HUT 102 and normal T cells must await complete nucleotide sequence analysis of the normal IL-2 receptor gene.

To investigate whether the constitutive high-level expression of IL-2 receptor mRNA was secondary to HTLV-I–induced perturbation of the IL-2 receptor gene structure, we performed Southern blot analyses of restricted DNA extracted from leukemic T-cell lines established from the peripheral blood of six ATL patients (Fig. 3). The five Eco RI restriction fragments for the IL-2 receptor were identical in size in both the ATL and normal T cells. These data suggest that HTLV-I–associated IL-2 receptor expression is probably not due to, or associated with, IL-2 receptor gene rearrangement. Furthermore, these studies provided no evidence for selective IL-2 receptor gene amplification in the ATL cell lines studied. The single-copy IL-2 receptor gene is located on the short arm of chromosome 10 (10p14-15) (*12*). Karyotype analysis of several ATL cell lines has not revealed consistent translocations involving chromosome 10, suggesting that chromosomal breakage is not involved in the high-level expression of IL-2 receptors characteristic of ATL cells.

To further study the deregulation of IL-2 receptor gene expression in ATL cells, we used nuclear transcription assays with isolated HUT 102 nuclei (Fig. 4). In contrast to normal T cells, which must be activated with antigen or mitogen before IL-2 receptors are expressed (*13*), the IL-2 receptor gene was constitutively transcribed in HUT 102 cells. This constitutive expression of the IL-2 receptor gene may reflect direct or indirect *trans*-acting transcriptional activation by the "LOR protein" encoded by the long open reading (LOR) frame associated with the pX region of HTLV-I. Sodroski *et al.* (*14*) showed that the LOR region of HTLV-I encodes a 42-kD protein that can enhance the transcription of genes under the control of the HTLV-I long terminal repeat (LTR) in a *trans*-acting manner. These authors have speculated that the LOR protein enhances HTLV-I replication and also may activate cellular genes involved in neoplastic transformation.

In normal T cells, stimulation with phytohemagglutinin (PHA) and phorbol myristate acetate (PMA) induces transcription of the IL-2 receptor gene within 3 hours (*15*). Paradoxically, stimulation of HUT 102 cells with PHA and PMA resulted in rapid and selective inhibition of IL-2 receptor gene transcription (Fig. 4). This effect was not the result of a generalized nonspecific inhibition of gene expression, since PHA and PMA addition did not alter active transcription of genes encoding histocompatibility antigen (HLA), transferrin receptor (Fig. 4), or c-*myc* (not shown). IL-2 receptor gene transcription is a transient event in normal PHA- and PMA-activated T cells (*15*). After peak transcription at 6 hours, IL-2 receptor gene transcription gradually declines, perhaps secondary to the action of a co-induced repressor mechanism similar to that described for the IL-2 gene (*16*). The constitutive expression of the IL-2 receptor gene in ATL cells may indicate that this putative repressor system is silent. We are intrigued by a model of ATL whereby the LOR protein selectively stimulates IL-2 receptor gene transcription but fails to activate the repressor mechanism. The addition of PHA and PMA, however, may activate the repressor mechanism and result in diminished IL-2 receptor transcription. This hypothesis can be formally tested when the promoter region of the IL-2 receptor gene is isolated. Furthermore, the IL-2 receptor promoter region can be compared with the LTR of HTLV-I for possible sequence homologies and functional LOR protein-binding capacity.

Deregulated expression of genes controlling cell growth and differentiation, including cellular oncogenes, has been associated with the genesis of various neoplasms. Further study of the abnormal regulation of IL-2 receptor gene expression in ATL cells may provide important insights into the molecular mechanisms of HTLV-I–mediated leukemogenesis.

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"Where" and "What" in Vision

Abstract. *The mixture of a few horizontal and vertical line segments embedded in an aggregate of diagonal line segments can be rapidly counted and their positions rapidly determined by a parallel (preattentive) process. However, the discrimination between horizontal and vertical orientation (that is, discrimination of a single conspicuous feature) requires serial search by focal attention. Under recent theories of attention, focal attention has been assumed to be required for the recognition of different combinations of features. According to the findings of this experiment, knowing "what" even a single feature is requires time-consuming search by focal attention. Only knowing "where" a target is is mediated by a parallel process.*

Traditionally, psychologists differentiate between detection and discrimination tasks. Detection is considered an easier task since the observer requires less information, whereas discrimination entails some further computation. Here we suggest that detection and localization can be done in parallel, and that the further computation required for discrimination is done by a serial process. By measuring processing time for detection and discrimination of orientation, we found that processing time is independent of the number of targets to be detected but depends on the number of targets to be identified. Furthermore, the processing time that is required to detect a small number of targets is sufficient to locate them quite accurately. That processing time is independent of the number of targets indicates that the targets are processed in parallel, whereas the dependence of processing time on the number of targets indicates serial processing. This serial process is required for even such a simple task as discrimi-

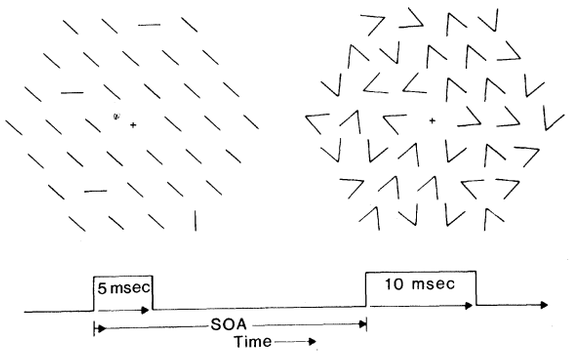
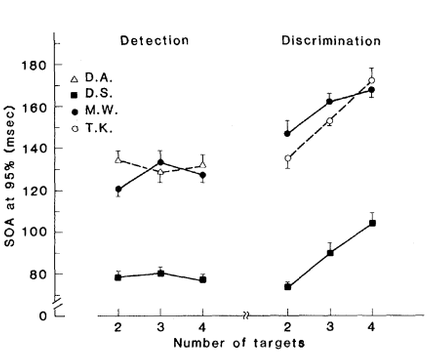
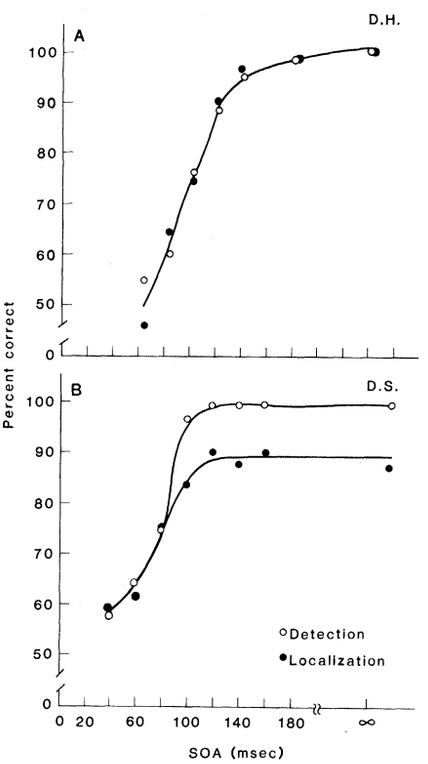


Fig. 1. (A) Temporal presentation of the stimuli used in the experiments. On the left is a stimulus with four targets and on the right the mask. The SOA is defined as the time difference between the onset of the stimuli and the onset of the mask. Display diameter was 8° of visual angle, white lines on black background, viewed from a distance of 1 m.





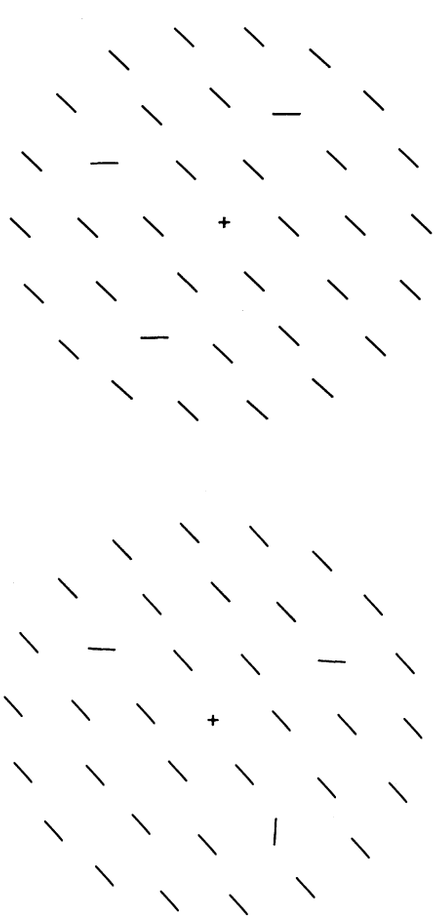


Fig. 2 (top left). The SOA required to reach 95 percent correct responses as a function of the number of targets. Different observers are indicated by different symbols. Error bars indicate one standard error of the mean. Fig. 3 (bottom left). Stimuli used in the localization experiment. Each pattern is formed of concentric rings made up of diagonal lines. The three targets can be seen as three vertices of two different triangles, one a right triangle and the other not. The targets could appear in any position in the second ring, so long as the intertarget distances were kept constant; thus, the two triangles were randomly oriented. An easy way to see the difference between the two triangles (when presentation time is long enough) is by counting the number of background (diagonal) lines in the second ring between each pair of targets; the numbers are 2, 2, 5 for the upper and 2, 3, 4 for the lower triangles. One-third of the presentations contained only two of the three targets. The patterns were presented briefly and followed by a mask as in Fig. 1. Fig. 4 (Right). Localization and detection of orientation gradients. The psychometric curves describe correct responses as a function of SOA for observers D.H. and D.S. Performance on the two tasks was the same, except for a region in which D.S. could not achieve more than 90 percent correct in the localization task even without the mask (SOA = ∞). Each data point is based on responses from 100 to 300 presentations.

nating between vertical and horizontal lines; thus, identification of even a single feature such as orientation requires some time-consuming processing by focal attention. Accordingly, our understanding of the role of focal attention has to be revised; focal attention is required for recognition (identification) of targets and not only for detecting differences in feature combinations (*1–3*). Any detection that cannot be achieved by the preattentive parallel system requires form recognition and thus serial inspection by focal attention.

Figure 1 illustrates the detection and discrimination tasks we used. Each stimulus consisted of 36 line elements (0.8° of visual angle long), most of which were diagonals; targets were either vertical or horizontal. Targets were always separated by at least two diagonal lines to avoid local interference between them. (The size and number of elements in these stimulus configurations is not critical for detection (*2, 3*) as long as the elements yield a texture.) In detection tasks, the observers reported the number of targets irrespective of their orientation (both vertical and horizontal); in each experiment they were presented with only two possible numbers of targets (one or two, two or three, or three or four). In discrimination tasks the observers determined whether all the targets had the same orientation or whether one had a different orientation from the others. The stimuli were presented briefly (5 msec) and were masked after a time interval [stimulus onset asynchrony (SOA)] by a patterned mask (for 11 msec) composed of randomly oriented V-shaped micropatterns. This method prevented the observers from a second fixation of the stimulus and enabled us to measure processing time, assumed to be related to SOA, for the different conditions. Since stimuli were exposed for only a short period, no eye movement could displace the stimulus on the retina; because of visual persistence, however, processing time could have been longer. The role of the mask was to terminate the processing by visually integrating with the stimulus and making further detection or discrimination impossible.

Performance was measured as the mean correct response at different SOA's and described by psychometric curves for the different tasks and different number of targets. (Each psychometric curve was constructed from an average of 1600 trials per observer.) Processing time was derived as the SOA required by the subject to reach 95 percent correct responses, by interpolation on the psychometric curves. This method

yielded estimates of processing time with a standard error of ~5 msec (that is, by taking into account response variability and the slope of the psychometric curve). Experiments were performed with highly trained observers who were familiar with psychophysical experiments in which displays are rapid and, in particular, with these experiments (through thousands of trials); except for one of them (D.S.), subjects were not familiar with the purpose of the experiments.

The mean slope of the detection curves is 1.9 msec per target with a standard deviation of 6.3 msec per target (Fig. 2). Thus, there was no significant increase in processing time with increasing number of targets. However, processing time for discrimination increased at a constant rate with the number of targets (Fig. 2). The average slope is 16.6 msec per target with standard deviation of 3.2 msec per target. Detection and discrimination of orientation clearly differ qualitatively. During a first stage, local gradients of orientation can be detected in parallel, but the direction and the magnitude of these gradients are unknown. In order to know *what* the orientation is in the neighborhood of the gradients, a second stage of serial inspection is required. The inspection time is ~17 msec per target, a time that seems to be independent of the detection time, which varies among observers. Interestingly, for each observer the discrimination time for two targets is the same as the detection time (Fig. 2).

Thus, knowing *what* the target is already requires serial inspection by focal attention. We next asked what process underlies knowing *where* a target is. We devised another experiment to show that at the detection stage observers are accurate in positional judgment. The observers were presented with either two or three targets; the three targets were arranged in two different patterns that can be described as triangles, one having a right angle and the other not (Fig. 3). The observers reported the number of targets, and when there were three, which spatial arrangement was presented. The psychometric curves for detection and localization overlap (Fig. 4). Localization reached its maximum at the same SOA as detection. Observer D.S. could perform the localization task with no better than 90 percent accuracy; that level was reached at the same time the targets could be detected—longer SOA's did not improve localization performance. Localization could be equated to detection by increasing the difference between the two triangles. The positional accuracy required to tell the two kinds of triangles apart was one or two line spacings between line elements; thus positional judgment is quite accurate at the detection stage.

Thus, detecting feature (orientation) gradients and locating them can be done in parallel, but identifying the features (orientation) and knowing what they are requires serial inspection with focal attention. What is surprising is that we find such scrutiny to be necessary for as simple a feature as the orientation of a line element that is regarded as a basic dimension in vision (*4–6*). This finding is inconsistent with the proposal that initial parallel feature processing in nontopographical feature spaces is followed by serial processing (with focal attention) to localize different features and to combine them according to their location (*1, 7*). In our experiments, the location of an object can be found by the parallel preattentive system; that parallel system is probably limited by its ability to detect feature gradients (over short spatial range) but not what occurs at these gradients. The role of focal attention might be suggested now as a necessary condition for knowing what actual features an object has. Whether our interpretation of detection versus discrimination as two different processes—parallel versus serial—will hold beyond orientation, that is, for other single features, such as color, direction of movement, and line segment width, remains to be seen.

Note added in proof: Recently we briefly presented a mixture of a few red and green disks (targets) embedded in an aggregate of yellow disks (each having the same size and luminance) followed by a mask of an aggregate of bipartite red-green disks. We found again that detecting and locating the colored targets could be done in parallel, whereas discriminating between their red and green colors required serial search by focal attention.

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Measles Virus Matrix Protein Synthesized in a Subacute Sclerosing Panencephalitis Cell Line

Abstract. *Measles virus generally produces acute illness. Rarely, however, persistent infection of brain cells occurs, resulting in a chronic and fatal neurological disease, subacute sclerosing panencephalitis (SSPE). Evidence indicates that expression of the measles virus matrix protein is selectively restricted in this persistent infection, but the mechanism underlying this restriction has not been identified. Defective translation of matrix messenger RNA has been described in one SSPE cell line. This report presents evidence that in a different SSPE tissue culture cell line IP-3-Ca, the matrix protein is synthesized but fails to accumulate. A general scheme is proposed to reconcile the different levels at which restriction of matrix protein has been observed.*

Subacute sclerosing panencephalitis (SSPE) is a rare, chronic, and invariably fatal disease resulting from persistent measles virus (MV) infection of the human central nervous system (*1*). Distinguishing SSPE from the far more common acute MV infection is the failure of virion progeny to be produced by the persistently infected brain cells (*1*). The inability to consummate viral reproduction has been ascribed to a defect in the expression of a single MV gene product, the matrix protein (*2, 3*). This conclusion is supported by studies showing matrix protein to be the only structural protein of MV undetected in brain cells from patients with SSPE or in derivative SSPE cell lines (*2*) and by the presumably related observation that patients with this disease have a selective deficiency of antibodies to matrix protein (*3*). To investigate the mechanism by which matrix protein is restricted, we examined the MV matrix gene products of the SSPE cell line IP-3-Ca. In contrast to the results of prior studies of SSPE, IP-3-Ca was found to direct the synthesis of all MV proteins, including matrix protein. Once synthesized, however, matrix protein did not accumulate because it was unstable.

The IP-3-Ca cell line was originally