Under the Curve with respect to the ground. Slope = changes of cortisol concentration during he day. Intercept = Early morning cortisol differences. * $p < .05$. ** $p < .001$.

The results showed (Table 1.3, lower portion) that the two-way interaction term between acceptance and non-acceptance was not significant in predicting the CAR, AUC_g or the diurnal cortisol slope. However, results in Table 1.3, upper portions showed significant main effects of peer acceptance in predicting the CAR(β per nmol/L CAR = -0.13, 95% CI: -0.09; -0.86, $p < 0.05$), AUC_g (β per nmol/L AUC_g = -0.23, 95% CI: -2.21; -0.38, $p < 0.01$) and diurnal cortisol slope (β per nmol/ cortisol slope = -0.17, 95% CI: -6.17; -0.31, $p < 0.05$). The model provided a good fit to the data (χ^2 (9, n = 222) = 13.54, SRMR = 0.023, RMSEA = 0.048, CFI = 0.97). With respect to the CAR, results implied that children with lower peer acceptance scores had a higher cortisol awakening response. With respect to the AUC_g, results implied that children with lower peer acceptance scores had higher overall cortisol output across the day. Given that cortisol levels decreased across the day (Table 1.2; Figure 1), the negative estimate of peer acceptance implies that higher levels of peer acceptance were associated with more negative betas, and thus higher declines in cortisol across the day (Figure 1). In addition to these effects, higher levels of emotional problems were associated with more negative beta's, thus steeper declines in the cortisol slope (β per nmol/L cortisol slope = -0.14).

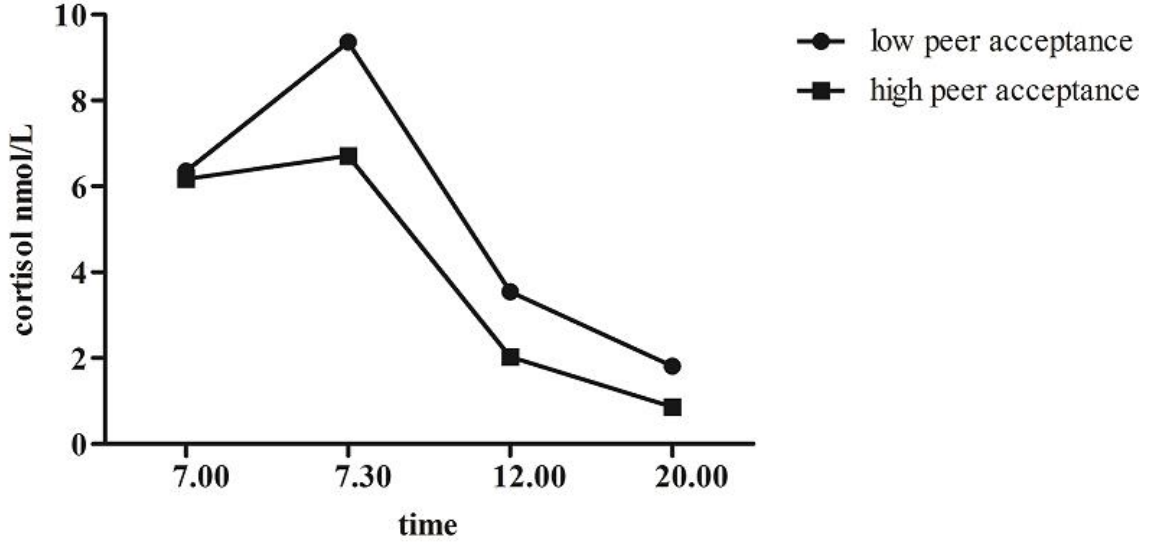

Figure 1: Cortisol concentration in nmol/L according to low and high peer acceptance. The x-axis depicts the timepoints of cortisol measurement (cortisol 1-cortisol 4).

Discussion

This study examined the association between peer appraisal and diurnal cortisol levels in a sample of children in the early years of mainstream elementary schools in the Netherlands. Our results revealed that low peer acceptance (scoring low on being liked) was associated with heightened CAR, heightened AUC_g and attenuated decreases in cortisol across the day, as indexed by the diurnal cortisol slope. Non-acceptance by peers (being disliked) or peer rejection (scoring low on being liked and high on being disliked) were not related to HPA activity. Collectively these results suggested heightened diurnal cortisol output on a weekend day among children who had lower peer acceptance in the classroom across a one-year interval.

Our results showed that low peer acceptance was associated with increased cortisol awakening response in our sample. Waking time was not significantly correlated with peer acceptance ($r = 0.04$). Therefore, we do not expect differences in waking time cortisol collection between peer accepted and peer non-accepted children. We further compared the magnitude of our CAR measure to previous studies. The range of our CAR is comparable to previous studies assessing the CAR in young children (for example Sarijdjan et al., 2015). Moreover, a previous study among children showed an awakening response (defined as an increase by at least 1.5 n/mol/L from awakening to 30 minutes later) in 90% of the sample (Bäumler et al., 2013). We had CAR scores of the same magnitude in 90% of our sample. Therefore we are confident that we actually captured a valid assessment of CAR in our sample.

Low peer acceptance was associated with diurnal cortisol in our sample. Low peer acceptance was associated with a flattened diurnal cortisol slope and heightened overall cortisol output. Poorly accepted children in our sample showed high cortisol levels in the morning, with less decline of cortisol concentration during the day as compared to the rest of the sample, resulting in heightened

evening cortisol levels. This failure of decrease of cortisol concentration during the day constituted the increased overall cortisol output.

Poorly accepted children in our sample showed lower-than-expected cortisol changes during the day. Similar to Peters et al., (2011) findings, low peer acceptance was associated with a flattened cortisol slope. Low peer acceptance is likely experienced during multiple school years as the stability of negative peer appraisal across school years is quite high (Coie &Dodge, 1990). Our peer appraisal assessment was based on two consecutive school years. The stability of our measure was a similar stability as found in earlier studies. Therefore, negative peer appraisal might represent a chronic stressor as children are exposed to such peer stress throughout multiple school years. Extended periods of stress have earlier been related to changes in the cortisol slope (Wolf et al., 2008).

Our hypothesis regarding peer rejection and the association with increased CAR as well as heightened diurnal cortisol was not confirmed. We used linear regression analysis, measuring associations, to test our hypotheses. Based on comparable research in an adult sample, we do not expect that level differences between week and weekend cortisol levels influence associations between peer relations and daily cortisol levels. Therefore, we suggest that our non-significant findings are not a result of possible cortisol level weekend-weekday differences. Earlier research underscores the notion that chronic stress during the week is significantly associated with altered cortisol levels during the weekend in adults (Berset et al., 2009; Geurts & Sonnentag, 2006).

We found that higher levels of emotional problems were associated with more negative betas, thus higher declines in the cortisol slope. This was not the focus of our study but still constitutes an interesting finding. Hyperactive HPA axis functioning has often associated with emotional problems in similar studies in children (Greaves-Lord et al., 2007, Feder et al.,

2004; Hartman et al., 2013). More insights into the cortisol slope and internalizing problems in children are needed to draw knowledgeable conclusions about related associations. Self-reports of emotional problems were not available for the current study since the children were too young. We suggest to compare our results with self-reports of internalizing problems and related associations with daily cortisol levels in a sample with older children.

Our results did not support earlier findings of Gunnar et al. (2003) who found that peer rejection was related to heightened cortisol levels in pre-schoolers. Daily cortisol concentration should be tested repeatedly to assess whether up-regulation of the daily HPA axis functioning is a relatively enduring, habitual condition of the HPA-axis.

It is further possible that children become even more susceptible to non-acceptance and rejection by peers in adolescence. Peer appraisal grows more important during adolescence and not fitting in with the peer group becomes a highly salient stressor during puberty (Brown, 1990). Additionally, more pronounced alteration of cortisol rates in pubertal as compared to pre-pubertal children have been reported (Gandia et al., 1990). Therefore, it needs to be assessed, whether peer non-acceptance and peer rejection might become significantly related to diurnal cortisol rates in puberty.

Our findings extend previous studies by showing that upregulation of daily cortisol is present in the early years of elementary school. Moreover, we firstly assessed the association between peer appraisal and CAR, AUC_g and cortisol slope to investigate the distinct association between negative peer appraisal and overall HPA axis functioning. We found upregulation of overall cortisol output, i.e., no blunted diurnal cortisol output, as a function of negative peer appraisal in this study. A steep cortisol slope, or strong decrease of cortisol concentration during the day, has been linked to general health, social support and wellbeing in

adults (Sjogren et al., 2006; Miller et al., 2007). A flattened slope (associated with low peer appraisal in our sample) is maladaptive, as variability in cortisol concentration is needed in order to respond to different experiences during the day (Saxbe, 2008).

We do not have data to test whether manifest stress in the week prior to our assessments of cortisol during the weekend day affected our results. However, based on related findings in adults (Berset et al., 2009), and given that we anticipate poor peer appraisal to constitute a chronic stressor, we did expect to find a significant association between peer social stress during the week and salivary cortisol during the weekend. Moreover, for reasons of feasibility and adherence to assessment protocol by instructing parents to assist their children in the cortisol collection during the weekend day, we choose to use this approach. The data suggests that heightened cortisol output on a weekend day might be linked to extended exposure to negative appraisal during the week. The pattern of low peer appraisal in the classroom during the week and the impossibility to recover from this during the weekend, may be linked to chronic stress exposure (Wolf et al., 2008). It has been suggested that experiences of the preceding day activate the CAR to prepare the body based on prior day experiences (Clow et al., 2010; Adam et al., 2007). Increases of the CAR have been reported to be a valid indication for chronic influences of social stress (Fries et al., 2009; Pruessner et al., 1997). Possibly as a consequence, the CAR shows higher intraindividual stability than the AUC_g and slope (Pruessner, 1997). An increase of the CAR after adverse experiences with peers during the previous day might consequently prepare the individuals to meet the demands of stress related to low peer acceptance during the upcoming day, even on a weekend day. Our results underscore the notion that chronic negative peer appraisal is associated with increases of daily HPA-axis functioning even when children are outside of their classroom peer context. Consistent upregulation associated with negative peer appraisal might indicate programming of the daily axis functioning

based on negative social experiences during childhood (Meaney et al., 2007). Our results suggest that influences on HPA axis functioning are mostly associated with peer appraisal in children of this age group. Evidence that negative peer appraisal is associated with higher cortisol levels is consistent with the findings of Gunnar et al. (2003). Thus, altered HPA-axis functioning may constitute the link between negative social experiences and the onset of psychopathology. We therefore suggest that future research should investigate whether upregulation of the HPA-axis mediates the link between negative peer appraisal and psychopathology in elementary school children in a longitudinal setting. The association between adverse peer experiences and AUCg, cortisol slope and CAR should be studied by logging these data on several consecutive days, including both weekdays and weekend days. Upregulation of the HPA-axis constitutes a risk factor for emotional problems in children and adolescents (Bruce et al. 2002). It is possible that after prolonged hypersecretion of cortisol for several months, the HPA-axis becomes downregulated as a result of reduced expression of the glucocorticoid receptor (Miller et al., 2007). Therefore, changes of heightened HPA axis activation towards downregulation might only be visible after chronic exposure to peer rejection in late childhood.

Limitations

We averaged the peer nomination scores of 2013 and 2014 since cortisol was collected between these two time points for the current study. Therefore, we cannot draw a knowledgeable conclusion on the direction of the relation between peer appraisal and cortisol. However, we are convinced that averaging the peer nomination scores for our purposes is favorable since this approach guarantees a more stable measure of peer appraisal. As suggested previously in adult samples, a flattened cortisol slope can also be an indicative of negative experiences during the day. Overall cortisol output has been shown to be influenced by daily hassles as well as activity

during the day (Adam et al., 2007; Miller et al., 2007). High cortisol levels are linked to negative affect (e.g., anger or tension) and may become cumulative during a day, resulting in heightened morning and evening cortisol values during an overall "bad day" (Saxbe, 2008; van Eck and Nicolson, 1994). This may thus suggest that poorly accepted children experience more daily hassles when compared to better accepted peers. We suggest that future studies focus on a design including daily experiences through Ecological Momentary Assessment, which can provide valuable information on inter individual differences in negative social experiences (Steptoe et al., 2007). In this manner, daily hassles and other daily social stress, for example in the family context that might influence daily cortisol output, can be controlled for. To distinguish between within-person state variation and chronic alterations of the AUCg and cortisol slope, cortisol samples on consecutive days, also during the week, need to be collected. Future studies should focus on exploring the role of altered stress activation as a potential mediator between negative peer experiences and the onset of psychopathology (Luman et al., 2010; Saridjan et al., 2014). Swapping of first and second sample could have resulted in obtained negative values for CAR (20% of the sample). Furthermore, no information on daily activities, time between waking and first sampling, medication use, sleeping pattern, or food intake, were collected. Self-reports might provide additional insights into individual daily experiences of negative peer appraisal in children. However, self-reports on peer appraisal and victimization often do not correspond with peer nominations on victimization (Scholte et al., 2013). Self-reports of peer appraisal might mediate the relationship between sociometric peer status reports and diurnal cortisol change. A genetic predisposition could underlie our observed association. Variants in genes involved in endocrine development, (Goodyer et al., 2010), give rise to individual differences in cortisol levels. Higher initial cortisol levels might lead to increased perceived stress and might re-inforce

avoidance or little contact with peers in the classroom, resulting in low peer acceptance. Nevertheless, molecular genetic variances influencing cortisol levels have not been reliably demonstrated (Saridjan et al., 2014), therefore our results emphasize the notion of negative peer appraisal being associated with heightened daily cortisol levels.

Conclusion

Our findings suggest that low appraisal by the peer group constitutes a stressful experience that is associated with heightened HPA-axis activation in early elementary school children. The current study evidences a psychobiological mechanism that might explain how peer appraisal at the group level might contribute to alterations of stress system functioning in children. The findings emphasize that preventive interventions need to be directed at peer processes in elementary school. We firstly assessed whether mere negative peer appraisal is initially associated with HPA-axis functioning in children in primary school. More specifically, teachers need to monitor peer appraisal processes in the classroom. Teachers need to be further trained in helping children with developing successful coping strategies for stressful social experiences such as low peer appraisal in the peer context. Consequently, social competence training should be embodied in the school curriculum to prevent detrimental influences on the stress system activation.

Our findings suggest that further studies should research the associations between behavioural manifestations of peer rejection and HPA- axis functioning. Importantly, no reference value for maladaptive overall cortisol output and cortisol slope changes are available for children, so more insights into maladaptive daily cortisol patterns are needed (Ice et al., 2004). Future studies should focus on exploring the role of altered stress activation as a potential mediator between negative peer experiences and the onset of psychopathology (Luman et al., 2010;

Saridjan et al., 2014). These studies are needed to gain a better understanding of the developmental cascades.

Chapter 3.

Boy's Chronic Low Peer Preference in Elementary School associates with ANS and HPA-axis Responses to an Interpersonal Peer Stressor in Late Childhood

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Abstract

Peer rejection, or low peer preference by classmates during elementary school is highly distressing for children. Such low peer preference may affect children's physiological responses to new experiences of social stress. The goal of this study was to assess ANS and HPA-axis responses to an acute interpersonal stressor among late elementary school boys with a history of low versus high peer preference. To this end, 53 boys (*M* age = 10.98 years, *SD* = .68) with stable high (highest 35-percentile, *n* = 33) and stable low (lowest 35-percentile, *n* = 20) peer social preference scores across the three years prior to the lab-study were included. In the lab, the boys were subjected to a standardized version of the Yale Interpersonal Stressor for children (YIPS-C). Heart rate and heart rate variability, and cortisol and α-amylase concentrations were measured at seven time points during the procedure. Results showed that low peer preferred children had decreased cortisol and increased heart rate variability responses to the YIPS-C, compared to high preferred children. There were no group differences regarding heart rate or α-amylase responses. Results of this study suggest that children with a history of low peer preference show a downregulation of their stress system responses to interpersonal stressors.

Introduction

Poor peer preference by elementary school classroom peers is a social stressor, and has been linked to mental health problems, such as internalizing or externalizing behavior problems (Parker, 2006). The impact of adverse environmental exposure, including peer social stressors, on maladaptive outcomes, might be explained by affected re-activity of the two major stress systems, the Autonomic Nervous System (ANS) and the Hypothalamus-Pituitary-Adrenocortical axis (HPA-axis) (Laurent et al., 2016; Ouellet-Morin, 2011; Parker, 2006; Sijtsema et al., 2013). Previous studies on the association between peer stressors and physiological stress responses focused mostly on (young) adolescent

samples (Newman et al., 2014; Ouellet-Morin et al., 2011; Ouellet-Morin et al., 2013). However, poor peer preference is, especially as a chronic elementary school stressor, linked to maladaptive outcomes already in the elementary school ages (Ladd, 2006). Moreover, previous stress-response studies directed at school aged children omitted studying both the HPA and ANS system (Chen et al., 2018; Gunnar et al., 2003; Ouellet-Morin et al., 2013; Knack et al., 2013; Peters et al., 2011; Vaillancourt et al., 2011). The goal of this study was to assess both ANS and HPA-axis responses to a psychosocial stressor among late elementary school boys with a history of low versus high peer preference during elementary school.

A few seconds after exposure to a stressor, the typical response is the 'fight or flight' reaction (Porges, 1995). This fight or flight response is a quick responding system which reacts to stress-provoking factors. This system aims to prepare the body for action by among others increasing heart rate. The fight or flight response is translated into the two branches of the Autonomic Nervous System (ANS): the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). Through a withdrawal of the PNS (the vagal break) the SNS is activated to respond to the stressor. PNS responses can be measured by heart rate variability. Typically, heart rate variability (HRV) should decrease in response to a stressor (Porges, 1995), so that heart rate can increase to prepare the body to cope with the stressor. This pattern of response to a social stressor was indeed found among children and adolescents (Stroud et al., 2009). SNS responses can be measured by the enzyme α-amylase (sAA) (Granger et al., 2007; Stroud et al., 2006). When the SNS is activated, the salivary glands are activated too by increasing the protein-to-fluid ratio of for example sAA in the saliva. Thus, sAA levels typically increasing following a stressor to prepare the body for action (Porges, 2007; Stroud et al., 2009).

In addition to the ANS, a second stress system that responds to stress provoking factors, is the Hypothalamus-Pituitary-Adrenocortical (HPA) axis. The end-product of the HPA-axis is the steroid hormone cortisol. The peak level of cortisol is measurable in saliva approximately

20 minutes after experiencing the stressor (Kudielka & Kirschbaum, 2005; Sapolsky, 2000). When confronted with a stressful situation such as social evaluative situations or acute experiences of social exclusion, the adaptive bodily response of an individual would be to have a temporary increase in the secretion of cortisol (Dickerson & Zoccola, 2013). Indeed, apart from ANS activity, results from Stroud et al. (2009) also showed that experiences of social exclusion during an interpersonal stressor in an experimental setting were associated with increased levels of salivary cortisol. Thus, both the ANS and HPA-axis respond to social stressors. It is, however, yet unclear how children's history of chronic low peer preference affects these responses to an acute social exclusion experience.

Children, like adolescents and adults, have a fundamental need to be accepted and to belong to the larger peer group (Baumeister & Leary, 1995; Williams, 2007). Low peer preference among classroom peers may signal a child's difficulties in fulfilling this fundamental need, and thus constitutes a social stressor. Indeed, studies have shown that poor acceptance among classmates in elementary school was associated with heightened levels of cortisol across the day, suggesting elevated HPA-axis activity (Behnsen et al., 2018; Peters et al., 2011). However, prolonged exposure to social stressors might lead to "tear and wear" of the physiological stress system, resulting in a downregulation of stress responses to acute (social) stressors. A meta-analysis showed that prolonged experiences of stress were associated with an absence of cortisol (HPA-axis) concentrations in response to acute stressors and reduced daily cortisol output in adults (Miller et al., 2007). This down-regulation, or blunting of the stress-system may be important to protect the body from prolonged exposure to physiological stress output (Miller et al., 2007). However, blunted heart rate and cortisol stress reactivity and heightened heart rate variability have also been related to a range of negative health conditions, obesity, depression and burn out (Carroll et al., 2008; Phillips et al., 2012; Ginty et al., 2013; de Rooij 2013) and behavioral problems and (sub clinical) depression in children (Laurent et al., 2016; Ouellet-Morin, 2011; Sijtsema et al., 2013).

A number of prior studies explored the association of childhood history of peer problems with stress reactivity in response to an acute psychosocial stressor. Most of these earlier studies focused on peer victimization and assessed stress re-activity when the children were in (junior) high school or in young adulthood. These studies showed that in comparison with non-victimized peers, high school youths who were victimized in elementary school showed blunted cortisol responses to a public speaking stress task (Ouellet-Morin et al., 2013; Knack et al., 2011; Vaillancourt et al., 2011). Regarding ANS measures, young adults aged 21 with a history of victimization during high school showed decreased heart rate in response to a social stressor when compared to their non-victimized controls (Newman et al., 2014). Together these studies suggest that a history of adverse peer experiences might be linked to blunted stress reactivity to a social stressor. One recent study focused on elementary school children, and found that exposure to elementary school peer-victimization was associated with increased, not decreased cortisol responses to a public speaking task (Chen et al., 2018). This study did, however, not have a measure of stable or chronic victimization.

We will add to the existing literature by addressing two important literature gaps. First, previous studies often focused on either ANS *or* HPA-axis responses to interpersonal stress, rather than assessing indexes of both systems. In order to capture general stress responses to psychosocial stressors, multiple measures of both the ANS and the HPA-axis should be assessed (Bauer et al., 2002; Granger et al., 2007). For example, in previous studies adolescents and adults showed HPA-axis but not ANS responses to a stressor (Gerra et al., 2001; Granger et al., 2007, Schommer, Hellhammer & Kirschbaum, 2003). When ANS reactivity is mirrored in HPA-axis reactivity (heart rate reactivity and cortisol) to a stressor, the stress response was linked to feelings of predictability and controllability (Schommer, Hellhammer & Kirschbaum, 2003). Thus, differences of ANS and HPA-axis responses might be linked to feelings of uncontrollability and a subsequent risk for the onset of internalizing or externalizing problems. Therefore, it is

important to include measures for HPA-axis and ANS response in order to identify ANS and HPA-axis response patterns. Additionally, responses of specific physiological modalities within the ANS or HPA-axis may also be of importance. In adults, high heart rate variability but no significant reduction in heart rate at rest, were related to PTSD symptoms (Hopper et al., 2006; Sack et al., 2004). In this manner, the inclusion of measures from both ANS and HPA-axis activity in biosocial studies has the potential to improve our understanding of individual differences in stress-related vulnerability to low peer preference and subsequent risks for the onset of psychopathology. Second, associations of elementary school adverse peer experiences with individual differences in acute stress responses to interpersonal stressors were mostly assessed when the children were in (early) adolescence, after the transition to middle or high school. The transition to high school, in addition to advanced puberty may have impacted the stress responses (Gandia et al., 1990). Importantly, studying social stressors in elementary school is important as already during the elementary school years, experiences of low peer preference have been linked with negative outcomes like psychopathology (Ladd, 2006; van Lier & Koot, 2010). As said, the one study assessing the link between peer stressors and stress reactivity in childhood did not use a measure of chronic peer stress (Chen et al., 2018). This makes it unclear what this study implies for understanding childhood blunted stress responses, as this is linked to prolonged stress exposure (Miller et al., 2007).

In this study, boys with a history of low versus high preference among classroom peers we assessed on their ANS and HPA-axis reactivity following a psychosocial stressor in late elementary school. To this end, 53 boys aged 11 years old, of whom 20 had a history of low peer preference, and 33 who had a history of high peer preference across three consecutive years prior to the experimental procedure participated in a lab study. Boys were subjected to a psychosocial stressor, which was partly based on the Yale Interpersonal Stressor for children (YIPS-C; Stroud et al., 2009), while their ANS and HPA-axis responses were assessed. Only boys were included as they may be more status-oriented

toward the broader peer group and may be more affected by low peer acceptance than girls, who are more focused on intimate, dyadic friendships (Rose & Rudolph, 2006; Rudolph, 2002). We hypothesized that boys with a history of low peer preference would show decreased heart rate, increased heart rate variability, decreased α-amylase and decreased cortisol responses to the psychosocial stressor when compared to boys with a history of high peer preference.

Methods

Participants

Stress responses to a psychosocial stress-task of 53 primary school boys (mean age = 10.98 years, *SD* = 0.71, median = 11.05, range = 9.50 – 12.09 years) were collected in October 2017 – June 2018 during a lab study. The participants were selected from a longitudinal classroom-based study on the social, emotional and (social) cognitive development of children during primary school (Behnsen et al., 2018; de Wilde, Koot, van Lier, 2016; Tieskens et al., 2018). The participants lived in the eastern part of the Netherlands, had mostly a Dutch-Caucasian background (90%), and the family socioeconomic status (SES) was low in 10% of the sample. Given the described potential differences of the impact of poor social preferences between boys and girls (Rose & Rudolph, 2006; Rudolph, 2002), to confine variance and for reasons of feasibility we only focused on boys.

Participant selection for the lab study was based on children's classroom peer preference scores, which were assessed across three annual waves (2013 – 2015; see measures), prior to the lab study. Children with an average peer preference across three years falling in the 35% lowest percentile were classified as having a history of below average peer preference (henceforth referred to as 'low peer preferred'). Children falling in the 35% highest percentile were classified as having a history of above average peer preference (henceforth referred to as 'high peer preferred'). The correlations of social preference on adjacent years in the current study were high (r = 0.71 & r = 0.70). Moreover, none of

the low peer preferred boys scored one standard deviation above the mean of social preference and vice versa for high peer preferred boys. This suggests that participants had a relatively stable peer preference over time which concurs with previous findings on the stability of social preference across development (Jiang & Cillessen, 2005). Based on the inclusion criteria of high and low peer preference, 146 boys were selected to be approached for participation in the lab study. Of these children, contact information of 139 boys (69 low preferred, 70 high preferred) was available and these boys were subsequently contacted. Exclusion criteria for the lab study were heart diseases (heart rhythm disorder, heart muscle disease or congenital heart defect), severe other physical health problems in the two years prior to the lab study, and use of medication including corticosteroids and asthma medication (e.g., Kudielka & Kirschbaum, 2005). Five children were excluded due to these criteria. Of the 134 remaining boys, 53 boys and their parents agreed to participate in the study (20 low peer preferred boys, *M* age = 10.97 years, *SD* = 0.60; 33 high peer preferred boys, *M* age = 10.99 years, *SD* = 0.78).

Low peer preferred children who participated in the study, did not differ significantly from the rest of the approached low peer preferred children regarding their average peer preference score, $F(1,73)= 0.23$, $p = .09$, age, $F(1,73)= 0.70$, $p = 0.23$, or pubertal status, X^2 $(1,73)= 0.02$, $p = 0.10$. Similarly, participating high peer preferred children and high peer preferred children who declined did not differ significantly on peer preference score $F(1,72)=0.32$, $p = 0.52$ age $F(1,72)= 0.62$, $p = 0.31$ or pubertal status, X^2 $(1,73)= 0.05$, $p = 0.41$. Informed consent for participation was obtained from children and parents according to the Declaration of Helsinki (World Medical Association, 2013). All study procedures were approved by the Institutional Scientific and Ethical Review Board of the Vrije Universiteit Amsterdam, Faculty of Behavioral and Movement Sciences (protocol no: VCWE-2015-205R1). Data collection was conducted by the first author, who was blinded to the social preference status of the participants during the period of data

collection. Children received two tickets, worth € 38,- to a local zoo for their participation.

Procedures

Classroom Based Assessments was assessed during three consecutive annual school visits prior to the lab study, children completed a peer nominations measure (see measures) in their classroom. Trained research assistants (master level or completed psychology education) instructed the children and supervised them when completing the questionnaire. Children were seated in exam formation and were monitored for not sharing information with classmates.

The psychosocial stress procedure-lab study was conducted between October 2017 – June 2018. Children were accompanied by one of their parents to the laboratory. Parents were asked to instruct their children to refrain from exercising 24-hours before testing, from eating two hours before testing and from drinking caffeine. Two weeks before testing, children were further notified that they had to prepare a short – four minute – talk about themselves that they needed to present to two other children. Topics that were suggested included 'Which school do you go to?' and 'What are your hobbies?'. Parents were instructed to help their children with the preparations. All lab-sessions were conducted in the afternoon, between 14.00 and 17.00 p.m. to minimize fluctuations in cortisol levels due to circadian rhythmicity (Groeschl et al., 2003). Room temperature of the testing room was set at 20 degrees Celsius.

After arriving at the lab, children and parents were asked to take a seat in the testing room, and the procedure was explained to children and parents. The electrodes for heart rate measurement were attached to the participant (see Measures, Heart rate and heart rate variability). The parent(s) were then asked to go to the waiting room.

The design of the lab study is depicted in Figure 2.1. Participants completed all tasks in the testing room. Participants were first asked to fill in questionnaires assessing their baseline subjective stress levels and completed a non-stressful task (Balloon Analogue Risk Task; BART;

Lejuez et al., 2002; results not included in the present study) (Baseline phase, min. -12 to -5). In the task-preparation phase (min. -5 to 0) children prepared for the stress-task. In the stress phase (Inclusion, min. 0 to 7; Ignoring, min. 7 to 8; Exclusion, min. 8 to 9) the psychosocial stress procedure (see Social Exclusion Paradigm) was completed. During the stress procedure children delivered their prepared talk. In the post-stressor phase (min. 9 – 38) children completed additional questionnaires and non-stressful tasks. Data on BART and other cognitive tasks performance are not discussed in the current paper. After completing the procedures, children were debriefed (min. 38 – 43).

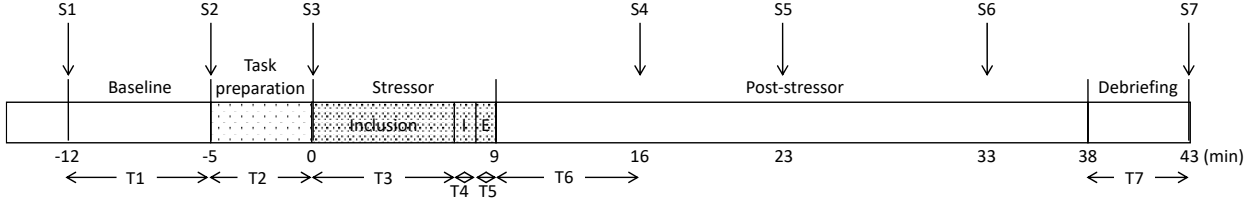

Figure 2.1. Overview of stress-lab study. T = time intervals of assessment of heart rate and heart rate variability. S = collection points of saliva. I = ignoring phase of stressor. E = exclusion phase of stressor.

Interpersonal Stressor was induced via peer exclusion with a psychosocial stress procedure. The task was developed as a live interpersonal interaction task with peers based on the stress procedure of the YIPS-C (Stroud et al., 2009). Similar psychosocial stressors have previously been shown to evoke significant heart rate and blood pressure responses in children and adolescents (Stroud et al., 2009). A standardized and computerized psychosocial stress procedure was used in the present study, and consisted of pre-recorded introductions and reactions of two same-aged and same-sex unfamiliar peers (confederates). Participants were instructed that before coming to the lab-assessments, they had to prepare a four-minute talk with the goal to introduce themselves to the two unfamiliar peers. Prior to the procedure, participants were given five minutes to prepare for their talk to the confederates. The psychosocial stress procedure consisted of three phases and was projected on a screen of a laptop computer. During the first phase of the stressor (inclusion) which lasted for six minutes, the two confederates introduced themselves. After four minutes, the confederates invited the participant to give his prepared talk. During the remaining two minutes of the inclusion period, the confederates listened closely to the participant using non-verbal cues such as nodding. In the second phase (ignoring phase), which lasted for one minute, the confederates started moving their bodies and chair positions away from the participant, showed less interest in the participant and gradually ignored the participant. During the third phase (exclusion phase, one minute) the two confederates focused on each-other and started whispering to each-other. Meanwhile, the participant was supposed to continue giving his talk. A maximum of two standardized prompts were provided by the experimenter in case a participant stopped talking during the procedure ("Is there anything else you want to tell them about?" and "Can you think of anything else you want to share with them?").

During debriefing participants were informed that ignoring and exclusion during the procedure was standardized and not based on their responses. Participants were shown a pre-taped video message in which the confederates explained their role ("We were instructed to ignore

you."), and expressed their appreciation of the child's effort by complimenting the child on the performed task. Children received a small gift for participation at the end of each annual school visit.

Measures

Peer status (high/low peer preference) of participants in the lab study was based on these children's classroom social preference score in the three school years prior to the lab study. The peer preference scores were averaged across the three waves. Children falling in the 35% lowest percentile were classified as 'low peer preferred', and children falling in the 35% highest percentile were classified as 'high peer preferred'. None of the low peer preferred children scored one standard deviation above the mean of social preference on one of the three waves. Likewise, none of the high peer preferred children scored one standard deviation below the mean of social preference score on one of the three waves. In the spring of 2013, 2014 and 2015 children in participating classrooms completed a peer nomination form on iPads. Children were asked to nominate an unlimited number of classmates who they liked and who they disliked. Like and dislike nominations were Z-standardized within each classroom for each year. A social preference score for each year was then computed by subtracting the Z-standardized dislike from the Z-standardized like nomination score ($Z_{like} - Z_{dislike}$). This peer preference score was then again Z-standardized within classrooms (Coie, Dodge, & Coppotelli, 1982). The correlations of peer preference on adjacent study years were $r = .71$ and $r = .70$, p's $< .01$.

Heart rate and heart rate variability during the lab study were assessed with the VU University Ambulatory Monitoring Device (VU-AMS) for heart rate measurement (De Geus, Willemsen, Klaver & Van Doornen, 1996; www.vu-ams.nl). Heart rate and heart rate variability changes were measured continuously throughout the procedure. HR and HRV data of seven pre-defined data points were averaged and used in the analyses (see Figure 2.1); at baseline (-12 min until - 5 min; T1), anticipation (-5 min until 0 min; T2), inclusion (0 min - 7 min; T3),

ignoring (7 min - 8 min; T4), exclusion (8 min - 9 min; T5) and during the questionnaire following the stressor (9 min - 16 min; T6) and finally after recovery of the experimental procedure (38 min - 43 min; T7). The VU-AMS device collects electrocardiogram (ECG) and impediance cardiography (ICG) readings to assess heart rate (De Geus & Van Doornen, 1996). The device has repeatedly been used to test heart rate and heart rate variability among children and adolescents (e.g., Nederend et al., 2017). This device assesses thoracic impedance and ECG from a simple seven electrode configuration was assessed with the VU University Ambulatory Monitoring Device (VU-AMS) (De Geus, Willemsen, Klaver & Van Doornen, 1996). The device collects electrocardiogram (ECG) and impediance cardiography (ICG) readings to assess heart rate (De Geus & Van Doornen, 1996). VU-AMS data were imported into the VU-AMS5fs software to create a visual representation of cardiac data, to manually correct for missing data (DeGeus & Van Doornen, 1996). Artefacts longer than 5 seconds or more than 10% percent of the whole registration period were discarded (Sijtsema et al., 2013). Heart rate (HR) was based on the average heart rate in beats per minutes (bpm) across the four measurement points. Heart rate variability (HRV) was based on the average standard deviation of interbeat-intervals measured in milliseconds (SDNN) across the four measurement points. This indicator is a widely used short-term indicator of heart rate variability and has been shown to index parasympathetic rather than sympathetic nervous system functioning (Munoz et al., 2015). Heart rate of the ECG was averaged across all valid beats by the first author.

Cortisol and α-amylase levels during the lab study were extracted from saliva. In total, seven saliva samples were collected during the procedure (see Figure 2.1). Saliva was sampled with Salivette sampling devices (Sarsted, Rommelsdorf, Germany). Saliva was firstly sampled after filling in the questionnaires, on average 12 minutes (-12; S1) before the stressor, representing the baseline before starting the experimental procedure (M = 2.94 p.m., SD = 1.01). The second saliva sample was collected on average 5 minutes (-5; S2) before the stressor,

representing the period of VU-AMS attachment/start procedure (*M* = 3.07 p.m. *SD* = 1.02). The third saliva sample was collected after anticipation of the stressor, immediately before the stressor (0 min; S3), representing the period of first questionnaire completion (*M* = 3.09 p.m. *SD* = 1.03). The cortisol and α-amylase response time of individuals may vary widely (Young et al. 2004). Thus, several saliva samples were collected after the stressor: the fourth saliva sample was collected 16 minutes (S4) after the start of the stressor (*M* = 3.29 p.m. *SD* = 1.06), the fifth 23 minutes (*M* = 3.50 p.m. *SD* = 1.02; S5), the sixth 33 minutes (*M* = 3.77 p.m. *SD* = 0.99; S6), and the seventh 43 minutes after the start of the stressor (*M* = 3.91 p.m. *SD* = 1.00; S7). Saliva samples were stored at −20°C for preservation until analysis and collectively send to the laboratory (Kirschbaum Laboratory in Dresden, Germany) for analysis. A time-resolved fluorescence immunoassay was implemented to determine the cortisol and α-amylase concentration in the samples. Intra- and interassay coefficients of variation were below 7% (Saridjan et al., 2014). A-priory, it was decided that outliers of 3 SDs of the mean on cortisol measures would be deleted in order to rule out possible influence of outliers by contamination or by non-reported medication use. No cases were removed by virtue of this criterion.

Manipulation check

Perceived Stress (PS; Lesage & Berjot, 2011) during the lab study was measured on a 10-point scale at baseline, prior to the stressor, after the stressor, and during recovery (see Figure 2.1). Children were asked to rate their level of distress, and perceived heart rate. Participants were asked "How stressed do you feel?" and "How fast does your heart beat?". The correlation between the two items was r = 0.68. The scale has good sensitivity for acutely distressing events and significant relationships with heart rate (Lesage & Berjot, 2011).

Participants' ratings of evoked stress by the stressor were assessed with open questions during the debriefing phase when children were asked whether, and what part exactly of the stressor was stressful for them. Participants were asked "What did you think about the

conversation with the other two children?" and "Did you find it stressful a) to present, b) to get acquainted with new peers, and c) when the two other children stopped listening?". The participants were further asked to elaborate on what they found stressful during these phases of the procedure.

Control variables physiological stress response

The Pubertal Developmental Scale *(*PDS, Petersen et al., 1988) was used to assess pubertal status with five self-assessment questions on physical growth, pubic hair, skin changes, voice changes and beard growth. Answers were provided on a four-point Likert scale (1: has not started yet, 2: just started, 3: surely started, 4: is completed). Pubertal status is distinguished into five groups based on sum scores of items on body hair growth, facial hair growth and voice change: 1 Pre-Pubertal (3 points), 2 Early Puberty (4-5 points), 3 Mid-Pubertal (6-8 points), 4 Advanced Pubertal (9-11 points) (Petersen et al., 1988). Cronbach's alpha was 0.72.

Participants' self-reported levels of daily stress were assessed using the Maastricht Stress Questionnaire (MSL), assessing physical and psychological stress symptoms in daily life (Kraag et al., 2008). Psychological (e.g., "I find it hard to calm down") and physiological (e.g., "I have a stomach ache") stress symptoms were measured with ten items each. Answers were given on a 5-point Likert scale. Cronbach's alpha for the questionnaire (both scales combined) was 0.76. The scale has good sensitivity for acutely distressing events and significant relationships with heart rate (Lesage & Berjot, 2011).

Waking time and sleep duration, dairy/caffeine intake, medication use, allergies, acute infections were assessed with a questionnaire designed for this experiment and was filled in after the stressor during the experiment. Items assessed *waking time* (time to indicate*), sleep duration* (time to indicate), *dairy intake in the last 24 hours* (yes/no), *caffeine intake in the last 24 hours* (yes/no), *medication use* (yes/no, follow up question on medication type), *allergies* (yes/no), *acute infections* (yes/no, open question on symptoms).

Family Socioeconomic Status (SES) was assessed through parental occupation using the Dutch Working Population Classifications of Occupations Scheme (Statistics Netherlands, 2001). The highest occupation level (from father or mother) was considered to reflect household SES (Kalff et al., 2001). Low SES was defined as being unemployed of having an elementary job or less (for example being a cleaner) (Statistics Netherlands 2010). Household SES was dummy coded as 0 = medium to higher level, 1= unemployed to lower level SES.

Age was assessed with a demographic questionnaire.

Control variable social preference

Psychosocial problems were measured with the Strength and Difficulties Questionnaire (SDQ; Goodman et al., 1997), which was completed by a parent of the participant at the day of the lab study. This questionnaire is a brief 25 item behavioral screening instrument for 3-16-year-old children (Goodman et al., 1997). Questions are answered on a 5-point visually aided Likert scale ranging from 1 [*not true at all*] to 5 [*very true*]). The SDQ is comprised of 5 sub-scales (emotional problems, conduct problem, hyperactivity, peer problems, prosocial behavior), and a total problems score (sum of subscales except prosocial). This SDQ total problems score was used. The SDQ total problems score showed good reliability with Cronbach's Alpha of 0.84.

Statistical Analyses

We tested our hypotheses using repeated measures analyses of variance (RM-ANVA). Four repeated measures ANOVAs were fitted, one for each outcome (HR, HRV, α-amylase and cortisol). The seven data points for HR and HRV and α-amylase and cortisol as depicted in Figure 2.1 (see also measures) were used. Peer status (high versus low peer preferences) was added as a between subject effect in the RM-ANOVAS. Main effect of time (manipulation check) and time*peer status effects (main study hypotheses) were tested. The control variables were included in the main analysis. In addition to testing for main effect of time (manipulation check) on the main outcome variables, manipulation check was further assessed on self-reports on perceived stress and ratings of

evoked stress by the stressor. IBM SPSS Statistics version 25 was used for analyses. In all analyses, Greenhouse-Geisser statistics are reported when necessary to correct departures from sphericity. Results with a *p*-level of < 0.05 were reported as significant.

Results

Descriptive Statistics

Descriptive statistics of the demographics and confounding factors of stress reactivity are depicted in Table 2.1. Low peer preferred children had higher scores on parent reported psychosocial problems.

Table 2.1 Descriptives of Potential Confounding Factors Stress Reactivity for Low and High Peer Preferred Boys

	Low peer preferred (n = 20)		High peer preferred (n = 33)		Test	
	M	*SD*	*M*	*SD*	*t (df)*	*p*
Age	10.97	.76	10.99	.78	.56 (51)	.76
Waking time	7.12	.45	7.40	.56	1.80 (51)	.08
Sleep duration	9.20	1.16	9.55	1.16	1.56 (51)	.13
MSL	1.95	.29	1.87	.29	-.88 (51)	.38
SDQ	2.25	4.1	1.81	.32	-.39 (51)	.00
					X^2 *(df)*	*p*
Pubertal Status	1.72	.89	1.55	.90	1.94 (51)	.74

	%	%		
Low SES	17	12	.15 (51)	.69
Dairy intake	55	65	.54 (51)	.59
Caffeine intake	0	9		.17
			1.37(51)	
Medication use	25	15	.88	.38
Allergies	40	18	1.83	.07
Acute infections	15	10	.39	.69

Manipulation Check

Results of repeated-measures ANOVA showed a significant main effect of time for HR $F(6, 312) = 43.63$, $p = 0.01$ and HRV $F(6, 312) = 11.83$, $p = 0.01$ (Table 2.2), and of α-amylase $F(6, 312) = 2.17$, $p = 0.04$ and cortisol $F(6, 312) = 3.06$, $p = 0.01$ (Table 2.3) and on self-rated perceived stress (VAS scales) $F(3,156) = 4.83$, $p = 0.01$. Perceived stress was significantly higher after the stress test in comparison with anticipation, $F(3,156) = 8.68$, $p = 0.01$ and recovery, $F(3,156) = 3.29$, $p = 0.04$. This pattern of perceived stress was similar for low and high peer preferred children $F_{\text{time*peer status}}(3,156) = 0.77$, $p = 0.48$. Subjective ratings of evoked stress by the stressor were similar for low and high peer preferred children $F(1,52) = 5.79$, $p = 0.64$. Results of manipulation check showed that 86 % of the participants reported that they experienced the exclusion by the confederates as stressful, 72% of the participants reported that they experienced presenting themselves to unknown peers as stressful, while 63% reported getting acquainted with new peers as stressful. These patterns were similar for low and high preferred children.

Table 2.2. Means, Standard Deviations and Test of Time and Time*Peer Status Differences for Heart Rate and Heart Rate Variability for Low and High Peer Preferred Boys

	HR				HRV			
	Low preferred		High preferred		Low preferred		High preferred	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
T1	79.27	8.79	79.52	7.26	78.52	27.54	65.83	15.59
T2	87.02	8.42	89.15	9.08	91.69	25.22	71.61	21.97
T3	81.68	9.10	83.81	8.15	**89.62**	30.96	**74.10**	21.99
T4	81.58	9.11	84.33	8.53	**80.57**	28.45	**68.37**	20.41
T5	81.68	9.10	85.81	8.15	**84.07**	33.93	**64.79**	20.58
T6	80.90	8.64	80.90	8.64	91.02	30.42	83.72	19.80
T7	79.50	8.70	79.27	6.70	85.39	35.39	81.76	28.45

	Test			Test		
	F	*df*	*P*	*F*	*df*	*p*
Time	43.63	6(312)	.01	11.83	6(312)	.01
Time*peer status	1.04	6(312)	.38	4.65	6(312)	.01

Note. Bold entries within HR or HRV represent significant differences between low and high preferred boys.

Table 2.3. Means, Standard Deviations and Test of Time and Time*Peer Status Differences for Cortisol and α-amylase for Low and High Peer Preferred Boys

	Cortisol (n/mol)				α-amylase (n/mol)			
	Low preferred		High preferred		Low preferred		High preferred	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
S1	2.23	1.82	2.40	2.20	202.05	152.63	162.86	98.73
S2	1.95	1.16	2.68	2.74	165.27	113.12	145.63	92.41
S3	1.76	1.95	2.36	2.12	157.86	107.99	135.84	79.72

S4	**1.67**	1.77	**3.03**	5.02	212.19	140.87	187.47	131.3
S5	**1.59**	1.72	**2.38**	2.09	177.63	102.80	152.81	98.50
S6	1.39	1.61	1.80	1.33	181.30	110.46	161.09	90.27
S7	1.37	1.61	1.89	2.63	177.71	103.21	161.55	76.57

	Test			Test		
	F	*df*	*P*	*F*	*df*	*p*
Time	3.06	6(312)	.01	2.17	6(312)	.04
Time*peer status	2.92	6(312)	.02	9.00	6(312)	.97

Note. Bold entries within cortisol and α-amylase represent significant differences between low and high preferred boy

History of Peer Preference and ANS and HPA-axis Responses to Psychosocial Stressor

For HRV and cortisol, between-group differences over time were found. Results during task-preparation and the interpersonal stress task showed increased HRV levels in low compared to high peer preferred children ($F_{\text{time*peer status}}$ (6, 312) = 4.65, p = 0.01). Planned simple contrasts showed that this effect was significant on all three time points between inclusion (t0-7), ignoring (t7-8), and exclusion (t8-9) (all P values < 0.05, Table 2.2, Figure 2.3). Results during task-preparation and the stress task showed decreased cortisol levels in low compared to high peer preferred children ($F_{\text{time*peer status}}$ (6, 312) = 2.92, p = 0.02). Planned simple contrasts showed that this effect was significant on two time points at 16 and at 23 minutes (all P values < 0.05, Table 2.3, Figure 2.5). Results of time*peer status repeated measures ANOVAs showed no significant differences for HR (Table 2.2, Figure 2.2) and α-amylase (Table 2.3, Figure 2.4) between high/low preferred children.

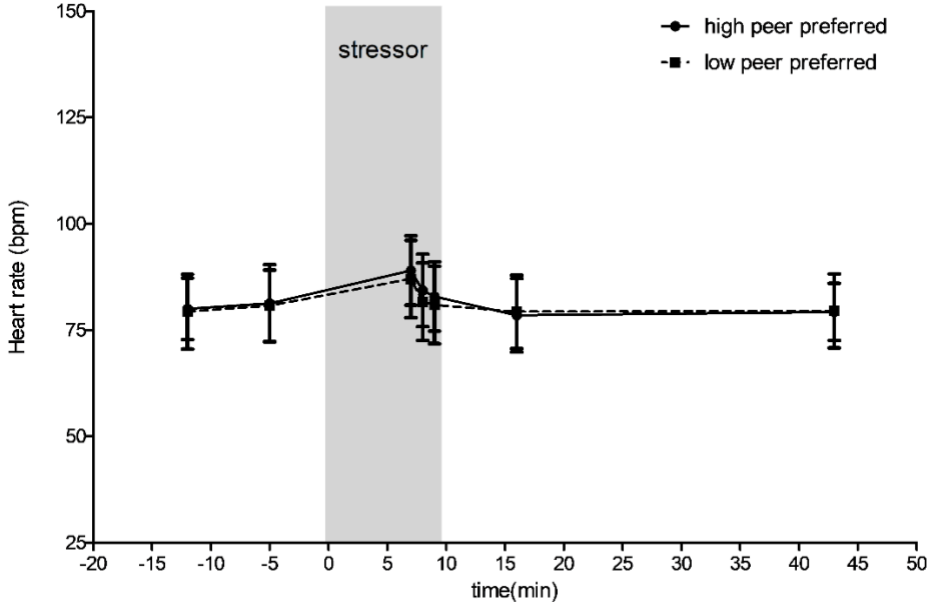

Figure 2.2. Mean (±SEM) heart rate response to the psychosocial stressor for high and low peer preferred boys (N = 53).

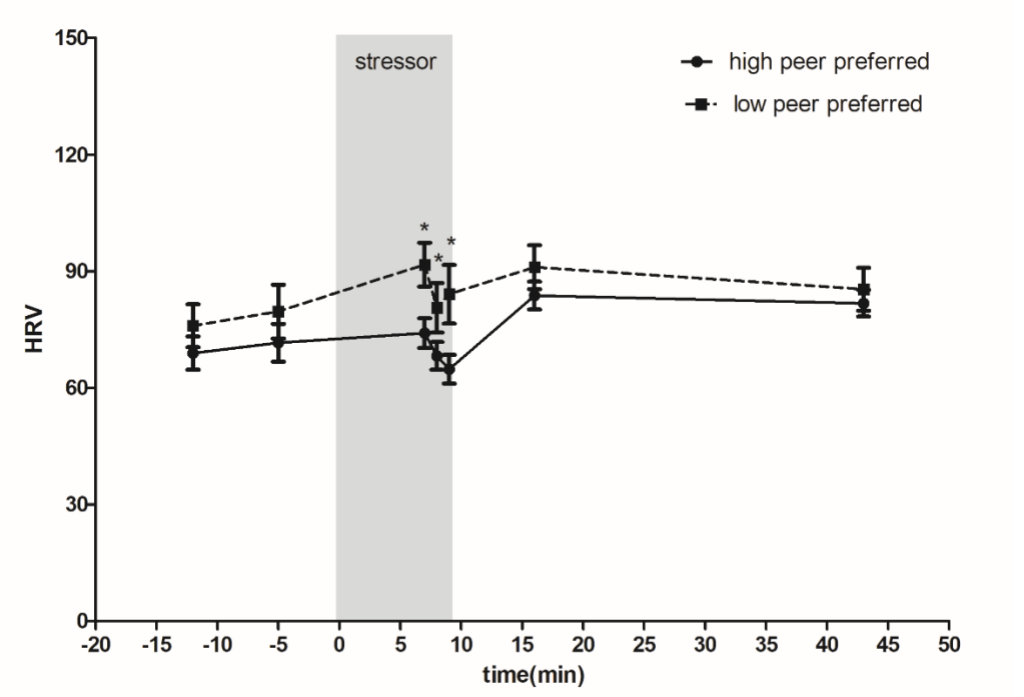

Figure 2.3. Mean (±SEM) heart rate variability response to the psychosocial stressor for high and low peer preferred boys (N = 53). * = difference significant at $p < .05$

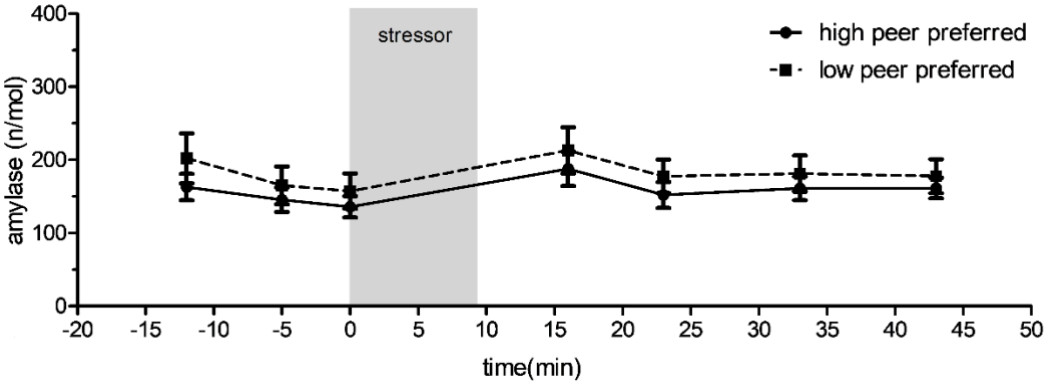

Figure 2.4. Mean (± SEM) α-amylase responses to the psychosocial stressor of high and low peer preferred boys (*N* = 53). Pre-S = pre=stressor, Post-S= post-stressor

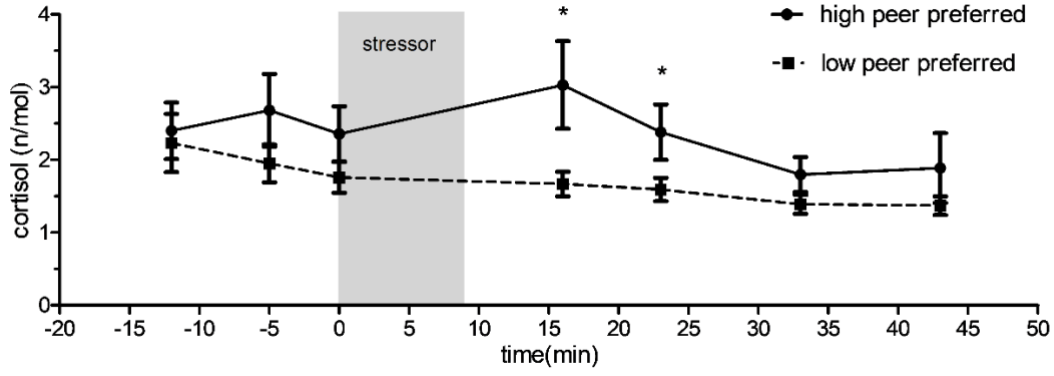

Figure 2.5. Mean (± SEM) cortisol responses to the psychosocial stressor of high and low peer preferred boys (N = 53). Pre-S = pre=stressor, Post-S= post-stressor
* = difference significant at $p < .05$

Discussion

This study examined whether a history of chronic high versus low peer preference, was associated with altered ANS and HPA-axis responses to a psychosocial stressor among elementary school boys. We found that heart rate variability and cortisol responses, but not heart rate and α-amylase responses, differed between children with a history of low versus high peer preference. The results of this study thus suggest that already in the elementary school period, adverse social experiences like low peer preference get "under the skin" by affecting the ANS and HPA-axis responses of children when faced with a social stress task.

As expected, low peer preferred boys, compared to high peer preferred children, showed lower secretions of cortisol following the stress task. In fact, low peer preferred children showed no increases in cortisol in response to the stressor. The results might suggest blunting of HPA-axis responses among low peer preferred children. This down-regulation, or blunting of the stress-system may be important to protect the body from prolonged exposure to physiological stress output and related health problems (Miller et al., 2007). In addition, low peer preferred children had higher levels of heart rate variability during the stressor. This suggests that PNS activity remains high during a challenging task, thereby limiting the possibility of the SNS to increase after arousal, for instance by increasing HR. This lack of arousal suggests blunting of the ANS. Based on Miller's (2007) theory on downregulation of the stress system, this reduced stress response to acute psychosocial stress after experiencing prolonged low peer preference might be physiologically adaptive. A possible alternative explanation could be that low preferred children did not show the expected cortisol response as the stressor might not be as threatening as social exclusion they experience on a daily basis in the peer context. Being excluded and rejected by peers represents an experience that low preferred children are most probably used to, thus they might habituate to these experiences by showing reduced stress responses to acute rejection. Nevertheless, this possible difference regarding perceived stress between low and high peer

preferred children was not mirrored by differences in affective responses to the stressor. Thus, assessed group differences regarding physiological stress responses may not be mediated by perceptions of increased stressor intensity but that at similar level of stressor intensity, low preferred children show decreased physiological responses. Future studies should further include affective measures such as video taping of facial expressions, which might be less prone to self-reporting bias and might substantiate group influences on affective and physiological responses (Stroud et al., 2009).

Although reduced ANS and HPA-axis responses of low peer preferred boys might be physiologically adaptive, these boys may not be able to respond behavioural and emotional adaptively to interpersonal challenges, based on their prior negative experiences in the peer context (Stenseng et al., 2015). Results may signal a psychobiological risk pathway towards developing internalizing and externalizing symptoms. For instance, blunted ANS and HPA-axis responses are suggested to indicate fearlessness and sensation seeking, which might subsequently become related to engaging in externalizing behaviors (Raine, 2002). Heightened sensation seeking behavior further leads individuals to try to seek out a state of normalized physiological arousal by seeking out stimulation (Goeders, 2003). As a consequence, low peer preferred boys might further be vulnerable to affiliate with deviant peers and to develop behavioral problems. Likewise, flattened cortisol responses and reduced as well as increased heart rate variability responses to a psychosocial stressor have previously been associated with internalizing and externalizing symptoms in children (Laurent et al., 2016; Ouellet-Morin, 2011; Sijtsema et al., 2013).

Our results showed no significant group differences in heart rate or α-amylase responses. These findings could be due to the small sample size. Alternatively, the findings might suggest that elementary school peer context stress is mostly associated with the PNS (heart rate variability) but not to the SNS (α-amylase). These results therefore may suggest that the PNS and SNS respond differently among low peer preferred children (Berntson et al., 1991; Hajcak et al., 2003). This

activation pattern of the ANS has earlier been related to PTSD symptoms in adults, in which high heart rate variability but no significant reduction in heart rate at rest was found (Hopper et al., 2006; Sack et al., 2004).

Our results extended previous studies in three important ways. First, previous studies mostly assessed individual differences in stress responses to psychosocial stressors during adolescence. During full blown puberty, stress responses are affected by maturation (Gandia et al., 1990). We assessed chronic peer preference and associated stress responses in elementary school and in pre/early-pubertal states. Our results thus provide tentative support for an adjustment, or downregulation of the psychobiological regulation of stress among low peer preferred boys still attending primary education. Second, in line with earlier studies, our results suggest that chronic peer problems are linked to reduced rather than heightened stress responses (Blackhart et al., 2007; Gunnar et al., 2003; Knack et al., 2011; Ouellet-Morin et al., 2013; Vaillancourt et al., 2011) and increased heart rate variability (Newman, 2014; Stroud et al., 2009) and showed this already in childhood. Opposed to our results, one earlier study focusing on peer problems and stress reactivity to a speaking task found heightened cortisol responses to the stressor in children (Chen et al., 2018). Differences in the period of assessment of peer problems may explain this. Chen et al. (2018) assessed victimization experiences during one semester, whereas in our study peer appraisal was assessed during 3 years of elementary school. Our results thus suggest that particularly chronic exposure to low peer preference might result in downregulation of stress responses to acute social stressors, and that this is visible already in childhood. Third, previous studies often focused on either ANS or HPA-axis responses to interpersonal stress. We assessed indicators of both systems simultaneously and found effects of the stressor on both HPA-axis and ANS functioning. These results might imply that low peer appraisal represents a strong social stressor that impacts both major stress systems as early as during childhood.

Overall, our results suggest that exposure to elementary school low peer preference in every-day classrooms may be considered a severe

stressor. Our findings suggest changes of biopsychological processes in children experiencing chronic low peer preference (see in this regard also (Vaillancourt, Hymel, & McDougall, 2013). In addition to this, earlier studies showed that chronic peer problems were related to more activation in brain regions related to emotion regulation in response to a social exclusion experience in experimental settings (e.g. Moor et al., 2012; Will et al., 2016; Asscheman et al., 2019). Collectively, our and these studies highlight the detrimental effect of exposure to low peer preference and suggest that in children from the general population, such experience may become embodied in the psychophysiology of these children, already at pre-pubertal ages.

Limitations

A limitation of the study is the small sample size, which might explain our null findings regarding group differences of heart rate and amylase reactivity. Due to the small sample size, longitudinal analysis based on the three consecutive waves to establish more insights regarding prolonged poor peer acceptance were not possible, we had to rely on average scores of three waves. Thus, our findings regarding prolonged poor preference need to be interpreted with caution. Future studies should repeat this current study with a bigger sample size to establish the full nature of stress reactivity related to prolonged poor classroom peer acceptance. A further potential limitation is the characteristics of the assessed sample of elementary school children in the overarching longitudinal study. The children who participated in the current lab-study consisted mostly of white children from urban parts of the Netherlands with relatively few children of low SES families. It needs to be assessed whether our findings extend to more heterogeneous populations. Furthermore, we only tested boys for this study. It is possible that girls with low peer preferences show different stress responses following a psychosocial stressor as girls are often less sensitive to social status differences (Rudolph, 2002). However, due to practical reasons it was not possible to assess a similar large group of girls to test for possible sex-differences. There was a time gap of two years between the previous

annual waves of peer preference assessment and the lab study. Due to this time gap, it is not clear when stress reactivity adapts in response to individual differences in peer status. More frequent assessments of stress reactivity in response to a psychosocial stressor over a longer time period are needed to establish more insights on after how long the stress system is downregulated following peer rejection.

Due to limitations in the frequency of collecting saliva samples, the timing of collecting saliva was set to optimize measuring cortisol responses. However, α-amylase responses are faster than cortisol responses with α-amylase responses usually peaking after ten minutes after a stressor, while cortisol responses peak after 15-20 minutes (Granger et al., 2007; Stroud et al., 2009). For instance, we collected saliva 16 minutes after the start of the stressor. It is possible that our procedure was less sensitive to capture α-amylase responses. However, our results suggest that cortisol and α-amylase peaked at the same time point at 6 and 23 minutes after the start of the stressor (see Figure 2.4 and 2.5). In addition, both cortisol and α-amylase responses vary among children. It is therefore not possible to specifically pinpoint the cortisol and α-amylase responses to the specific time periods of the psychosocial stressor (inclusion, ignoring, exclusion), as could be done for heart rate (variability). Finally, this study assumed a direction of effects of low peer preference affecting ANS and HPA axis responses. Physiological stress responses are likely to be influenced by peer processes, but this relationship probably unfolds in a bidirectional manner (Granger et al., 2012). Future longitudinal studies are needed to understand the possible bidirectional nature between stress reactivity and poor classroom peer acceptance.

Conclusion

The present study showed that children who are poorly preferred among their elementary classroom peers may become, at the physiological level, less reactive to social challenges than high preferred children. This could be indicative of a hyposensitivity or hypovigilance to social challenges. Thus, the findings of the current study emphasize that teachers, school

psychologists and clinicians should, in addition to the more deliberate peer victimization, be aware of the impact that the passive process of low peer preference may have on primary school children, for instance by monitoring classroom peer rejection. In many countries, including the Netherlands, there is legislation ensuing schools to actively prevent and react on bullying. The findings of the current study imply such anti-bullying strategies at schools should not merely focus on extinguishing the bullying behavior, but should also focus on low peer preference. Apart from school or classroom level interventions, poorly preferred children may need training in improving their social interactions with peers. For instance, biofeedback training and emotion regulation strategy training could be used to help these children to develop adaptive stress responses to interpersonal challenges. This can help these children in regulating their future interactions with peers towards more positive peer interactions.

PART 2

The Role of the context in the link between school social stressors, (perceived) stress system activity and subsequent anxiety symptoms

Chapter 4.

Peer acceptance in elementary school is related to diurnal cortisol levels: influence of teacher-student relationship

Submitted for publication as: Behnsen, P., Buil, J. M., Huizink, A., Lier, P. Peer preference in elementary school related to diurnal cortisol levels: teacher-student relationships make a difference.

Abstract

The aim of the current study was to assess warmth in the teacher-student relationship as a moderator in the association of peer acceptance among classroom peers and daytime HPA axis activity in 282 early elementary school children (56% boys, M = 6.97 years). Saliva samples were collected on four occasions on a Saturday, from which the Cortisol Awakening Response (CAR), diurnal cortisol concentration (AUC_g) and diurnal cortisol slope were calculated. Poorly accepted children had elevated CAR, heightened AUC_g and a reduced diurnal cortisol slope. Moderation analyses showed that AUC_g was highest when peer acceptance was low, while simultaneously teacher-student relationship warmth was high. This indicates that negative and discrepant social experiences at school may be stressful for children.

Introduction

Elementary school children, as do all humans, have a fundamental need to belong to a group (Baumeister & Leary, 1995). Violations of this fundamental need to belong may be the result of classroom exclusion (Williams, 2007). Indeed, peer exclusion has been referred to as a hurtful social experience, which children perceive as highly stressful (Williams, 2001; 2007), and is associated with long lasting effects on children's healthy development (Guyer et al., 2018). Socially excluded children may be mostly low accepted in a social context, such as the classroom (Coie et al., 1990), which might represent a subtle but very potent stressful experience in the peer context. Yet, little is known about the association of peer exclusion stress in early elementary school and the physiological stress system in children. A few earlier studies found that classroom peer exclusion in elementary school children affect Hypothalamic-Pituitary-Adrenal (HPA) axis activity (Behnsen et al., 2018; Gunnar et al., 2003; Peters et al., 2011). However, in elementary school classrooms, children have, in addition to their relationships with the broader peer group, a relationship with the teacher. The quality of the

relationship with the teacher has also been implicated with (un)healthy child outcomes (Huber et al., 2012; Spilt et al., 2014; Wang et al., 2013), with a poor teacher-student relationship having adverse (Sabol & Pianta, 2012) and a positive teacher-student relationship having beneficial (Badanes et al., 2012; Sabol & Pianta, 2012 Yeung & Leadbeater, 2010) effects of children's health. A positive, warm, teacher-student relationship might protect children against the potential negative consequences of peer exclusion (Huber et al., 2012; Spilt et al., 2014; Wang et al., 2013). Therefore, the goal of the current study is to assess the role of the teacher-student relationship in the prospective association between low peer acceptance among classroom peers and daytime HPA axis activity in children attending mainstream elementary schools.

The Hypothalamic-Pituitary-Adrenal (HPA) axis is one of the stress systems (Cohen et al., 2007). One of the hormones produced of this stress-system is the hormone cortisol. Activation of the HPA axis is essentially an adaptive mechanism that enables the human body to maintain physiological stability in response to general stress signals. Prolonged elevations of cortisol levels, however, may indicate a maladaptive stress (re)activity. It could signal a failure to terminate the neuroendocrine stress response which may result in depletion of stress hormones needed for adaptive stress responses (Sapolsky, 2000). Thus, heightened cortisol levels can eventually prevent successful stress responses to daily (social) stressors.

Cortisol levels follow a diurnal curve, which increases directly after awakening (Cortisol Awakening Response, CAR), typically followed by a decrease thereafter across the day. Individual differences in diurnal cortisol patterns are assessed through the CAR, the diurnal cortisol slope, which represents change of cortisol concentration from morning until evening, and the daytime cortisol curve (AUC_g), which represents an estimation of the total cortisol output during the day (Saxbe, 2008). Heightened CAR, AUC and a flatter slope may be indicative of elevated cortisol levels during the day, may suggest heightened physiological stress and may knife of adaptive stress (re)activity. Dysregulated HPA axis activity, expressed as heightened or

lowered diurnal cortisol levels (cortisol slope, AUC_g and CAR), have been linked to memory problems, attention problems, less coping capacities and negative effects on socioemotional and behavioral development in elementary school children (Flynn & Rudolph, 2007; Heffelfinger & Newcomer, 2001; Ruttle et al., 2011; Smider et al., 2002).

Previous research in the current sample of 282 early elementary school children (56% boys, *M* = 6.97 years) found that elementary school children who are poorly accepted by their peers in the classroom show an increased CAR, a slower decrease in cortisol, and overall higher cortisol levels across the day on a weekend day (Behnsen et al., 2018). Another study was conducted among elementary school children in which socially excluded children showed heightened cortisol levels at school compared to included children (Peters et al., 2011). Collectively, these studies suggest that poor peer relationships within elementary school classrooms may indeed index strong social stressors for affected children that are manifested in increased cortisol output of children. For the current sample we tested cortisol patterns in the weekend as previous studies suggested that peer exclusion is associated with increased cortisol output during a school day and even during a weekend day.

It is important to note that the classroom landscape may also provide opportunities for social support for children who are poorly accepted by classmates. Indeed, in line with social support theories (Adams, Santo & Bukowski, 2011; Lakey & Cohen, 2000; Spilt et al., 2014; Yeung & Leadbeater, 2010), having a positive, warm relationship with the teacher can offer emotional support for poorly accepted children, and provide them with a sense of belonging. Teachers are an important attachment figure for elementary school children (Verschueren & Koomen, 2012). Previous studies have shown that a supportive teacher-student relationship may help children to regulate stress originating from adverse (social) contexts (Badanes et al., 2012; Sabol & Pianta, 2012). For example, receiving high levels of support by teachers buffered children who experienced peer difficulties from developing

maladjustment problems (Huber et al., 2012; Spilt et al., 2014; Wang et al., 2013; Yeung & Leadbeater, 2010).

It is important to note, however, that a warm relationship with the teacher may not always benefit at-risk children. First, having a warm relationship with teachers but at the same time having troublesome relations with peers indicates a quite a discrepancy in classroom relationships for the child. Such a discrepancy has been linked with psychological distress. For example, it has been found that in adults a discrepancy in social support (e.g. feeling supported in one social context but not in another) contributes to psychological distress (Cho et al., 2012). Moreover, some evidence suggests that if a warm teacher-child relationship develops into teacher dependence, this may also no benefit the child. Indeed, it was found that if children who face difficulty in social interactions (shyness) have dependent relationships with teachers, these children are at risk of socio-emotional difficulties (Arbeau et al., 2010; also discussed in Sabol & Pianta, 2012).

To our knowledge, no previous empirical studies focused on role of the teacher-student relationship in the association between peer stressors and HPA output among elementary school children. However, it was found that children in classrooms characterized by non-supportive, low quality teacher-child interactions showed – in line with previous results found for low peer acceptance - heightened cortisol patterns (Ahnert et al., 2012; Lisonbee et al., 2008). Moreover, Peters et al., (2012) found buffering by friendships in the relations between poor peer experiences and cortisol levels. This suggests that also for cortisol output, the effect of peer social stressor can be nullified by protective social agents in the classroom. Whether this also holds for the teacher-child warmth is unknown.

The goal of this study is to examine whether having a supportive teacher-student relationship in the classroom moderated the association of low peer acceptance with diurnal levels of cortisol. In line with the social support theory (Adams, Santo & Bukowski, 2011; Lakey & Cohen, 2000; Spilt et al., 2014; Yeung & Leadbeater, 2010), we expected that the association between low peer acceptance and heightened daily

cortisol levels was stronger for children who experience lower warmth in their relationship with the teacher. All related associations were assessed in 282 early elementary school children (56% boys, *M* = 6.97 years). When studying this link, we included age, sex, emotional and behavioral problems and classroom friendships as control variables as previous studies found main or moderation effects of these variables with peer acceptance or with cortisol output in children (e.g. Alink et al., 2008; Blackhart et al., 2007; Boivin, et al., 1995; Bruce et al., 2002; Hodges & Perry, 1999; Kirschbaum, Wust, & Hellhammer, 1992; Peters et al., 2011; Rudolph et al., 2010; Saridjan et al., 2014; Solberg & Olweus, 2003; Strough & Covatto, 2002).

Methods

Sample

The participants of this study were part of the "Happy Children, Happy Adolescents?" research project, a classroom-based study on the impact of social experiences on behavioral-, emotional-, and academic- and cognitive development of children (*N* = 1624 children in *N* = 61 classrooms, participation rate 90%). Only children of whom we had complete family contact information, and whose primary caregiver was actively involved in the study in 2013 (*N* = 657) were approached for collecting saliva for cortisol extraction. A total of 282 participants provided valid cortisol samples for the current study, of which 56.6 % were boys and 89.1% had an average or high socioeconomic status (see Behnsen et al. 2018 for the detailed procedure). Collecting the saliva data was done across a one-year period (2013-2014) when children had a mean age of 6.97 years, *SD* = 0.99 years, range = 5 to 9 years old. Children who were not included in the current study did not differ in peer acceptance (*t* (273) = 0.87, *p* = 0.39), or perceived warmth of the teacher-student relationship (*t* (213) = -0.73, *p* = 0.47) from children who were excluded. Children who were included in the study were on average younger *M* = 6.97 (*SD* = .99; range 5 to 9 years old) than children who

were excluded (M = 7.14; SD =0.86; range 6 to 9 years old) from the current study (t (272) = -3.36, $p < 0.001$).

Procedures

Questionnaires and peer nominations assessing (among others) school social experiences, and teacher-student relationship were completed by teachers and children in schools. Children were seated in exam setting when completing the measures. Children were supervised by trained interviewers. Saliva samples for cortisol data were obtained at home by the children with help of their parents and were collected during one day between spring of 2013 and the fall of 2014. We collected diurnal cortisol levels at home on a Saturday. Earlier studies suggest that heightened cortisol levels in the weekend may result from less effective recovery from stress experienced during the week (Berset et al., 2009). Therefore, concentrations in samples taken on a Saturday may indicate levels of stress during the preceding week.

Measures

Cortisol levels were measured in saliva collected with four saliva collection tubes by mean of passive drool (Donzella et al., 2008). Detailed written instructions were sent to the participants, including visual instructions explaining children and their parents how and when to collect the saliva, and how to preserve the tubes. Participants were instructed to provide the first sample directly at awakening (Cortisol 1), the second sample 30 minutes afterwards (Cortisol 2), the third at 12 p.m. (Cortisol 3) and the fourth at 8 p.m. (Cortisol 4). The average time of the first sample collection was 7.07 a.m. with a margin of 45 minutes. Parents were called prior to the cortisol collection day to remind them to assist their children with cortisol collection at the specific time points. Parents were instructed to help their children with refraining from brushing their teeth, physical activity, leaving their bed and eating before the first and second cortisol collection time point at 7.00 and 7.30, respectively. They were further asked to not eat directly before collecting

saliva at any point and to only drink water directly before the cortisol collection. Parents were instructed to store the cortisol tubes in their freezer before returning them by prepaid mail envelopes. They were asked to send the samples on a weekday and not on a Friday to avoid samples being out of the freezer for more than two days. After receiving the samples, the cortisol tubes were stored at -20°C. After completion of the data collection, samples were sent on dry ice in one batch to the laboratory of the Department of Biological Psychology, Technical University of Dresden, Germany for analysis. Salivary cortisol concentrations were measured using a commercial immunoassay with chemiluminescence detection (CLIA; Hamburg, Germany). Cortisol data of 13 samples was not usable due to possible contamination or insufficient data (Behnsen et al., 2018).

We computed three variables of the separate cortisol measures within a day: the cortisol awakening response (CAR), the area under the curve with respect to the ground (AUC_g), and the diurnal cortisol slope. The CAR was computed by subtracting Cortisol 1 from Cortisol 2 (Wust et al., 2000). The AUC_g was calculated as the total area under the curve between the four time points (Saxbe, 2008). The AUC_g represents the total cortisol secretion during the day. The last cortisol time point measurement was regressed on the first cortisol time point measurement, which predicted the diurnal cortisol slope (Saridjan, 2014). The second cortisol sample was not included in this measurement to avoid effects of the CAR. Flatter slopes, as indexed by less negative betas, imply a slower cortisol decline during the day.

Peer acceptance was assessed using peer nominations. All children completed the peer nomination procedure in the spring of 2013 and in 2014 in their classroom. Children were presented a list of names of their classmates and were asked to nominate an unlimited number of peers in the classroom who they liked (peer acceptance) (Coie et al., 1990). Children could not nominate themselves. To account for differences in class size, the sum scores of peer acceptance were divided by the number of participating children in the classroom minus one, because self-nomination was not possible.

Warmth in teacher-student relationship was assessed in the spring of 2013 and in 2014 with the translated questionnaire Young Children's Appraisal of Teacher Support (Y-CATS; Spilt, Koomen & Mantzicopoulos, 2010) to rate the quality of the teacher-student relationship from the perspective of the student. The subscale on warmth was used which consisted of 11 items (e.g., my teacher says nice things about my work). Every item has two answer possibilities, true and not true, corresponding with the score 0 and 1. Cronbachs alpha's was 0.64 for 2013, which corresponds to values reported by Spilt et al. (2010).

Control variables

Number of friends was assessed in the spring of 2013 and in 2014 by asking children who their best three best friends are (Bukowski, Hoza, & Boivin, 1994). Reciprocated (mutual) friendship nominations were used and defined as classmates who nominated each other among their three best friends in the classroom.

Emotional problems and behavioral problems were assessed by parents in 2013 and in 2014 using the subscale emotional problems and behavioral problems of the Strengths and Difficulties Questionnaire (SDQ; Goodman & Scott, 1999). Parents were asked to score items on a 5-point scale, ranging from not true (0) to definitely true (4). The emotional problems subscale consists of 5 items, including "scared a lot". The behavioral problems scale consists of 5 items, including "often has anger outbursts". Cronbach's alphas were 0.62 for emotional problems, and 0.50 for behavioral problems, which was similar to other studies (Goodman, 2000).

Sex of children was dummy coded with 0 = girls and 1 = boys.

Calendar age of the children was used to control for children's chronological age in years.

All independent variables were z-standardized for the main analyses to improve interpretability of the intercepts and to avoid multicollinearity in the moderation analysis.

Statistical Analysis

A model containing all cortisol outcomes (CAR, AUC_g, cortisol slope) simultaneously was fitted, in which main effects of peer acceptance and teacher-student relationship warmth were tested. In the second step, the interaction effect of peer acceptance x teacher-child warmth was added to the model. The direction of the moderation effect was assessed by probing the interaction term, by assessing the effect of peer acceptance for high (1 *SD* above the mean) and low (1 *SD* below the mean) values of teacher-student relationship warmth (Holmbeck, 2002). Paths estimates were controlled for all control variables. Mplus version 7 (Muthen & Muthen, 2016) was used for fitting the nested regression models. Standard errors were adjusted for clustering of data at the school level using a sandwich estimator (Williams, 2000). Results with a two-sided *p*-level of < 0.05 were reported as significant.

Results

Descriptive Statistics

Descriptive statistics and correlations of the variables are depicted in Table 3.1. There was a significant negative correlation between peer acceptance and CAR ($r = -0.18$, $p < 0.01$), AUC_g ($r = -0.20$, $p < 0.01$) and slope ($r = -0.03$, $p < 0.05$). There was no correlation between peer acceptance and warmth in the teacher-student relationship.

Table 3.1. Descriptives and Correlations

Variables	Mean	SD	Range	1.	2.	3.	4.	5.	6.	7.	8.
CAR	0.94	1.37	-2.28-9.02	-							
AUCg	3.33	0.21	2.72-3.97	.54**	-						
Slope	-5.43	3.77	-14.9-17.8	.34**	.40**	-					
Age	6.97	0.99	5.00-10.00	-.70	-.01	-.03	-				
Beh.Pr	1.94	0.86	1.00-5.00	.06	-.01	-.09	-.06	-			
Em.Pr.	1.79	0.69	1.00-5.00	.01	-.01	-.08	-.06	.23**	-		
PeerA.	0.35	0.18	0.03-0.78	-.18**	-.20**	-.03*	.01	-.08	-.13*	-	
Friend.	1.18	0.91	0.00-3.00	.03	.06	.04	-.02	-.12	-.06	.35*	-
Warm.	9.52	1.39	0.00-11.00	.02	.06	.02	.07	-.09	-.05	.02	.02

Note. *$p < .05$. **$p < .01$. Raw scores are described for all descriptives, z-scores were used for all analyses. Beh.Pr. = Behavior problems, Em.Pr. = Emotional problems, PeerA. = Peer acceptance, Friend. = Reciprocal friendships, Warm. = Warmth in teacher-student relationship.

Peer acceptance, teacher-student relationship and cortisol levels

Our hypotheses were tested using a series of nested model analyses. CAR, AUC_g and diurnal cortisol slope served as outcome variables and were simultaneously included in the model. Models containing main effects, and two-way interaction terms of peer acceptance and warmth in teacher-student relationship were analyzed. Results are depicted in Table 3.2.

The results in step 1 (main effects) show a negative main effect of peer acceptance on the CAR (*B* = -0.17, *SE* = 0.09, β = -0.13, *p* = 0.05), AUC_g (*B* = -0.19, *SE* = 0.08, β = -0.17, *p* = 0.02) and the cortisol slope (*B* = -0.13, *SE* = 0.05, β = -0.12, *p* = 0.02). Overall, these results showed that children with a lower acceptance among peers show a higher total cortisol output throughout the day. There were no significant main effects of warmth in the teacher-student relationship on the CAR, AUC_g or the slope (see Table 3.2).

In the second step the interaction term between peer acceptance and teacher-student relationship warmth was added to the model. The results showed a significant interaction effect between peer acceptance and teacher-student relationship warmth in predicting the AUC_g (*B* = -0.17, *SE* = 0.06, β = -0.16, *p* = 0.01). No significant interaction effects of peer acceptance and teacher-student relationship warmth on the CAR or the slope were found (see Table 3.2).

Table 3.2. Associations Between Peer Acceptance, Warmth in Teacher-Student Relationship and Cortisol Measures

	CAR			AUCg			Slope		
	B (se)	*Beta*	*p*	*B (se)*	*Beta*	*p*	*B (se)*	*Beta*	*p*
Step 1									
Age	-0.08 (0.08)	-.06	.35	-0.13 (0.07)	-.12	.05	-0.01 (0.05)	-.01	.90
Sex	0.03 (0.08)	.02	.74	0.04 (0.07)	.03	.59	0.04 (0.08)	.03	.63
Behav. problems	0.13 (0.11)	.09	.24	0.06 (0.08)	.05	.39	0.13 (0.08)	.12	.13
Emot. problems	-0.05 (0.07)	-.03	.49	-0.09 (0.07)	-.08	.15	-0.12 (0.05)	-.11	.01
Friends	0.02 (0.04)	.01	.67	0.02 (0.04)	.02	.58	0.03 (0.02)	.02	.09
Peer	-0.17	-.13	.05	-0.19 (0.8)	-.17	.02	-0.13 (0.05)	-.12	.02

Acceptance	(0.09)								
Warmth	0.03	.02	.75	0.06	.05	.34	0.03 (0.15)	.02	.65
	(0.09)			(0.07)					
R^2	.03			.06			.04		
Step 2									
Age	-0.07	-.05	.40	-0.12	-.11	.07	-0.00 (0.05)	-.00	.95
	(0.05)			(0.07)					
Sex	0.04	.03	.64	0.05	.04	.45	0.04 (0.08)	.03	.62
	(0.03)			(0.07)					
Behav.	0.14	.10	.24	0.09	.08	.25	0.13 (0.09)	.12	.15
problems	(0.12)			(0.08)					
Emot. problems	-0.05	-.03	.49	-0.09	-.09	.13	-0.12 (0.05)	-.11	.01
	(0.07)			(0.07)					
Friends	0.01	.01	.84	0.00	.00	.98	0.04 (0.02)	.03	.06
	(0.04)			(0.05)					
Peer	-0.16	-.12	.05	-0.18	-.17	.01	-0.13 (0.50)	-.12	.02

Acceptance	(0.08)			(0.07)					
Warmth	0.03	.02	.73	0.07	.06	.25	.03 (0.16)	.02	.68
	(0.09)			(0.06)					
PeerAcc*	-0.10	-.08	.28	-0.17	-.16	.01	-0.01 (0.05)	-.00	.90
Warmth	(0.09)			(0.06)					
R^2	.04			.09			.04		

Note. Behav.Problems = Behavior problems, Emot.Problems = Emotional problems, PeerAcc. = Peer acceptance, Friends = Reciprocal friendships, Warmth = Warmth in teacher-student relationship

The interaction term of warmth in teacher-student relationship in the prediction of the AUC_g was probed (Figure 3.1) by evaluating the effect of peer acceptance for high (1 *SD* above the mean) and low (1 *SD* below the mean) values of teacher- student relationship warmth. Results showed that with higher levels of teacher-student relationship warmth, the association between peer acceptance and AUC_g was significant. Specifically, results showed that at higher levels of teacher-student relationship warmth, lower levels of acceptance predicted higher levels of cortisol (AUC_g) (*B* = -0.36, *SE* = 0.11, β = -0.36, *p* = 0.00). At lower levels of teacher-student relationship warmth, the association between peer acceptance and cortisol output was not-significant (*B* = -0.03, *SE* = 0.08, β = -0.03, *p* = 0.73) (see Figure 3.1). As can be seen in Figure 3.1, children who were highly accepted among peers and who simultaneously experienced a warm teacher-student relationship showed the lowest levels of AUC_g, while children who were poorly accepted among peers and who had a warm relationship with their teacher had the highest level of AUC_g. Children with a less warm relationship with teachers showed an intermittent level of AUC_g, which was equal for low and high peer acceptance

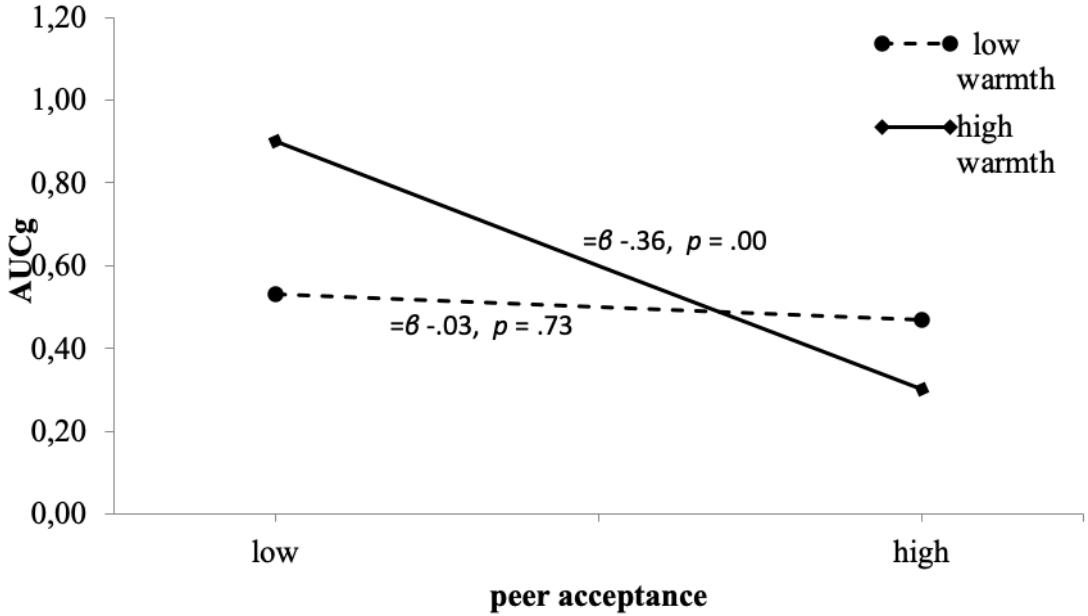

Figure 3.1. Interaction effect peer acceptance x warmth teacher- student relationship predicting AUCg.

Internal replication of the interaction results

Peer acceptance and warm teacher-student relationship scores were also assessed in 2014 and our results were replicated with this data. The correlation between peer acceptance across the measurements was r = 0.41, $p < 0.01$. The correlation between warmth across the measurements was r = 0.28, $p < 0.01$. The results showed a significant interaction effect between peer acceptance and teacher-student relationship warmth in predicting the AUCg (B = -0.16, SE = 0.07, β = -0.15, p = 0.02). Probing of the interaction term showed replication of our previous results. At higher levels of teacher-student relationship warmth, lower levels of acceptance predicted higher levels of cortisol (AUC_g) (B = -0.33, SE = 0.09, β = -0.32, p = 0.00).

Discussion

In the current study we assessed the influence of peer acceptance and warmth in the teacher-student relationship on diurnal cortisol levels among elementary school children on a Saturday. We found that low peer acceptance was related to higher CAR, higher AUC_g and a reduced cortisol slope (Behnsen et al., 2018), which was in line with earlier findings on children's social relationships with peers and cortisol output (Peters et al., 2011). Furthermore, the results of the current study showed that warmth in the teacher-student relationship influenced the association between peer acceptance and the AUC_g. That is, total cortisol levels (AUC_g) were highest when peer acceptance was low while these children simultaneously experienced a warm teacher-student relationship. The AUC_g was lowest when both peer acceptance and teacher-child warmth were high. With low teacher-child warmth, peer acceptance was unrelated to AUC_g. Against our expectations, warmth in the teacher-student relationship did not buffer against the negative effects of low peer acceptance on cortisol levels in children in the current sample. These results were replicated with data from 2014, when children had other teachers and possibly further peers and thus other relationships in the classroom setting. Thus, the internal replication showed the stability

of our results. Consequently, our results did not support the social support theory, which has been proposed by previous authors (Lakey & Cohen, 2000).

Our findings suggest that dealing with low peer acceptance in the face of receiving positive attention from the teacher is particularly stressful. These findings are not line with most earlier studies, which showed that a warm teacher-student relationship buffered the detrimental effects of stressful social experiences on internalizing symptoms (Spilt et al., 2014) and externalizing problems (Huber et al., 2012; Wang et al., 2013). However, it has previously been suggested that (very) warm and close teacher-student relationships might be related to socio-emotional difficulties, such as teacher-rated child anxiety in shy children (Arbeau et al., 2010; Sabol & Pianta, 2012). Thus, our results might support earlier suggestions that a positive relationship with the teacher might not always play a protective role (Arbeau et al., 2010; Sabol & Pianta, 2012). We firstly assessed the influence of peer acceptance and warmth in the teacher-student relationship on diurnal cortisol levels.

Peters et al.'s (2011) research group found that the number of friends buffered the association between peer exclusion and daily cortisol levels already in childhood. However, we controlled for a possible effect of friendships and did not find a significant effect.

It is possible that in general teachers might suspect that children are poorly accepted by peers and may try to compensate these negative experiences by trying to foster a warm teacher-student relationship. As a consequence, low accepted children might perceive the received social support from teachers as being due to their failure to develop satisfying relationships with the broader peer group (Bolger et al., 2000), thereby aggravating the impact of poor peer acceptance. This hypothesis is in line with earlier suggestions, very close teacher-student relationships might further restrict children's opportunities for social interaction with other children (Birch & Ladd, 1997; Arbeau et al., 2010; Hamre & Pianta, 2001). For example, Bolger et al. (2000) suggested that receiving social support can make feelings of incompetence and emotional problems more pronounced. This is further supported by the finding that children

who receive more attention from teachers can be viewed by other peers as strange or as the 'teacher's pet' (Arbeau et al., 2010; Hamre & Pianta, 2001), potentially resulting in distress in the affected child. This distress, in turn, might be expressed in heightened cortisol levels in poorly accepted children. However, it needs to be further assessed whether teachers indeed typically notice poorly accepted children's peer status, thus provided support and whether they perceived the teacher- student relationship as warm or dependent. Poor peer acceptance might also predict poor teacher acceptance (Hughes & Chen, 2011). Overall, teacher reports of peer status and the teacher-student relationship as well as poorly accepted children's reports of distress in the classroom are needed.

Additionally, it is possible that our results represent a pronounced need for social support among low accepted children, as the amount of support received and the need for support are often confounded (Lakey & Cohen, 2000). For example, earlier results indicated that a large discrepancy between the needed and received social support was related to heightened depressive symptoms in college students (Rankin et al., 2018). Similar to these earlier findings, the perceived received support by teachers might be less than low accepted children need. Consequently, heightened daily cortisol levels among low accepted children with self-reported warm teacher-student relationships might indicate need for help. More information on the actual desired social and emotional support among low preferred children is crucial to assess the impact of the discrepancy between desired and provided support. Regardless of the underlying process, our and others' results might indicate that warmth in the teacher-student relationship may not always be beneficial to the child in the face of negative social experiences with peers (Arbeau et al., 2010; Sabol & Pianta, 2012).

Limitations and implications

This study has several limitations. First, this study was based on cortisol measured in the weekend. Although increased cortisol levels in the weekend signal emotional problems (Behnsen et al., 2018), we don't

know to which extent our results are generalizable to weekdays. It might further be important to collect cortisol during weekdays. This would make it possible to examine the relative supportive effects of teachers on cortisol levels within the school context. However, our results might suggest that effects of classroom social stressors might still be present during a day that the child is not in the school context. Second, we only assessed children's report of perceived warmth by the teacher. It is important to assess children's need for social support in the classroom-setting to further explore the associated impact on heightened cortisol levels. Third, we had no information on social support received by other authority figures (such as parents) during the day of cortisol assessment. It is possible that other adults play an important role in offering (or denying) social support to the children in our sample in their daily lives. Our reported moderation effects might be different for other authority figures such as parents and other caretakers. The effect of related additional social support should be assessed in future studies.

Conclusion

Our research findings emphasize that having a warm teacher-student relationship might not unambiguously represent a social buffer in a classroom where a child is confronted with low peer appraisal. Future research should focus on examining sources of effective social support for children who are poorly accepted. Overall, our findings suggest that both consistency and discrepancy in acceptance and warmth received in the classroom are important predictors of HPA-axis functioning. The results have several implications for the classroom. Early intervention and prevention studies are needed to further explicate these results. In terms of early intervention, training programs for teachers could focus on fostering teachers' awareness of the possible impacts of low peer preference and teacher-student relationships on physiological stress levels. For example, recent investigations examined relationship-focused reflection programs on teacher sensitivity, teachers were more sensitive in targeting teaching techniques to individual needs of their students after participating in the intervention (Spilt et al., 2012). In this regard, it is

important that teachers not (only) aim to develop a warm, supporting relationship with a child that is poorly accepted as means to compensate for this poor acceptance, but specifically focus on helping these children with building positive relationships with peers. While implementing related reflection programs in the future, teachers should be encouraged to discuss students' needs in the face of low peer preference in the classroom.

Chapter 5 – classroom stress, perceived stress, anxiety

Chapter 5.

The Potential Moderating Role of Living in a Conflict Area on the link between Poor Relations with Peers and Teachers, Perceived Stress and Change in Anxiety Symptoms in Israeli School Children

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Chapter 5 – classroom stress, perceived stress, anxiety

Abstract

Perceived stress associated with relational victimization from peers and conflictual relations with the teacher has been linked with the development of anxiety symptoms in children. Living in conditions of ongoing stress from the broader environment has also been related to anxiety symptoms in children. In this study, we examined a) the indirect effect between classroom psychosocial stressors (i.e., relational victimization and conflictual relationships with teachers), perceived stress and anxiety symptom development, and b) whether this indirect effect was stronger for children living in a high threat region than for children living in a lower threat region.

Children participating in the study attended elementary school either in a high threat of armed conflict region (15 seconds to hide in bomb shelter when alarm sounds, n = 220) or in a lower threat of armed conflict region (60 seconds to hide in a bomb shelter when alarm sounds, n = 188) in Israel. Children were first assessed on conflictual relationships with teachers and peers, subjectively perceived stress and anxiety in 2017 (T_0; M age = 10.61 years, SD = 0.78; 45% boys) and re-assessed (T_1) one year later, in 2018. Perceived stress mediated the association between classroom psychosocial stressors and anxiety development. No moderation by threat-region was found in this indirect effect. However, the association between perceived stress and anxiety development was only significant for children in the high threat region. Our study suggests that threat of war conflict amplifies the association between perceived stress and the development of anxiety symptoms.

Introduction

Anxiety in children may develop from a complex set of risk factors. While anxiety is one of the most pervasive and common mental disorders, risk factors for the development of anxiety are understudied. There is strong evidence that exposure to environmental stressors and psychosocial stressors early in life can influence the development of

anxiety (Racine et al., 2021). We will focus on classroom psychosocial stressors in Israeli children who live in armed conflict zones, which has been linked to the development of anxiety symptoms (Evans & English, 2002; Hammen, 2005; Kar, 2009; Slattery et al., 2012).

One important psychosocial risk factor for anxiety in childhood are negative relationships with teachers and classroom peers. These psychosocial stressors within the classroom environment constitute important childhood risk factors for the development of perceived stress as well as subsequent anxiety problems (van der Wal et al., 2003; Veenstra et al., 2005; Wang & Fletcher, 2017). Furthermore, particularly self-reported perceived stress has been associated with increased anxiety symptoms in European and US American childhood samples (Dieleman et al., 2015; Monk et al., 2001; Pittig et al., 2013) and also in Israeli adolescents (Dimitry, 2012). This may indicate that the association between psychosocial classroom stressors and the development of anxiety symptoms is partially explained via children's subjectively perceived stress levels.

Another important psychosocial risk factor for anxiety is stress derived from the living environment, particularly the (threat of) being exposed to conflict and violence (Bar-Haim et al., 2010; Dubow et al., 2012). The effects of psychosocial risk factors in the classroom, the conflictual nature of relationships with peers and teachers, on the development of anxiety via perceived stress might be amplified in the context of conflict and threat (Cohen & Eid, 2007). Therefore, the first aim of this study was to test whether social stressors at school (i.e. conflictual relationships with teachers and peers) are associated with Israeli children's levels of perceived stress, and – in turn – with the development of anxiety symptoms. Our second aim was to examine whether the indirect association between relational victimization and conflictual relationships with the teacher, perceived stress and anxiety development was stronger for children growing up in a high threat (of armed conflict) region, compared to children growing up in a lower threat region of Israel.

Allostatic load- stressors across multiple contexts

The cumulative burden of chronic stressors, such as ongoing political conflict, is referred to as allostatic load. Ideally, individuals with high allostatic load show higher levels of self-rated perceived stress (Tomba & Offidani, 2012), indicating that subjectively perceived stress levels might be a marker of allostatic load. Furthermore, high allostatic load is associated with poorer mental health among children and adolescents (Evans & English, 2002). Thus, children who experience a combination of psychosocial stressors at school (conflictual relationships) as well as environmental stressors (living in a threat region) might experience a higher allostatic load (perceived stress) and therefore an increased risk of developing anxiety problems.

The influence of negative classroom social experiences on anxiety symptoms

An important psychosocial factor to investigate is the classroom, in which children spend a lot of time during the day. Childhood relational peer victimization comprises deliberate and repeated behaviour intended to actively exclude a child from social activities, or to threaten or damage a victim's relationship with peers (Crick & Bigbee, 1998). Furthermore, a conflictual teacher-child relationship refers to a pattern of negativity, and lack of support of the teacher to the child and is distressing for children (Hatfield & Williford, 2017). Conflictual relationships in the classroom have been linked to perceived stress (Wang& Fletcher, 2017). In turn, perceived stress has been associated with higher levels of anxiety symptoms in European and US American childhood samples (Dieleman et al., 2015; Monk et al., 2001) and also in Israeli adolescents (Dimitry, 2012).

The influence of Gaza vicinity on the indirect association between classroom psychosocial stressors, perceived stress and anxiety

Another important contextual factor to consider is the living environment, particularly the exposure to conflict and violence. Children growing up in the Gaza vicinity experience frequent alarm soundings,

sometimes multiple times per day (Cohen & Eid, 2007; Doeland, 2012) and have only 15 seconds to seek shelter (Lahav et al., 2019). Children living in area's further away from the Gaza strip may be incidentally exposed to rocket alarms and have longer period (e.g., one minute or more) to seek shelter (Besser & Neria, 2012). People living in geographical closeness to the Gaza strip are at risk of suffering death or injury due to the rocket attacks, experience a lack of control or symptoms of post-traumatic stress disorder (Bar-Haim et al., 2010; Barber and Schluterman, 2009; Cohen & Eid, 2007; Doeland, 2012; Dubow et al., 2012; Israeli Ministry of Foreign Affairs, 2015).

The link between children's perceived stress associated with psychosocial stressors within the classroom context and the development of anxiety symptoms might be more amplified among children living in the Gaza vicinity compared to children living further away from the Gaza strip. This because being exposed to classroom psychosocial stressors in combination with being exposed to a stressful living environment would likely result in more allostatic load, as expressed by children's subjectively perceived stress. Related results would emphasize that teachers and school counselors should be particularly aware of the effects of exposure to school social stressors, perceived stress and anxiety in children in conflict regions.

The aim of the current study

Our first aim was to test whether psychosocial stressors in children's classroom environment (i.e., relational victimization and conflictual relationships with teachers) were associated with changes in anxiety symptoms one year later, via perceived stress. Our second aim, on moderation by threat-region, was to test whether the association between relational victimization/conflictual teacher-child relationships, perceived stress and anxiety symptoms was stronger for children living in the high threat region than for children living in the lower threat region. To this end, children (aged 9-11 years at first assessment)

attending mainstream elementary schools in Israel were followed across one school year.

Methods

Sample

Data were collected in seven mainstream elementary schools in Israel. Of the total sample of 530 children, *n* = 269 children of four schools (18 classrooms) were living in a midsized city in the direct vicinity of Gaza (Sderot; 15 seconds to bomb shelter when alarm sounds, high threat region), and *n* = 261 children of three schools (21 classrooms) were living in a midsized city (Be'er Sheva; 60 seconds region; lower threat region). Children were first assessed in 2017 (T_0; grades 4-5, *M* age = 10.61 years, *SD* =0.78 years; 45% boys) and re-assessed in 2018 (T_1; grades 5-6, *M* age = 11.12 years, *SD* =0.96 years). In the seven schools that participated in this study, these schools with participating children were randomly selected out of 20 schools in total. These schools were asked to participate in the study as they are representative of the population in the regions we included in the study. Only children from Jewish schools were assessed in the current study. However, the children were representative of the general population in the addressed regions. The questionnaires were completed anonymously, in Hebrew. The questionnaires were translated into Hebrew from the original Dutch or composed in Hebrew specifically for this study.

Only children with valid data on anxiety symptoms at T_1 (main outcome variable) were included in the present study, resulting in 408 children (lower threat region *n* = 188, high threat region *n* = 220). Non-included children did not differ from included children on gender and age, or on T_0 scores of anxiety, perceived stress, relational victimization of conflictual teacher-child relationship (all *p*'s > .05). However, excluded children were more likely to come from the lower threat region when compared to the high threat region; $\chi^2(1) = 15.507$, $p < 0.001$.

Procedure

Ethical approval was obtained from the Israeli Ministry of Education's ethic committee as well as from the Helsinki committee of Soroka medical centre in Israel. Parents of participants provided written informed consent after procedures were fully explained. Self- and teacher-reported data were collected during a school day at school at both waves.

Measures

Anxiety symptoms were reported by the teacher and assessed with the Problem Behavior At School Interview (PBSI) (Erasmus MC, 2000). The PBSI is a 42-item instrument that assesses internalizing and externalizing symptoms in children as perceived by teachers. The 5-item anxiety scale was used, items included "This child is nervous or tense". Teachers rated children on a 5-point Likert scale, ranging from 0 [*never*] to 4 [*often*]. Sum scores were used. Cronbach's Alpha was 0.84 at T_0 and 0.79 at T_1. Student's anxiety measured with the PBSI was associated with other outcomes such as peer rejection, self-concept and teacher-child interaction in previous published studies (e.g. Breeman et al., 2015). The PBSI has been shown to have adequate convergent validity, and sensitivity to change was demonstrated in a preventive intervention study (Spilt et al., 2013).

Perceived Stress was assessed with the Maastricht Stress Questionnaire, which is a self-report questionnaire measuring physical and psychological stress symptoms experienced during the past week (Kraag et al., 2009). The 10-item psychological scale was used, items included general perceived stress items "I find it hard to calm down". One item of the scale refers to stress in the classroom "How often do you have the feeling that the other children in the classroom are too much for you?". Children rated on a 4-point Likert scale, ranging from 0 [*never*] to 3 [*often*]. Sum scores were used. Cronbach's alpha was 0.89 at T_0 and 0.76 at T_1. Perceived stress measured with the Maastricht Stress

Questionnaires was previously associated with other measures such as stress awareness (Kraag et al., 2009).

Psychosocial stressor relational victimization was assessed with the Social Experiences Questionnaire Self-Report (SEQ-S; Grotpeter & Crick, 1996). The 5-item relational victimization scale was used, items included "Are you excluded (e.g., from games) if a classmate is angry at you - by that angry child?". Children rated on a 5-point Likert scale, ranging from 0 [*not true*] to 4 [*very true*]. Sum scores were used. Cronbach's Alpha was 0.79 at T_0 and .76 at T_1. Relational victimization measured with the Social Experience Questionnaire was previously linked to meaningful measures such as anxiety and depressive symptoms (Dempsey & Storch, 2008; Storch, et al., 2005).

Psychosocial stressor conflictual teacher-child relationships were assessed with The Young Children's Appraisals of Teacher Support (Y-CATS; Mantzicopoulos, 2005). The Y-CATS assesses children's perceptions of the relationship with their teacher. The 10-item conflict subscale was used, items included "My teacher gets angry with me". Every item has two answer possibilities, 0 [*true*] and 1 [*not true*]. Sum scores were used. Cronbach's alpha was 0.76 at T_0 and 0.74 at T_1. Self-reports of conflictual teacher-child relationships assessed with the Young Children's Assessment on Teacher Support were previously linked to children's problem behavior (Mantzicopoulos, 2005; Spilt et al., 2010).

Environmental stress region was dummy coded with 0 = lower threat region and 1 = high threat region.

Control variables

Sex and **age** were assessed with self-report, sex was coded with 0 = female, 1 = male.

Family size was assessed by asking children how many children live in their family. Increased family size has been related to heightened perceived stress among children (Shaw et al., 1994), thus we included family size as a control variable.

Statistical analysis

Our study hypotheses were tested using autoregressive cross-lagged path models (see Figure 4.1 for the full model, including the indirect effects). We first tested whether classroom T_0 psychosocial stressors predicted anxiety development from T_0 to T_1, via T_0 perceived stress, without moderation by stress-region. In step I, we tested whether relational peer victimization and teacher-child conflict predicted relative change in the level of anxiety symptoms one year later. In step II, we added the mediator perceived stress and tested an indirect effect from T_1 relational victimization/ teacher-child conflict to change in anxiety symptom levels from T_0 to T_1, via T_0 perceived stress. Path estimates were controlled for sex, age, family size, and threat region.

Second, we tested for moderation by threat-region using multiple-group models (lower vs0 high threat region), using the Satorra-Bentler Chi Square Difference Test (Satorra & Bentler, 2001). In step III, we tested for moderation of main effects. To this end, we tested whether the paths from relational victimization/teacher-child conflict, respectively, to subsequent anxiety differed between the two groups. Next, we tested for moderation of the indirect effect. Specifically, in step IV we tested whether path estimates of T_0 relational victimization/conflictual teacher-child relationship, respectively, to T_0 perceived stress (paths A1 and A2) differed between the group. In step V, we tested whether the path estimate of T_0 perceived stress to T_1 anxiety (path B) differed between groups. Potential differences in indirect effects (step VI), were tested using the Wald test of parameter constraints (Asparouhov & Muthen, 2010). All estimates that were not part of our hypotheses (e.g., within-time residual error correlations) were freely estimated across the two groups.

All models were fitted in Mplus version 8.0 (Muthen and Muthen, 2012), using the MLR-estimator. Standard errors of path estimates were adjusted to account for clustering of data within schools using a sandwich estimator (Williams et al., 2000). Model fit was determined using the comparative fit index (CFI), root mean square error

of approximation (RMSEA) and standardized root mean squared residual (SRMR). For the CFI, values of 0.95 and higher indicate acceptable fit, and for RMSEA and SRMR, values of 0.08 and lower indicate acceptable fit (Muthen & Muthen, 2012).

Results

Descriptive Statistics

Table 4.1 shows descriptive statistics. There were 207 unique air alarm soundings in the high threat region, and no occasion of air alarm in the lower threat region across the 2017-2018 period (Central Bureau of Statistics Israel, 2020). Furthermore, children in the high threat region had significant higher scores on teacher-rated anxiety at both assessments than children in the lower threat region. No statistically significant differences between the threat regions on the other study variables were found. Correlations of study variables by threat region are in Table 4.2.

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Table 4.1. Descriptive Statistics of Sample Characteristics and Study Variables for Overall Sample, and by Threat Region

	Overall		High Threat Region		Lower Threat Region		Test	
Rocket alarms 2017-2018 (n)			207		0			
	%		%		%		X^2	*p*
Boys	48		48		49		.00	.94
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*
Age	10.61	0.78	10.70	0.93	10.53	0.62	1.39	.16
Family Size	3.02	.93	3.02	.92	3.03	.94	.10	.86
Anxiety T_0	2.78	3.38	3.15	3.56	2.19	2.85	8.71	<.01

Anxiety T_1	3.08	3.27	3.57	3.45	2.28	2.79	14.40	<.01.
Perceived Stress T_0	10.68	5.64	10.56	5.83	11.06	5.55	0.69	.41
Perceived Stress T_1	11.08	5.94	10.06	6.05	11.85	5.67	3.67	.06
Relational Victimization T_0	1.74	1.92	1.70	2.00	1.79	1.84	.31	.58
Relational Victimization T_1	1.63	1.92	1.56	1.90	1.71	1.95	.63	.43
Teacher-Child Conflict T_0	3.73	2.69	3.51	2.65	3.92	2.73	1.68	.09
Teacher-Child Conflict T_1	3.33	2.63	3.11	2.56	3.58	2.69	1.83	.06

Note. Teacher-child conflict: conflictual teacher-child relationships, T0= 2017, T1= 2018

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Table 4.2. Correlations Between Study Variables for High Threat Region (below diagonal) and Lower Threat Region (above diagonal)

	1	2	3	4	5	6	7	8
1. Anxiety T0	-	.49**	.16*	.11	.11	.09	.17*	.13
2. Anxiety T1	.59**	-	.12	.06	.07	.17*	.14	.06
3. Perceived Stress T0	.18**	.19**	-	.57**	.34**	.24**	.38**	.20**
4. Perceived Stress T1	.08	.17*	.51**	-	.26**	.35**	.21**	.35**
5. Relational Victimization T0	.22**	.19**	.35**	.16*	-	.39**	.22**	.08
6. Relational Victimization T1	.25**	.15**	.29**	.29**	.57**	-	.16*	.19**
7. Teacher-Child Conflict	.19**	.16*	.47*	.21**	.31**	.24**	-	.52**

T0								
8. Teacher-Child Conflict	.21**	.17*	.29**	.38**	.16*	.17**	.56**	-
T1								

*p <.05. **p < .01. *Note.* Teacher-child conflict: conflictual teacher-child relationships, T0= 2017, T1= 2018, high threat region n = 220, lower threat region n = 188.

Chapter 5 – classroom stress, perceived stress, anxiety

Classroom Psychosocial Stressors, Perceived Stress and Anxiety Symptoms

The main effect model (step I) showed that T_0 teacher-child conflict was directly associated with change in anxiety symptoms from T_0 to T_1 (β = 0.06, p = 0.04), but relational victimization was not (β = 0.05, p = 0.38). The indirect effect model (step II), showed significant indirect effects for both psychosocial stressors (indirect effect relational victimization β = 0.02, p = 0.02; indirect effect teacher-child conflict: β = 0.03, p = 0.03). Specifically, T_0 teacher-child conflict (β = 0.37, $p < 0.001$) and T_0 relational victimization (β = .25, $p < .001$) both predicted T_0 perceived stress (paths A1 and A2 of the indirect effect), which, in turn, predicted the development of anxiety from T_0 to T_1 (β = 0.09, p = 0.02; path B of the indirect effect). All other path estimates are in Figure 4.1. Model fit of the indirect effect model was adequate (CFI 0.935; SRMR = 0.070; RMSEA = 0.092).

Moderation by Threat Region

Multiple group models (lower vs. high threat region) were fitted to test for moderation by threat region. Results showed that, in the main effects model (step III), the paths of relational victimization T_0 to anxiety T_1 ($\Delta SB\chi^2(1) = 0.4$, p = 0.15) and from teacher-child conflict T_0 to anxiety T_1 ($\Delta SB\chi^2(1) = 1.76$, p = 0.09) did not differ between the groups. Results from moderation tests of the indirect effects model, showed that estimates of path A1 (relational victimization to perceived stress; $\Delta SB\chi^2(1) = 0.12$, p = 0.79) and path A2 (teacher-child conflict to perceived stress; $\Delta SB\chi^2(1) < 0.10$, p = .90) of the indirect path (step IV) showed no differences in path estimates for the two threat regions. However, estimates from perceived stress T_0 to anxiety T_1 (path B, step V) differed between the groups ($\Delta SB\chi^2(1) = 5.68$, p = 0.01) with a significant association for children in the high threat region (β = 0.11, p = 0.02) but not for children in the lower threat region (β = 0.05, p = 0.46). Lastly (step VI), results showed that the indirect path of relational victimization/conflictual teacher-child relationship T_0, perceived stress T_0

to anxiety T_1 did not differ between the groups ($\Delta W\chi^2(1) = .46$, $p = .74$). Estimates for all other paths can be found in Figure 4.2.

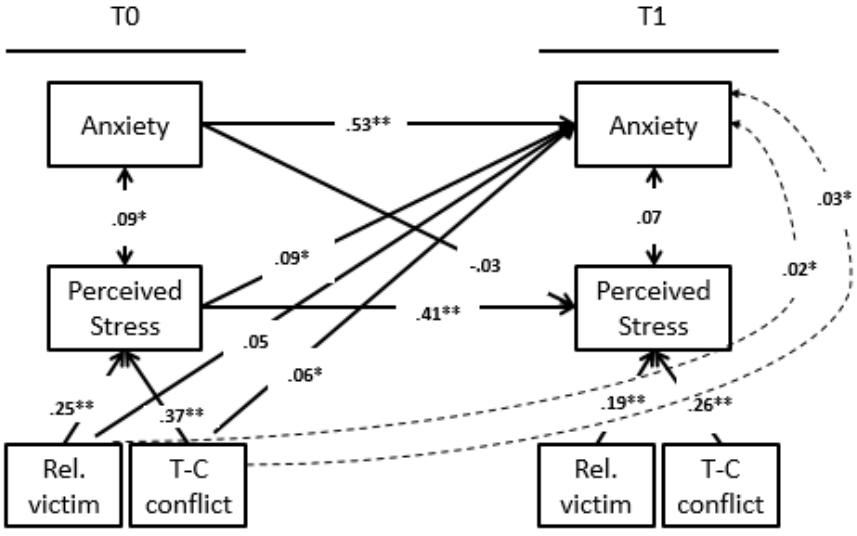

Figure 4.1. Overview of path model. Entries in single headed arrows reflect path estimates (standardized regression coefficients) across the high and lower threat region. Entries in double headed arrows reflect correlations coefficients. Entries in the dotted arrow reflect the indirect effect. Rel. victim = Relational victimization. T-C conflict = Teacher-Child Conflict, n = 408, Overall sample, CFI = 0.95, RMSEA = 0.04 and SRMR = 0.04, *p <.05, **p < .01.

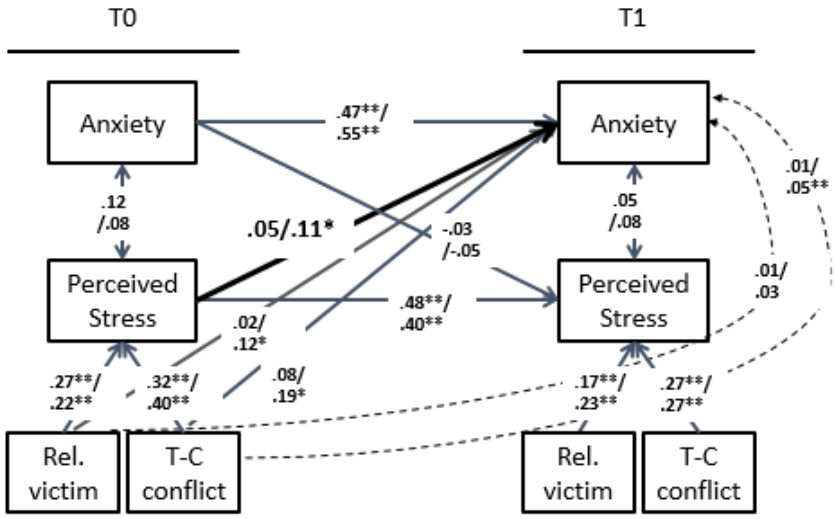

Figure 4.2. Results of path estimates in lower (upper entries) and high (lower entries) threat region. Entries in single headed arrows reflect standardized regression coefficients. Entries in double headed arrows reflect correlations coefficients. Grey entries are not significantly different between threat regions. Bold entries, of T0 perceived stress to T1 anxiety symptoms are significantly different (p =.02) between threat regions. Entries in the dotted arrow reflect the indirect effect. Rel. victim = Relational victimization. T-C conflict = Teacher-Child Conflict, high threat region n = 220, lower threat region n = 188, CFI = 0.99, RMSEA = 0.02 and SRMR = 0.03.*p <.05, **p < .01.

Chapter 5 – classroom stress, perceived stress, anxiety

Discussion

The aim of this study was to explore the possible exacerbating effect of living in a conflict environment on the link between the conflictual relationships with peers and teachers, perceived stress and anxiety symptoms in a sample of Israeli school children. Pertaining to our first aim, perceived stress mediated the association between classroom psychosocial stressors and anxiety development. Pertaining to our second aim, no moderation by threat-region was found in this indirect effect. The association between perceived stress and anxiety development was only significant for children in the high threat region.

Our findings strengthened previous research on the link between perceived stress and anxiety symptoms in children and adolescents (Dimitry, 2012; Walsh et al., 2010). Previous studies on classroom stress and anxiety development did not consider war-conflict vicinity (Dimitry, 2012; Johnsona et al., 2002; Moss, 2003; Rowe et al. 2016). We extended findings from previous studies by showing that the stress-anxiety association depended upon chronic stress exposure associated with war-conflict vicinity.

As predicted, the results showed an indirect path of relational victimization/conflictual teacher-child relationship on anxiety symptoms via perceived stress. The indirect association of relational victimization/conflictual teacher-child relationship on anxiety symptoms via perceived stress did not significantly differ between threat regions. It is possible that the differences between the threat groups in the association between perceived stress and anxiety are not strong enough to differentiate the two indirect pathways from each other. The link between perceived stress and anxiety symptoms was significant in the higher but not in the lower threat region. The moderation analysis showed a significant association for children in the high threat region but not for children in the lower threat region. In line with the cumulative risk hypothesis, perceived stress in combination with higher environmental stress constitute a risk for the development of anxiety symptoms in children in Israel.

It was also somewhat surprising to find that only mean levels of anxiety were higher in the high versus lower-risk region, but not levels of perceived stress. It is possible that anxiety levels in the high threat region were higher due to the imminent threat experienced by children living in this region. In high threat regions, chronic exposure may lead to reduced or blunted perceived and physical stress responses in order to avoid excessive stress responses and associated detrimental health problems in a context of prolonged stress (Miller et al., 2007). However, markers of physical stress responses and information on coping abilities are needed. We would like to see our results replicated in other studies examining broader environmental sources of chronic stress, such as socioeconomic status, or stressors associated with conflict situations as in the present study.

Limitations and Implications

The results of the influence of perceived stress to anxiety should be considered with caution, as effects are small in the current study. Related to the sample studied, it needs to be tested whether our results can be generalized to other conflict areas. Furthermore, we lacked information on the experiences of family stress and socioeconomic status information of our assessed families. For example, heightened perceived and physiological stress activity has been linked to lower socioeconomic status and higher levels of maternal distress (Bates et al., 2017). Higher socioeconomic status could be expected in the lower threat region compared to the high threat region, as the average socioeconomic status in the lower threat region neighborhoods was higher (Central Bureau of Statistics Israel, 2020). The measurement of anxiety symptoms with teacher report is another limitation. By using self-report and teacher report insights to address the stress-anxiety link, we tested our research questions in a multiple- informant approach design. Characteristics of teachers, such as sex and gender identity, age and teaching experiences can also possibly influence the assessed results. Unfortunately, we could not consider these characteristics because we did not have the according

information. Conflictual relationships in the classroom and the mediator of interest, perceived stress, were both self-report measures. Therefore, shared method variance could have influenced the found associations.

Overall, the findings emphasize that continuous exposure to living in high threat regions makes schoolchildren increasingly vulnerable to anxiety symptoms via perceived stress in the classroom. Our results suggest that school psychologists and counselors should be particularly aware of exposure to school social stressors in children in high threat regions. Effective school-based trauma interventions using cognitive-behavioral techniques for children and adolescents have been designed to reduce posttraumatic stress and anxiety symptoms (Jaycox, 2004; Kataoka et al., 2003; Rolfsnes and Idsoe, 2011). Our findings suggest that related school-based interventions should be implemented in schools in high-risk regions like the Gaza vicinity. Our results also suggest exploring stressors associated with the family and the broader environment when trying to understand the association of school social stressors, perceived stress and anxiety development in elementary school aged children.

Chapter 5 – classroom stress, perceived stress, anxiety

Chapter 6.

General Discussion

As of the beginning of elementary school, peer status and peer relations play an important role in children's and adolescents's social and emotional development (Bukowski et al., 2018). Relationships with peers may even have an influence on children's stress system (re)activity. However, our knowledge on individual differences in stress system activity and what role (negative) social experiences play in these individual differences is far from complete. In this regard, we lack insights into whether associations between peer environmental influences and daily cortisol levels actually exist and how children's prior peer environmental influences shape acute stress responses as limited research has been directed at this. Moreover, the possible effects of the peer environment on children's stress needs to be studied in concert with the broader social and environmental context. The purpose of this is to further our understanding of the role of the broader social and environmental context on the pathway of classroom peer social stressors, children's stress activity or perceived stress, and possible negative outcomes such as internalizing symptoms. Therefore, the overall aim of this thesis was to increase our understanding of the association between peer environmental influences in the classroom setting and stress (re)activity and the role of immediate and broader environmental contexts in this link. The overarching aims in this thesis were:

1. **To further our understanding of the role of children's peer environment on children's stress system (re)activity**
2. **To further our understanding of the role of the teacher-childhood relationships and broader environmental stress in the pathway of school social stressors, (perceived) stress/stress system activity, and possible negative outcomes such as children's anxiety symptoms**

These questions were addressed in two sections. The first section (chapter 2 and chapter 3) addressed peer environmental influences and stress (re)activity. The second section (chapter 4 and 5) examined the impact of the immediate and broader context in the link between school social stressors and (perceived) stress system activity and subsequent anxiety symptoms. In this general discussion, the answers to these research questions will be discussed, first per section and later in an

overarching discussion. Some limitations of the studies will be considered and implications for both research and practice will be presented.

Part 1: Children's peer environmental influences and the association with stress system activation

The studies in the first part of this thesis explored the association between peer environmental influences and the stress system. In **chapter two** we tested the association of early elementary school classroom peer social experiences with individual differences in diurnal cortisol concentration across a day. In **chapter three** we explored acute ANS and HPA-axis responses to a psychosocial stress task among late elementary school children who had a history of prolonged negative or positive peer experiences in the earlier years of elementary school. The studies in chapters 2 and 3 examined stable peer status influences (i.e., peer (non-)acceptance across two years (Chapter 2) and peer (non-)acceptance across three years and the response to acute peer exclusion (Chapter 3). Different assessment methods (i.e., daily HPA-axis activity measures (Chapter 2) and HPA-axis and ANS-reactivity measures (Chapter 3) were used. Several findings stand out.

In **chapter 2** we provided insights into diurnal patterns of children's HPA-axis activity levels outside of the peer environment on a weekend day. Our results revealed that low classroom peer acceptance was associated with heightened Cortisol Awakening Response (CAR), heightened daytime cortisol curve ($AUC_{g)}$ and attenuated decreases in cortisol (cortisol slope) across the weekend day. Collectively, our results suggested heightened diurnal cortisol output on a weekend day among children who had lower peer acceptance in the classroom across two years. Our results underscore the notion that chronic negative peer appraisal is associated with increases of daily HPA-axis activity, even when children are outside of their classroom peer context.

Our findings presented in **chapter 3** examined whether a history of high versus low peer preference was associated with altered ANS and HPA-axis responses to a psychosocial stress task among elementary

school boys. Boys were gradually excluded by same aged boys during a conversation in this task. We found that heart rate variability and cortisol responses, but not heart rate and α-amylase responses, differed between children with a history of low versus high peer preference. As expected, boys with a history of low peer preference, compared to boys with a history of high peer preference, showed lower secretions of cortisol following the stress task. In fact, boys with the history of low peer preference showed no increases in cortisol in response to the stress task. The results might suggest blunting of HPA-axis responses and higher levels of heart rate variability during the stressor among low peer preferred children. This activation pattern of the ANS has earlier been related to PTSD symptoms in adults. Reduced heart rate variability but no significant changes (increases or decreases) in heart rate were found among adults with PTSD symptoms (Hopper et al., 2006; Sack et al., 2004).

Overall, the results of **Chapter 2** and **Chapter 3** suggest that already in the elementary school period, adverse social experiences like low peer preference get "under the skin". Both studies emphasized that peer relationships are an important factor in the development of children's stress (re)activity. The combined results of the two studies thus suggest that already in late elementary school period, adverse social experiences like low peer preference affect the ANS and HPA-axis (re)activity of children. These findings were in line with previous studies (i.e., Peters et al., 2011). The present studies showed that children who are poorly preferred among their elementary classroom peers may become, at the physiological level, more activated on a daily level but less reactive to social challenges than high preferred children. This pattern of heightened cortisol daily levels but less reactivity shown by low preferred children could potentially be physiologically adaptive but also represent a precursor for non-adaptive behaviour for them.

The two chapters differed in the found cortisol (re)activity patterns. Negative peer appraisal during childhood was linked to upregulation (chapter 2). Moreover, negative (social) experiences during the preceding day might activate daily cortisol levels to prepare the body

based on prior day experiences (Clow et al., 2010; Adam et al., 2007). Variability in cortisol concentration is needed in order to respond flexibly to different experiences during the day (Saxbe, 2008). Thus, consistently heightened cortisol levels but reduced changes of these levels throughout the day are maladaptive. Stress responses to acute psychosocial stress after experiencing prolonged low peer preference were reduced (chapter 3). Based on Miller's (2007) theory on downregulation of the stress system, stress responses to acute psychosocial stress after experiencing prolonged low peer preference are reduced (chapter 3) in order to avoid possible negative health outcomes such as cardiovascular diseases. Thus, reduced changes of daily cortisol activity levels and less reactivity might propose similar adaptive health implications, namely to avoid negative health outcomes in the face of adverse social experiences in the peer context. Overall, the results might indicate programming of the cortisol daily rhythm based on negative peer appraisal (Meaney et al., 2007).

The cortisol (re)activity patterns that we found have similar behavioral implications.

Positive peer experiences, being liked, were linked to more normative stress (re)activity which may demote the risk for the onset of psychopathology. These findings are in line with previous literature suggesting that positive peer experiences during childhood and adolescence might promote self-regulation skills (Farley & Kim-Spoon, 2014). Adaptive self-regulation skills may allow children to make more appropriate, well-reflected and thoughtful decisions which can promote positive peer relationships and health outcomes.

In contrast, our findings of chapter 2 and 3 suggest that low peer appraisal represents a strong social stressor that impacts both major stress systems as early as during childhood. We assessed indicators of both systems simultaneously and found effects of peer stressors become embodied in both HPA-axis and ANS functioning.

Our results suggest that exposure to elementary school low peer preference in every-day classrooms may be considered a severe social stressor. Chronic low peer preference might alter stress system activity

and emotions circuits in response to social stressors. As a response to social stressors, stress system activity is suggested to be downregulated and children under chronic stress mature earlier (Callaghan & Tottenham, 2016). This physical developmental "preparation" for expected new stressors seemingly comes at costs.

Altered stress system in low peer accepted children is likely linked to less well- developed self-regulation and behavioral problems. Reduced changes of daily cortisol levels after experiencing peer stressors in the classroom (chapter 2) as well as reduced cortisol and heart rate variability reactivity in response to a new peer stressor (chapter 3) may be indicative of such maladaptive emotion regulation strategies. Reduced self-regulation and reduced flexibility might be linked to a lack of social skills essential for coping with challenges in various psychosocial contexts. As a consequence, the impact of (accumulative) social stress on stress system activity can be detrimental for adaptive development of social and behavioral skills necessary for social interactions in the classroom.

Reduced social and behavioral skills could potentially hinder adaptive self-regulation needed to aid children in restoring social connections. Similarly, heightened daily cortisol levels and blunted ANS and HPA-axis responses have been linked to subsequent externalizing behaviors (Goeders, 2003; Ouellet-Morin, 2011; Laurent et al., 2016; Raine, 2002) and internalizing symptoms (Greaves-Lord et al., 2007; Feder et al., 2004; Hartman et al., 2013; Sijtsema et al., 2013). Thus, the findings of the two chapters suggest that low peer preferred children may show altered stress system activity and consequently may not be able to respond behaviorally and emotionally adaptive to interpersonal challenges (Stenseng et al., 2015). Overall, these results suggest that children with positive peer experiences follow a healthy, adaptive stress (re)activity functioning, while children with negative peer experiences seem to follow a trajectory that could further hamper their healthy emotional and behavioral development. By following children for a prolonged time, measuring their stress reactivity and also their emotional

and behavioral development, it is possible to further assess the impact of negative peer experiences.

Part 2: The teacher-childhood relationships and environmental threat context play a role in the link between school social stressors, (perceived) stress system activation and subsequent anxiety symptoms

The social context in which children grow up in, guide the course of the development of stress (re)activity. Therefore, it is important to consider the mutual exchange between individual children and their social context (Boyce, 1998). The studies in Chapter 2 & 3 focused on one aspect of the social context in which children grow up, namely their relationships and interactions with peers. However, the environmental context is broader than relationships and interactions with peers. Therefore, in part two of the thesis, the potential impact of negative peer experiences in the classroom, stress activity and subsequent internalizing symptoms as well as the role of the immediate classroom and broader environmental context were further examined.

In the second part of the thesis, we examined the role of risk and protective factors in the broader classroom social environment and how the broader environment may affect the link between school social stressors, perceived stress or stress system activation, and subsequent anxiety symptoms. Specifically, we studied risk and protective factors stemming from two levels of possible influence. First, we took the perspective of the broader classroom ecology by studying how the teacher-child relationships affected the link between peer social stressors and stress system activity. However, apart from the immediate school environment, the environment in which children live may have cumulative or interactive effects on children's development of stress (re)activity and emotional development. Therefore, we also took the perspective of studying children's stress in classrooms across groups of children differing in their exposure to broader environmental stressors. To that end, we studied high or low levels of teacher support in the classroom setting, and stress from the broader environment as potential

buffering or aggravating factors in children's stress experiences and in the pathway to psychopathology symptoms.

In **Chapter 4** we explored whether warmth in the teacher-student relationship moderates the association of (lower) peer acceptance among classroom peers with daytime cortisol levels. The results of the study in Chapter 4 showed that experiencing a warm teacher-student relationship influenced the association between peer acceptance and the AUC_g. However, against our expectations and not in line with previous studies, warmth in the teacher-student relationship did not buffer against the negative effects of low peer acceptance on cortisol levels in children in the current sample. Specifically, total cortisol levels (AUC_g) were highest when peer acceptance was low while these children simultaneously experienced a warm teacher-student relationship. The AUC_g was lowest when both peer acceptance and teacher-child warmth were high, which was expected. Warm and close teacher-student relationships might be related to socio-emotional difficulties in poorly preferred children due to the experienced discrepancy in social support in the classroom. Thus, our results might support earlier suggestions that a positive relationship with the teacher does not always play a protective role (Arbeau et al., 2010; Sabol & Pianta, 2012), and may depend upon how peers in the classroom appreciate the child.

Chapter 5 further dove into the role of the broader context on the link between peer relations, (perceived) stress activity and internalizing symptoms. In this study, we studied children in their classroom in two areas in Israel. Children living in these two areas differ in the extent to which they are exposed to air alarms following rocket attacks, with some living in the Gaza vicinity and being exposed to frequent air alarms, with others living in an area with low exposure to air alarms/rocket attacks. We examined the moderating effect of living in an area with high versus lower threat of rocket attacks on the association between perceived stress, originating from classroom social stressors, and the development of anxiety symptoms in children across a one-year interval.

Our findings confirmed that the association between perceived stress, originating from social school stressors, and anxiety symptoms

was modified by the stress originating from the broader environment region. Specifically, the link of classroom social stressors to perceived stress to anxiety was only significant among children who lived in the high-threat area, not among those living in the lower threat area. Our study thus suggests that threat of war-conflict plays a significant role in the relationship between classroom social stressors and anxiety symptoms and serves as an environmental risk factor for children's development of anxiety problems. Our findings strengthened previous research on the link between perceived stress to the development of anxiety symptoms in children and adolescents (Dimitry, 2012; Estevez, 2005, Walsh et al., 2010) by showing that the stress-anxiety association depended upon chronic stress exposure originating from the broader environment.

Numerous children grow up with differences in experienced warmth in the relationship with the teacher and differences in ongoing conflicts in the broader environment. However, the specific relationship of peer problems in the school context and (perceived) stress system activation and anxiety symptoms among children has never before been studied regarding the unique roles of teacher-student relationships and uncontrollable environmental stress in a war context. The results in chapters 4 & 5 suggest that a discrepancy in social support (poor peer acceptance and warm teacher-student relationship) in the classroom setting (chapter 4) or living in a war-conflict region (chapter 5) can augment the impact of (perceived) stress originating from other social sources. Altogether, the findings of these two chapters suggested a complex interplay between social influences by peers, teachers and the broader environment in predicting stress (dys)regulation and perceived stress and subsequent anxiety symptoms.

It was previously suggested that the microsystem and macrosystem impact the development of internalizing symptoms (Bronfenbrenner & Morris, 2006). Our findings may suggest that a high stress threshold that children experience in the microsystem (discrepant social support; Chapter 4) and/or macrosystem (war-conflict; Chapter 5) might render additional stressors in the classroom context more

problematic. As a consequence, the ability to cope with other social stressors in the peer context might be reduced (Comer & Kendall, 2007; Sapolsky, 2004). Thus, children's capacity to effectively cope with daily stressors may be diminished (Adam et al., 2007). Consequently, both the immediate classroom environment and the environment in which children live, aggravates pathways between peer related stress and dysregulated stress activity. Subsequently, the risk for internalizing problems seems to be increased (chapter 5).

Limitations

The present thesis increases our understanding of stress system activity, the role of the peer relations in this development as well as how negative peer relationships may become embedded in children's stress system activity. Yet, when interpreting the overall findings in this thesis, several limitations should be considered, in addition to the specific limitations mentioned in each chapter.

First, all presented studies examined the link between the role of classroom peers and the stress system. However, effects of social relations with for example parents, siblings, and peers outside of the classroom context may also influence children's and adolescent's stress system activity. These social relations can be either sources of social support or potential stressors, which may, as was found in chapter 4 for teachers, influence the association of peer relationships with stress system activity.

Second, the findings of this thesis, except those in chapter 5, are based on a sample of Dutch children participating in a classroom-based study in central and eastern parts of the Netherlands. Schools were not randomly selected but rather reflected a convenience sample of schools that were willing to participate in the longitudinal study, in which the sub-studies were embedded. The sample consisted mostly of children from a Caucasian ethical background and from medium to high socioeconomic households. Children in chapter 5 were from low to medium socioeconomic households in Israel. Thus, the results of most of our studies cannot be generalized to children from broader ethnical or

socioeconomic background. Future studies are needed to examine the generalizability of these findings.

Third, apart from chapter 5, the studies presented in this thesis were only partly based on longitudinal data. Therefore, care is needed when interpreting the direction of effects. Cross-lagged analyses in chapter 5 can determine temporal ordering, whereas other studies examined associations between peer variables and stress system activity. No causal interferences can be made from association-based analyses because bidirectional effects between processes can be expected over the course of development. The stress system activation alterations found among children with poor peer relations could already have been present before elementary school, for example due to negative experiences in the family context or in kindergarten. In turn, affected children might make negative peer experiences in elementary school since the respective children possibly lack adaptive social emotional skills. However, prior studies suggest that peer experiences uniquely predict internalizing and externalizing problems and children become more sensitive to rejection over time (i.e., Gooren et al. 2011; London et al. 2007; van Lier & Koot, 2010). As such, future studies should assess peer relations and stress system (re)activity before the transition to elementary school and should follow children for a prolonged time also in high school to assess children's development of stress system activity, the impact of peer problems and their emotional development.

Recommendations for future research

The results of this thesis suggest that peers play an important role in children's social development and stress system functioning. There are, however, other research questions that remain and should be examined in future research.

The first recommendation for future studies concerns the study design. The results of this thesis may suggest that peer influences on children's stress regulation may start early. Moreover, the effects of peer relationships may change over the course of development as they are dynamic. For example, generally the influence of peers increases

throughout development while individual differences in how children respond to peer influences might also change. Therefore, future studies should assess social behavior and stress system activity already at the start of formal schooling such as during kindergarten. Furthermore, specific studies should in general combine measures of physiological stress (re)activity and psychological stress responses, as respective responses often diverge (e.g., Schommer, Heller & Kirschbaum, 2003). In this way, a more detailed understanding of the influence of changing peer relations on stress system activity can be established.

The second recommendation for future research concerns studying the broader influence of social relations, for instance protective factors of parents, siblings or friends outside the classroom. Although in general, poor peer relations are relatively stable across primary school (Brendgen et al., 2001), some poorly preferred children manage to overcome further behavioral, emotional or peer related difficulties by having supportive friendships or support by parents (Hodges, et al., 1999; Lakey & Cohen et al., 2000). It remains unclear how support by friends and parents can protect poorly accepted children from negative peer experiences with regard to stress system activity.

A third recommendation for future studies is to conduct studies that are able to provide more insights into the temporal ordering of the associations of peer relations, stress system functioning and socio-emotional development. Such research projects need to assess stress (re)activity together with peer relationships and internalizing symptoms across several years. These studies should further focus on the psychological processes that may connect negative peer relations, stress system activity and internalizing (and externalizing) symptoms. For example, it needs to be assessed whether reduced perceived self-efficacy, distorted social cognitions and distorted social evaluations, as potential factors, are part of the psychological mechanisms that alter stress system activity and increase the risk for internalizing symptoms as a result of reduced peer acceptance in the classroom. Such insights are crucial in order to improve preventive interventions targeting the influence of peer relations on socio-emotional development.

Clinical implications

The findings of this thesis provide important implications for practice. Specifically, the results of the chapters suggest that peers play an important role in children's social development and stress system functioning. Although this was not studied in this thesis, one may speculate about the consequences of the found associations in our childhood samples. During adolescence, peers become increasingly important for the healthy development of youth (Baumeister & Leary, 1995; Coie et al., 1990; Ryan & Shim, 2008; Williams, 2007). The affected stress regulation and associations with internalizing problems that we found, may place these children at risk of their further healthy peer relationship development. For example, during adolescence, affected children may show chronic dysregulated stress (re)activity and internalizing problems as a consequence of negative peer experiences. These adolescents may start to show more withdrawn behavior, e.g., reduced social support seeking and less attached relationships with peers and teachers in the classroom which further hinders healthy social development. We further found stress activity patterns that were previously related to externalizing symptoms among low preferred children (e.g., in chapter 3). Thus, these adolescents may also show increased aggressive behavior and risk seeking as a consequence of negative peer experience and dysregulated stress system activity. In this manner, this negative cascade may promote internalizing and/or externalizing problems and thus the development of psychopathology among affected children. This underscores the importance of focusing on facilitating healthy classroom peer social relationship development during kindergarten and the elementary school period, focusing on individual children and classrooms as a whole.

Interventions should be focused on the classroom context in which children learn how to deal with (social) stress. On a classroom level, effective school-based interventions using cognitive-behavioral techniques for children and adolescents to increase resilience and to reduce stress symptoms could be implemented (Kataoka et al., 2003; Jaycox, 2004; Stein et al., 2003). Children (and teachers) should be

taught how altered stress regulation affects self-efficacy, social cognitions and social behavior and goals. The interventions should further focus on teaching children social and emotional skills, the importance of positive peer relations and a positive classroom climate from kindergarten onwards to promote healthy social and emotional developments. By means of psycho-education, the social climate in the classroom could be improved in a more systematical manner. The proposed classroom activities can help children with expressing feelings and engaging in support-seeking behavior, and at the same time can help restoring child's sense of security and self-efficacy in the classroom (Rolfsnes and Idsoe, 2010). For example, previous studies have shown that higher coping self-efficacy reduced the negative effects of peer victimization on anxiety, depression and externalizing symptoms, while lower self-efficacy was associated with greater symptoms of depression and anxiety in adolescence (Singh & Bussey, 2011). Moreover, resilience training should be offered to non-accepted children. During resilience training children learn strategies for cognitive restructuring in order to adjust negative social expectations, learn how to become more socially competent and learn new coping strategies for negative experiences in the peer context. The whole classroom can learn how to use affective coping and prevention strategies in order to better deal with unpredictable stressors and social contexts. Another additional possibility for intervention among poorly preferred children is heart rate variability biofeedback training (HRV-BF). HRV-BF training has been extended to the treatment of depression and anxiety and substance use reduction among adults (Goessl, Curtiss & Hofmann 2017). During this training, feedback is provided through visual or auditory signals that are extracted from a smartphone application. With help of this feedback, poorly accepted children learn how to increase heart rate variability, which helps to control self-regulation. The method targets emotion dysregulation and can help to better be able to handle everyday (social) stress that can never fully be prevented (El-Sheikh & Erath, 2011).

Schools and psychologists require a joint effort together with policymaking and health institutions to implement suggested changes.

Policymaking strategies to advice institutions and schools to implement socio-emotional learning strategies, and psycho-education on peer stressors and the effects on stress activity and subsequent psychopathology as a core element in teaching programs. Specifically, psycho-education on social stress and the effects on stress system activity and subsequent psychopathology is lacking. It should be decided which programs could be implemented in classrooms based on scientific evidence on effectiveness of tackling related problems. In this manner, social-emotional learning and understanding of needed skills of children could be implemented in a more systematic manner and healthy socio-emotional development could be fostered.

Conclusion

This thesis was set out to further our understanding of the impact of receiving negative social evaluations or being victimized by peers in elementary school of stress system (re)activity and subsequent anxiety symptoms in elementary school children. Findings from this thesis suggest that children affected by peer related stressors may show altered stress system (re)activity, may become more sensitive to new negative peer experiences. As a result, subsequently, concerned children may be at risk for developing anxiety symptoms.

Parents and children might sometimes worry about peer relations in the classroom setting. The thesis suggests that the worries might be justified. Apart from the social benefits, classroom dynamics bear the risk for developmental hazards, which can be emphasized by the immediate and more distant environmental context. Thus, social experiences in the peer context play a key role in the development of children's stress system activity, which might further shape their emotional and behavioral outcomes throughout development.

Chapter 5 – classroom stress, perceived stress, anxiety

References

A

Adam, E. K., Klimes-Dougan, B., & Gunnar, M. R. (2007). Social regulation of the adrenocortical response to stress in infants, children, and adolescents: Implications for psychopathology and education.

Adams, R. E., Santo, J., & Bukowski, W. M. (2011). The presence of a best friend buffers the effects of negative experiences. *Developmental Psychology, 47*, 1786–1791. doi: https://doi.org/10.1037/a0025401

Ahnert, L., Harwardt-Heinecke, E., Kappler, G., Eckstein-Madry, T., & Milatz, A. (2012). Student–teacher relationships and classroom climate in first grade: How do they relate to students' stress regulation? *Attachment & Human Development, 14*, 249-263.doi: https://doi.org/10.1080/14616734.2012.673277

Alink, L. R. A., van IJzendoorn, M. H., Bakermans-Kranenburg, M. J.,Mesman, J., Juffer,F., & Koot, H. M. (2008). Cortisol and externalizing behavior in children and adolescents: Mixed meta- analytic evidence for the inverse relation of basal cortisol and cortisol reactivity with externalizing behavior. *Developmental Psychobiology*, 50, 427–450. doi: https://doi.org/10.1002/dev.20300

Appleyard, K., Egeland, B., van Dulmen, M. H., & Alan Sroufe, L.(2005). When more is not better: The role of cumulative risk in child behavior outcomes. *Journal of Child Psychology and Psychiatry, 46*, 235-245.

Arbeau, K. A., Coplan, R. J. and Weeks, M. (2010). Shyness, teacher–child relationships, and socio-emotional adjustment in grade I. *International Journal of Behavioral Development, 34*, 259–269. doi: https://doi.org/10.1177/0165025409350959

Asparouhov, T., & Muthén, B. (2010). Chi-square statistics with multiple imputation.

B

Badanes, L. S., Dmitrieva, J., & Watamura, S. E. (2012). Understanding cortisol reactivity across the day at child care: The potential buffering role of secure attachments to caregivers. *Early Childhood Research Quarterly, 27*, 156–165. doi: https://doi.org/10.1016/j.ecresq.2011.05.005

Barber, B. K., & Schluterman, J. M. (2009). An overview of the empirical literature on adolescents and political violence. In B. K. Barber (Ed.), Adolescents and war: How youth deal with political violence. New York, NY: Oxford University Press.

Bar-Haim, Y., Holoshitz, Y., Eldar, S., Frenkel, T. I., Muller, D., Charney, D. S., ... & Wald, I. (2010). Life-threatening danger and suppression of attention bias to threat. *American Journal of Psychiatry*, *167*, 694-698.

Bartels, M., Van den Berg, M., Sluyter, F., Boomsma, D. I., & de Geus, E. J. (2003). Heritability of cortisol levels: review and simultaneous analysis of twin studies. *Psychoneuroendocrinology*, *28*(2), 121-137. doi: https://doi.org/10.1016/s0306-4530(02)00003-3

Bates, R., Salsberry, P., & Ford, J. (2017). Measuring stress in young children using hair cortisol: The state of the science. *Biological Research for Nursing*, *19*, 499-510.

Bauer, A. M., Quas, J. A., & Boyce, W. T. (2002). Associations between physiological reactivity and children's behavior: Advantages of a multisystem approach. *Journal of Developmental & Behavioral Pediatrics*, *23*(2), 102-113.doi:https://doi.org/10.1097/00004703-200204000-00007

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*(3), 497. doi: https://doi.org/10.1037//0033-2909.117.3.497

Bäumler, D., Kirschbaum, C., Kliegel, M., Alexander, N., & Stalder, T. (2013). The cortisol awakening response in toddlers and young children. *Psychoneuroendocrinology*, 38(11), 2485-2492.

Beauchaine, T. P. (2015). Respiratory sinus arrhythmia: A transdiagnostic biomarker of emotion dysregulation and psychopathology. *Current opinion in psychology*, *3*, 43-47.

Behling, O., & Law, K. S. (2000). *Translating questionnaires and other research instruments: Problems and solutions* (Vol. 133). sage.

Behnsen, P., Buil, M., Koot, S., Huizink, A., & van Lier, P. (2018). Classroom social experiences in early elementary school relate to diurnal cortisol levels. *Psychoneuroendocrinology*, *87*, 1-8. doi: https://doi.org/10.1016/j.psyneuen.2017.09.025

Berntson, G. G., Cacioppo, J. T., & Quigley, K. S. (1991). Autonomic determinism: the modes of autonomic control, the doctrine of autonomic space, and the laws of autonomic constraint. *Psychological review*, *98*(4), 459.doi: https://doi.org/10.1037//0033-295x.98.4.459

Berset, M., Semmer, N.K., Elfering, A., Amstad, F.T., Jacobshagen, N. (2009). Work characteristics as predictors of physiological recovery on weekends. *Scandinavian Journal of Work and Environmental Health.* 188–192. doi: https://doi.org/10.5271/sjweh.1320

Besser, A., & Neria, Y. (2012). When home isn't a safe haven: Insecure attachment orientations, perceived social support, and PTSD symptoms among Israeli evacuees under missile threat. *Psychological Trauma: Theory, Research, Practice, and Policy*, *4*, 34.

Besser, A., Neria, Y., & Haynes, M. (2009). Adult attachment, perceived stress, and PTSD among civilians exposed to

ongoing terrorist attacks in Southern Israel. *Personality and Individual Differences, 47*, 851-857.

Birch, S. H., & Ladd, G. W. (1997). The teacher-child relationship and children's early school adjustment. *Journal of school psychology, 35*, 61-79. doi: https://doi.org/10.1016/s0022-4405(96)00029-5

Björkqvist, K., Lagerspetz, K. M., & Kaukiainen, A. (1992). Do girls manipulate and boys fight? Developmental trends in regard to direct and indirect aggression. *Aggressive behavior, 18*(2), 117- 127.

Blackhart, G.C., Eckel, L.A., Tice, D.M. (2007). Salivary cortisol in response to acute social rejection and acceptance by peers. *Biological Psychology, 75*, 267–276. doi: https://doi.org/10.1016/j.biopsycho.2007.03.005

Boivin, M., Hymel, S., & Bukowski, W. M. (1995). The roles of social withdrawal, peer rejection, and victimization in predicting loneliness and depressed mood in childhood. *Development and Psychopathology, 7*, 765–785. doi: https://doi.org/10.1017/s0954579400006830

Bolger, N., Zuckerman, A., & Kessler, R. C. (2000). Invisible support and adjustment to stress. *Journal of Personality and Social Psychology, 79*, 953-961. doi: https://doi.org/10.1037/0022-3514.79.6.953

Boyce, W. T., Frank, E., Jensen, P. S., Kessler, R. C., Nelson, C. A., & Steinberg, L. (1998). Social context in developmental psychopathology: Recommendations for future research from the MacArthur Network on Psychopathology and Development. *Development and Psychopathology, 10*(2), 143-164.

Breeman, L. D., Wubbels, T., Van Lier, P. A. C., Verhulst, F. C., van der Ende, J., Maras, A., ... & Tick, N. T. (2015). Teacher characteristics, social classroom relationships, and children's social, emotional, and behavioral classroom

adjustment in special education. *Journal of School Psychology*, *53*, 87-103.

Brendgen, M., Vitaro, F., Bukowski, W. M., Doyle, A. B., & Markiewicz, D. (2001).Developmental profiles of peer social preference over the course of elementary school: associations with trajectories of externalizing and internalizing behavior. *Developmental Psychology*, *37*(3), 308.

Bronfenbrenner, U., & Morris, P. (2006). The Bioecological Model of Human Development. Chapter 14 in Learner, R (Ed) Hand book of Child Psychology, *Volume 1 Theoretical Models of Human Development*.

Brown, B. B., 1990. Peer groups and peer cultures.

Bruce, J., Davis, E. P., Gunnar, M. R. (2002). Individual differences in children's cortisol response to the beginning of a new school year. *Psychoneuroendocrinology*, *27*, 635- 650.

Bukowski, W. M., Hoza, B., & Boivin, M. (1994). Measuring friendship quality during pre- and early adolescence: The development and properties of the Friendship Qualities Scale. *Journal of Social and Personal Relationships, 11*, 471–484. doi: https://doi.org/10.1177/0265407594113011

Bukowski, W. M., Castellanos, M., Vitaro, F., & Brendgen, M. (2015). Socialization and experiences with peers.

C

Callaghan, B. L., & Tottenham, N. (2016). The stress acceleration hypothesis: Effects of early-life adversity on emotion circuits and behavior. *Current Opinion in Behavioral Sciences*, *7*, 76-81.

Carroll, D., Phillips, A. C., & Der, G. (2008). Body mass index, abdominal adiposity, obesity, and cardiovascular reactions to psychological stress in a large community

sample. *Psychosomatic Medicine*, *70* (6), 653-660. doi: 10.1097/PSY.0b013e31817b938

Central Bureau of Statistics (2020, June). Retrieved from: https://www.gov.il/en/departments/central_bureau_of_statistics.

Chen, G. H., Kong, Y. H., Deater-Deckard, K., & Zhang, W. X. (2018). Bullying Victimization Heightens Cortisol Response to Psychosocial Stress in Chinese Children. *Journal of Abnormal Child Psychology*, *46*(5), 1051-1059. doi:10.1007/s10802-017-0366-6

Chida, Y., & Steptoe, A. (2008). Positive psychological well-being and mortality: a quantitative review of prospective observational studies. *Psychosomatic medicine*, *70*(7), 741-756. doi: https://doi.org/10.1016/j.biopsycho.2008.10.004

Cho, S., Zunin, I. D., Chao, P. J., Heiby, E. M., & McKoy, J. (2012). Effects of pain controllability and discrepancy in social support on depressed mood among patients with chronic pain. *International Journal of Behavioral Medicine*, *19*, 270-279. doi: https://doi.org/10.1007/s12529-011-9175-4

Cillessen, A. H., Bukowski, W. M., & Haselager, G. J. (2000). Stability of sociometric categories. *New directions for child and adolescent development*, *2000*(88), 75-93.

Cohen, M., & Eid, J. (2007). The effect of constant threat of terror on Israeli Jewish and Arab adolescents. *Anxiety, Stress, & Coping*, *20*, 47-60.

Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *Journal of the American Medical Association*, *298*, 1685– 1687. doi: https://doi.org/10.1001/jama.298.14.1685

Cohen, S., Janicki-Deverts, D., Miller, G. E., (2007). Psychological stress and disease. *Jama*, *298*, 1685-1687.

Coie, J. D., Dodge, K. A., & Coppotelli, H. (1982). Dimensions and types of social status: A cross-age perspective.

Developmental Psychology, 18, 557-570.doi: https://doi.org/10.1037//0012-1649.18.4.557

Coie, J. D., Dodge, K. A., Kupersmidt, J. B., (1990). Peer group behaviour and social status. Peer rejection in childhood, 17.

Comer, J. S., & Kendall, P. C. (2007). Terrorism: The psychological impact on youth. *Clinical Psychology: Science and Practice*, *14*(3), 179.

Craig, W. M. (1998). The relationship among bullying, victimization, depression, anxiety, and aggression in elementary school children. *Personality and Individual Differences*, *24*,123-130.

Crick, N. R., Grotpeter, J. K., (1996). Children's treatment by peers: victims of relational and overt aggression. *Developmental Psychopathology, 8*, 367-380.

Crick, N. R., & Bigbee, M. A. (1998). Relational and overt forms of peer victimization: a multiinformant approach. *Journal of Consulting and Clinical Psychology*, *66*,337-347.

Currie, C., Zanotti, C., Morgan, A., Currie, D., de Looze, M., Roberts, C., . . . Barnekow, V. (2012). *Social determinants of health and well-being among young people. Health behaviour in school-aged children (HBSC) study: International report from the 2009/2010 survey*. WHO Regional Office for Europe, Copenhagen.

D

DeCaro, J. A. (2008). Methodological considerations in the use of salivary α-amylase as a stress marker in field research. *American Journal of Human Biology: The Official Journal of the Human Biology Association*, *20*(5), 617-619.

De Geus, E. J., & Van Doornen, L. J. (1996). Ambulatory assessment of parasympathetic/sympathetic balance by impedance cardiography. *Ambulatory assessment: Computer-assisted psychological and psychophysiological methods*

in monitoring and field studies, 141-163.doi: https://doi.org/10.1037/e526132012-266

De Geus, E. J., Willemsen, G. H., Klaver, C. H., & van Doornen, L. J. (1995). Ambulatory measurement of respiratory sinus arrhythmia and respiration rate. *Biological Psychology, 41*(3), 205-227.doi: https://doi.org/10.1111/j.1469-8986.1990.tb02343.x

de Rooij, S. R. (2013). Blunted cardiovascular and cortisol reactivity to acute psychological stress: A summary of results from the Dutch Famine Birth Cohort Study. *International Journal of Psychophysiology*, *90*(1), 21-27.doi: https://doi.org/10.1016/j.ijpsycho.2012.09.011

de Wilde, A., Koot, H. M., & van Lier, P. A. (2016). Developmental links between children's working memory and their social relations with teachers and peers in the early school years. *Journal of Abnormal Child Psychology*, *44*, 19 –30. doi:10.1007/s10802-015-0053-4

Deater-Deckard, K., (2001). Annotation: Recent research examining the role of peer relationships in the development of psychopathology. *Journal Of Child Psychology and Psychiatry*, 42, 565-579.

Demaray, M. K., Malecki C, Rueger S, Brown S., Hodgson Summers S. (2009) The role of youth's ratings of the importance of socially supportive behaviors in the relationship between social support and self-concept." *Journal of Youth and Adolescence*, 38, 13- 28. doi: https://doi.org/10.1007/s10964-007-9258-3

Dempsey, Allison G., and Eric A. Storch. (2008). Relational victimization: The association between recalled adolescent social experiences and emotional adjustment in early adulthood. *Psychology in the Schools, 45*, 310-322.

Dickerson, S. S., & Zoccola, P. M. (2013). Cortisol responses to social exclusion. *The Oxford handbook of social exclusion*, 143-151.GA, March.

Dieleman, G. C., Huizink, A. C., Tulen, J. H., Utens, E. M., Creemers, H. E., van der Ende, J., & Verhulst, F. C. (2015). Alterations in HPA-axis and autonomic nervous system functioning in childhood anxiety disorders point to a chronic stress hypothesis. *Psychoneuroendocrinology*, *51*,135-150.

Dimitry, L. (2012). A systematic review on the mental health of children and adolescents in areas of armed conflict in the Middle East. *Child: care, health and development*, *38*, 153-161.

Doeland, E. M. (2012). The influence of terrorist threats on Israeli children and adolescents. *Social Cosmos*, *3*, 61-67.

Donzella, B., Talge, N. M., Smith, T. L., & Gunnar, M. R. (2008). To spear or not to spear: comparison of saliva collection methods. *Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology*, *50*, 714-717. doi: https://doi.org/10.1002/dev.20340

Dubow, E. F., Huesmann, L. R., Boxer, P., Landau, S., Dvir, S., Shikaki, K., & Ginges, J. (2012). Exposure to political conflict and violence and posttraumatic stress in Middle East youth: Protective factors. *Journal of Clinical Child & Adolescent Psychology*, *41*, 402-416.

E

Ellis, B. J., & Del Giudice, M. (2014). Beyond allostatic load: Rethinking the role of stress in regulating human development. *Development and psychopathology*, *26*(1), 1-20.

El-Sheikh, M. O. N. A., Gordis, E. B., & Stroud, L. R. (2007). Salivary α-Amylase in Biobehavioral Research: Recent Developments and Applications. *Annals of the New York*

Academy of Sciences, *1098*(1), 122-144.doi: https://doi.org/10.4135/9781412976244.n5

El-Sheikh, M., Erath, S. A., Buckhalt, J. A., Granger, D. A., & Mize, J. (2008). Cortisol and children's adjustment: The moderating role of sympathetic nervous system activity. *Journal of Abnormal Child Psychology*, *36*(4), 601-611.

Erasmus MC. (2000). *Problem Behavior at School Interview*. Department of Child and Adolescent Psychiatry. Rotterdam.

Estévez, E., Musitu, G., & Herrero, J. (2005). The influence of violent behavior and victimization at school on psychological distress: The role of parents and teachers. *Adolescence*, *40*, 183-196.

Evans, G. W., & English, K. (2002). The environment of poverty: Multiple stressor exposure, psychophysiological stress, and socioemotional adjustment. *Child development*, *73*, 1238-1248.

F

Farley, J. P., & Kim-Spoon, J. (2014). The development of adolescent self-regulation: Reviewing the role of parent, peer, friend, and romantic relationships. *Journal of adolescence*, *37*(4), 433-440.

Feder, A., Coplan, J. D., Goetz, R. R., Mathew, S. J., Pine, D. S., Dahl, R. E., ... & Weissman, M. M. (2004). Twenty-four-hour cortisol secretion patterns in prepubertal children with anxiety or depressive disorders. *Biological Psychiatry*, 56(3), 198-204.

Flynn, M., Rudolph, K.D., (2007). Perceptual asymmetry and youths' responses to stress: Understanding vulnerability to depression. *Cognition and Emotion*, *21*, 773-788.doi: https://doi.org/10.1080/02699930600824635

Fries, E., Dettenborn, L., Kirschbaum, C., 2009. The cortisol awakening response (CAR): facts and future

directions. *International Journal of Psychophysiology*, 72, 67-73.

G

Gandia, A., Bolufer, P., Rodriguez, A., & Antonio, P. (1990). Salivary cortisol increases with age in children. *Journal of Clinical Chemistry and Clinical Biochemistry*, *28*(9), 655.

Geurts, S. A., & Sonnentag, S., (2006). Recovery as an explanatory mechanism in the relation between acute stress reactions and chronic health impairment. *Scandinavian Journal of Work, Environment & Health*, 482-492.

Gerra, G., Zaimovic, A., Mascetti, G. G., Gardini, S., Zambelli, U., Timpano, M., ... & Brambilla, F. (2001). Neuroendocrine responses to experimentally-induced psychological stress in healthy humans. *Psychoneuroendocrinology*, *26*(1), 91-107.doi: https://doi.org/10.1016/S0306-4530(00)00046-9

Gini, G., Card, N. A., & Pozzoli, T. (2018). A meta-analysis of the differential relations of traditional and cyber-victimization with internalizing problems. *Aggressive Behavior*, *44*, 185-198.

Ginty, A.T., Gianaros, P.J., Derbyshire, S.W.G., Phillips, A.C. Carroll, D. (2013). Blunted cardiac stress reactivity relates to neural hypoactivation. *Psychophysiology*, *50*(3), 219-229.

Goeders, N. E. (2003). The impact of stress on addiction. *European Neuropsychopharmacology*, *13*(6), 435-441. doi: https://doi.org/10.1016/j.euroneuro.2003.08.004

Goessl, V. C., Curtiss, J. E., & Hofmann, S. G. (2017). The effect of heart rate variability biofeedback training on stress and anxiety: a meta-analysis. *Psychological medicine*, *47*(15), 2578-2586.

Goodman, R. (1997). The Strengths and Difficulties Questionnaire: a research note. *Journal of child psychology and*

psychiatry, *38*(5), 581-586.doi: https://doi.org/10.1037/t00540-000

Goodman, R., & Scott, S. (1999). Comparing the Strengths and Difficulties Questionnaire and the Child Behavior Checklist: is small beautiful?. *Journal of Abnormal Child Psychology*, *27*, 17-24. doi: https://doi.org/10.1037/t64266-000

Goodman, R., Ford, T., Simmons, H., Gatward, R., & Meltzer, H. (2000). Using the Strengths and Difficulties Questionnaire (SDQ) to screen for child psychiatric disorders in a community sample. *The British journal of psychiatry*, *177*(6), 534-539.doi:https://doi.org/10.1192/bjp.177.6.534

Goodman, R. (2001). Psychometric properties of the strengths and difficulties questionnaire. *Journal of the American Academy of Child & Adolescent Psychiatry*, *40*, 1337-1345.

Gooren, E. M., van Lier, P. A. C., Stegge, H., Terwogt, M. M., & Koot, H. M. (2011). The development of conduct problems and depressive symptoms in early elementary school children: The role of peer rejection. Journal of Clinical Child & Adolescent Psychology, 40, 245-253. doi:10.1080/15374416.2011.546045

Granger, D. A., Fortunato, C. K., Beltzer, E. K., Virag, M., Bright, M. A., & Out, D. (2012). Focus on methodology: salivary bioscience and research on adolescence: an integrated perspective. *Journal of Adolescence*, *35*(4), 1081-1095.doi:https://doi.org/10.1016/j.adolescence.2012.01.005 Granger, D. A., Kivlighan, K. T.,

Greaves-Lord, K., Ferdinand, R. F., Oldehinkel, A. J., Sondeijker, F. E., Ormel, J., & Verhulst, F. C.(2007). Higher cortisol awakening response in young adolescents with persistent anxiety problems. *Acta Psychiatrica Scandinavica*, *116*(2), 137-144.

Grotpeter, J. K., & Crick, N. R. (1996). Relational aggression, overt aggression, and friendship. *Child Development*, *67*(5), 2328-2338.

Gröschl, M., Rauh, M., & Dörr, H. G. (2003). Circadian rhythm of salivary cortisol, 17α-hydroxyprogesterone, and progesterone in healthy children. *Clinical chemistry*, *49*(10), 1688-1691.doi: https://doi.org/10.1373/49.10.1688

Gruenewald, T. L., Kemeny, M. E., Aziz, N., & Fahey, J. L. (2004). Acute threat to the social self: Shame, social self-esteem, and cortisol activity. *Psychosomatic medicine*, *66*(6), 915-924.

Gunnar, M. R., (2000). Early adversity and the development of stress reactivity and regulation. The effects of early adversity on neurobehavioural development, 31, 163-200.

Gunnar, M. R., Sebanc, A. M., Tout, K., Donzella, B., & van Dulmen, M. M. (2003). Peer rejection, temperament, and cortisol activity in preschoolers. *Developmental Psychobiology*, *43*(4), 346-368. doi: https://doi.org/10.1002/dev.10144

Guyer, A. E., Jarcho, J. M., Bukowski, W. M., Laursen, B., & Rubin, K. H. (2018). Neuroscience and peer relations. *Handbook of peer interactions, relationships, and groups*, 177-199.

H

Hajcak, G., McDonald, N., & Simons, R. F. (2003). To err is autonomic: Error-related brain potentials, ANS activity, and post-error compensatory behavior. *Psychophysiology*, *40*(6), 895-903.doi:https://doi.org/10.1111/1469-8986.00107

Hammen, C. (2005). Stress and depression. *Annual Review of Clinical Psychology*, *1*, 293-319.

Hamre, B. K., & Pianta, R. C. (2001). Early teacher–child relationships and the trajectory of children'school outcomes through eighth grade. *Child Development*, 72, 625–638. doi: https://doi.org/10.1111/1467-8624.00301

Hartman, C. A., Hermanns, V. W., de Jong, P. J., & Ormel, J., (2013). Self-or parent report of (co-occurring) internalizing and externalizing problems, and basal or reactivity measures of HPA-axis functioning: A systematic evaluation of the internalizing-hyperresponsivity versus externalizing-hyporesponsivity HPA-axis hypothesis. *Biological psychology*, 94(1), 175-184.

Hartup, W. W. (1989). Social relationships and their developmental significance. *American psychologist*, *44*(2), 120.

Hatfield, B. E., Hestenes, L. L., Kintner-Duffy, V. L., & O'Brien, M. (2013). Classroom Emotional Support predicts differences in preschool children's cortisol and alpha-amylase levels. *Early Childhood Research Quarterly*, *28*, 347-356. doi: https://doi.org/10.1016/j.ecresq.2012.08.001

Hatfield, B. E., & Williford, A. P. (2017). Cortisol patterns for young children displaying disruptive behavior: links to a teacher-child, relationship-focused intervention. *Prevention Science*, *18*, 40-49.

Hay, D. F., Payne, A., & Chadwick, A. (2004). Peer relations in childhood. Journal of Child Psychology and Psychiatry, 45, 84-108. doi:10.1046/j.0021-9630.2003.00308.

Heffelfinger, A. K., & Newcomer, J. W. (2001). Glucocorticoid effects on memory functioning over the human lifespan. *Development and Psychopathology*, *13*, 491–513. doi: https://doi.org/10.1017/s0954579401003054

Hinnant, J. B., O'Brien, M., & Ghazarian, S. R. (2009). The longitudinal relations of teacher expectations to achievement in the early school years. *Journal of educational psychology*, *101*(3), 662.

Hodges, E. V. E., & Perry, D. G. (1999). Personal and interpersonal antecedents and consequences of victimization by peers. *Journal of Personality and Social Psychology, 76,*

677–685. doi: https://doi.org/10.1037/0022-3514.76.4.677

Hodges, E. V. E., Malone, M. J., & Perry, D. G. (1999). Individual risk and social risk as interacting determinants of victimization in the peer group. *Developmental Psychology, 33*, 1032–1039. doi: https://doi.org/10.1037/0012-1649.33.6.1032

Holmbeck, G. N. (2002). Post-hoc probing of significant moderational and mediational effects in studies of pediatric populations. *Journal of pediatric psychology*, *27*, 87-96. doi: https://doi.org/10.1093/jpepsy/27.1.87

Hopper, J. W., Spinazzola, J., Simpson, W. B., & van der Kolk, B. A. (2006). Preliminary evidence of parasympathetic influence on basal heart rate in posttraumatic stress disorder. *Journal of Psychosomatic Research*, *60*(1), 83-90. doi: https://doi.org/10.1016/j.jpsychores.2005.06.002

Huber, R. S., Sifers, S. K., Houlihan, D., & Youngblom, R. (2012). Teacher support as a moderator of behavioral outcomes for youth exposed to stressful life events. *Education Research International*. doi: https://doi.org/10.1155/2012/130626

Hughes, J. N., & Chen, Q. (2011). Reciprocal effects of student–teacher and student–peer relatedness: Effects on academic self-efficacy. *Journal of applied developmental psychology*, *32*, 278-287. doi: https://doi.org/10.1016/j.appdev.2010.03.005

I

Ice, G.H., Katz-Stein, A., Himes, J., Kane, R.L., (2004). Diurnal cycles of salivary cortisol in older adults. *Psychoneuroendocrinology*, 29, 355-370.

Israeli Ministry of Foreign Affairs (2015). The Jewish Policy Center. http://www.jewishpolicycenter.org/prr/history.php

J

Jaycox, L. H. (2004). *Cognitive behavioral intervention for trauma in schools*. Longmont, CO: Sopris West Educational Services.

Johnsona, R. M., Kotch, J. B., Catellier, D. J., Winsor, J. R., Dufort, V., Hunter, W., & Amaya-Jackson, L. (2002). Adverse behavioral and emotional outcomes from child abuse and witnessed violence. *Child maltreatment*, *7*(3), 179-186.

K

Kalff, A. C., Kroes, M., Vles, J. S. H., Hendriksen, J. G. M., Feron, F. J., Steyaert, J., ... & van Os, J. (2001). Neighbourhood level and individual level SES effects on child problem behaviour: a multilevel analysis. *Journal of Epidemiology & Community Health*, *55*(4), 246-250.

Kar, N. (2009). Psychological impact of disasters on children: review of assessment and interventions. *World journal of pediatrics*, *5*, 5-11.

Kataoka, S. H., Stein, B. D., Jaycox, L. H., Wong, M., Escudero, P., Tu, W., et al. (2003). A school-based mental health program for traumatized Latino immigrant children. *Journal of the American Academy of Child and Adolescent Psychiatry, 42*, 311-318.

Kawabata, Y., Crick, N. R., & Hamaguchi, Y. (2013). The association of relational and physical victimization with hostile attribution bias, emotional distress, and depressive symptoms: A cross-cultural study. *Asian Journal of Social Psychology*, *16*, 260-270.

Kiecolt-Glaser, J. K., Renna, M. E., Shrout, M. R., & Madison, A. A. (2020). Stress reactivity: what pushes us higher, faster, and longer—and why it matters. *Current directions in psychological science*, *29*(5), 492-498.

Kirschbaum, C., Wust, S., & Hellhammer, D. H. (1992). Consistent sex differences in cortisol responses to psychological stress. *Psychosomatic Medicine, 54*, 648–657. doi: https://doi.org/10.1097/00006842-199211000-00004

Kirschbaum, C., Hellhammer, D. H., (1994). Salivary cortisol in psychoneuroendocrine research: recent developments and applications. *Psychoneuroendocrinology*, 19, 313- 333.

Knack, J. M., Jensen-Campbell, L. A., & Baum, A. (2011). Worse than sticks and stones? Bullying is associated with altered HPA axis functioning and poorer health. *Brain and cognition*, *77*(2), 183-190. doi: https://doi.org/10.1016/j.bandc.2011.06.011

Kochel, K. P., Ladd, G. W., & Rudolph, K. D. (2012). Longitudinal associations among youth depressive symptoms, peer victimization, and low peer acceptance: An interpersonal process perspective. *Child development*, *83*(2), 637-650.

Koss, K. J., Hostinar, C. E., Donzella, B., Gunnar, M. R., (2014). Social deprivation and the HPA axis in early development. *Psychoneuroendocrinology*, 50, 1-13.

Kraag, G., Meesters, C., Fekkes, M., Kok, G., & Huijer Abu-Saad, H. (2008). The Development of MUSIC, a short stress symptoms questionnaire for preadolescents. *Unpublished manuscript, Maastricht University, Maastricht, Belgium*.

Kraag, G., Van Breukelen, G. J., Kok, G., & Hosman, C. (2009). 'Learn Young, Learn Fair', a stress management program for fifth and sixth graders: longitudinal results from an experimental study. *Journal of Child Psychology and Psychiatry*, *50*, 1185-1195.

Kubiak, S. P. (2005). Trauma and cumulative adversity in women of a disadvantaged social location. *American Journal of Orthopsychiatry*, *75*, 451-465.

Kudielka, B. M., & Kirschbaum, C. (2005). Awakening cortisol responses are influenced by health status and awakening time but not by menstrual cycle phase. *Psychoneuroendocrinology*, *28*(1), 35-47.doi: https://doi.org/10.1016/s0306-4530(02)00008-2

L

Ladd, G. W., Troop-Gordon, W., (2003). The role of chronic peer difficulties in the development of children's psychological adjustment problems. *Childhood Development*, 74, 1344–1367.

Ladd, G. W. (2006). Peer rejection, aggressive or withdrawn behavior, and psychological maladjustment from ages 5 to 12: An examination of four predictive models. *Child Development, 77*(4), 822-846. doi:10.1111/j.1467-8624.2006.00905.x

Lahav, E., Shahrabani, S., & Benzion, U. (2019). Emotions, Risk Perceptions and Precautionary Actions of Citizens during a Military Operation Using a New Defence Technology: The Israeli Case of the Iron Dome. *Defense and Peace Economics*, *30*, 666-686.

Lakey, B., & Cohen, S. (2000). Social support and theory. *Social support measurement and intervention: A guide for health and social scientists*. doi: https://doi.org/10.1093/med:psych/9780195126709.003.0002

Laurent, H., Vergara-Lopez, C., & Stroud, L. R. (2016). Differential relations between youth internalizing/externalizing problems and cortisol responses to performance vs. interpersonal stress. *Stress*, *19*(5), 492-498.doi: https://doi.org/10.1080/10253890.2016.1218843

Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., Stuart, G. L., ... & Brown, R. A. (2002). Evaluation of a behavioral measure of risk taking: the Balloon Analogue Risk Task (BART). *Journal of Experimental Psychology: Applied*, *8*(2), 75. doi: 10.1037//1076-898X.8.2.75

Lesage, F. X., & Berjot, S. (2011). Validity of occupational stress assessment using a visual analogue scale. *Occupational*

medicine, *61*(6), 434-436.doi: https://doi.org/10.1093/occmed/kqr037

Lisonbee, J. A., Mize, J., Payne, A. L., & Granger, D. A. (2008). Children's Cortisol and the Quality of Teacher – Child Relationships in Child Care. *Child Development, 79,* 1818–1832. doi: https://doi.org/10.1111/j.1467-8624.2008.01228.x

Luman, M., Sergeant, J. A., Knol, D. L., Oosterlaan, J., (2010). Impaired decision making in oppositional defiant disorder related to altered psychophysiological responses to reinforcement. *Biologal Psychiatry*, 68, 337-344.

M

MacDonald, G., & Leary, M. R. (2005). Why does social exclusion hurt? The relationship between social and physical pain. *Psychological bulletin*, *131*(2), 202.

Mantzicopoulos, P. (2005). Conflictual relationships between kindergarten children and their teachers: Associations with child and classroom context variables. *Journal of School Psychology*, *43*, 425-442.

Mayseless, O. (2005). Ontogeny of Attachment in Middle Childhood: Conceptualization of Normative Changes.

McCrory, E., De Brito, S. A., & Viding, E. (2012). The link between child abuse and psychopathology: a review of neurobiological and genetic research. *Journal of the Royal Society of Medicine*, *105*(4), 151-156.

Meaney, M.J., Szyf, M., Seckl, J.R., (2007). Epigenetic mechanisms of perinatal programming of hypothalamic-pituitary-adrenalfunction and health. *Trends of Molecular Medicine*, 13, 269-277.

Michels, N., Sioen, I., Huybrechts, I., Bammann, K., Vanaelst, B., De Vriendt, T. De Henauw, S., (2012). Negative life events, emotions and psychological difficulties as determinants

of salivary cortisol in Belgian primary school children. *Psychoneuroendocrinology*, 37, 1506-1515.

Miller, G. E., Chen, E., & Zhou, E. S. (2007). If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans. *Psychological bulletin*, *133*(1), 25. doi: 10.1037/0033-2909.133.1.25

Monk, C., Kovelenko, P., Ellman, L. M., Sloan, R. P., Bagiella, E., Gorman, J. M., & Pine, D. S. (2001). Enhanced stress reactivity in paediatric anxiety disorders: implications for future cardiovascular health. *International Journal of Neuropsychopharmacology*, *4*, 199-206.

Moor, B. G., Güroğlu, B., de Macks, Z. A. O., Rombouts, S. A., Van der Molen, M. W., & Crone, E. A. (2012). Social exclusion and punishment of excluders: neural correlates and developmental trajectories. *Neuroimage*, *59*(1), 708-717. doi: 10.1016/j.neuroimage.2011.07.028

Morales, J. R., & Guerra, N. G. (2006). Effects of multiple context and cumulative stress on urban children's adjustment in elementary school. *Child development*, *77*, 907-923.

Moss, K. (2003). Witnessing violence-aggression and anxiety in young children. *Health Reports*, *14*, 613-951.

Munoz, M. L., van Roon, A., Riese, H., Thio, C., Oostenbroek, E., Westrik, I., ... & Snieder, H. (2015). Validity of (ultra-) short recordings for heart rate variability measurements. *PLoS One*, *10*(9), e0138921.doi: https://doi.org/10.1371/journal.pone.0138921

Murray, C., & Murray, K. M. (2004). Child level correlates of teacher–student relationships: An examination of demographic characteristics, academic orientations, and behavioral orientations. *Psychology in the Schools*, *41*, 751-762.

Muthén, L. K., Muthén, B. O., (2005). Mplus: Statistical analysis with latent variables: User's guide (1998-2012). Los Angeles: Muthén & Muthén.

Muthén, L. K., & Muthén, B. O. (2012). Mplus user's guide (1998–2012). *Los Angeles, CA: Muthén & Muthén*, *6*.

Muthén, L. K., & Muthén, B. (2016). Mplus. The comprehensive modelling program for applied researchers: user's guide, 5.

N

Nederend, I., Ten Harkel, A. D., Blom, N. A., Berntson, G. G., & de Geus, E. J. (2017). Impedance cardiography in healthy children and children with congenital heart disease: Improving stroke volume assessment. *International Journal of Psychophysiology*, *120*, 136-147.*doi*: https://doi.org/10.1016/j.ijpsycho.2017.07.015

Newman, M. L. (2014). Here we go again: Bullying history and cardiovascular responses to social exclusion. *Physiology & behavior*, *133*, 76-80.doi: https://doi.org/10.1016/j.physbeh.2014.05.014

Nickerson, A. B., & Nagle, R. J. (2005). Parent and peer attachment in late childhood and early adolescence. *The journal of early adolescence*, *25*(2), 223-249.

O

O'Connor, T. G., Ben-Shlomo, Y., Heron, J., Golding, J., Adams, D., & Glover, V., (2005). Prenatal anxiety predicts individual differences in cortisol in pre-adolescent children. *Biological Psychiatry*, *58*(3), 211-217.

Ouellet-Morin, I., Odgers, C. L., Danese, A., Bowes, L., Shakoor, S., Papadopoulos, A. S., ... & Arseneault, L. (2011). Blunted cortisol responses to stress signal social and behavioral problems among maltreated/bullied 12-year-old children. *Biological psychiatry*, *70*(11), 1016-1023. doi: https://doi.org/10.1016/j.biopsych.2011.06.017

Ouellet-Morin, I., Wong, C. C. Y., Danese, A., Pariante, C. M., Papadopoulos, A. S., Mill, J., & Arseneault, L. (2013).

Increased serotonin transporter gene (SERT) DNA methylation is associated with bullying victimization and blunted cortisol response to stress in childhood: a longitudinal study of discordant monozygotic twins. *Psychological medicine*, *43*(9), 1813-1823.doi: https://doi.org/10.1017/s0033291712002784

P

Parker, K. J., Buckmaster, C. L., Sundlass, K., Schatzberg, A. F., & Lyons, D. M. (2006). Maternal mediation, stress inoculation, and the development of neuroendocrine stress resistance in primates. *Proceedings of the National Academy of Sciences*, *103*(8), 3000-3005.doi: https://doi.org/10.1073/pnas.0506571103

Peters, E., Riksen-Walraven, J. M., Cillessen, A. H., & de Weerth, C. (2011). Peer rejection and HPA activity in middle childhood: Friendship makes a difference. *Child development*, *82*, 1906-1920.doi: https://doi.org/10.1111/j.1467-8624.2011.01647.x

Petersen, A. C., Crockett, L., Richards, M., & Boxer, A. (1988). A self-report measure of pubertal status: Reliability, validity, and initial norms. *Journal of Youth and Adolescence*, *17*(2), 117-133.doi: https://doi.org/10.1007/bf01537962

Phillips, A. C., Roseboom, T. J., Carroll, D., & de Rooij, S. R. (2012). Cardiovascular and cortisol reactions to acute psychological stress and adiposity: cross-sectional and prospective associations in the Dutch Famine Birth Cohort Study. *Psychosomatic Medicine*, *74*(7), 699-710.

Pina, A. A., Villalta, I. K., Ortiz, C. D., Gottschall, A. C., Costa, N. M., & Weems, C. F. (2008). Social support, discrimination, and coping as predictors of posttraumatic stress reactions in youth survivors of Hurricane Katrina. *Journal of Clinical Child & Adolescent Psychology*, *37*, 564-574.

Pittig, A., Arch, J. J., Lam, C. W., & Craske, M. G. (2013). Heart rate and heart rate variability in panic, social anxiety,

obsessive–compulsive, and generalized anxiety disorders at baseline and in response to relaxation and hyperventilation. *International Journal of Psychophysiology*, *87*, 19-27.

Porges, S. W. (1995). Orienting in a defensive world: Mammalian modifications of our evolutionary heritage. A polyvagal theory. *Psychophysiology*, *32*(4), 301-318. doi: https://doi-org.vu-nl.idm.oclc.org/10.1111/j.1469-8986.1995.tb01213.x

Porges, S. W. (2001). The polyvagal theory: phylogenetic substrates of a social nervous system. *International journal of psychophysiology*, *42*(2), 123-146.

Porges, S. W. (2007). The polyvagal perspective. *Biological psychology*, *74*(2), 116-143.doi: https://doi.org/10.1016/j.biopsycho.2006.06.009

Preacher, K. J., Curran, P. J., & Bauer, D. J. (2003). Probing interactions in multiple linear regression, latent curve analyses, and hierarchical linear modeling. *Retrieved November*, *14*, 2005. doi: https://doi.org/10.1037/e633942013-311

Pruessner, J. C., Wolf, O. T., Hellhammer, D. H., Buske-Kirschbaum, A., Von Auer, K., Jobst, S., Kirschbaum, C. 1997. Free cortisol levels after awakening: a reliable biological marker for the assessment of adrenocortical activity. *Life Sciences*, *61*, 2539-2549.

R

Racine, N., McArthur, B. A., Cooke, J. E., Eirich, R., Zhu, J., & Madigan, S. (2021). Global prevalence of depressive and anxiety symptoms in children and adolescents during COVID-19: a meta- analysis. *JAMA pediatrics*, *175*(11), 1142-1150.

Raine, A. (2002). Annotation: The role of prefrontal deficits, low autonomic arousal, and early health factors in the development of antisocial and aggressive behavior in

children. *Journal of Child Psychology and Psychiatry, 43*(4), 417-434. doi: https://doi.org/10.1111/1469-7610.00034

Rankin, J. A., Paisley, C. A., Mulla, M. M., & Tomeny, T. S. (2018). Unmet social support needs among college students: Relations between social support discrepancy and depressive and anxiety symptoms. *Journal of Counseling Psychology, 65*, 474. doi: https://doi.org/10.1037/cou0000269

Rasmussen, A., Nguyen, L., Wilkinson, J., Vundla, S., Raghavan, S., Miller, K. E., & Keller, A. S. (2010). Rates and impact of trauma and current stressors among Darfuri refugees in Eastern Chad. *American Journal of Orthopsychiatry, 80*, 227-236.

response to the beginning of a new school year. *Psychoneuroendocrinology, 27*,645-650. doi: https://doi.org/10.1016/s0306-4530(01)00031-2

Rolfsnes, E. S., & Idsoe, T. (2011). School-based intervention programs for PTSD symptoms: A review and meta-analysis. *Journal of Traumatic Stress, 24*, 155–165.

Rose, A. J., & Rudolph, K. D. (2006). A review of sex differences in peer relationship processes: potential trade-offs for the emotional and behavioral development of girls and boys. *Psychological Bulletin, 132*, 98-131. doi:10.1037/0033-2909.132.1.98

Rowe, S. L., Zimmer-Gembeck, M. J., & Hood, M. (2016). From the child to the neighbourhood: Longitudinal ecological correlates of young adolescents' emotional, social, conduct, and academic difficulties. *Journal of Adolescence, 49*, 218-231.

Rubin, K. H., Wojslawowicz, J. C., Rose-Krasnor, L., Booth-LaForce, C., & Burgess, K. B. (2006). The best friendships of shy/withdrawn children: Prevalence, stability, and

relationship quality. *Journal of Abnormal Child Psychology, 34*(2), 139-153.

Rudolph, K. D. (2002). Gender differences in emotional responses to interpersonal stress during adolescence. *Journal of Adolescent Health, 30*, 3-13. doi: https://doi.org/10.1016/s1054-139x(01)00383-4

Rudolph, K.D., Troop-Gordon, W., Granger, D.A. (2010). Peer victimization and aggression: Moderation by individual differences in salivary cortiol and alpha-amylase. *Journal of Abnormal Child Psychology*, *38*, 843–856. doi: https://doi.org/10.1007/s10802-010-9412-3

Ruttle, P. L., Shirtcliff, E. A., Serbin, L. A., Fisher, D. B. D., Stack, D. M., & Schwartzman, A. E. (2011). Disentangling psychobiological mechanisms underlying internalizing and externalizing behaviors in youth: Longitudinal and concurrent associations with cortisol. *Hormones and Behavior*, *59*, 123-132. doi: https://doi.org/10.1016/j.yhbeh.2010.10.015

Ryan, A. M., & Shim, S. S. (2008). An exploration of young adolescents' social achievement goals and social adjustment in middle school. *Journal of Educational Psychology*, *100*(3), 672.

S

Sabol, T. J., & Pianta, R. (2012). Recent trends in research on teacher-child relationships. *Attachment & Human Development*, *14*, 213-231. doi: https://doi.org/10.1080/14616734.2012.672262

Sack M, Hopper J.W. & Lamprecht F. (2004) Low respiratory sinus arrhythmia and prolonged psychophysiological arousal in PTSD: heart rate dynamics and individual differences in arousal regulation. *Biological Psychiatry*, *55*, 284–90. doi: https://doi.org/10.1016/s0006-3223(03)00677-2

Sagi-Schwartz, A. (2008). The well-being of children living in chronic war zones: the Palestinian—Israeli case. *International Journal of Behavioral Development, 32*(4), 322-336.

Sandi C. & Haller J. (2015). Stress and the social brain: behavioural effects and neurobiological mechanisms. *National Review of Neurosci*ence, *16*, 290–304.

Sapolsky, R. M., Romero, L. M., & Munck, A. U. (2000). How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. *Endocrine reviews*, *21*(1), 55-89.doi: https://doi.org/10.1210/er.21.1.55

Sapolsky, R. M. (2004). *Why zebras don't get ulcers: The acclaimed guide to stress, stress-related diseases, and coping-now revised and updated*. Holt paperbacks.

Saridjan, N. S., Velders, F. P., Jaddoe, V. W., Hofman, A., Verhulst, F. C., & Tiemeier, H. (2014). The longitudinal association of the diurnal cortisol rhythm with internalizing and externalizing problems in pre-schoolers. The Generation R Study. *Psychoneuroendocrinology*, *50*, 118-129.doi: https://doi.org/10.1016/j.psyneuen.2014.08.008

Satorra, A., & Bentler, P. M. (2001). A scaled difference chi-square test statistic for moment structure analysis. *Psychometrika*, *66*, 507-514.

Saxbe, D.E. (2008). A field (researcher's) guide to cortisol: tracking HPA axis functioning in everyday life. *Health Psychology Review*, *2*, 163-190. doi: https://doi.org/10.1080/17437190802530812

Schommer, N. C., Hellhammer, D. H., & Kirschbaum, C. (2003). Dissociation between reactivity of the hypothalamus-pituitary-adrenal axis and the sympathetic-adrenal-medullary system to repeated psychosocial stress. *Psychosomatic medicine*, *65*(3), 450-460.

Shamai, M., & Kimhi, S. (2006). Exposure to threat of war and terror, political attitudes, stress, and life satisfaction among

teenagers in Israel. *Journal of Adolescence*, *29*(2), 165-176.

Shaw, D. S., Vondra, J. I., Hommerding, K. D., Keenan, K., & Dunn, M. (1994). Chronic family adversity and early child behavior problems: A longitudinal study of low income families. *Journal of Child Psychology and Psychiatry*, *35*, 1109-1122.

Shirtcliff, E. A., Essex, M. J., (2008). Concurrent and longitudinal associations of basal and diurnal cortisol with mental health symptoms in early adolescence. *Developmental Psychobiology*, *50*, 690-703.

Sijtsema, J. J., Nederhof, E., Veenstra, R., Ormel, J., Oldehinkel, A. J., & Ellis, B. J. (2013). Effects of family cohesion and heart rate reactivity on aggressive/rule-breaking behavior and prosocial behavior in adolescence: The Tracking Adolescents' Individual Lives Survey study. *Development and Psychopathology*, *25*(3), 699-712. doi: https://doi.org/10.1017/s0954579413000114

Sjogren, E., Leanderson, P., Kristenson, M., (2006). Diurnal Saliva Cortisol Levels and Relations to Psychosocial Factors in a Population Sample of Middle-Aged Swedish Men and Women. *International Journal of Behaviour Medicine*, *13*,190.

Slattery, D. A., Uschold, N., Magoni, M., Bär, J., Popoli, M., Neumann, I. D., & Reber, S. O. (2012). Behavioural consequences of two chronic psychosocial stress paradigms: anxiety without depression. *Psychoneuroendocrinology*, *37*, 702-714.

Smider, N. A., Essex, M. J., Kalin, N. H., Buss, K. A., Klein, M. H., Davidson, R. J., et al. (2002). Salivary cortisol as a predictor of socioemotional adjustment during kindergarten: A prospective study. *Child Development*, *73*, 75–93. doi: https://doi.org/10.1111/1467-8624.00393

Solberg, M. E., & Olweus, D. (2003). Prevalence estimation of school bullying with the Olweus Bully/Victim Questionnaire. *Aggressive Behavior*, *29*, 239–268. doi: https://doi.org/10.1002/ab.10047

Spilt, J. L., Koomen, H. M., & Mantzicopoulos, P. Y. (2010). Young children's perceptions of teacher–child relationships: An evaluation of two instruments and the role of child gender in kindergarten. *Journal of Applied Developmental Psychology*, *31*, 428-438.

Spilt, J.L., Koomen, H.M.Y., Thijs, J.T., & van der Leij, A. (2012). Supporting teachers' relationships with disruptive children: The potential of relationship-focused reflection. *Attachment & Human Development, 14*, 305–318.

Spilt, J. L., Koot, J. M., & van Lier, P. A. (2013). For whom does it work? Subgroup differences in the effects of a school-based universal prevention program. *Prevention Science*, *14*(5), 479-488.

Spilt, J. L., Van Lier, P. A., Leflot, G., Onghena, P., & Colpin, H. (2014). Children's social self-concept and internalizing problems: The influence of peers and teachers. *Child development*, *85*, 1248-1256. doi: https://doi.org/10.1111/cdev.12181

Spirito, A., Stark, L. J., Grace, N., Stamoulis, D., (1991). Common problems and coping strategies reported in childhood and early adolescence. *Journal of Youth and Adolescence, 20*, 531-544.

Stalder, T., Evans, P., Hucklebridge, F., Clow, A., (2011). Associations between the cortisol awakening response and heart rate variability. *Psychoneuroendocrinology*, *36*, 454462.

Statistics Netherlands, (2001). Standaard Beroepenclassificatie 1992 (SBC 1992), verbeterde editie 2001 [Eng: Working Population Classifications of Occupations Scheme].

Stein, B. D., Jaycox, L. H., Kataoka, S. H., Wong, M., Tu, W., Elliot, M. N., et al. (2003b). A mental health intervention for

school children exposed to violence. *Journal of the American Medical Association, 290,* 603–611.

Stenseng, F., Belksy, J., Skalicka V. and Wichstrom L. (2015) Social exclusion predicts impaired self-regulation: a 2-year londitudinal panel study including the transition from preschool to school. *Journal of Personality, 83*(2),212-230. doi: https://doi.org/10.1111/jopy.12096

Storch, E. A., Crisp, H., Roberti, J. W., Bagner, D. M., & Masia-Warner, C. (2005). Psychometric evaluation of the social experience questionnaire in adolescents: Descriptive data, reliability, and factorial validity. *Child psychiatry and human development, 36,* 167-176.

Storch, E. A., Masia-Warner C., Crisp H. & Klein R. (2005) Peer victimization and social anxiety in adolescence: A prospective study. *Aggressive Behavior: Official Journal of the International Society for Research on Aggression, 31,* 437-452.

Stroud, L. R., Foster, E., Papandonatos, G. D., Handwerger, K., Granger, D. A., Kivlighan, K. T., & Niaura, R. (2009). Stress response and the adolescent transition: Performance versus peer rejection stressors. *Development and psychopathology*, *21*(1), 47-68.doi: https://doi.org/10.1017/s0954579409000042

Stroud, L. R., Tanofsky-Kraff, M., Wilfley, D. E., & Salovey, P. (2000). The Yale Interpersonal Stressor (YIPS): Affective, physiological, and behavioral responses to a novel interpersonal rejection paradigm. *Annals of Behavioral Medicine*, *22*(3), 204.doi: https://doi.org/10.1007/bf02895115

Strough, J., & Covatto, A. M. (2002). Context and age differences in same-and other-gender peer preferences. *Social Development, 11,* 346-361. doi: https://doi.org/10.1111/1467-9507.00204

Summerfield, D. (1995). Addressing human response to war and atrocity. In *Beyond trauma* (pp. 17-29). Springer, Boston, MA.

T

Taylor, S. E. (2011). Social support: A review.

Thabet, A. A., & Vostanis, P. (2000). Post traumatic stress disorder reactions in children of war: a longitudinal study. *Child abuse & neglect*, *24*(2), 291-298.

Thayer, J. F., Hansen, A. L., Saus-Rose, E., & Johnsen, B. H. (2009). Heart rate variability, prefrontal neural function, and cognitive performance: the neurovisceral integration perspective on self-regulation, adaptation, and health. *Annals of behavioral medicine*, *37*(2), 141-153.

Tieskens, J. M., Buil, J. M., Koot, S., Krabbendam, L., & Van Lier, P. A. (2018). Elementary school children's associations of antisocial behaviour with risk-taking across 7–11 years. *Journal of child psychology and psychiatry*, *59*(10), 1052-1060. doi:10.1111/jcpp.12943

V

Vaillancourt, T., Duku, E., Becker, S., Schmidt, L. A., Nicol, J., Muir, C., & MacMillan, H. (2011). Peer victimization, depressive symptoms, and high salivary cortisol predict poorer memory in children. *Brain and Cognition*, *77*(2), 191-199.doi: https://doi.org/10.1016/j.bandc.2011.06.012

Vaillancourt, T., Hymel, S., & McDougall, P. (2013). The biological underpinnings of peer victimization: Understanding why and how the effects of bullying can last a lifetime. *Theory into Practice, 52*(4), 241-248. doi:10.1080/00405841.2013.829726

van der Wal, M. F., de Wit, C. A. M., & Hirasing, R. A. (2003). Psychosocial health among young victims and offenders

of direct and indirect bullying. *Pediatrics*, 111, 1312-1317.

van Eck, M.M., Nicolson, N.A. (1994). Perceived stress and salivary cortisol in daily life. Annals of Behaviour Medicine, 16, 221-227.

van Lier, P. A., & Koot, H. M. (2010). Developmental cascades of peer relations and symptoms of externalizing and internalizing problems from kindergarten to fourth-grade elementary school. *Development and psychopathology*, *22*(03), 569-582.doi: https://doi.org/10.1017/s0954579410000283

Veenstra, R., Lindenberg, S., Oldehinkel, A. J., de Winter, A. F., Verhulst, F. C., & Ormel, J. (2005). Bullying and victimization in elementary schools: a comparison of bullies, victims, bully/ victims, and uninvolved preadolescents. *Developmental Psychology*, *41*, 672–682.

Verschueren, K., & Koomen, H. M. (2012). Teacher–child relationships from an attachment perspective. *Attachment & human development*, *14*, 205-211. doi: https://doi.org/10.1080/14616734.2012.672260

W

Walsh, S. D., Harel-Fisch, Y., & Fogel-Grinvald, H. (2010). Parents, teachers and peer relations as predictors of risk behaviors and mental well-being among immigrant and Israeli born adolescents. *Social science & medicine*, *70*, 976-984.

Wang, M. T., Brinkworth, M. E., & Eccles, J. S. (2013). The moderation effect of teacher-student relationship on the association between adolescents' self-regulation ability, family conflict, and developmental problems. *Developmental Psychology*, *49*, 690-705. doi: https://doi.org/10.2991/icassr.2013.47

Wang, D., & Fletcher, A. C. (2017). The role of interactions with teachers and conflict with friends in shaping school adjustment. *Social Development*, *26*(3), 545-559.

Watamura, S. E., Kryzer, E. M., & Robertson, S. S., 2009. Cortisol patterns at home and child care: Afternoon differences and evening recovery in children attending very high quality full-day center-based child care. *Journal of Applied Developmental Psychology*, *30*(4), 475-485.

Will, G. J., van Lier, P. A., Crone, E. A., & Güroğlu, B. (2016). Chronic childhood peer rejection is associated with heightened neural responses to social exclusion during adolescence. *Journal of Abnormal Child Psychology*, *44*(1), 43-55.doi: https://doi.org/10.1007/s10802-015-9983-0

Williams, C. R., Ecklund, W. L., Johnston, P. E., & Gage, K. S. (2000). Cluster analysis techniques to separate air motion and hydrometeors in vertical incident profiler observations. *Journal of Atmospheric and Oceanic Technology*, *17*, 949-962.

Williams, R.L. (2000). A note on robust variance estimation for cluster-correlated data. *Biometrics*, *56*, 645–646. doi: https://doi.org/10.1111/j.0006-341x.2000.00645.x

Williams, K. D. (2001). *Ostracism: The power of silence*. New York: Guilford Publications.

Williams, K. D. (2007). Ostracism. *Annual Review Psychology*, *58*, 425-452. doi:10.1146/annurev.psych.58.110405.085641

Williams, K. D. (2007). Ostracism: The kiss of social death. *Social and Personality Psychology Compass*, *1*, 236-247. doi: https://doi.org/10.1111/j.1751-9004.2007.00004.x

Williams, R. (2007). The psychosocial consequences for children of mass violence, terrorism and disasters. *International Review of Psychiatry*, *19*, 263-277.

Wolf, J. M., Nicholls, E., & Chen, E., (2008). Chronic stress, salivary cortisol, and α-amylase in children with asthma and healthy children. *Biological psychology*, *78*, 20-28.

Woodward, L. J., & Fergusson, D. M. (1999). Childhood peer relationship problems and psychosocial adjustment in

late adolescence. *Journal of Abnormal Psychology, 27,* 87-104. doi: https://doi.org/10.1037/e529382014-015

Woodward L.J., & Fergusson D.M., (2000). Childhood peer relationship problems and later risks of educational under-achievement and unemployment. *Journal of Child Psychology and Psychiatry Allied Disciplines*, *41*,191–201.

World Medical Association. (2013). World medical association declaration of helsinki: Ethical principles for medical research involving human subjects. *JAMA, 310*(20), 2191-2194. doi:10.1001/jama.2013.281053

Wust, S., Wolf, J., Hellhammer, D. H., Federenko, I., Schommer, N., & Kirschbaum, C. (2000).The cortisol awakening response-normal values and confounds. *Noise and health*, *2*, 7.

Y

Yeung, R., & Leadbeater, B. (2010). Adults make a difference: the protective effects of parent and teacher emotional support on emotional and behavioral problems of peer-victimized adolescents. *Journal of Community Psychology*, *38*, 80-98. doi: https://doi.org/10.1002/jcop.2035

Young, E. A., Abelson, J., & Lightman, S. L. (2004). Cortisol pulsatility and its role in stress regulation and health. *Frontiers in neuroendocrinology*, *25*(2), 69-76.doi: https://doi.org/10.1016/j.yfrne.2004.07.001.

Young, C. C., & Dietrich, M. S. (2015). Stressful life events, worry, and rumination predict depressive and anxiety symptoms in young adolescents. *Journal of Child and Adolescent Psychiatric Nursing*, *28*, 35-42.

Z

Zwierzynska, K., Wolke, D., & Lereya, T. S. (2013). Peer victimization in childhood and internalizing problems in adolescence: a prospective longitudinal study. *Journal of abnormal child psychology*, *41*(2), 309-323.

English Summary

With the start of elementary school, children and adolescents spend most of their day with their peers in school. Peers provide important feedback and reference about their emotional and social behaviour, which allows them to learn about stress and emotion regulation. Some children are treated poorly by their peers, for instance because they are socially excluded.
Chronic difficulties with peers can be an important source for social stress and have been linked to the development of a wide range of psychological problems, including anxiety, depression, and aggression. These negative outcomes may arise due to an interplay between the child's peer experiences and their stress (re) activity. The studies in this thesis aimed to examine this interplay. The two overarching questions in this thesis addressed our understanding of the role of children's peer environment on children's stress system (re)activity. The purpose of this dissertation was to further our understanding of the role of environmental stress in the pathway of school social stressors, (perceived) stress/stress system activity, and possible negative outcomes such as anxiety.

The theoretical framework described in the introduction makes clear that initial experiences of (negative) social experiences trigger stress. In this dissertation, the focus is on peer acceptance, non-acceptance, relational victimization as indicators of (negative) social experiences. Peer acceptance refers to who is liked in the classroom, whereas non-acceptance indicates who is disliked, which can both be measured through peer nomination scores (Coie et al. 1982). Scoring low on peer acceptance does not necessarily mean that a child is actively disliked. The child may be mostly excluded in the social evaluation among peers (Coie et al. 1990). Being poorly accepted and highly non-accepted by peers is referred to as peer rejection (Deater-Deckard, 2001; Coie et al. 1990). Relational victimization, for example being excluded by peers, is considered a behavioural manifestation of peer rejection (Olweus 1986, 1993). Since peer acceptance and non-acceptance influence each other, it is important to consider both when studying their link with stress system functioning.

The stress system activation allows children to respond in an adaptive manner to peer stressors, such as with increased attention to the social context and alertness. The major stress system is composed of the Autonomic Nervous System (ANS) and the Hypothalamus-Pituitary-Adrenocortical (HPA) axis. Activity of the ANS can be measured at rest and in response to a stressor. Typically, heart rate variability should decrease in response to a stressor (Porges, 1995), so that heart rate can increase to prepare the body to cope with the stressor. Stress (re)activity measures how children respond to everyday stress. The end-product of the HPA-axis is the steroid hormone cortisol. Cortisol levels can be measured at rest and in response to a stressor.

Cortisol concentrations typically rise directly following awakening and decline throughout the day, with a slight peak around noon. However, prolonged forms of stress trigger changes in stress (re) activity, which may lead to chronic peer difficulties and eventually the development of serious mental health problems such as anxiety and depression. Our knowledge on individual differences in stress system activity and what role (negative) social experiences play in these individual differences is far from complete. In this regard, we lack insights into whether associations between peer environmental influences and stress levels actually exist and how children's prior peer environmental influences shape acute stress responses as limited research has been directed at this. The possible effects of the peer environment on children's stress needs to be studied in concert with the broader social and environmental context, as they are likely to mutually influence each other throughout development.

The studies in the first part of this thesis explored the association between peer environmental influences and the stress system. In chapter 2, we tested the association of peer social experiences within the early elementary school classroom with individual differences in cortisol concentration across a day. In chapter 3, we explored acute stress responses to a psychosocial stress task among elementary school children, who either had a history of prolonged negative or positive peer

experiences in the earlier years of elementary school. A psychosocial stress task induces stress during a laboratory procedure, in our case through a conversation with unknown peers, who gradually exclude the child. In Chapter 4, we explored whether warmth in the teacher-student relationship influences the association of (lower) peer acceptance among classroom peers with daytime cortisol levels. Warmth was measured by asking children about their experiences of teacher support. Finally, in Chapter 5 we further dove into the role of the broader context, i.e., living in a war-conflict area, on the link between peer relations, (perceived) stress activity and internalizing (anxiety) symptoms.

To address our questions, data were used from two different datasets. The first dataset was set out to examine the social, behavioural and emotional development in the context of the developing relationships with classroom peers and teachers of Dutch children across the primary school period (Chapters 2, 3 and 4). The original longitudinal study is based on 1500 children from 22 elementary schools in urban and rural areas in the Netherlands. This multi-cohort study started in 2011, children from the oldest cohort were first assessed when they were in group 1 (Dutch group 3). The study was designed to develop an effective stepped prevention system to pinpoint factors that account for the development of problem behaviour at early stage. The second dataset explored how the impact of everyday school social stressors on children's aggressive behaviour and anxiety is affected by environmental stressors. In a natural experimental design, we studied children from schools in three different geographic regions: (A)high stress environment in Israel (defined as living in a region in which citizens have 20 seconds to get into a bomb shelter when alarm sounds), (B) medium stress environment in Israel (60 seconds to get into a bomb shelter), (Chapter 5). The study was based on 600 children attending 20 mainstream elementary schools and examined children annually starting at ages 9-11 years.

Do peer relationships go under the skin?

In chapter 2 we provided insights into daily patterns of children's stress system activity levels at home, outside the classroom environment on a weekend day. Our results revealed that low classroom peer acceptance was associated with heightened stress system activity levels and attenuated changes in stress system activity across a day. These results represent a non-adaptive stress response, as high changes in stress activity are required to respond adaptively to stressful daily events.

Our findings presented in chapter 3 examined whether children, who are both lowly liked and highly disliked by their classroom peers (also referred to as peer rejection), showed altered stress system responses to a new experience of social exclusion, which was tested in a computer game. The results suggest that the stress systems, namely the Hypothalamus-Pituitary-Adrenal (HPA)-axis and the Autonomic Nervous System (ANS) do not respond in concert among low peer preferred children, which could reflect a maladaptive stress response. Low preferred children showed less stress reactivity in response to the new experience of social exclusion, which makes them less prepared to respond to social challenges.

Overall, the results of Chapter 2 and Chapter 3 suggest that already in the elementary school period, adverse social experiences like low peer preference get "under the skin". Both studies emphasized that peer relationships are an important factor in the development of children's stress (re)activity. The combined results of the two studies thus suggest that already in late elementary school period, adverse social experiences like low peer preference affect the stress system (re)activity of children. Our findings suggest that low peer preference represents a social stressor that impacts both major stress systems as early as during childhood. As a response to social stressors, stress system activity is altered, which comes at costs. Altered stress system (re)activity in low peer preferred children is likely linked to less well- developed self-regulation and behavioural problems, although this needs to be further examined.

What is the role of the context in the link between negative social stressors and (perceived) stress system activation?

In Chapter 4 we explored whether warmth in the teacher-student relationship influences the association of (lower) peer acceptance among classroom peers with daytime stress system activation. Warmth was measured by asking children about their experiences of support provided by the teacher. The results of the study in Chapter 4 showed that experiencing a warm teacher-student relationship influenced the association between peer acceptance and the stress system activation. Specifically, total stress system activation levels were highest when peer acceptance was low while these children simultaneously experienced a warm teacher-student relationship. Children with low peer acceptance and a warm teacher-student relationship might experience stress due to the experienced discrepancy in social support in the classroom. Stress system activation was lowest when both peer acceptance and teacher-child warmth were high, which was expected.

In Chapter 5, we explored the role of the broader context on the link between peer relations, (perceived) stress activity and anxiety symptoms. In a natural experimental design, we studied children from schools in three different geographic regions: (A) high stress environment in Israel (defined as living in a region in which citizens have 20 seconds to get into a bomb shelter when alarm sounds), (B) medium stress environment in Israel (60 seconds to get into a bomb shelter). With this design we could assess how living in a broader stressful environment may affect the impact of school social stressors on anxiety development. Children living in these two areas differ in the extent to which they are exposed to air alarms following rocket attacks, with some children living in the Gaza vicinity and being exposed to frequent air alarms, and others living in an area with low exposure to air alarms/rocket attacks. We examined the influencing effect of living in an area with high versus lower threat of rocket attacks on the association between classroom social stressors, perceived stress and the development

of anxiety symptoms in children across a one-year interval. The link of perceived stress to anxiety was only significant among children who lived in the high-threat area, not among those living in the lower threat area. Our study suggests that threat of war-conflict plays a significant role in the relationship between perceived stress and anxiety symptoms.

Overall, the results in chapters 4 and 5 suggest that a discrepancy in social support in the micro-environment (classroom setting; chapter 4) or experienced distress in the macro-environment (living in a war-conflict region; chapter 5) can augment the impact of (perceived) stress from other social sources. Children's capacity to effectively cope with daily stressors may be diminished in children living in a war-conflict region. Consequently, both the immediate classroom environment and the environment in which children live, increases risks for developing anxiety symptoms.

Negative peer relations go skin deep - Implications

Our findings suggest that children with positive peer experiences have a healthy, adaptive stress (re)activity functioning. Low peer preferred children may show altered stress system activity, which might contribute to the inability to respond in an adaptive way, both in terms of behaviour and emotions in response to daily stress. Similarly, heightened stress activation levels and altered stress system responses have been linked to anxiety symptoms. Thus, classroom dynamics bear the risk for developmental problems, including the development of anxiety symptoms. Social experiences in the peer context and the broader environmental context play a key role in the development of children's stress system activity and could further shape their emotional and behavioural outcomes throughout development.

Nederlandse samenvatting

Vanaf het begin van de lagere school brengen kinderen en adolescenten het grootste deel van hun dag door met leeftijdsgenoten, in het Engels *peers* genoemd. *Peers* geven kinderen belangrijke feedback over hun emotionele en sociale gedrag ten opzichte van hun leeftijdsgenoten. Sommige kinderen worden door hun leeftijdsgenoten slecht behandeld, omdat zij bijvoorbeeld sociaal worden buitengesloten en niet bij een vriendengroep kunnen aansluiten. Problemen met leeftijdsgenoten kunnen een belangrijke bron zijn voor sociale stress en kunnen ook een rol spelen bij de ontwikkeling van een breed spectrum aan psychologische problemen, waaronder angst, depressie of agressie. Deze negatieve gevolgen kunnen ontstaan door een wisselwerking tussen de ervaringen met *peers* en iemands eigen gevoeligheid voor stress, die gemeten kan worden met stress (re)activiteit. De studies in dit proefschrift onderzoeken het samenspel tussen deze factoren. De twee overkoepelende vragen in dit proefschrift gaven ons inzicht in de rol van de peer-omgeving van kinderen bij het functioneren van het stresssysteem van kinderen. Het doel hiervan was om ons begrip te vergroten over de invloed van omgevingsstress op (waargenomen) stress en angst.

Het theoretische kader dat in de inleiding wordt beschreven, maakt duidelijk dat (negatieve) sociale ervaringen stress veroorzaken. De (negatieve) sociale ervaringen die in ons onderzoek werden gemeten, waren acceptatie, niet-acceptatie en relationeel pesten. Acceptatie door leeftijdsgenoten geeft aan wie aardig gevonden wordt in de klas, terwijl niet-acceptatie beschrijft wie niet aardig gevonden wordt. Zowel acceptatie als niet-acceptatie door leeftijdsgenoten zijn gemeten door middel van peer-nominatiescores (Coie et al. 1982). Een lage score op acceptatie door leeftijdsgenoten betekent niet noodzakelijkerwijs dat de leeftijdsgenoten van een kind actief een hekel hebben aan dat kind. In hoge mate niet geaccepteerd worden door leeftijdsgenoten betekent dat het kind wordt afgewezen door leeftijdgenoten (Deater-Deckard, 2001; Coie et al. 1990). Relationeel pesten, bijvoorbeeld uitgesloten worden door leeftijdsgenoten, wordt beschouwd als een gedragsmanifestatie van afwijzing door leeftijdsgenoten (Olweus 1986, 1993). Aangezien

acceptatie door leeftijdsgenoten en niet-acceptatie elkaar beïnvloeden, is het belangrijk om beide mee te nemen bij het bestuderen van hun verband met stress.

Het belangrijkste stresssysteem is samengesteld uit het Autonome Zenuwstelsel (ANS) en de Hypothalamus-Hypofyse- Bijnier (HPA) as. Activiteit van de ANS kan worden gemeten in rust en als reactie op een stressor. De hartslag is een maat waarmee de activiteit van het ANS kan worden gemeten, terwijl het cortisolniveau iets zegt over de activiteit van de HPA-as. Cortisolconcentraties stijgen doorgaans direct na het ontwaken en nemen gedurende de dag af, met een lichte piek rond het middaguur. De activering van het stresssysteem stelt kinderen in staat om op een adaptieve manier te reageren op peer -stressoren, zoals met verhoogde aandacht voor de sociale context en alertheid. Langdurige vormen van stress veroorzaken echter tegenovergestelde veranderingen, die kunnen leiden tot chronische peer-problemen en uiteindelijk tot de ontwikkeling van ernstige psychische problemen zoals angst en depressie.

Onze kennis over individuele verschillen in stresssysteemactiviteit en welke rol (negatieve) sociale ervaringen spelen in deze individuele verschillen is verre van compleet. In dit opzicht missen we inzicht in de vraag of relaties tussen peer- omgeving en stressniveaus daadwerkelijk bestaan en in hoeverre peer-omgevingsinvloeden van kinderen acute stressreacties vormgeven. De mogelijke effecten van de peer-omgeving op stressactiviteit van kinderen moeten worden bestudeerd in relatie tot de bredere context, oftewel de leefomgeving van kinderen. De bredere context en de peer-omgeving beïnvloeden waarschijnlijk elkaar tijdens de ontwikkeling.

De studies in het eerste deel van dit proefschrift onderzochten de relatie tussen de peer context en het stresssysteem. In hoofdstuk 2 hebben we de relatie onderzocht tussen sociale ervaringen in de peer context op de basisschool met individuele verschillen in cortisolconcentratie gedurende een dag. In hoofdstuk 3 hebben we acute stressreacties op een psychosociale stresstaak onder basisschoolkinderen onderzocht. Een psychosociale stress taak induceert stress tijdens een procedure in het

laboratorium, in ons geval via een gesprek met onbekende *peers* die het kind steeds een beetje meer buiten sluiten. Kinderen in deze studie hadden een geschiedenis van langdurig negatieve of juist positieve peerervaringen op de basisschool. In hoofdstuk 4 hebben we onderzocht of warmte in de relatie tussen leerkracht en leerling de associatie van (lagere) peer-acceptatie en cortisolniveaus overdag beïnvloedt. Warmte in de relatie met de leerkracht werd gemeten door kinderen te vragen over hun ervaringen van steun door de leerkracht. Hoofdstuk 5 beschrijft de rol van de bredere context, namelijk het leven in een oorlogsconflictgebied op kinderleeftijd, bij het verband tussen peer-relaties, (waargenomen) stressactiviteit en internaliserende (angst) symptomen.

Om onze vragen te beantwoorden werden gegevens uit twee verschillende datasets gebruikt. De eerste dataset was opgezet om de sociale, gedrags- en emotionele ontwikkeling te onderzoeken in de context van de zich ontwikkelende relaties met *peers* en leraren van Nederlandse kinderen in de basisschoolperiode (Hoofstuk 2,3 en 4). Het oorspronkelijke longitudinale onderzoek is gebaseerd op 1500 kinderen van 22 basisscholen in stedelijke en landelijke gebieden in Nederland. Dit multicohortonderzoek is gestart in 2011 en kinderen uit het oudste cohort werden voor het eerst onderzocht in groep 1 (Nederlandse groep 3). De tweede dataset onderzocht hoe de impact van alledaagse sociale stressfactoren op school op het agressieve gedrag en de angst van kinderen wordt beïnvloed door omgevingsstressoren. In een experimenteel ontwerp bestudeerden we kinderen van scholen in drie verschillende geografische regio's: (A)omgeving met hoge stress in Israël (gedefinieerd als wonen in een regio waar burgers 20 seconden de tijd hebben om in een schuilkelder te komen als het alarm afgaat), (B) omgeving met gemiddelde stress in Israël (60 seconden om in een schuilkelder te komen), (hoofdstuk 5). De studie was gebaseerd op 600 kinderen die naar 20 reguliere basisscholen gingen en onderzocht jaarlijks kinderen in de leeftijd van 9-11 jaar.

Gaan peerrelaties onder de huid zitten?

In hoofdstuk 2 hebben we op een weekenddag gekeken naar dagelijkse patronen van stressactiviteit van kinderen buiten de klas-omgeving. Onze resultaten laten zien dat lage peer-acceptatie werd geassocieerd met verhoogde activiteitsniveaus van het stresssysteem en minder veranderingen in stresssysteemactiviteit gedurende een dag. Deze resultaten representeren een niet adaptieve stress respons, omdat hoge veranderingen in stressactiviteit zijn juist nodig om adaptief op stressvolle dagelijkse gebeurtenissen te kunnen reageren.

In hoofdstuk 3 onderzochten wij of kinderen die niet vaak door hun klasgenoten worden aangewezen als leuke kinderen maar juist vaak worden aangewezen als kinderen die niet leuk zijn (ook wel peer afwijzing genoemd) andere stresssysteemreacties op een computer taak laten zien, waarbij uitsluiting door leeftijdsgenoten wordt nagebootst. De resultaten suggereren dat de stresssystemen, namelijk de hypothalamus-hypofyse-bijnier (HPA)-as en het autonome zenuwstelsel (ANS) niet samen reageren bij kinderen met een lage voorkeur door hun *peers*, wat een onaangepaste stressreactie zou kunnen weerspiegelen. Kinderen met een lage voorkeur vertoonden minder stressreactiviteit in reactie op de computer taak.

Over het algemeen suggereren de resultaten van hoofdstuk 2 en hoofdstuk 3 dat, al in de basisschoolperiode, ongunstige sociale ervaringen zoals lage peer preferentie "onder de huid" komen te zitten. Beide studies benadrukten dat peer-relaties een belangrijke factor zijn bij de ontwikkeling van de stress (re)activiteit van kinderen. Onze bevindingen suggereren dat lage peer preferentie een belangrijke sociale stressor is die al in de kindertijd beide stresssystemen beïnvloedt. Als reactie op sociale stressoren wordt de activiteit van het stresssysteem aangepast, wat kosten met zich meebrengt. Veranderde stresssysteem activiteit bij kinderen met lage peer preferentie is waarschijnlijk gekoppeld aan minder goed ontwikkelde zelfregulering en gedragsproblemen, maar dit moet verder onderzocht worden.

Wat is de rol van de context in de relatie tussen negatieve sociale stressoren en (waargenomen) activering van het stresssysteem?

In hoofdstuk 4 hebben we onderzocht of warmte in de relatie tussen leraar en leerling het verband tussen (lagere) peer-acceptatie en activering van het stresssysteem beïnvloedt. Dit bleek inderdaad het geval te zijn. In het bijzonder was de activiteit van het stresssysteem het hoogst wanneer de acceptatie van *peers* laag was, terwijl deze kinderen tegelijkertijd een warme leraar-student-relatie ervoeren. Kinderen met lage peer acceptatie en warme relatie met hun leerkracht kunnen stress ervaren vanwege de ervaren discrepantie in sociale ondersteuning in de klas. De activering van het stresssysteem was het laagst wanneer zowel peer-acceptatie als de warmte in de leraar-kind relatie hoog waren.

Tot slot hebben we in hoofdstuk 5 de rol van de bredere context op het verband tussen peer-relaties, (waargenomen) stressactiviteit en angstsymptomen onderzocht. Voor kinderen die in de Gaza-gebieden wonen, verschilt de mate waarin ze blootgesteld worden aan luchtalarmen na raketaanvallen, waarbij sommige kinderen worden blootgesteld aan frequente luchtalarmen, terwijl anderen in een gebied leven met een lage blootstelling aan luchtalarmen of raketaanvallen. We onderzochten het mogelijke effect van het leven in een gebied met een hoge versus lagere dreiging van raketaanvallen op de associatie tussen sociale stressoren in de klas, waargenomen stress en de ontwikkeling van angstsymptomen bij kinderen gedurende een interval van een jaar bij 9-11-jarige kinderen. De link van waargenomen stress met angst was alleen significant bij kinderen die in het gebied met hoge bedreiging woonden, en niet onder degenen die in het lagere dreigingsgebied wonen. Onze studie suggereert dat dreiging van oorlogsconflict een belangrijke rol speelt in de relatie tussen waargenomen stress en angstsymptomen.

Over het algemeen suggereren de resultaten in hoofdstukken 4 en 5 dat een discrepantie in sociale ondersteuning in de micro-omgeving (klasomgeving; hoofdstuk 4) of ervaringen van stress in

de macro-omgeving (leven in dreigingsgebied; hoofdstuk 5) de impact van (waargenomen) stress resulterend uit andere sociale bronnen kan vergroten. Al met al suggereren de bevindingen van deze twee hoofdstukken dat een hoge stressdrempel die kinderen ervaren in de klas en/of bredere omgeving (waargenomen) stressactiviteit kan beïnvloeden. Het vermogen van kinderen om effectief om te gaan met dagelijkse stressoren kan worden verminderd. Derhalve lijkt zowel de onmiddellijke klasomgeving als de omgeving waarin kinderen leven het risico op angstsymptomen te vergroten.

Negatieve peer-relaties gaan diep onder de huid zitten – implicaties

Onze bevindingen suggereren dat kinderen met positieve peer-ervaringen een gezonde, adaptieve stress (re)activiteit ontwikkelen. Kinderen met lagere peer acceptatie kunnen veranderde activiteit van het stresssysteem vertonen en kunnen daarom mogelijk niet (emotioneel) adaptief reageren op interpersoonlijke uitdagingen. Op dezelfde wijze zijn verhoogde stress activeringsniveaus en veranderde reacties van het stresssysteem gekoppeld aan angstsymptomen. Sociale dynamieken in de klas dragen dus het risico van ontwikkelingsproblemen, die kunnen worden benadrukt door de factoren uit de directe of verdere omgeving. Sociale ervaringen in de peer-context spelen een sleutelrol bij de ontwikkeling van de activiteit van het stresssysteem van kinderen en kunnen hun emotionele en gedragsresultaten beïnvloeden tijdens de verdere ontwikkeling.

About the author

Pia Behnsen was born on August 14th, 1989, in Hamelin, Germany. She graduated from high school (Gymnasium) in 2009 at the Albert Einstein Gymnasium and started the bachelor program Liberal Arts and Sciences, major Social Sciences at Amsterdam University College, a joined honours degree of the University of Amsterdam and Vrije University. After obtaining her bachelor's degree (Cum Laude) in 2012 she joined the research master program Clinical Developmental Psychology at Vrije University. Here, she became interested in child and adolescent development. Following her graduation in 2014, she continued her work in developmental psychology as PhD student at the Vrije Universiteit of Amsterdam under the supervision of prof. dr. Pol van Lier and prof. dr. Anja Huizink. In her PhD project she studied the role of peers in the development of stress system (re) activity and internalizing symptoms using longitudinal observational data. During her PhD, Pia followed a two year clinical training to become a systemic counselor at the Gesellschaft fuer Systemische Therapie in Berlin, Germany. The results of her doctoral work are described in this dissertation. Since March 2020, Pia is currently working as a systemic therapist to implement and extend her knowledge on social relationships, relational dynamics and social-emotional development.

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