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Age and puberty differences in stress responses during a public speaking task: Do adolescents grow more sensitive to social evaluation?

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Summary During adolescence pubertal development is said to lead to an increase in general stress sensitivity which might create a vulnerability for the emergence of psychopathology during this period. However, the empirical evidence for increasing stress sensitivity is scarce and mixed.

Biological responses (salivary cortisol and alpha-amylase) were investigated during a social-evaluative stressor, the Leiden Public Speaking Task, in 295 nine to 17-year olds. Specific attention was paid to different elements of the task, that is anticipation to and delivery of the speech. Biological reactivity to the speech task increased with age and puberty, particularly during anticipation.

Current findings support the idea that biological stress sensitivity increases during adolescence, at least in response to a social-evaluative situation. The increasing stress sensitivity appears related to both age and pubertal maturation, but unique contribution could not be distinguished. The importance of measuring anticipation is discussed.

1. Introduction

Adolescence has been described as a period of increased stress sensitivity (e.g., Andersen and Teicher, 2008). As a result adolescents are expected to show temporarily increased emotional responding, which Dahl refers to as 'normative affective changes' (Dahl, 2004, p. 7). Whereas infants and children are in someway buffered from stress (e.g., by reliance on the primary caregiver), it seems that the end of childhood is marked by the emergence of adult-like, somatic responses to stress (Gunnar and Vazquez, 2006). Several researchers (see for instance Dahl and Gunnar, 2009) attribute this change in stress sensitivity to puberty.

To study changes in stress sensitivity most research to date has focused on changes in basal levels of different systems (e.g., Kiess et al., 1995; Netherton et al., 2004). However, it is also informative to investigate age differences in the

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resulting stress *responsivity*. In a recent commentary, Spear (2009) commented on the value of studies that assess ''patterns of somatic activation in response to stressors and other challenges during puberty and the broader adolescent period'' (p. 91). Two recent studies (Gunnar et al., 2009b; Stroud et al., 2009) investigated age and puberty effects on stress responses to a social stressor, that is, an adapted version of the (Child) Trier Social Stress Test (TSST; Kirschbaum et al., 1993). The TSST involves an impromptu speech followed by an arithmetic task in front of an audience.

Gunnar et al. (2009b) used the TSST child version in a sample of eighty-two 9—15-year olds. For a subset of this sample ($n = 52$) information on puberty was also available. Stress responsivity was investigated through endocrinological data. Although the task resulted in the expected higher levels of cortisol, developmental effects observed for cortisol responsivity were weak. Fifteen-year olds responded more strongly than 11-year olds ($p < .10$) and puberty was marginally correlated with cortisol responsivity ($p < .10$). Gender differences were not obtained, except for the finding that among 13-year olds, girls had a stronger cortisol response than boys.

Stroud et al. (2009) used social exclusion tasks in addition to an elaborated version of the TSST. Two developmental groups were created based on age and pubertal status (39 children, 7—12 years and 43 adolescents, 13—17 years). The age ranges served as a proxy for Tanner stages I—III (early-mid puberty) and stages IV—V (late puberty). Participants were randomly assigned to either the TSST or social exclusion tasks. Stroud et al. measured changes in several biological stress parameters—including cortisol and alpha-amylase. In line with Gunnar, the task elicited a physical response and adolescents showed increased physical responding compared to children. For the TSST a statistically significant age effect was observed for cortisol, but not alpha-amylase, while for social exclusion tasks the opposite was observed. Gender effects were not studied, because of a lack of power.

Based on these two studies preliminary evidence has been provided for increased biological stress responsivity during adolescence. However, the reported effects are rather weak (Gunnar et al., 2009b) and inconsistent across biological parameters (Stroud et al., 2009). This might be due to: (i) limited statistical power as a result of relatively small samples per developmental group, and (ii) inadequate assessment of pubertal development. Stroud et al. used age as a proxy for puberty, while Gunnar et al. assessed pubertal development for a subset of their sample. The latter makes it difficult to draw firm conclusions about the contribution of puberty to stress sensitivity.

In addition, it might be useful to distinguish between different components of responses to social stressors, that is the anticipatory response to an upcoming stressor and the immediate response to the stressor at hand. Most stress studies try to avoid any form of anticipation within their design, as this might blunt the response to the task itself (Nicolson, 2008). Anticipation is thought to be kept to a minimum when participants have no foreknowledge about the upcoming task. In laboratory public speaking protocols this is accomplished by asking participants to give an impromptu speech; participants are not aware that the experiment includes giving a speech or they do not know ahead of time what their speech should be about (see Gunnar et al., 2009a). However, the distinction between an anticipation effect of an impending speech task and the immediate effect of the speech task itself might be especially important for revealing developmental differences.

Because peers and their opinions become more important during adolescence (Nelson et al., 2004), older adolescents might start to worry about a speech task in advance whereas younger adolescents might respond more strongly while doing the speech. Furthermore, adolescents' advanced cognitive abilities allow them to reflect on upcoming events, which would contribute to more worry before the actual speech and increased anticipatory stress responses. For instance, Muris et al. (2002) showed that among 3—14-year olds participants elaborated on their worries more with increasing age and cognitive development. Hence, anticipation might be particularly sensitive to developmental influences.

1.1. Current study

The main focus of the current paper is whether age and pubertal differences can be observed in stress responsivity as a result of pending social evaluation in a public speaking task. For this reason, a large sample of 9—17-year-old girls and boys was recruited to investigate differences in responsivity related to age and pubertal development. The Leiden Public Speaking Task (Leiden PST; Westenberg et al., 2009) used in the study allowed for a differentiated investigation of an anticipation effect of an impending speech task and the immediate effect of the speech task itself.

Biological responsivity was studied with two components of the human stress system: cortisol as a measure of the response of the hypothalamic—pituitary—adrenocortical axis (HPA-axis), and alpha-amylase as a measure of sympathetic nervous system (SNS) activity. The two branches of the stress response work on different timeframes. Cortisol responds slowly and its peak can be detected around 20 min after a stressor's onset (Nicolson, 2008). It is a suitable measure of enduring stress rather than a short stressor. In contrast, alpha-amylase is released at times when the body needs the most energy, at the time of action (Granger et al., 2007). Consequently, cortisol might be more sensitive to developmental differences during anticipation, whereas alpha-amylase might be more sensitive to developmental differences during the task.

Although gender differences related to biological responsivity have been observed in studies with adults, gender differences have not been observed in youth (e.g., Dedovic et al., 2009). Hence, explicit attention was given to potential gender effects on biological stress responsivity in the current sample of youth.

2. Methods

2.1. Participants

Data used in the current study are part of the Social Anxiety and Normal Development study (SAND; e.g., Miers et al., 2009; Sumter et al., 2009; Westenberg et al., 2009) which was approved by the Leiden University Medical Ethical Committee, the Netherlands and carried out in accordance with the Declaration of Helsinki. Parents provided active