into account when considering how experience integrates behavior with an environment—even a phylogenically novel one.

The experimental analysis of operant behavior has in general focused on situations where the nature of the response, as well as interactions among stimulus, response, and reinforcer, are presumed to be arbitrary—that is, dependent only on experimentally controlled relationships. The application of such results to situations involving nonarbitrary relationships and highly organized response systems must be made with care. Thus, while it is possible that adventitious contingencies of reinforcement were responsible for some aspects of the systematic elaboration of the pecking response described by Skinner, the possibility must also be considered that each component of the behavior represents an organized response pattern released into the situation by the stimulus configuration and an associative process. A procedure previously reported by Williams and Williams (*1*), which prevents the operation of direct or adventitious reinforcement contingencies, might prove helpful in analyzing the origin and development of the behavior Skinner describes. Such a procedure is currently being used in our laboratory to study the origin of topographical variants of the key-pecking response; the procedure has also proven useful for analyzing the interaction of different sources of control in the situation we reported (*2*).

It seems appropriate to acknowledge here that our work, although it adds new considerations to the analysis of operant behavior, depends as heavily on methods and concepts originally developed by Skinner as it does on naturalistic methods and ethological analysis.

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Scanpaths and Pattern Recognition

In their report (*1*) Noton and Stark present evidence that in 39 out of 60 instances four subjects made essentially the same initial sequence of eye movements (scanpaths) the second time they viewed a low-visibility picture as they did the first time. This result is not surprising. What is surprising is the authors' suggestion, based on these findings, that scanpaths tell us something about how subjects remember and recognize patterns. Noton and Stark acknowledge that under normal conditions recognition does not require eye movement. They then propose an internal attention mechanism in which the subject processes successive features of the pattern in the same sequence as that of the motor scanpath. On this precarious peg they hang their theoretical argument.

There are a number of problems associated with this line of reasoning. If a nonsense figure, never before seen by the subject, is exposed tachistoscopically at an exposure time too short to allow for eye movements, or if it subtends a visual angle of less than 2° (eye movements unnecessary), the subject will recognize the pattern exposed again under the same conditions, or under new conditions in which eye movements are permitted or even necessary. In this example there has been no opportunity for eye movement during the learning phase. How then can pattern recognition be due to the internal representation of the "memorized sequence of behavior" (*1*)? What sequence of behavior?

We recognize objects in various orientations and under a multitude of conditions. No one can seriously believe that if all subjects were forced, during recognition, to scan figure 1 (*1*) by a completely different path, even starting from the final scan and working backward, the picture would not be easily recognizable. The fact is that distinctive features are "normally" analyzed by the central nervous system without repetition of a fixed sequence.

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Our experiments were specifically and carefully designed to force the occurrence of scanning eye movements so as to externalize part of the visual pattern recognition process and thus to make it available for objective measurement and scientific study. A major assumption, one that we pointed out in our report (*1*), is necessary when we extrapolate from eye-movement scanpaths to hypothecated serialized attention shifts for the further application of our results to the normal viewing of bright small pictures or to pictures presented tachistoscopically. We stated: "Normally this processing is largely internal and beyond investigation" (*1*). In Noton's earlier "theory" paper (*2*) and in our full experimental paper (*3*), we discussed the serialized attention shifts; the fact is that these are not completely deterministic, requiring a feature-network modification of the feature-ring theory, and, in the case of tachistoscopic presentations, requiring short-term memory as well.

We are surprised that Spitz does not recognize the value of our experimental discovery of the scanpath in a field where so few hard data exist. The "precarious peg" that Spitz mentions (*4*) is not our extrapolation but the willingness of psychologists to theorize about processes in the central nervous system concerning which no experimental evidence exists. An example from his technical comment is characteristic—"The fact is that distinctive features are 'normally' analyzed by the central nervous system without repetition of a fixed sequence" (*4*).

The serial feature-ring theory based upon analogies from computer science preceded and predicted the experimental results (*2*). The scanpath is a clear objective finding presented in both the learning and recognition phases of viewing under experimental conditions similar to ours. Finally, the scanpath plays an important role in the strategy of eye-movement control (*5*) and will have to be taken into consideration when psychological theories of visual pattern recognition are further elaborated.

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