

# **Acute effect of parent-child communications using animal-shaped snack foods on cognitive performance: A pilot study**

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## **Abstract**

Communication with parents is important for the growth of children. We discovered that parent-child communications while eating crunchy snacks enhanced the creativity and frontal lobe gamma wave power of the children.

## **Introduction**

Communication with parents is important for the growth of children. Since the developing brain shows high levels of neural plasticity, communication with parents is expected to have a great influence on brain development. Few studies have investigated the effect of snack foods as a tool of communication. In this study, we examined the influence of parent-child talking over snacks shaped like 17 kinds of seafood, such as squid, shrimp, crab, and octopus, on imagination and electroencephalograms in children. In this study, we report the results of the pilot experiment.

## **Methods**

### *Experimental scheme*

The procedure of our experiment is shown in Figure 1A. Before each experiment, an electroencephalograph (EEG) recorder was attached to a child, and the EEG recording was started. A session consisted of EEG with the child's eyes closed (1 minute), EEG with the eyes open (1 minute), an explanation of the imagination test (picture 0) (2 minutes), the imagination test itself (photos 1-3) (1.5 minutes), parent-child communication (5 minutes), EEG with the eyes closed (1 minute), EEG with the eyes open (1 minute), and a second imagination test (photos 2-4) (1.5 minutes). The EEG recorder was removed immediately after the session.

### *Imagination test*

Five black-and-white photographs that are often used in the Rorschach test were

employed (images #0-4 in Fig. 1B). Image #0 was used to explain the imagination test to each parent and child pair. The explanation was given as follows: (1) A time limit of 30 s is allowed for each image; (2) during the time limit, a child must provide as many answers as possible about what a part of the image or the entire image looks like; (3) there is no correct or incorrect answer. At the explanation stage, the children were given sufficient time to respond to the image with at least one voluntary item. Images #1-3 were used before the communication, whereas images #2-4 were used after the communication. The total number of answers during the image presentation and the latency from the start of the presentation of a new image to the first answer were measured.

#### *Human EEG*

Six healthy children (two males and four females,  $25.9 \pm 5.4$  years old, mean  $\pm$  SD) participated in our EEG experiments. The experiment contained two conditions (eyes open and eyes closed). One EEG session took approximately 30 min. EEGs at AF7, Fpz, AF8, F3, Fz, F4, and Cz (following the international 10/10 coordinate convention) were collected at 500 Hz (the right earlobe was used as a reference) with a wireless EEG system (Polymate Mini AP108, Miyuki Giken Co., Ltd, Tokyo, Japan) with pasteless dry electrodes (National Institute of Information and Communications Technology, Japan) (Naruse, 2014). Eye movements and blinks were simultaneously recorded with an electrode put on the left eyelid. The recorded EEG and eye-blink-related signals were saved on a computer using the Mobile Acquisition Monitor Program (NoruPro Light Systems) through a Bluetooth wireless connection. The EEGs were analyzed using the EEGLAB MATLAB toolbox and in-house subroutines written in MATLAB (Delorme and Makeig, 2004). The raw data were preprocessed offline by linear trend removal and bandpass filtering (1 to 40 Hz). Additionally, EEG epochs that contained large potentials were identified by visual inspection and excluded. These noisy epochs were generally derived from eye movements and blinks. To explore whether the alpha, beta, or gamma power during the post-eye-opening period differed from the values during the pre-eye-opening period, two-tailed paired *t*-tests were used.

#### *Communications*

A parent and a child sat side by side at a table and had a free conversation for 5 min while eating snacks. Because Ottotto (manufactured by Morinaga), crunchy, grain-based crackers that are shaped like 18 different sea creatures, was provided as the snack, the main content of the dyad's communication was about the animals, for example, "What is this animal?" or "Look for an octopus."

#### **Results and Discussion**

We evaluated the influence of parent-child communications over crunchy snacks on

children's imagination and speech ability using the imagination test. Prior to the snacks and the parent-child communications, the total number of answers that each child gave to images #2 and #3 was  $3.5 \pm 0.8$  (mean  $\pm$  SD of 6 subjects). It significantly increased to  $5.3 \pm 1.6$  after the communications (Fig. 2A;  $P = 0.031$ ,  $Z = 2.232$ , Wilcoxon signed rank test;  $P < 0.05$ , Shapiro-Wilk normality test). The latencies from the start of presenting the first image to the first answer were  $11.6 \pm 9.4$  s before the communications and  $6.5 \pm 4.3$  after the communications, and the effect was not significant ( $P = 0.50$ ,  $T = 64.5$ , Mann-Whitney rank-sum test;  $n = 18$  sessions of 6 subjects). Therefore, the parent-child communications with crunchy snacks were likely to enhance the children's imagination. This finding is consistent with our behavioral observation of children, which shows a tendency for communications to stimulate active utterance by children.

We analyzed EEGs of the frontal and parietal lobe before and after the parent-child communications over crunchy snacks. Out of a total of six participants, three participants in which a peak in the alpha band power was evident during the closed-eye period before and after the communications were used in the subsequent analyses because of high data reliability. Analysis revealed that the gamma power on the left side of the frontal lobe increased after the communications (Fig. 3). The frontal lobe is a neocortical area that is greatly developed in primates, including humans, and is thought to contribute to higher-level cognitive functions. In addition, the gamma band is suggested to be involved in concentration and imagination. Taken together with the results of the imagination tests, the EEG results show that parent-child communications over crunchy snacks, specifically, the animal-shaped snacks used in this study, may have a beneficial effect on cognitive functions such as imagination and communication skills in children. Our work investigated only an acute effect, and further studies are necessary to reveal longer-term effects on the development of cognitive functions.

## References

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- Naruse Y (2014) Development of mobile wireless EEG system with dry electrode. *Proc Life Eng Symp* 1:130-132.

## Notes

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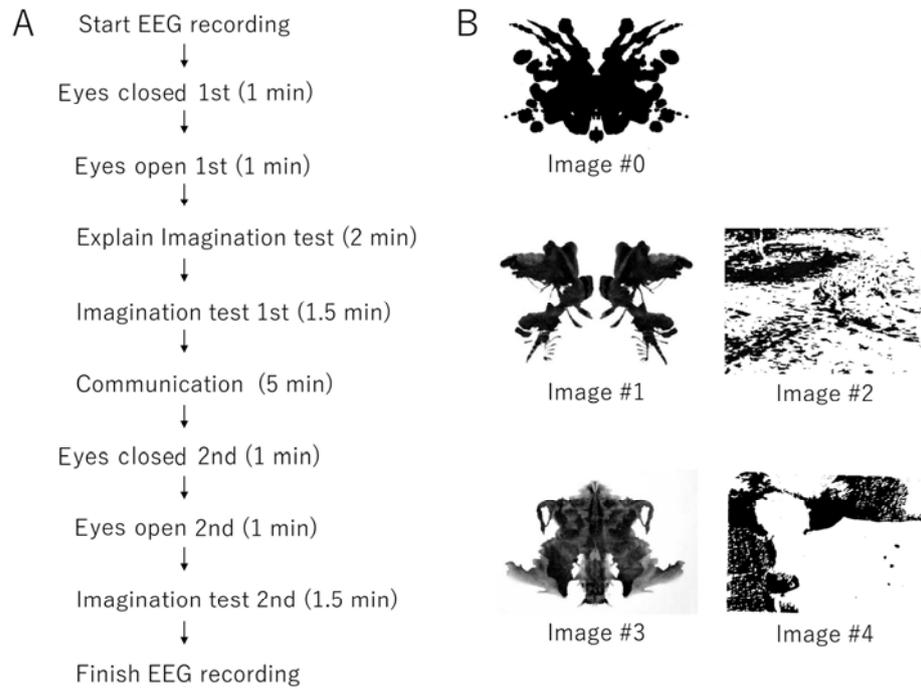


Figure 1. Experimental paradigm A. Time course of a single experimental section. B. The five images used in the imagination test.

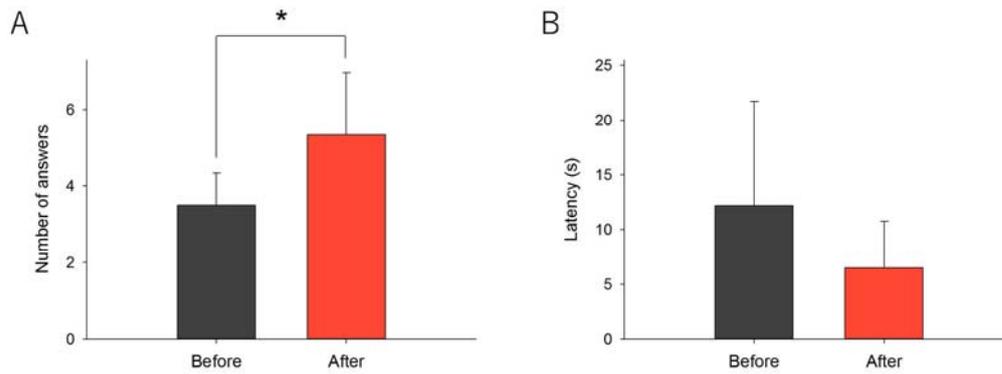


Figure 2. Imagination test results A. The total numbers of items (answers) increased after the parent-child communications. ( $P < 0.05$ , normality test (Shapiro-Wilk);  $*P = 0.031$ ,  $Z = 2.232$ ,  $n = 6$ , Wilcoxon signed-rank test). B. The latencies to the first answers tended to be smaller after the parent-child communications.  $P < 0.05$ , normality test (Shapiro-Wilk);  $P = 0.502$ ,  $T = 64.5$ ,  $n$  (big) = 18,  $n$  (small) = 6, Mann-Whitney rank-sum test.

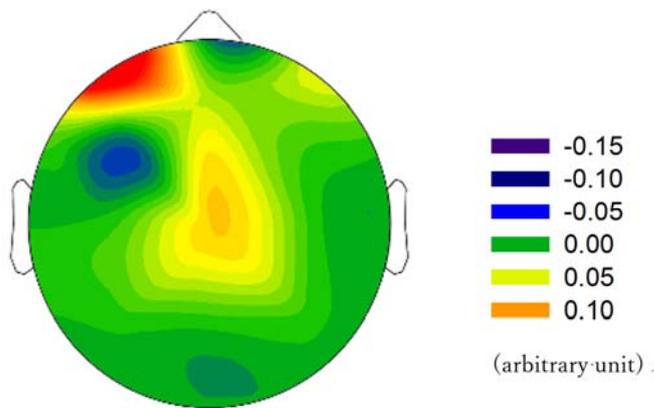


Figure 3. Changes in the EEG gamma power after parent-child communications. Electroencephalograms were recorded from seven electrodes placed on the frontal and parietal lobes. The average values of the EEG gamma power changes of three participants between the pre- and post-communication periods are displayed in a pseudocolor scale. The gamma power of the left frontal lobe was increased after the parent-child communications.