Experimental procedure of Household Activities and Physical Activity

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Abstract

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Protocol

Step 1.

Before performing the experiments, we explained the SCWT to the participants and they practiced 10 sheets of SCWT (six of congruent and four of incongruent conditions). The screen showed one word. After the participants answered, they used the Enter Key to advance to the next screen.

Step 2.

The participants' frontal area was covered with optodes. The optodes were set based on the lower center probe, which was anchored at Fpz according to the international 10-20 system. We used 27 optodes comprising 14 light emitters and 13 light detectors to obtain 42-channel measurements of cortical hemodynamic changes. The distance between pairs of detector probes was set at 3.0 cm. To obtain three-channel measurements of skin blood flow, we used three optodes comprising light detectors to the right, middle, and left of the prefrontal cortex. The distance between these detector probes was set at 1.5 cm.

Step 3.

SCWT was conducted for a total length of 5 min and 30 s. The screen showed one word for both congruent and incongruent tasks. After the participants answered, they used the Enter Key to advance to the next screen. In addition, for the purpose of alleviating the noises in hemodynamics due to physical exercise, subjects placed their chin on the holder in a sitting position and performed the SCWT. The SCWT had a periodic block design involving task (30 s) and rest (20 s) blocks. The task blocks comprised three congruent and three incongruent blocks. There were seven rest blocks. The contents of the three congruent and three incongruent blocks were different and randomized. Whether the test was started with a congruent or an incongruent block was counterbalanced using a random number table.

Step 4.

The heart rate of subjects was recorded in a sitting position.

Step 5.

Subjects performed two experiments: HA and control. The HA and control experiments were performed on different days in a randomized order. The HA experiments included vacuuming a dirty floor. For the HA experiment, there were shreds of paper (total 8 g) and plastic balls with a diameter of 6 mm (total of 100 balls) on the floor within an area of 2.2 × 1.8 m. Participants were instructed to vacuum the floor as completely as possible in 10 min, including preparing (retrieve the vacuum cleaner and plug in the cord) and returning (unplug the cord and return the vacuum cleaner) the vacuum cleaner.

The control experiments required participants to perform the motion of vacuuming as a physical activity task so that the intensity of the physical activity of the HA and control experiments was equal. The control experiments included performing the motions of vacuuming a clean floor. While executing the motion of vacuuming as a physical activity task, there were no paper shreds or plastic balls on the floor within an area of 2.2 × 1.8 m. Participants were instructed to imitate the motion of vacuuming for 10 min, including preparing (only retrieve the vacuum cleaner) and returning (only return the vacuum cleaner) the vacuum cleaner.

The heart rate was recorded every 2 min during the tasks of vacuuming and just executing the motions.

Step 6.

In both experiments, a 5-min rest time in a sitting position was set after the vacuuming and control tasks.

Step 7.

In the same way, prior to the vacuuming and control tasks, the SCWT was conducted again.

Step 8.

After the HA experiments, participants were asked to state the level of their feeling of accomplishment on a 5-point Likert scale.

Step 9.

The channel coordinates on the Montreal Neurological Institute standard template were localized by the probabilistic registration method using a 3D digitizer (FASTRAK, Polhemus, Colchester, VT, USA). This enabled us to localize a probabilistic estimate of the structural labels of the Talairach Daemon, which are based on Brodmann areas. We used six regions of interest (ROIs): channels 21, 29, and 38 were localized in the right frontopolar prefrontal cortex; channels 22, 31, and 39 were localized in the left frontopolar prefrontal cortex; channels 2, 3, 11, and 12 were localized in the right dorsolateral prefrontal cortex; channels 6, 7, 14, and 15 were localized in the left dorsolateral prefrontal cortex; channels 18, 35, and 36 were localized in the right ventrolateral prefrontal cortex; and channels 25, 41, and 42 were localized in the left ventrolateral prefrontal cortex.

Step 10.

We converted the oxy-Hb signal to a numerical value for statistical analysis. We performed a baseline correlation using LABNIRS prior to the analysis. Before the initiation of the task period, the optional data range area with points of 0 and 5.0 s for the rest period was set as the baseline. The skin blood

flow was removed using segment-independent component analysis within the fNIRS software. Independent component analysis was performed in a segment that distinguishes 42 channels of cerebral blood flow and three of skin blood flow. The component in which the coefficient of spatial uniformity for three components of skin blood flow was over 0.5 was selected among the 42 components of cerebral blood flow, and the component with high correlation was removed. To exclude the noises due to heart rate and respiration, the changes in the oxy-Hb signals were smoothed with a moving average.

Step 11.

The heart rate of subjects was recorded in a supine position on another day. Participants supinely rested for 15 min for relaxation. Subsequently, the heart rate was measured for 1 min. Participants were instructed not to speak and to minimize movement during data collection.