

Salivary alpha-amylase levels and big five personality factors in adults

Reprinted from: Neuroendocrinol Lett 2010;31(6): 771–774.

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Key words: salivary alpha-amylase; sympathoadrenal medullary system; big five; aging; personality; stress

Abstract

Salivary alpha-amylase (sAA) has been utilized as a non-invasive measure of sympathoadrenal medullary (SAM) activation. Little is known regarding the relationship between personality inventories and baseline sAA. This study was designed to examine the relationships between the scores of big five inventory (BFI) factors, age, and sAA in adults (aged twenty to seventy years old).

We assessed 97 participants' BFI scores and sAA. The correlations between the BFI factor scores and sAA were examined.

We observed (1) a positive correlation between Neuroticism and sAA, and a negative correlation between Agreeableness and sAA and (2) a positive correlation between age and sAA. These correlations between BFI scores and sAA remained significant after controlling for age. After controlling for age, all BFI factors except Conscientiousness were related to sAA.

Subjects with high Neuroticism and low Extraversion, Agreeableness and Openness may have high sAA. sAA has been demonstrated to be useful for examining the relationship between adrenergic activity and personality, in a non-invasive manner.

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INTRODUCTION

Alpha-amylase is one of the major protein components of saliva. The salivary enzyme alpha-amylase has been proposed as a marker for stress-induced activity of the sympathetic nervous system (SNS) and recent studies have underscored the usefulness of salivary alpha-amylase (sAA) in this regard (Nater *et al.* 2009). It is widely accepted that psychological stress could produce physiological effects. Two primary systems are particularly involved in setting on the stress response, hypothalamus-pituitary-adrenocortical axis (HPA) and sympatho-adrenomedullary (SAM) system. The activation of HPA causes an increase in cortisol secretion in the adrenal cortex; while activation of SAM causes an increase in sAA (van Stegeren *et al.* 2006). Previous studies examined the relationship between big-five personality factors and HPA activation. Schommer and colleagues (1999) in Kirschbaum's group examined the relationship between salivary cortisol and Big-Five Inventory (BFI) factors and found no evidence for a close relationship between personality traits and circadian cortisol rhythm or a single cortisol stress response; while LeBlanc & Ducharme (2005) examined the influences of BFI on plasma cortisol and reported a positive correlation between extraversion and plasma cortisol level and a negative correlation between neuroticism and plasma cortisol. However, to date, no study examined the relationship between baseline sAA levels and personality traits. Because our previous study revealed sAA levels are associated with impulsivity in temporal discounting (Takahashi *et al.* 2007), it is important to examine the relationship between sAA and personality. The present study was designed to investigate the possible influence of personality traits, as revealed by the Big-Five Inventory (BFI), on sAA levels in a group of about one-hundred subjects. The BFI identifies the major components or dimensions of personality. Therefore, the present investigation is important for a better understanding of the role of adrenergic activity in determining personality.

METHODS

Subjects

Participants (N=103) were recruited through advertisements run in local newspapers. Of these, six participants who were unable to provide satisfactory saliva samples due to dry mouth were excluded from the analysis. The mean age of participants was 47.37 years (S.D. = 13.01, range = 21–69) and fifty were male and forty-eight were female.

Experimental protocols

Previous studies have found circadian rhythms in sAA levels (Nater *et al.* 2007; Nater *et al.* 2009). Therefore, in order to avoid potential confounds due to the circadian rhythm, we collected all participants' saliva samples between 9:00 and 9:30AM. Participants were given instructions not to eat or drink anything except for water, and to refrain from physical exercise before the experiment. We collected three salivary alpha-amylase samples from each participant, and calculated the mean of all three samples.

Salivary alpha-amylase assessment

To measure SAM system activity, we measured sAA with the same methodology and device (amylase-monitor, Nipro Co. Ltd, Japan) as in our previous study (Takahashi *et al.* 2007). This device, developed by analytical chemists Yamaguchi *et al.* (2006), utilizes a reagent paper containing 2-chloro-4-O-beta-d-galactopyranosylmaltoside (Gal-G2-CNP), a substrate of amylase. When Gal-G2-CNP is hydrolyzed by amylase, the hydrolyzed product (CNP) changes emission wavelengths (reflectance) with time. The collecting paper was directly inserted into the oral cavity, and approximately 20–30 min microL of saliva was collected from under the tongue over a period of 10 to 30 seconds. The reflectance 30 s after the initial time was automatically measured by the optical device. In total, the measurement of sAA level was completed in approximately one minute. The levels from the three sAA levels of the three samples were significantly correlated with each other (1st and 2nd : $r=0.69$, $p<0.0001$, 1st and 3rd : $r=0.54$, $p<0.0001$, 2nd and 3rd : $r=0.64$, $p<0.0001$).

Measuring Big-Five inventory

To assess participants' personality traits we employed the Japanese version of BFI (Murakami & Murakami, 1999), this scale is based on Goldberg's original BFI (Goldberg, 1992). The BFI assesses five personality factors (Extraversion, Neuroticism, Conscientiousness, Agreeableness, and Openness). This scale consists of 70 questionnaires. Individuals rated the all items on a binary scale (whether each item is applied to them or not). Participants answered the BFI two months before saliva samples were collected. BFI scores were standardized within each age range (20–29, 30–39, 40–49, 50–59, 60–69). Because higher scores of Neuroticism scale in the Japanese version of the BFI correspond to lower scores in the English version, we reversed the Neuroticism scores of the Japanese version before the following statistical analyses.

Demographic and health questionnaires

In the present study, participants completed demographic and health questionnaires. For the demographic questionnaires participants reported sex, age, and other background information. In the health questionnaire participants reported their health conditions and medical history, in order to exclude subjects with neuroendocrine disruptions. Furthermore, participants were asked to report their height and weight, from which we calculated each participant's Body Mass Index (BMI). In addition, participants provided their health related information (i.e. awakening time, smoking status and use of oral contraceptives).

RESULTS

Demographic data

Table 1 shows participants' demographic data (i.e. sex, age, body mass index, smoking status). The sAA levels are similar to those reported in previous studies which employed the same sAA assessment protocols (Yamaguchi *et al.* 2006; Takahashi *et al.* 2007). The present study included an older sample of participants than previous studies (Ben-Aryeh *et al.* 1990; Nater *et al.* 2007). In order to examine the effect of cigarette smoking on sAA levels, we examine the correlations between smoking status and salivary alpha-amylase levels. No significant correlation was found between sAA levels and the number of cigarettes smoked per day, the number of years participants had smoked or the number of diseases reported by participants. Also, the awakening time did not influence sAA levels.

Moreover, no significant correlation between BMI and sAA was observed ($p > 0.1$). Furthermore, we conducted a t-test on sex differences in sAA levels between male and female subjects and found no significant sex difference

Tab. 1. Demographics of participants.

Sex	50 male, 48 female
Age	21-69 (47.34 ± 13.01)
Body mass index (Kg/m ²)	16.85-33.41 (22.63 ± 3.21)
smoking status	76 smoker, 22 non-smoker

(Male sAA ; M = 41.49 kU/L, SD = 48.66, Female sAA ; M = 38.01 kU/L, SD = 39.77, $t(96) = -0.70$, n.s.), consistent with previous studies reporting that there is no sex difference in sAA levels (Rantonen & Meurman 2000; Ben-Aryeh *et al.* 1986).

Salivary alpha-amylase, Big-five, and age

We examined the relationships between BFI factor scores (i.e., Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness) and sAA levels. Consequently, we observed that sAA was positively and negatively correlated with Neuroticism and Agreeableness, respectively. The correlations are presented in Table 2 and the corresponding scatterplots are presented in Figure 1 (Neuroticism) and Figure 2 (Agreeableness).

These correlations suggest that participants with higher sAA levels may have higher scores on Neuroticism and lower scores on Agreeableness. In order to examine the effect of age on sAA, we examined the correlation between participants' age and sAA level. We then observed a positive correlation between age and sAA level ($r=0.31$, $p=0.0005$, see Figure 3). This finding indicates that older subjects may have higher sAA levels.

Finally, because age and sAA level were strongly correlated, we conducted partial correlation analyses that controlling for age in the relationships between BFI scores and sAA level (Table 3). The results demonstrated that Neuroticism was positively and Agreeableness was negatively (partially) correlated with sAA level. This again indicates that participants with higher sAA levels may be higher in Neuroticism and lower in Agreeableness. Furthermore, after controlling for age, we additionally observed negative correlations between sAA and both Extraversion and Openness (Table 3).

Tab. 2. Correlations between Big five inventory factors and salivary alpha-amylase level.

	1	2	3	4	5	6
1 sAA level		-0.16	0.31***	-0.12	-0.21*	-0.18
2 Extraversion			-0.21*	0.24*	0.32**	0.3**
3 Neuroticism				-0.08	-0.12	-0.22*
4 Conscientiousness					0.3**	0.48***
5 Agreeableness						0.28**
6 Openess						-

* $p < 0.05$, ** $p < 0.005$, *** $p < 0.001$

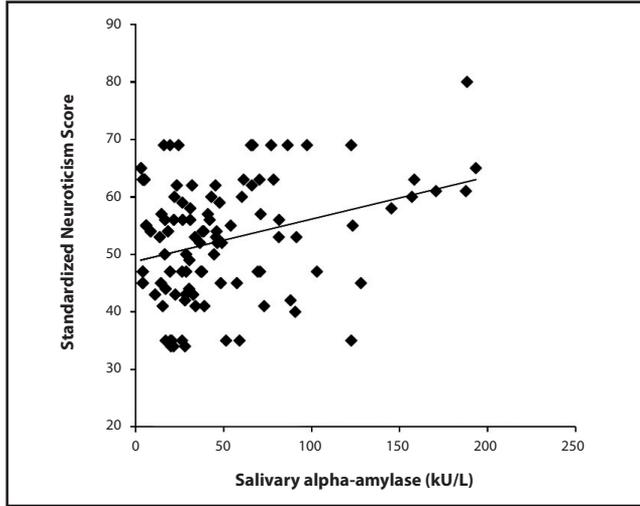


Fig. 1. Scatterplot of sAA level and neuroticism. Vertical axis indicates neuroticism and horizontal axis indicates salivary alpha-amylase level ($r=0.31$).

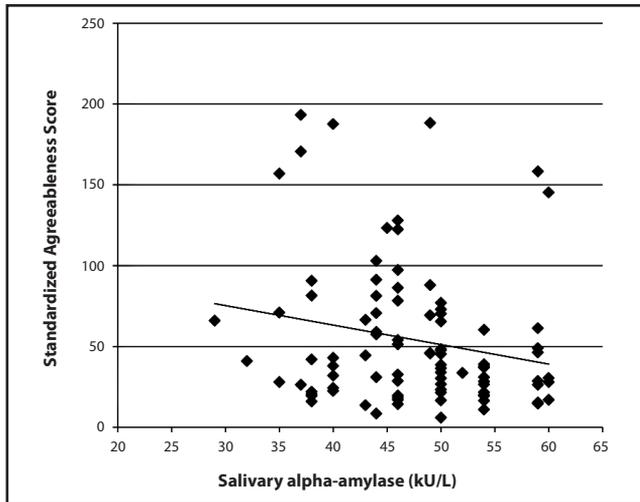


Fig. 2. Scatter plot of sAA level and agreeableness. Vertical axis indicates agreeableness and horizontal axis indicates salivary alpha-amylase levels ($r=-0.21$).

DISCUSSION

This study is the first to (i) observe the relations of salivary alpha-amylase to big five personality factors (i.e., positive: Neuroticism, negative: Extraversion, Agreeableness, Openness, see Table 3) and (ii) clearly demonstrate that salivary alpha-amylase level increases with age. As stated earlier, a previous study

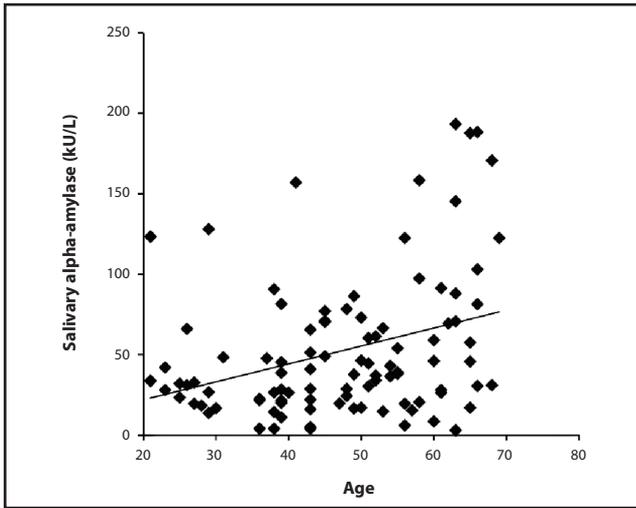


Fig. 3. Scatter plot of age and salivary alpha-amylase level ($r=0.31$). Horizontal axis indicates age and vertical axis indicates salivary alpha-amylase level.

Tab. 3. Partial correlations between Salivary alpha-amylase level and Big-five inventory.

	sAA level
Extraversion	-0.23*
Neuroticism	0.32**
Conscientiousness	-0.07
Agreeableness	-0.24*
Openness	-0.22*

* $p < 0.05$, ** $p < 0.005$, *** $p < 0.001$

by LeBlanc and Ducharme (2005) reported that plasma cortisol level positively correlated with Extraversion and negatively correlated with Neuroticism, which is completely opposite of the current finding in our study regarding the relationship between sAA and BFI factors (see Table 3). This indicates that the relation of SAM activity to personality is opposite of the relation of HPA activity to personality. Future psychoneuroendocrinological studies should investigate psychoneurobiological mechanisms underlying these markedly distinct roles of SAM and HPA systems in determining personality traits. Also, as state in the method section, the assessment of sAA was conducted two-month after the assessment of the BFI factors. Therefore, it can be said that the BFI can predict future sAA, which has implications for the predic-

tion of neuropsychiatric illnesses such as mood disorders by utilizing BFI. Moreover, according to previous studies, the effect of age on sAA has been unclear (Rohleder & Nater 2009). Our present study, for the first time, clearly indicates that age may increase sAA in relatively old people. Future developmental psychoneuroendocrinological studies should examine how changes in SAM systems occur according to aging.

ACKNOWLEDGEMENT

The study reported in this article was supported by Grant-in-aid 19046005 (Toshio Yamagishi) by the Japan Society for the Promotion of Science.

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