

Table 1 ECL intensities of different cycles between the wild-type and the mutant samples

Cycles	ECL intensity(cps)			
	undigested wild-type sample	digested wild-type sample	undigested mutant sample	digested mutant sample
25	46.0±2.0	48.0±2.4	47.0±1.6	5.0±0.4
30	178.0±6.0	175.0±5.0	176.0±6.0	7.0±1.0
35	214.0±8.0	209.0±6.4	212.0±7.0	6.0±0.7

restriction endonuclease technology, was used to detect point mutation of codon 235 of *PS-1* gene *in vitro*. The results show that this method can reliably discriminate the wild-type and the mutant genes with high sensitivity, speed, accuracy and easiness of operation. The method supplies a new approach for detecting the point mutation of FAD-related genes. It may be applied in the early diagnosis of Alzheimer's disease.

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Effects of pattern shape on adaptation of dLGN cell

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Abstract Pattern adaptation is one of the fundamental sensory processes in the visual system. In this study, we compared pattern adaptation induced by two types of sinusoidal drifting grating in dLGN cells of cat. The two types of grating have the same parameters (e.g. spatial frequency, temporal frequency and contrast) except their pattern shapes, one of which is normal grating and the other annular grating. The results suggested that the annular grating elicited stronger response and stronger pattern adaptation than the normal grating. This is consistent with the adaptation and aftereffect to the two types of drifting gratings seen in psychology and may reflect the subcortical neural mechanism underlying these psychological phenomena.

Keywords: cat, dLGN, pattern adaptation, normal grating, annular grating.

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Pattern recognition and pattern adaptation are important functions of the visual system on information processing, but it is still unclear which level of the visual pathway they initiate. It is widely agreed that the cells processing the complicated information of object shape (e.g. the contour of the object, the orientation of one line) are located in areas 17 and 18 of the visual cortex and the senior cortex^[1—4]. De Weerd and his colleagues (1994) studied the cell responses in visual cortex and subcortex of cat using focal brain lesions, and found that, when areas 17 and 18 were damaged, the animal was still able to recognize the object shape. However, when the subcortical inputs to these areas were damaged, the ability of recognition was abolished. This suggested that the subcortex is related to the shape recognition function^[5]. Nothdurft and his colleagues' study (1990) in cat dLGN cells revealed that if the shape of dots constructing a pattern was different, the responses would be different, and the differences were more obvious when the cell was stimulated by the edge of the patterns^[6]. Shou et al. first reported that the dLGN cells had pattern adaptation, and the pattern adaptation was not due to the feedback from visual cortex^[7].

The psychological experiments indicate that the adaptation and the aftereffect induced by annular grating are stronger than those induced by normal grating^[3]. In

this study, we recorded the response and compared the degree of pattern adaptation of dLGN cells of cat induced by these two types of grating. We also studied the differences of the adaptations and response amplitudes in dLGN cells induced by different patterns. Furthermore, we tried to support the results that the response amplitude of cell has consanguineous correlations with the recognition of object's shape in the subcortical visual system.

1 Materials and methods

The preparation of animals used in this research is reported previously^[7,8]. Fifteen adult cats (weight 2.1—3.6 kg) were used. Program written in Visual C was used to generate the visual stimulus, on a 17-inch Philips CRT monitor. The stimulus was restricted in a circular area with the diameter of 18 cm (equal to 7° visual angle). The mean luminance of pattern was 19 cd/m², and the environment luminance on the cornea was 0.1 lux. The distance from the screen to animal eyes is 142 cm (2.5 cm on the screen is equal to 1° visual angle). The visual stimulus in this study is shown in Fig. 1. The spatial frequency and temporal frequency of grating were optimal for the recorded cell, and the luminance and contrast of the grating were the same for the recorded cell. In most conditions of our experiments, the temporal frequency was kept at 3 Hz and the contrast value was always kept at 0.9. The drifting sinusoidal grating on screen lasted 30 s, 90 cycles. While the stimulus was normal grating, its orientation was optimal to the cell. The annular grating could have two moving directions (inward and outward). To eliminate the influence of flash, a static grating lasting for 5 s was presented on the screen prior to the moving grating.

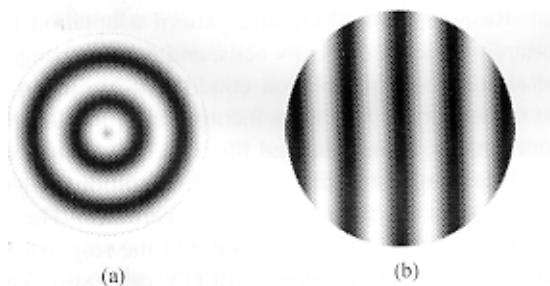


Fig. 1. The annular grating and normal grating used in the experiment. The region of pattern stimulation is a circle with the diameter of 18 cm (equal to 7° visual angle). The black part of the grating presents dark, and the white part presents bright. The luminance of the grating is tuned sinusoidally. (a) An annular grating, which can drift in two directions (inward and outward). (b) A normal grating, which can have orientation from 0 to 180°.

Two types of electrodes were used in our experiment. One is the tungsten-in-glass microelectrode, with impedances from 2 to 20 M Ω . The other was glass microelectrode filled with 3 mol/L NaCl, whose tip was 1—2 μ m and impedance was 5—10 M Ω . The electrical signals

were amplified with an intracellular amplifier (Nihon Kohden, MEZ-8201, Japan) and an extracellular pre-amplifier (KDS-1, China), and then digitized by an ITC-18 data collector (Instrutech, USA) with sample intervals of 100 μ s.

Before recording, the cat optic disk was projected upon a white screen positioned 142 cm from the eye to determine the position of the area centralis. For each cell recorded, receptor field was determined on the white screen to figure out the eccentricity and to determine the relevant position of receptor field on retina. Data acquisition and analysis was done in the Igor software (WaveMetrics, USA). Before visual stimulation the spontaneous responses of the cells were recorded for background exclusion purposes. Spikes discrimination was done by software. An example of peristimulus-time histograms (PSTHs) is shown in Fig. 2. One single column represents the response in 5 cycles of stimulation. Each complete recording contained 18 columns. The amplitude of the first column was defined as the initial value, while the average amplitude from the seventh to the seventeenth columns was defined as the plateau value. The adaptation index was defined as the ratio between the plateau response and the initial response^[7].

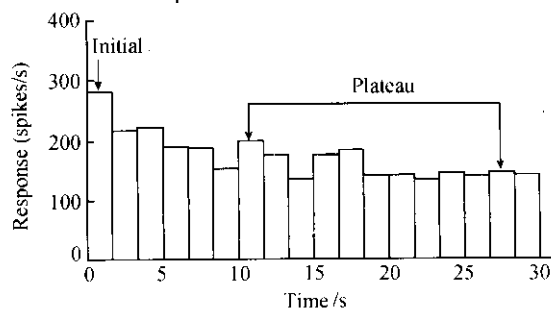


Fig. 2. The PSTH of the response amplitude in stimuli. The ordinate shows the visual response amplitudes and the abscissa shows time. One single column represents 5 cycles of stimulation. Each complete recording lasts 30 s, and contains 18 columns. The amplitude of the first column is defined as the initial value, while the average amplitude from the seventh to seventeenth columns is defined as the plateau value. Adaptation index (AI)=plateau value/initial value.

2 Results

In this study, we recorded 53 dLGN cells. Most of the cells showed obvious differences in response amplitudes and adaptation indices when stimulated by the two different patterns.

(i) The effect of annular and normal gratings stimulations on response amplitude of dLGN cell. Fig. 3 is the cell number histogram showing the response difference of dLGN cells elicited by annular and normal grating stimulations among 53 dLGN cells. When stimulated by annular grating, 39 (74%) cells showed larger response amplitudes than those stimulated by normal grating. The response amplitude increased by 29%, and the response amplitude difference in these two conditions was significant (*t*-test, $P < 0.000002$).

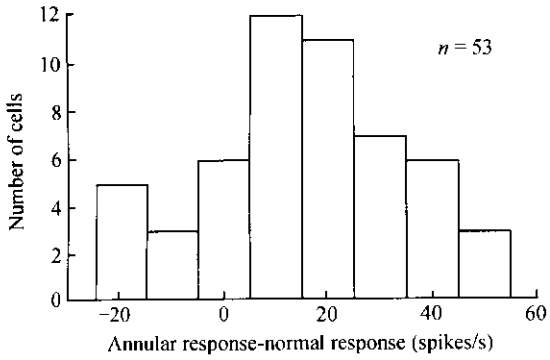


Fig. 3. The effects of annular and normal gratings on visual response amplitude of dLGN cells. The ordinate shows the number of cells, and the abscissa shows the difference of the visual response amplitude of cells when stimulated by annular and normal gratings (The response amplitude is defined by the average response).

(ii) The effect of annular and normal grating stimulations on pattern adaptation of dLGN cell. In the visual system, the response amplitude reduced gradually when the neuron was stimulated with repeated visual patterns. This kind of pattern adaptation is one of the important properties of dLGN cells. In the experiments, we compared the index of the pattern adaptations of dLGN cells stimulated by two types of gratings. Fig. 4(a) and (b)

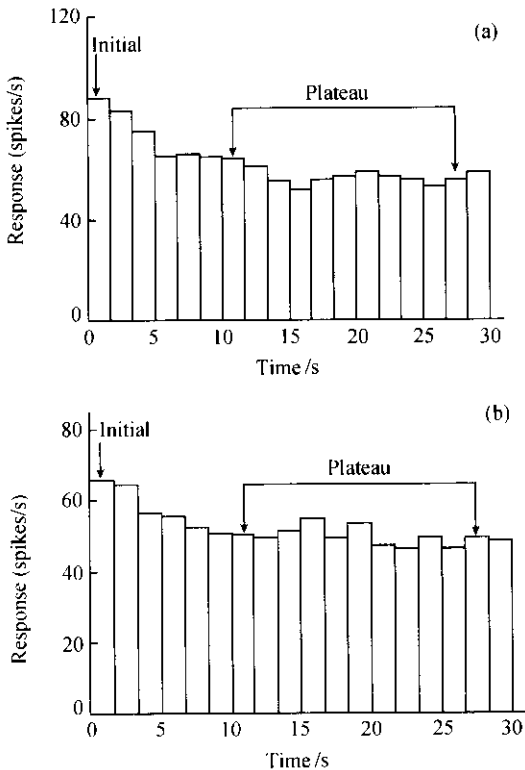


Fig. 4. The PSTHs of the responses amplitude when stimulated by annular and normal gratings. (a) The PSTH of the responses amplitude when stimulated by annular grating. (b) The PSTH of the response amplitude when stimulated by normal grating. In (a) and (b), the ordinate shows the visual response amplitude and the abscissa shows time.

shows the PSTHs of a dLGN cell when it was stimulated by normal grating and annular grating respectively. The adaptation index of cell stimulated by annular grating (AI = 0.65) is less than that stimulated by normal grating (AI = 0.76). Fig. 5 shows the comparison of the adaptation index between the situations of two types gratings. The average AI was 0.79 ± 0.10 for annular grating and 0.91 ± 0.19 for normal grating, and their difference was significant (*t*-test, $P < 0.0001$). Compared with the normal grating, about 36 (68%) dLGN cells' AI decreased in the annular grating condition.

3 Discussion

A number of assumptions have been proposed on the mechanism underlying pattern recognition in visual cortex. Most assumptions focused on the pattern adaptation of cells^[1,2,9]. The original studies indicated that pattern adaptation was a property of cortical cells, not of subcortical cells. Shou and his colleagues demonstrated that some dLGN cells exhibited a significant degree of adaptation^[7,10]. From our results, we confirmed Shou's assumption, and provided the evidence that the shape of pattern could influence the pattern adaptations of dLGN cells.

The grating shape and movement direction were the only differences between the two types of gratings in our experimental setup. Because some dLGN cells show orientation sensitivity, the optimal orientation of those cells was used so that the cells could reach their best response when stimulated by normal grating. However, the response elicited by the normal grating was still weaker than that elicited by the annular grating. This suggests that the annular grating is more effective stimulus.

Response amplitude and pattern adaptation are important properties of dLGN cells, and can be changed with the alteration of stimulation conditions. These properties are the important functions incorporating the information from outside. Hammond and his colleagues' study on visual cortex suggested that pattern recognition was related to the extent of adaptation of the cells^[9,11]. The results shown in Figs. 3 and 5 indicated that the response amplitude and adaptation index of dLGN cells stimulated by annular grating were greater than those by normal grating. These differences suggested that the responses of the dLGN cells were different to these two types of drifting grating. Because of the consistency of other optical parameters in our experiment setup, the difference in response amplitude and adaptation index of cells can only be accounted for by the different shapes of the stimulation gratings.

When the moving grating drifted through the receptor field of dLGN cell, the grating would pass through the annular surrounding and center receptor field, and the

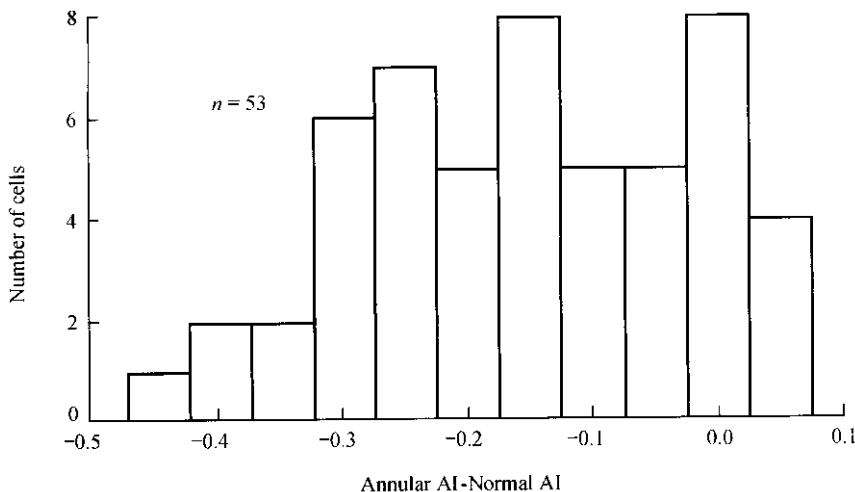


Fig. 5. The effects of annular and normal gratings on adaptation index of dLGN cells. The ordinate shows the number of cells, and the abscissa shows the difference of the adaptation index of cells when stimulated by annular and normal gratings.

response in the center could be depressed by that in the surrounding. When the normal grating with optimal spatial frequency drifted across the receptor field, one part of grating in the center and some others in the surrounding, the effect of the grating in surrounding could depress the response in center, so the response of the dLGN would be weaker. When the annular grating with optimal spatial frequency drifted across the receptor field, and the center of the grating on the center of receptor field, the grating drifted across the surrounding and center of receptor field in turn, and the depression of the surrounding would be less, so the response of the dLGN would be greater in this case. The results in visual cortex indicated that there would be aftereffect in the cells stimulated by grating. Only a part of the normal grating drifted across the surrounding and center receptor field of cell in turn, so the aftereffect of the stimulation would be weaker to the next grating, and the adaptation would be relatively weak. Whereas the annular grating could drift across receptor field holistically in turn, the aftereffect would be stronger, and the adaptation of the cell would be more significant.

Because of the difference of the proportion of pattern appearing in the surrounding and center of receptor field, and the difference of depressive effect from the surrounding to the center, the response amplitude and the pattern adaptation would be different. Therefore the recognition of object's shape at the single cell level was related to the pattern adaptation resulting from the depression.

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