

## Mechanism of visual information processing of geometric patterns

Mikiko Kumamoto, Tsutomu Shimono and Keiichi Mitani

Department of Behavioral Pediatric Dentistry,  
Graduate School of Medicine and Dentistry, Okayama University  
2-5-1 Shikata-cho, Okayama 700-8525, JAPAN

**Abstract** Brain activation is known to occur in the process of visual recognition, but the details of the mechanism are still unknown. In this study, we examined the behavioral and visual scanning patterns of rats to investigate the effectiveness of visual recognition of a triangle as visual stimulus in the Progressive Relaxation Method<sup>1)</sup>. The results indicated no difference in the rats' residence time between an inverted and upright triangle when the figures were displayed. For the gazing pattern, the rats gazed more at the right side of the inverted triangle (angled upwards to the right) than at the left side (angled upwards to the left). The opposite result was seen for the upright triangle with the rat gazing more at the left than the right side. The cause for this difference in the gazing frequency is in the angulation of the side, angled upwards to the right or left, rather than the location of the side, situated on the left or right. Furthermore, the gazing time for an inverted triangle was longer than that for an upright triangle, clearly indicating the effect of location of the upper-right angled side on the frequency of gazing. These results suggest the possibility of a high level of ease and preference in rats for visual scanning of an inverted triangle and its right side.

### Key words

Amenity,  
Dental fear,  
Intermittent stimulus,  
Progressive Relaxation Method,  
Visual environment,  
Visual stimulus

### Introduction

Studies related to dental fear, a universal problem in dental treatment, have been conducted mainly in the Western. Milgrom *et al.*<sup>2)</sup> and Kleinknecht *et al.*<sup>3)</sup> have reported that 76% and 75%, respectively, of the people in the United States have some type of dental fear. Additionally, Domoto and Weinstein have reported that approximately 80% of the surveyed subjects in Japan have dental fear<sup>4)</sup>. Many studies have concluded that this type of dental fear is the primary hindrance to patients' receiving dental treatments<sup>5)</sup>. An improvement in the amenities of the treatment rooms, for example placement of decorative plants or usage of fragrance, has been implemented as one method of relieving dental fear.

We examined the application of the Progressive Relaxation Method, which was developed by Edmund Jacobson and modified by Mitani *et al.*, to relieve patients of their dental fear, namely extreme mental strain. The characteristic of this method is the requirement for an intermittent stimulus in order to effectively transition from the state of mental and physical strain to that of relaxation. Eye movement and muscular tension in the hands have been shown to be effective stimuli. Hubel and Wiesel used macaque monkeys and chicks to clearly show that the striate body, the primary visual cortex, responded best to a line segment in a specific orientation<sup>6)</sup>. However, the most effective orientation differed by cells which are called "directionally-selective cells". They function in an innate way and degenerate with disuse<sup>7)</sup>. Hubel, Wiesel, and Stryker did not state whether or not the degree of inclination of a straight line could cause the difference in visual interest<sup>8)</sup>.

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Received on March 31, 2005

Accepted on June 2, 2005

Mitani *et al.* showed that rats directed more visual interest toward a horizontal line than a vertical line<sup>9,10</sup>. In addition, Hebb stated that a line angled upward to the right excites one class of neurons in the cortex, and a line angled upward to the left or a horizontal line each excites a different class of neurons<sup>11</sup>. From these findings and their own experiment using rats, Mitani and Xu indicated that the rats' visual interest in a triangle is innately and significantly stronger than interest in a circle. Kumamoto *et al.* demonstrated rats' preferences for an inverted triangle over an upright triangle and for a line angled upwards to the right over the left<sup>12</sup>.

In this study, we displayed to rats figures of Kenneth Noland's painting "The 17th step", which satisfied the requirements of the results from previous studies<sup>12</sup>, as a stimulus and examined rats' behaviors. We hoped that the results of this study will indicate a possible application of visual stimuli such as angled lines and triangles in patient's visual environment as intermittent stimuli in the Progressive Relaxation Method to relieve patients

of their dental fear.

## Materials and Methods

We used 8-week old Wistar rats that had no learning experience of specific geometric pattern recognition. Their average weight was 249 g. The purchased rats were raised in a breeding box in a dark room at 21°C with 58% humidity. The rats were habituated to the experimental environment beginning three days prior to the start of the experiment.

The displayed figure was Kenneth Noland's 1964 painting "The 17th Step" (Figs. 1a to c). The base of the large inverted triangle was 18.7 cm and that of a small inverted triangle was 9.35 cm. The small inverted triangle was rotated 180° to give the small upright triangle. The large and small inverted triangles are similar triangles and the right side is slightly longer than the left side. Therefore, the apex angle of the inverted triangle is to the left of the perpendicular bisector of the base. Data analysis was performed using the chi-squared test.

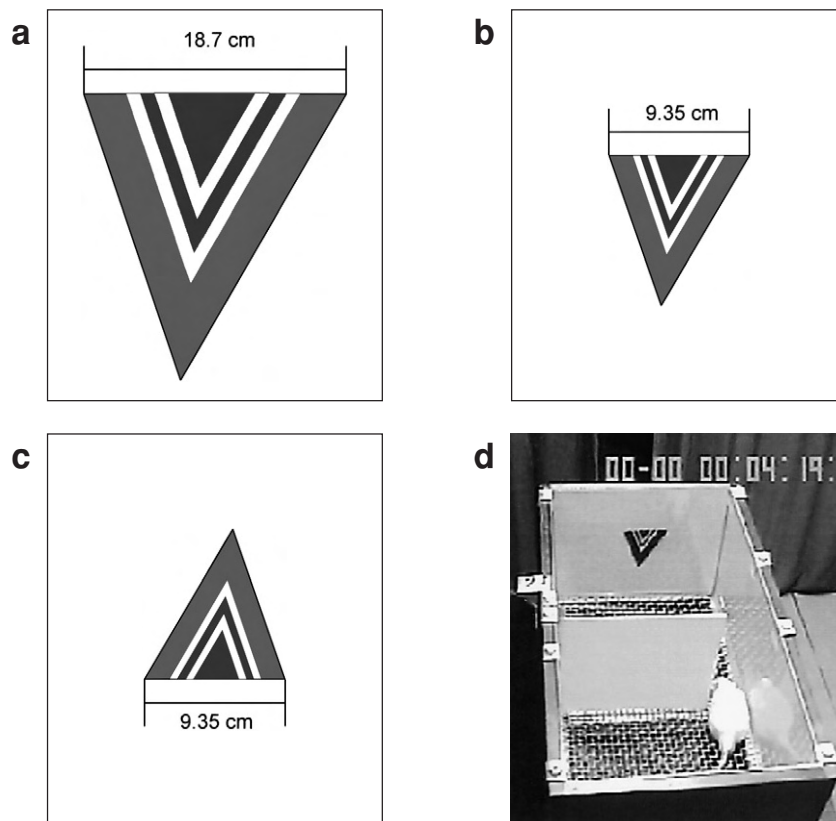


Fig. 1 Scheme of displayed triangles and breeding box

**a:** Large inverted triangle **b:** Small inverted triangle **c:** Small upright triangle **d:** photograph of breeding box

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