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Multiple time courses of salivary alpha-amylase and dimensions of affect in adolescence

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Summary Previous research has illustrated associations among daily experiences, emotions and stress-responding physiological systems. Recently, investigators have examined salivary alpha-amylase (sAA), a surrogate marker of the autonomic nervous system, and its associations with affect. The current study examined associations among affective valence, arousal and sAA across three different time courses at the momentary, daily and inter-individual level to understand varying influences of adolescents' daily emotional experiences on sAA reactivity and diurnal sAA activity. Adolescents ($N = 82$) provided salivary samples and diary reports of affect and experiences five times a day for three consecutive days. They also completed self-report questionnaires on trait affect. Findings from multilevel growth curves demonstrated that adolescents in our sample displayed typical sAA diurnal rhythms with levels dropping 30 min after waking and then increasing across the day to a peak in the late afternoon. Within person momentary experiences of high arousal positive affect were associated with momentary sAA reactivity. Prior day experiences of high arousal negative affect were associated with a greater amylase awakening response (i.e., greater decrease) and flatter slopes the next day. Trait positive affect was also associated with flatter sAA slopes. Our findings suggest that both affective arousal and valence should be accounted for when examining differences in sAA reactivity and diurnal patterns. Further, our results indicated that emotion-physiology transactions among adolescents occur over varying time scales for salivary alpha-amylase as well as cortisol.

1. Introduction

Daily socioemotional experiences of children and adolescents are associated with changes in physiology across multiple time courses: momentary, day-to-day, yearly, and ontogenetically (Adam, 2012). Alterations across time are hypothesized to be adaptations to sociocultural environments and biological states. Specific momentary and daily

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events, such as experiencing discrete emotions, may differentially affect physiological stress-responding systems. For instance, prior research investigating hypothalamic-pituitary-adrenal (HPA) axis function in adolescents found that momentary loneliness was associated with increased momentary cortisol and high levels of loneliness one day were related to increased cortisol awakening responses the next day (Doane and Adam, 2010). Examining physiological systems in response to socioemotional experiences simultaneously across *multiple* time scales can provide insight into how dimensions of emotion and physiology are related.

Salivary alpha-amylase (sAA) is another valuable surrogate marker to assess stress-related physiological changes. sAA is a digestive enzyme secreted in response to autonomic nervous system (ANS) activation (Granger et al., 2007). Both sympathetic and parasympathetic nervous system innervations stimulate the secretion of sAA via α- and β-adrenergic mechanisms. Therefore, sAA can be conceptualized as a surrogate marker of ANS activation and central noradrenergic activity (Bosch et al., 2011; Cubała and Landowski, 2014). Researchers have also demonstrated causal links between levels of sAA and ANS activity using experimental designs (e.g., Rohleder et al., 2004).

Studies utilizing lab paradigms have shown that sAA responds to a variety of stress tasks and affective stimuli (Nater and Rohleder, 2009). For example, evidence indicates that sAA increases in response to both cognitive tasks (e.g., Noto et al., 2005) and psychosocial stress tasks (Takai et al., 2004; Gordis et al., 2006). Further, sAA is sensitive to emotional stimuli such as affectively-valenced pictures (Bosch et al., 2003; Sánchez-Navarro et al., 2012) and aversive videos (Segal and Cahill, 2009), suggesting that sAA is an indicator of distress. Research has also demonstrated that sAA levels increase in response to stress-provoking experiences in naturalistic settings. For example, researchers have documented increases in sAA concentrations prior to taking an exam (Bosch et al., 1996) and before one's first skydive (Chatterton et al., 1997). Elevated momentary levels of sAA have also been associated with greater chronic stress (Nater et al., 2007).

Despite a growing sAA literature, few researchers have investigated relations between momentary affective experiences and sAA reactivity outside of controlled laboratory settings (i.e., naturalistic sAA reactivity). Nater et al. (2007) reported associations between momentary positive affect and increased sAA, indicating that emotional valence may contribute to specific changes in sAA. A study examining physiological stress reactivity during a naturalistic fear challenge found that sAA concentrations increased in response to fear, but only for those who perceived the experience as negative, indicating that both arousal and valence may stimulate sAA activity (Buchanan et al., 2010). Adam et al. (2011) hypothesized that emotional arousal may be a more salient indicator of sAA reactivity than valence. Their findings demonstrated that momentary sAA levels were associated with high arousal affective states, regardless of emotional valence. sAA exhibits a diurnal pattern opposite that of cortisol: sAA concentrations have a substantial decrease during the 30 min after waking, then increase across the day with peaks in the late afternoon or evening (Nater et al., 2007; Out et al., 2013). Understanding the coupling of affective states and sAA diurnal activity is critical in adolescence given developmental changes in affect and ANS activity (Larson et al., 2003; Adam et al., 2011). Notably, researchers have not yet identified whether daily experiences of emotion are associated with sAA diurnal rhythms the next day. The chronometric model of emotion-stress physiology transactions (Adam, 2012) has only been substantiated with cortisol (e.g., Doane and Adam, 2010); therefore, we examined whether changes in affective states and corresponding sAA activity unfolded over a variety of time courses (Adam, 2012). This hypothesis is supported through research demonstrating relations between interpersonal stress and day-to-day changes in diurnal sAA (Savla et al., 2013), as well as associations between ''trait-like'' emotional disorders (e.g., Post Traumatic Stress Disorder, PTSD; Major Depressive Disorder, MDD) and altered diurnal sAA patterns (Thoma et al., 2012; Cubała and Landowski, 2014). Thus, the current study examined associations among several dimensions of affective experiences and sAA across three different time courses: momentary, daily, and inter-individually, to understand the varying influences of adolescents' daily affective experiences on diurnal sAA activity.

2. Method

2.1. Participants

Data came from a diverse sample of adolescents anticipating college enrollment in the subsequent fall ($N = 82$; see Doane and Zeiders, 2014). Participants were recruited through orientation activities for the psychology department at a large southwestern university and/or through email. Participants were required to live within 35 miles of the university, be a senior in a local high school, and confirm they were coming to the university the subsequent fall. The sample was racially/ethnically diverse and representative of the university: 54% Non Hispanic White, 23% Latino/Hispanic descent, 13% multiracial, 5% African American and 5% Asian American/Pacific Islander (see Table 1). Participants were excluded from analyses for one or more of the following reasons: fibromyalgia ($n = 1$), corticosteroid medication use ($n = 1$), noncompliance with protocols ($n = 2$), insufficient questionnaire data ($n = 2$), or 75% or more of salivary samples with sAA levels below measurement range ($n = 9$). The final analytic sample consisted of 68 adolescents (25% male), aged 17—18 years ($M = 18.04$, $SD = .37$).

2.2. Procedure

Participants selected three typical consecutive weekdays to participate. Weekdays rather than weekends were selected to minimize the influence of varying sleep schedules on ANS activity (e.g., Meerlo et al., 2008). Participants signed consent forms upon delivery of materials to their homes; parental consents were collected for participants under the age of 18. Participants were compensated $40. Study materials included three diary booklets, an actigraph watch, track cap compliance device with straws, vials, and questionnaires. Participants provided salivary samples and diary entries immediately after waking, 30 min later, twice during the day, and at bedtime for three consecutive days (e.g., Adam et al., 2011). In total, participants were required to