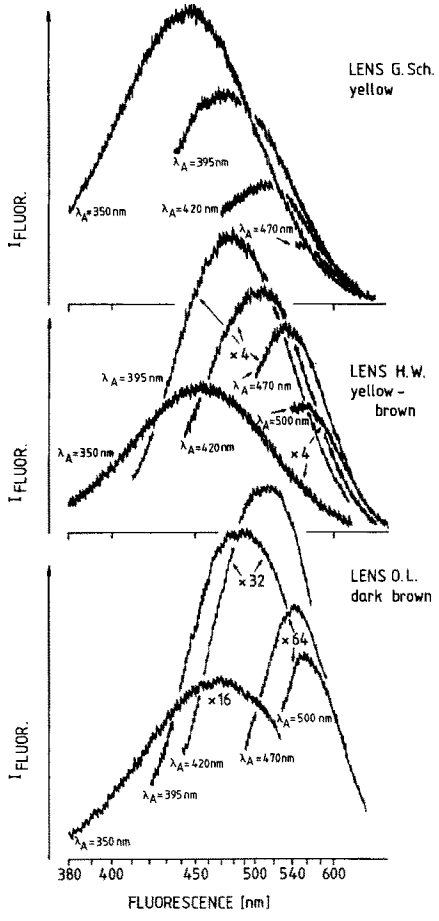

Fig. 1. Fluorescence spectra obtained with three different-colored lenses after excitation with 350, 395, 420, 470, and 500 nm. For comparison, the intensity of the spectra must be multiplied by the factors given

disease. Since a light yellow lens already exhibits a well-expressed fluorescence pattern, it should be possible to detect a very early cataract formation, especially if this method can be used in vivo. At present, a suitable apparatus is under construction.

Ascorbic acid solutions, as is well known, change their color from transparent to yellow, brown and finally to dark brown with time ("aging"). This effect seems to be due to autooxidation; the products formed are, however, still unknown. A freshly prepared ascorbic acid solution, which is transparent, has no fluorescence at all. This again corresponds to the healthy lens, at least for the excitation wavelengths above 395 nm. The "aged", colored ascorbic acid solutions exhibit the same fluorescence spectra as the lenses if the appropriate and corresponding colors are used. Because of the similarity of the fluorescence spectra between lenses and colored ascorbic acid solutions, the former are not shown separately. These results indicate strongly that the chromophores described recently [4] might be identical with ascorbic acid in its different oxidation states which are colored and still have to be identified. The colorless reduced state of ascorbic acid, present normally in tissues, is not fluorescent.

These observations support the finding that oxidative processes seem to be responsible for cataract formation [5, 7]. As a result of this, ascorbic acid will be oxidized either directly or indirectly by diminishing the concentration of, e.g., red. glutathione [7–9].

From the results obtained, one might conclude that this new sensitive technique, in which monochromatic excitation (between 350 and 500 nm) and spectral registration over a certain wavelength interval (370–650 nm) is used, will permit the detection of physiological changes very early in the course of nuclear cataract and might be applied, if therapy should be available later on, for monitoring the progress in treatment. The fluorescence spectra allow an accurate determination of the actual state of the disease. Since they resemble those obtained with colored (oxidized) ascorbic acid solutions, the results indicate a disturbance of the ascorbic acid metabolism or of its redox system, which might be either the result or the cause of cataract formation. Because of the availability of ascorbic acid in the lens as a natural substance, no administration of an artificial chromophore, such as fluorescein, is required. At present, more detailed investigations concerning the involvement of other biomolecules and their interaction(s) with ascorbic acid in cataract formation are being conducted.

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Neuronal Oscillations in the Human Brain

Discontinuous Initiations of Pursuit Eye Movements Indicate a 30-Hz temporal Framework for Visual Information Processing

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In experiments on temporal information processing, one particular number continually occurs. This number is 30 ms. For instance, histograms of simple or choice reaction time are often multimodal with an intermodal distance of approximately 30 ms [1, 2] when reaction times are sampled under stationary conditions. Order threshold in the visual, auditory and tactile modality is close to 30 ms [3]. Several other studies on temporal processing using different experimental paradigms have also resulted in this value (e.g., [4]; for an overview see [5]), indicating an underlying oscillatory mechanism. Histograms for the latencies of saccadic eye movements are often also multimodal, showing intermodal distances of 30 to 40 ms [6]. Here we re-

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port an observation on the discontinuous initiation of pursuit eye movements. Again, the intervals between the modes in the histogram characterizing the latency of pursuit eye movements are close to 30 ms. We believe that the multiple occurrence of 30 ms in a variety of temporal tasks cannot be due to chance, but indicates a general neuronal mechanism that coordinates the processing of sensory information and consequently the motor output.

Pursuit eye movements were recorded in three subjects using an infrared reflection technique. Both eyes have been recorded simultaneously. The pursuit movements were triggered by a visual stimulus that moved with constant velocity in horizontal direction. The circular target had a diameter of 15 min visual angle and it was projected onto a screen with a luminance of 1 cd m^{-2} at a distance of 56 cm. Target movements were initiated after a short period of fixation when the eyes were at primary position. Target velocities were varied between 1 and 10 deg s^{-1}. The head of the subjects was fixed using a bite-board in order to obtain stable recordings and to prevent eye movements induced by vestibular stimulation. In these experiments the spatial resolution of the recording system was 6 min visual angle and the temporal resolution was 3 ms.

An example of a typical eye movement response under these conditions is shown in Fig. 1 for the left eye of one subject. After a latency of approximately 130 ms a pursuit movement can be seen (arrow) which is followed after a short interval by a "catch-up" saccade bringing the visual axis onto the moving target. Then the target is followed by a pursuit movement. In the example shown here the target moved with 6 deg s^{-1} to the right.

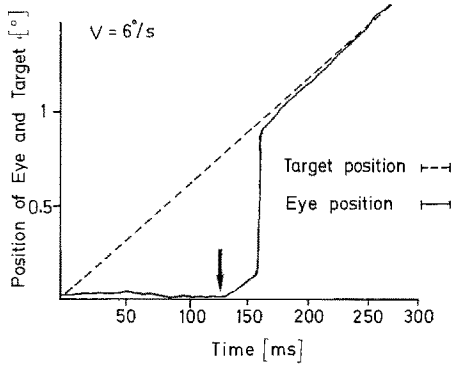

Fig. 1. Example of a pursuit movement triggered by a visual stimulus moving to the right with 6 deg s^{-1}. *Arrow* indicates the onset of the pursuit movement after 130 ms followed by a saccade that brings the visual axis onto the moving target

From the three observers who participated in these experiments, 463 pursuit movements, as shown in Fig. 1, were collected. In order to obtain reliable estimates of the pursuit latencies, off-line analysis with a special mathematical algorithm was performed, developed on the basis of expert knowledge. This algorithm took into account results from previous experiments. We defined minimal and maximal values of possible pursuit latencies, the direction of stimulus motion and the limits of the velocity gain, thus preventing blinks from being mistaken as eye movements. Furthermore, a procedure was developed to preclude ocular oscillations from being mistaken as pursuit movements. With this algorithm errorless detections of pursuit movements were possible, i.e., in 250 selected cases the visual evaluation confirmed without exception the algorithmic computations.

The latencies of the pursuit movements for velocities of 6 deg s^{-1} are collected in the histogram of Fig. 2. As the data of the three subjects were similar in form and covered the same range of latencies, the data of the three subjects were pooled in one histogram. As can be seen, the resulting distribution of the pursuit latencies does not show a unimodal, but a multimodal characteristic. Certainly four, perhaps even five modes can be distinguished. The temporal interval between the modes is either 30 or 40 ms. The most prominent mode at 130 to 140 ms corresponds to a value of pursuit latency that is close to a value given by others (e.g., [7]).

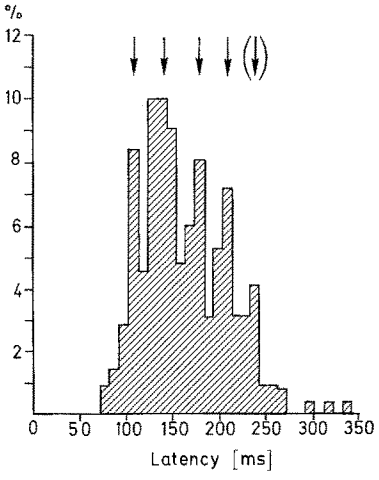

Fig. 2. Histogram on the basis of 463 latencies of pursuit eye movements in three subjects. Temporal resolution for latency measurements was 3 ms; the data are summarized in 10-ms bins. *Arrows* indicate the temporal position of modes that are separated by 30 to 40 ms

As in previous experiments in which completely different paradigms were employed, again a value of approximately 30 ms is observed in these experiments. Thus, manual reaction time to visual stimuli, saccadic latencies, and also pursuit latencies show an identical temporal response pattern. We conclude that, independent of experimental conditions and the response mode, stimulus onset triggers (or resets instantaneously) a neuronal oscillation with a period of approximately 30 ms, i.e., a frequency close to 30 Hz. Such a neuronal oscillation may provide the temporal framework for sampling sensory information and for initiating the motor response. If sensory information were processed continuously, such multi-modalities in frequency distributions as described here and elsewhere could not occur, as has been discussed previously [2] with respect to choice reaction time.

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