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Early neglect and abuse predict diurnal cortisol patterns in adults
A study of international adoptees

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Summary Neglect and abuse early in life have been associated with increased and decreased cortisol levels, and also with an altered diurnal cortisol slope. In the present study, we investigated the long-term relationship between early maltreatment — at different levels of severity — and basal cortisol secretion in adults adopted as children. A sample of international adoptees was followed from childhood to adulthood. In childhood, adoptive parents had provided information about neglect and abuse prior to adoption. As adults, adoptees collected saliva samples four times a day. The relationship between early maltreatment and cortisol secretion was examined, primarily with multilevel analyses in 623 adoptees. Morning cortisol levels were lower in adoptees whose adoptive parents had reported severe neglect or abuse than in non-neglected or non-abused participants (respective estimates (standard errors (SEs)) and *p*-values: −0.33 (0.090), $p = 0.0002$ and −0.63 (0.20), $p = 0.002$). Relative to non-neglected adoptees, those who had allegedly experienced severe neglect also had a flatter diurnal slope (estimate (SE) and *p*-value: 0.028 (0.0088), $p = 0.002$). In contrast, relative to non-abused participants, adoptees whose reported abuse was moderately severe had high cortisol levels and a steeper cortisol diurnal slope (respective estimates (SEs) and *p*-values: 0.29 (0.13), $p = 0.003$ and −0.039 (0.012), $p = 0.01$). Thus, early neglect and abuse appear to have associations with cortisol levels and the diurnal slope, even when children are raised in another environment after their early maltreatment. Our study suggests that the severity of the early maltreatment may be related to the basal cortisol pattern.

1. Introduction

Children who experience neglect or abuse in early childhood are at increased risk for psychiatric problems in

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childhood, adolescence and adulthood (Trickett and McBride-Chang, 1995; Tyler, 2002). It has been proposed that this relationship is underlain at least in part by changes in the hypothalamic–pituitary–adrenocortical (HPA) system (Heim and Nemeroff, 2001; Sánchez et al., 2001), a notion based on studies showing that changes in the HPA axis co-occur with psychiatric problems (DeBellis et al., 1999; Pariante, 2003; Van de Wiel et al., 2004). Because the HPA axis is highly plastic during early life (Gunnar and Vazquez, 2006), its set point and activity can be altered lastingly by extremely stressful experiences in this period, such as early maltreatment.

Several researchers have investigated the association between early maltreatment and basal levels of cortisol, the final product of the HPA system. These authors have observed that alterations in cortisol release caused by early maltreatment encompass two seemingly opposing patterns. In the first pattern, abused children may have higher cortisol levels than non-abused children (Cicchetti and Rogosch, 2001b,a); this relative overproduction of cortisol is termed hypercortisolism. In the second pattern, adults who were abused as children may have lower cortisol levels than adults who were not abused (Heim et al., 2001; Yehuda et al., 2001; Roy, 2002). This relative decrease in cortisol secretion is termed hypocortisolism.

Early maltreatment seems to be related not only to the cortisol level, but also to the diurnal rhythm seen in cortisol secretion. This rhythm is characterized by a quick rise in the cortisol level within the first 30 min after awakening (known as the cortisol awakening response (CAR); Pruessner et al., 1997; Wüst et al., 2000). The cortisol level then decreases, typically reaching a very low level in the evening. Whereas little research has been conducted on the relationship between the cortisol diurnal rhythm and early maltreatment, overall findings indicate that maltreatment is associated with a flatter diurnal slope (Cicchetti and Rogosch, 2001a; Weissbecker et al., 2006). However, some studies found that once the circumstances of a maltreated person had improved, that person's cortisol patterns were likely to have normalized (as reviewed in: Gunnar and Fisher, 2006; Bruce et al., 2000; Fisher, 2005).

Most human research on the effect of early maltreatment on basal cortisol levels has focused on abused participants. These adult studies usually had small sample sizes, and often consisted solely of women (Gunnar and Vazquez, 2006). The results of the few studies which were conducted on the consequences of neglect are inconsistent. Overall, they show that neglect had a minor effect on basal cortisol levels (Gunnar and Vazquez, 2001, 2006). These results are consistent with the conclusion of several animal models (Sánchez et al., 2001).

To determine whether various levels of neglect and abuse in early childhood are associated with cortisol levels under basal conditions in adulthood, we investigated a large sample of adults who had been adopted internationally as children, many of whom had experienced neglect, with or without abuse. As all had been adopted early in life and raised under new circumstances, the maltreatment would presumably have ended post-adoption. Early maltreatment was specified according to its severity.

2. Methods

2.1. Sample and procedure

The sample was derived from a study on international adoptees who were born outside The Netherlands and had been legally adopted by non-relatives in The Netherlands between January 1972 and December 1975. Before adoption, many of the participants in our study had lived under dreadful circumstances. For example, several of them had been extremely malnourished, had suffered from severe physical diseases, or had received hardly any emotional warmth. Half of our sample of international adoptees had come from Korea, Colombia and India; the others came from countries including Indonesia, Bangladesh, Lebanon and Austria.

The adoptive parents of these international adoptees had been approached for participation in research in 1986 (baseline) and 1989–1990 (Time 2). The adopted children of the parents who had participated at baseline were contacted between 1999 and 2002 (Time 3). The details of the sampling procedures are reported elsewhere (Verhulst et al., 1990a; Tieman et al., 2005).

Between January 2004 and February 2006, we sought contact with the 1521 adult adoptees who had participated in the third assessment, except for five individuals who had died, 50 who had emigrated, 10 who had requested at an earlier stage to be removed from the sample, and 77 who were untraceable. Of the 1379 subjects approached, 365 refused to participate and 133 did not respond, leaving 881 who participated (60.1% corrected response rate).

Participants were asked to provide four saliva samples; 831 of them eventually providing saliva (at one or more time point) sufficient for analyses. Because reported information on both forms of early maltreatment was uncertain or missing for 130 of these participants, the people concerned were not included in the sample. This left 701 participants.

Of these 701 participants, 31 used corticosteroid-containing medication, 32 were pregnant, and 13 had extreme outliers in cortisol values (above four standard deviations (SDs) of the mean cortisol levels). Furthermore, the cortisol diurnal rhythms of two participants were reversed; the saliva samples had probably been swapped. These 78 subjects were excluded from analyses, leaving 623 participants. Furthermore, five cortisol samples were excluded because of extreme non-compliance in the time of sampling. Two of these were from people whose daily rhythm had shifted due to breastfeeding, and three were from people who were not compliant with the timing of one of the morning values (more than 50 min between the two cortisol assessments).

This left 623 participants for analyses, and between 601 and 608 valid measurements per sampling moment. Of these 623 adoptees, 345 were women (55.4%). Participants were on average 30.8 years old, and had been adopted at a mean age of 27.0 months. A large group had experienced early maltreatment: 104 had experienced severe neglect, 173 some neglect, and 298 no neglect. Fifteen had experienced severe abuse, 39 some abuse, and 436 no abuse. No information was available on neglect for 48 participants or on abuse for 133 participants; in most cases this was due to uncertainty about maltreatment.