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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 min 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.

1. 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 and 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, 2000; Shirtcliff and 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 and 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 min after awakening. Two other cortisol measures represent daytime changes in cortisol concentration, namely the daytime cortisol curve

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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, 2008). Thus, although negative peer experiences may represent (prolonged) stressful social experiences (MacDonald and Leary, 2005; , 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 et al. (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 and Koot, 2010).

2. Methods

2.1. 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 $t(499) = -1.28$, $p = 0.20$, peer non-acceptance $t(499) = 1.01$, $p = 0.31$, and age $t(499) = 8.11$, $p = 0.42$ from the rest of the approached children. Children who participated in the cortisol data collection were equal on peer acceptance $t(1197) = -0.0.34$, $p = 0.73$ and non-acceptance $t(1197) = 1.89$, $p = 0.06$, 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, $t(209) = -0.66$, $p = 0.44$ or peer non-acceptance, $t(210) = 0.73$, $p = 0.47$.

2.2. Design

The current study used data assessed over a one-year period. Children were 5–8 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