Effects of Negative Air Ions on
Task Performance, Mood and Physiological Indices

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Negative air ions can be generated by an electric discharge with high voltage and a water drop breakup (Lenard effect). Regarding a development of riverside, around where the negative air ions are mainly produced by the Lenard effects, the purpose of this study is to examine the effects of negative air ions produced by the Lenard effects. Therefore, they were generated using an ultrasonic humidifier that can make a very fine water spray.

Fifteen male students participated in this study. Two experimental sessions were continuously performed. After five-minute resting period (PRE), subjects were instructed to perform five-minute mental arithmetic tasks (MTH). Then they took a rest (POST) again. These three experimental blocks (PRE, MTH and POST) were repeated twice in the same manner except the negative air ion density. A half of the subjects were exposed by negatively ionized air in the first session. On the contrary, the negative air ions were given in the second session for the other half subjects after the normal air session (control). In the negative ion condition, the average ion density was 1350 ions/cm³. The negative air ions were generated during whole session including PRE and POST resting periods. The negative ion density in the normal air condition was 390 ions/cm³. Average room temperature and relative humidity in both conditions were 25.3 C, 56.6%, 25.7 C, 40.5%, respectively.

The mental arithmetic task contained five levels of difficulty. The subject always started from the medium level (level 3). From then on, the task level automatically shifted according to the subject’s response, i.e., when his response was correct, the level went up and vice versa. The arithmetic equations were presented every five seconds despite their responses. This task method (MATH) was proposed by Turner et al (1986). The average difficulty level and mean reaction time (msec) for sixty answers were obtained as performance indexes.

A 92-word checklist was constructed from State and Trait Anxiety Inventory (20 items), Stress Arousal Checklist (30 items) and Profiles of Mood States (65 items) by rejecting identical items. These 92 items were presented on the CRT screen one by one and were checked in the same manner with a four-point rating scale (“definitely”, “slightly”, “cannot decide” and “not”) by mouse. Ten mood scales, state anxiety, stress, arousal, tension-anxiety (T-A), anger-hostility (A-H), depression-dejection (D-D), vigor, fatigue, friendliness, and confusion-bewilderment (C) were obtained before and after every block (totally ten times). A subjective workload score (WWL: Weighted Workload) was also obtained by the NASA-Task Load Index after every task (totally four times).

The ECG from the CM₅ lead, arterial blood pressure at the radial artery using the non invasive arterial tonometry method, photoelectric finger plethysmogram (PTG) from a left index finger, respiration by the strain-gauge around the chest, tissue blood volume from a nasal tip by the Laser-Doppler flow meter (MASS), cerebral regional oxygen saturation (rSaO₂) and hemoglobin volume (HbI) on right and left prefrontal by the near-infrared spectroscopy, and EEG (Fz, Cz and Oz) were continuously recorded. Following parameters were calculated from above signals: low frequency component (LF), high frequency component (HF), LF/HF ratios (LF/HF), total power (TP) from the heart rate variability spectral analysis, heart rate (HR), PTG amplitudes (PTG amp), PTG baseline fluctuation (PTG trend), blood volume (BV), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Pulse Pressure (PP), mean blood pressure (MBP), rSaO₂, and HbI.

One participant was rejected from the following analysis because the ion density in the negative ion condition was considerably low. All variables were standardized in each participant and tested with MANOVA (SPSS) with the following within subject factors: ION (two levels: control vs ion), BLOCK (three levels: PRE,
MTH and POST for physiological parameters, three levels: before TASK, after TASK, after REST for mood scales) and ORDER (two levels: session 1 and session 2).

Results on moods showed that the state anxiety score and the confusion score were significantly lower in the ION condition than control (p<0.05 and p<0.01). The WWL had no significant differences between the conditions. Mental Demand, one of the six subscales of the NASA-TLX, was lower in the ION condition, but it did not reach the significant level (p<0.10). No significant difference was found in task performance scores between conditions.

The HRV TP and HF power were significantly lower in the ION condition (p<0.05 and p<0.05). The PP and SBP showed significantly high values in the ION condition. The PTG trend is larger in the ION condition (p<0.05), but no significant difference was found in PTG amp. The HR and MASS did not show significant differences between conditions. The right rSaO$_2$ and left Hbl were lower in ION condition (p<0.05 and p<0.05) and Hbl showed higher variation (CV) on the right side (p<0.10).

The results did not clearly support previously reported effects, i.e., relaxation, performance improvement, parasympathetic nervous system activity enhancement, etc. It may due to relatively low ion density and short-term exposure. However, some negative moods and a subjective workload subscale may be eased by negative air ions. It is reported that negative air ions stimulate vibrant health and left people with an exhilarated feeling (Heinerman, 1997). This effect may sometimes enhance sympathetic nervous system activity. It is possible that above results is due to difference in humidity between the conditions because the negative air ions were generated using a humidifier, and relative humidity in the ION condition was much higher than the Non-ion condition. However, as far as negative air ions are produced by the Lenard effects, the effects of humidity may not be separated.

REFERENCES
Heinerman, J., 1997 Negative Ion Regeneration For Youthfulness and Longevity, Retrieved from: watershed.net/negion_longevity_art.htm

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