Effect of level and duration of steady state noise exposure on salivary alpha-amylase activity in young females

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ABSTRACT

The purpose of this study is to clarify the relationship between noise and salivary alpha-amylase activity (sAA) in order to examine its validity to evaluate auditory effect on humans. Nineteen young females were exposed to 9 combined conditions constituted with three levels (60, 70, and 80 dB L_{Aeq}) and three durations (15, 90, and 300 seconds) of pink noise. The results showed that the higher the noise level and the longer the exposure to noise, the more uncomfortable they felt. There were, however, no significant relationships between the sAA and noise level, exposure duration, and discomfort feeling. It is obvious that the sAA is less sensitive to noise than the subjective responses, although another kinds of noise should be tested in further experiments.

INTRODUCTION

Alpha-amylase activity in saliva of humans has been expected to be a non-invasive and objective biomarker for psychological stress, and various kinds of stressors have been examined (Yamaguchi 2007; Nater and Rohleder 2009). However, little is known about the effect of noise. This study conducts the experiment using human subjects in order to investigate their salivary alpha-amylase activity (sAA) when they are exposed to noise.

METHODOLOGY

The subjects were 19 Japanese female students at Nara Women's University. All of them reported no hearing disabilities and ranged in age from 21 to 35. Each subject gave her written informed consent prior to the experiment, but was not informed of the concrete experimental conditions in order to prevent bias or prejudice concerning each condition. All of the subjects participated voluntarily in all sessions, and were compensated for their participation.

The pink noise published by Architectural Institute of Japan (2004) was used for this experiment. Three durations (15, 90, and 300 seconds) at each of three levels (60, 70, and 80 dB L_{Aeq}) constituted 9 experimental conditions. In order to prevent the order effect, the noise at each condition was presented in a random order to the subjects by using the headphones (VICTOR HP-RX500). After each noise exposure, the subjects reported their impressions of the sound environment by responding to a questionnaire, and set the testing strips for collecting saliva under their tongues. Then the experimenter inserted the strips into the handheld analyzer (NIPRO CM-2.1) and recorded the values of sAA. After the 20 minutes rest, the noise exposure at the other conditions and measurements were conducted in the same manner. At the end of the experiment, the noise sensitivity of the subjects with the range from 0 to 6 was measured by means of WNS-6B (Kishikawa et al. 2006).

The raw values of sAA [kU/L] were converted to the AMY [dimensionless] with the range from 1 to 5 as follows (Higashi et al. 2004).

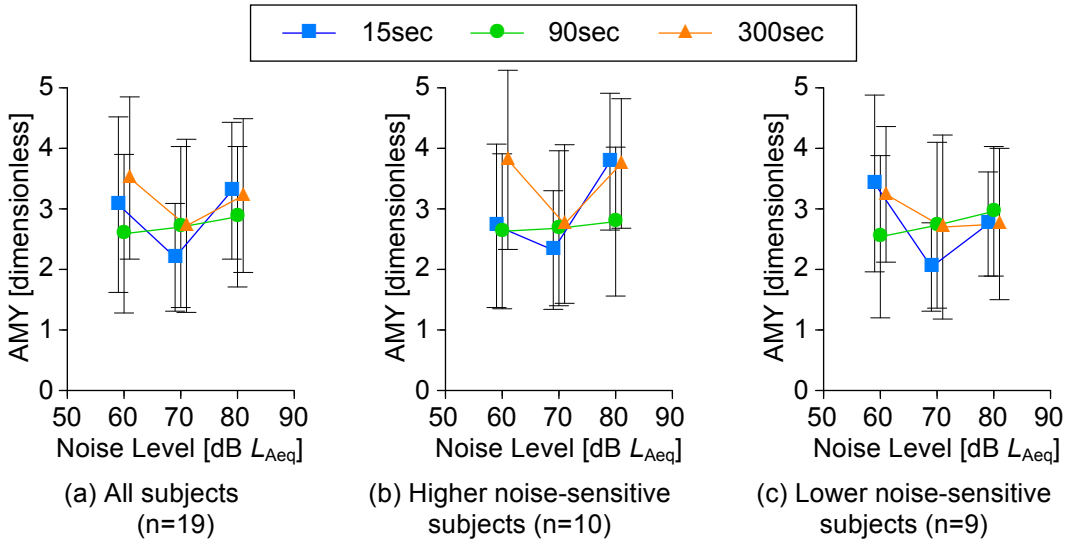

Figure 1: AMY vs noise level

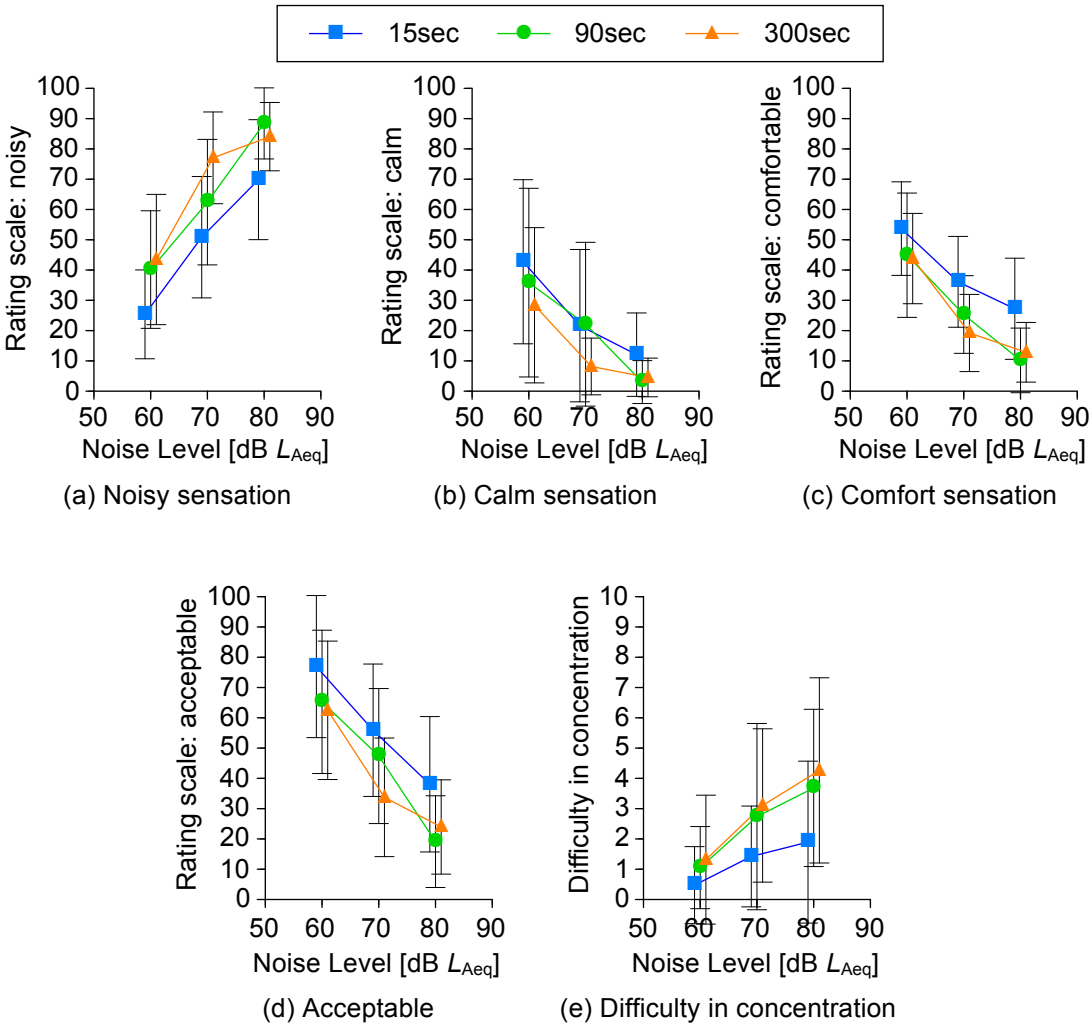

Figure 2: Subjective response vs noise level

Table 1: The results of two-factor ANOVAs with regard to the subjective responses

Probability	Noisy	Calm	Comfortable	Acceptable	Difficulty in concentration
Main effect: noise level	0.000	0.000	0.000	0.000	0.000
Main effect: duration	0.000	0.000	0.000	0.000	0.000
Interaction	0.079	0.308	0.338	0.153	0.092

$$AMY = 4\frac{sAA - sAA_{min}}{sAA_{MAX} - sAA_{min}} + 1$$

Where, the sAA_{MAX} [kU/L] and sAA_{min} [kU/L] indicate the maximum and minimum sAA of each subject, respectively.

Five linear scales, so-called visual analogue scales, with regard to auditory feelings, and ten closed questions for measuring difficulty in concentration proposed by the Industrial Fatigue Research Committee of the Japan Society for Industrial Health (1970) were provided in the questionnaire. A numerical value from 0 to 100 was assigned to each response on the linear scale, and the number of “yes” responses was counted as a measure of difficulty in concentration.

RESULTS

Figs. 1(a) to 1(c) show the relationship between the noise level and the AMY for each

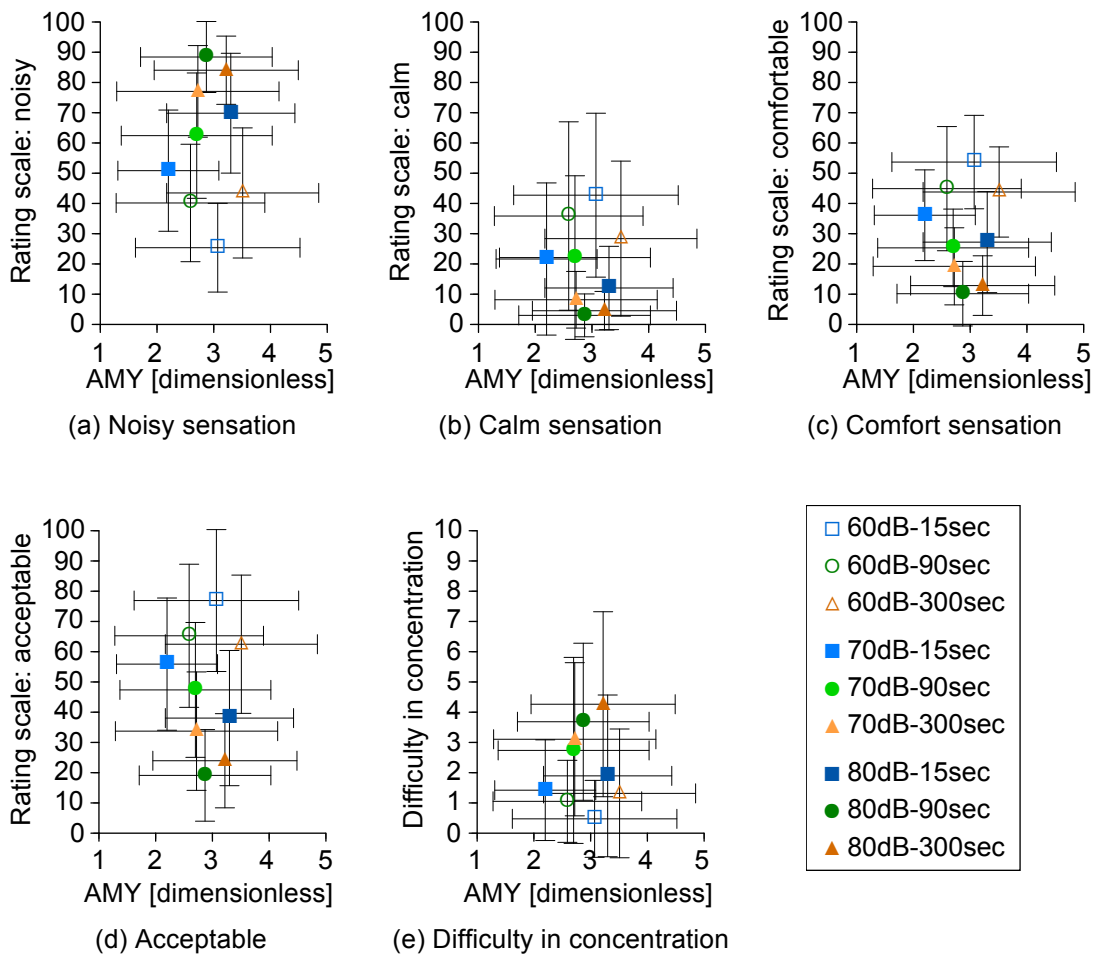

Figure 3: Subjective response vs AMY

duration time. As shown in Fig. 1(a) which indicated the results for all subjects, the AMY increased slightly with the increase of the noise level at 90 seconds condition, but represented the lowest at the middle level of 70 dB in cases of 15 and 300 seconds conditions. Figs. 1(b) and 1(c) also represented the AMY had little correlation to level and duration of noise even with regard to the insensible and sensible subjects who scored 0 to 3 and 4 to 6 on the WNS-6B respectively. The results of two-factor ANOVAs showed that both level and duration of noise had little significant effects on the AMY.

Figs. 2(a) to 2(e) show the relationship between the noise level and the subjective responses for each duration time. With higher noise level and with longer exposure, the noisy sensation and the difficulty in concentration increased and the calm, comfortable, and acceptable feelings decreased. Table 1 shows the results of two-factor ANOVAs. All of them were not only significantly associated with the main effects of noise level but duration time as well, but not with the interaction.

Figs. 3(a) to 3(e) show the relationship between the AMY and these subjective responses for each condition. The AMY correlated poorly with all subjective responses.

DISCUSSION

The results of this study indicate that the sAA has poor correlations with noise level, duration of noise exposure, and the subjective responses, regardless of whether a subject is sensitive to noise. The finding with regard to the noise level should be reproducible, since the previous study (Morrison et al. 2003) have reported that the level of hospital noise did not show a significant correlation with the sAA of 11 nurses. However, this could be due to the facts that three different levels and three different durations in this experiment are not very distinct, and that the steady pink noise are not very stressful compared with some significant stimuli such like footage of corneal transplant operation (Aragaki 2004) or 40-minute aerobic exercise (Nakabayashi et al. 2009). At least it is obvious that the sAA is less sensitive to noise than the subjective responses by the visual analogue scales or closed questions for measuring difficulty in concentration.

CONCLUSIONS

There are not many physiological methods to evaluate objectively the effect of moderate noise which can give us uncomfortable feelings but not pain. If the sAA could reflect sufficiently the strength of psychological stress due to noise, this method would contribute greatly to the advance of noise study. It is concluded that some sort of improvement or ingenuity must be required in order to evaluate the human response to noise by using the sAA, although higher noise level, longer exposure to noise, and another kinds of noise should be tested in further experiments prior to concluding that noise has no effect on the sAA.

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