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Assessment of Covariation by Humans and Animals: The Joint Influence of Prior Expectations and Current Situational Information

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In this article, we propose a theoretical framework for understanding and integrating people's and animals' covariation assessment. We argue that covariation perception is determined by the interaction between two sources of information: (a) the organism's prior expectations about the covariation between two events and (b) current situational information provided by the environment about the objective contingency between the events. Both accuracies and errors in people's and animals' covariation assessments are analyzed within this interactional theoretical framework. We then review four lines of research in support of this analysis. Finally, we consider the issue of accuracy versus rationality in covariation assessment.

A consensus has been forming among learning, clinical, and social psychologists: The ability to detect the relationships or covariations among stimuli, behaviors, and outcomes in one's environment is an important component of adaptive behavior. The covariation between two events may be defined in terms of their co-occurrence (i.e., the degree to which one event occurs more often in the presence than in the absence of the other event). Information about the relationships or covariations between events in the world provides people and animals with a means of explaining the past, controlling the present, and predicting the future, thereby maximizing the likelihood that they can obtain desired outcomes and avoid aversive ones.

The concept of covariation provides a cornerstone for a number of substantive areas within psychology. For example, contemporary learning theorists point to the role of objective contingencies among stimuli, outcomes, and responses as critical determinants of animals' and humans' behavior in Pavlovian and instrumental conditioning situations (e.g., Bindra, 1972; Bolles, 1972; Mackintosh, 1974; Maier & Seligman, 1976; Rescorla, 1967; Rescorla & Wagner, 1972; Tarpy, 1982). Cognitive social learning theorists (e.g., Bandura, 1969; 1977; Mischel, 1973; Rotter, 1966) have emphasized the role of generalized expectancies of response–outcome contingencies as determinants of humans' behavior. Crocker (1981) noted the importance of intuitive concepts of covariation for several research areas in social psychology as well, including attribution theory, implicit personality theories, stereotyping, and the psychology of helplessness and control. Finally, in the realm of clinical psychology, Tabachnik and Alloy (in press; Alloy & Tabachnik, 1983) have argued that covariation assessment is an integral component of many of clinicians' psychodiagnostic and therapeutic judgments, much of patients' psychopathology, and much of the therapeutic process itself.

Recent evidence suggests that the belief that one can explain, predict, or control events in the environment is important for organisms' physical and psychological well-being. Even if nonveridical, the perception of prediction and/or control over aversive outcomes decreases subjective pain and stress; reduces subjective and objective components of anxiety and

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depression; reverses problem solving and performance deficits associated with lack of control; reduces the negative impact of institutionalization in the aged; decreases the susceptibility to heart disease, cancer, and other psychosomatic illness; and finally, may even postpone death (see Averill, 1973; Baum & Singer, 1980; Garber & Seligman, 1980; Seligman, 1975; Sklar & Anisman, 1981; Thompson, 1981, for reviews of this work).

In light of the importance of explanation, control, and prediction of the environment, which at a more fundamental level depends on the ability to detect covariations between events, we pose an important question as the focus of our article: Under what conditions are organisms accurate in detecting the covariations between events? In reviewing the literature on human covariation judgments, some authors have emphasized the role of preconceived notions in distorting the accurate assessment of event covariations (e.g., Crocker, 1981; Nisbett & Ross, 1980). At the other extreme, some theorists in the animal learning tradition argue that animals do not have subjective representations of event contingencies at all (e.g., Levis, 1976; Rescorla & Wagner, 1972). We argue, however, that many animal learning phenomena may be parsimoniously explained and integrated with the findings on human covariation assessment by assuming that animals as well as people perceive event contingencies (see the Animal Studies section for a further discussion of this issue). Furthermore, we argue that a consideration of the interaction between prior expectations and objective situational information is necessary for an understanding of covariation perceptions, whether accurate or inaccurate, by both humans and animals. We believe that such an interactional analysis has theoretical value in that it (a) postulates basic contingency learning processes common to people and to animals, (b) integrates a wide body of research findings regarding both human and animal behavior, and (c) suggests new research strategies for investigating these contingency detection processes and their effects on behavior.

The remainder of this article is organized as follows: First, we explicate the theoretical framework that forms the basis for our integration of the human and animal contingency learning literatures. Then, we review four bodies of research in light of this framework. The first body of work examines humans' utilization of "prepackaged" covariation information in making causal attributions. In these studies, people are provided with information about cues that covary with specific behaviors or events and are then asked to infer the cause of the behavior or event on the basis of this covariation. The second line of research investigates people's abilities to actually detect covariations. In these studies, people are given the opportunity to observe co-occurrences between events and are required to determine the objective degree of contingency between these events. Next, we examine individual differences in covariation perception. In all of the sections on humans' utilization and detection of covariations, we attempt to show that the empirical findings are best summarized by our conceptual analysis involving the interaction between prior expectations and currently available situational information. We then review illustrative animal learning phenomena in order to show that many Pavlovian and instrumental conditioning findings may reflect contingency learning processes similar to those observed in humans. We suggest that the animal work may also be analyzed by a theoretical framework involving the interaction of expectations and situational information. Finally, we consider the issue of accuracy versus rationality in humans' and animals' covariation assessment and the question of what constitutes a rational or normatively appropriate model of covariation detection.

Assessment of Covariation: Making Sense of or Imposing Sense on the World

Current Perspectives in Cognitive and Social Psychology

Beginning with the work of Piaget (1952, 1954) and of Bartlett (1932), contemporary developments in cognitive and social psychology emphasize the ubiquity with which people go beyond the information given and use schemata or generalized knowledge about the self and the world in the perception, interpretation, and comprehension of everyday experience (e.g., Abelson, 1975; Ajzen, 1977; Bobrow & Norman, 1975; Bower, Black, & Turner, 1979; Bransford & Johnson, 1972, 1973; Cantor & Mischel, 1977, 1979; R. Harris & Monaco, 1978; Hastie, 1981; Lord, Ross, & Lepper, 1979; Markus, 1977; Minsky, 1975; Rumelhart, 1975; Schank & Abelson, 1977; Snyder & Uranowitz, 1978; Taylor & Crocker, 1981; Thorndyke, 1977; Woll & Yopp, 1978; Zadny & Gerard, 1974). Although the term *schema* has been defined in a number of ways by psychologists (e.g., Hastie, 1981; Neisser, 1967; 1976; Taylor & Crocker, 1981), it is generally used to refer to an organized representation of prior knowledge that guides the processing of current information. According to this view, schemata are not "fixed and lifeless" (cf. Bartlett, 1932) but are dynamic and often modified by the very information whose processing they guide.

The major theme emerging from contemporary work in cognitive and social psychology is that whereas schemata facilitate the perception, interpretation, and memory of situational information, an important byproduct of their operation is systematic bias or distortion. These recent developments in cognitive and social psychology are relevant to the focal issue of our article; they suggest that people's judgments of covariation are based on generalized expectations or beliefs rather than on situational information provided by everyday experience. However, whereas work in cognitive and social psychology emphasizes the schema or belief-based nature of information processing, in the remainder of this article we attempt to show that people's and animals' assessments of covariation, both accurate perceptions and errors, are influenced jointly by expectations and data. In this respect, our article differs importantly from two recent reviews of the human covariation judgment literature (Crocker, 1981; Nisbett & Ross, 1980, chap. 5). Both Crocker and Nisbett and Ross have heavily emphasized the expectation-based nature of covariation assessment and have paid little or no attention to the role of situational information in covariation perception. In addition, we propose that human and animal covariation detection can be analyzed in the same interactional framework.

An Expectation by Situational Information Interactional Framework

Two sources of information are relevant to perceiving the degree of covariation between two events: the situational information about the objective contingency between the events provided by the current environment and the organism's prior expectations or beliefs about the event covariation in question.[1] We propose that both of these information sources jointly determine covariation perception. However, the degree to which any particular subjective perception of contingency matches the objective contingency between events represented in the environment (i.e., is accurate) depends on the relative strength of prior expectations and current situational information. The concept of expectation strength refers to the degree to which the organism holds extant beliefs about the nature of the event covariation in question. Such expectations may arise either from prior direct experience with the events in similar situations or from various other sources (e.g., cultural transmission, biological predispositions). The concept of strength of situational information refers to the relative availability to the organism of information about event relationships in the present environment. Current situational information can be unavailable or weak because it is insufficient in quantity to support a covariation perception (e.g., the organism has had little experience with the events in the current situation) and/or because it is ambiguous (e.g., it is not very diagnostic).

The idea that expectations and situational information jointly influence inference processes is not unique to us, although we believe that we are the first authors to apply this interactional framework to the domain of covariation perception and to an integration of human and animal research findings. Several theories of human inference in other domains have incorporated these two sources of knowl-

[1] An important theoretical consideration concerns the selection of relevant expectations for determining the covariation between events. How do organisms decide which preconceptions to bring to bear on the detection of a particular environmental contingency? Are prior beliefs about only the specific events involved in an event covariation (e.g., button pressing and nickels) sufficient or are expectations about abstractions of these events (e.g., one's own responses and positive outcomes) also relevant? Although beyond the scope of the present article, this issue of how organisms define categories of event covariation needs to be resolved before a comprehensive understanding of organisms' covariation assessment can be achieved.

edge in explaining judgmental processes. For example, Bayes's theorem states that predictions should be based on prior event probabilities or base rates as well as on current event probabilities (cf. Kahneman & Tversky, 1972). Similarly, Metalsky and Abramson (1981) argued that generalized beliefs and situational information jointly determine the causal attribution process.

Table 1 summarizes the interaction between prior expectations and current situational information in determining covariation perception and provides the theoretical framework we use to organize and explain the human and animal contingency learning findings. This table is an adaptation of Metalsky and Abramson's (1981) 2 × 2 table for describing causal attribution processes. The cells of Table 1 are formed by considering the four possible combinations of low versus high strength of prior expectations and low versus high strength of current situational information. Although we view strength of expectations and situational information as continua, for ease of exposition we present these two dimensions as dichotomies in Table 1.

In Cell 1 of Table 1, both situational information and prior expectations regarding the covariation between two events are weak. Under such conditions, people and other animals should have great difficulty forming a perception of covariation. Thus, they forgo making a covariation inference at all or make an inference with low confidence.

In Cell 2 of the table, the strength of prior expectations about an event covariation is high, although as in Cell 1, situational information is weak and provides relatively little support for any particular covariation perception. Under these conditions, covariation judgments are predicted to be direct reflections of a priori expectations. People and animals are likely to form strong covariation perceptions in the face of weak evidence. The relative accuracy of such perceptions depends on the accuracy or appropriateness of the individual's extant beliefs.

In Cell 3, available situational information about the covariation between two events is stronger than are prior expectations. In the absence of strong beliefs about the covariation in question, humans' or animals' perceptions should accurately reflect the objective contingency between the events represented in the environment.

Finally, Cell 4 is of particular interest for understanding the nature of the interaction

Table 1
The Role of Prior Expectations and Current Situational Information in the Covariation Assessment Process

Prior expectations	Current situational information: Low	Current situational information: High
Low	*Cell 1:* A person or an animal will refrain from making any causal attribution or covariation inference at all or will make a judgment with low confidence.	*Cell 3:* A person or an animal will make a causal attribution or perceive covariation in line with the available situational information.
High	*Cell 2:* A person or an animal will make a causal attribution or perceive covariation in line with his/her/its prior expectancies.	*Cell 4:* Case 1—Prior expectations and situational information imply the same causal attribution or covariation perception. A person or an animal will make an attribution or perceive covariation with extreme confidence. Case 2—Prior expectations and situational information imply different causal attributions or covariation perceptions. A person or an animal is in a cognitive dilemma (see text for ways in which a person or animal might solve this dilemma).

Note. From "Attributional Styles: Toward a Framework for Conceptualization and Assessment" by G. I. Metalsky and L. Y. Abramson. In *Assessment Strategies for Cognitive-Behavioral Interventions,* edited by P. C. Kendall and S. D. Hollon, New York: Academic Press, 1981. Copyright 1981 by Academic Press. Adapted by permission.

between data-based and expectation-based processing in covariation inference. Cell 4 represents the situation in which both expectations and situational information strongly and independently suggest a particular covariation perception. If a priori expectations and situational information are congruent (Case 1 of Cell 4), the organism is in a fortunate position. With a minimal amount of cognitive effort, he/she/it could make a covariation judgment with accuracy and extreme confidence. If, however, generalized beliefs and situational information are incongruent and imply different perceptions of contingency (Case 2 of Cell 4), the perceiver is faced with what Metalsky and Abramson (1981) have called a *cognitive dilemma.* The person or animal could overlook, distort, or misremember current situational information and make a covariation judgment in line with prior expectations or reinterpret or ignore strongly held beliefs about the covariation in question in favor of the situational information instead. The evidence we review below suggests that people and animals faced with this dilemma generally make covariation assessments biased in the direction of their initial expectations. However, a substantial amount of belief-contradictory evidence or particularly salient contradictory evidence can lead to covariation assessments pulled in the direction of current situational information. In other words, the relative strength of the two sources of information determines the nature and accuracy of the covariation perception. Because an expectation about an event covariation is often formed on the basis of previous situational information about the relationship between the events, an intriguing implication of our interactional model is that an organism's earliest covariation experiences have a disproportionately large impact on later contingency detection.

Two important features of our theoretical framework should be emphasized. First, we refer to the joint influence of prior expectations and current situational information on covariation assessment as an interaction because the relative impact of one factor depends on the level or strength of the other factor. That is, the same level of situational information regarding an objective event covariation has less influence on an organism's perceptions of contingency when the organism has strong prior expectations about the event relationship than when it has weak preconceptions about the relationship. Strong expectations produce more biased interpretation of situational information than do weak ones. Second, the concepts of expectation strength and situational information strength refer equally to contingencies of positive, negative, and zero value. That is, the concept of strength is viewed as orthogonal to the particular content of expectations and situational information. The greater the quantity or diagnosticity of available environmental data about the covariation between two events, whether indicative of a positive, zero, or negative relation, the greater is the influence on covariation perception. Similarly, the stronger an organism's prior belief about an event relationship, whether the expectation is of a positive, zero, or negative covariation, the greater is the influence on contingency perception and the smaller is the relative impact of situational information. In the sections that follow, we review work on causal attribution, contingency detection, individual differences in contingency perception, and animal learning in order to further explicate and document the dynamic nature of the interaction between expectations and situational information in organisms' covariation assessment and describe some of the cognitive processes that may subserve this interaction.

Human Studies

Researchers have examined people's use and detection of relationships between events in two general types of laboratory tasks. In attribution studies, subjects are typically presented with real or hypothetical behaviors or events for which they must determine the cause. Investigators in this tradition are interested in the manner in which people make use of available information about the covariation between the behavior or event in question and possible causes of this behavior or event in arriving at causal attributions. It is interesting to note that in this line of research, subjects are provided with prepackaged covariation information; no attempt is made to examine the processes by which subjects actually perceive contingencies. In judgment of contingency or covariation studies, however, subjects are given the opportunity either to directly observe co-occurrences between events or to view summaries of co-occurrences and are required to determine the objective contingency between these events. The focal concern in this line of research is with the degree of correspondence between subjective judgments of covariation and the objective contingencies presented.

The Use of Covariation Information in Causal Attribution

Data-based processing. Beginning with Kelley's (1967) seminal paper on attribution theory, social psychologists have viewed the layperson as a *naive scientist* who rationally seeks out covariation information in order to draw inferences about the causes of events. Kelley argued that people infer the cause of a behavior or event by conducting experiments in which they attempt to determine whether the behavior or event under consideration occurs more often in the presence or in the absence of each of several potential causal factors. That is, people assess the degree to which observed behaviors or events covary with possible causes of these behaviors or events (the covariation principle). As in scientific analysis, the factor that best covaries with the behavior or event in question is assumed to be its cause.

According to Kelley, three types of covariation information are relevant to causal attribution: consensus, consistency, and distinctiveness. Consensus refers to the degree to which events covary across people. Consistency is the degree to which events covary over time. Distinctiveness is the degree to which events covary across stimuli in the environment. Similar to a statistical analysis of variance (ANOVA), an individual utilizes the available consensus, consistency, and distinctiveness information to arrive at the most plausible cause for the event or behavior in question. Kelley and his colleagues (Kelley, 1967, 1972, 1973; Orvis, Cunningham, & Kelley, 1975) have delineated the particular patterns of situational information that lead people to make specific types of attributions.

McArthur (1972, 1976) provided empirical support for Kelley's characterization of the layperson as a data-based processor. Subjects were asked to chose among four alternative causes for each of several hypothetical responses. Subjects in the experimental group were presented with consensus, consistency, and distinctiveness information with which to disambiguate the cause of the response in question; control subjects were given no situational information. McArthur found that when people are provided with sufficient covariation information, they can and do systematically employ such information in making statistically based causal inferences. McArthur's experimental group represents an instance of Cell 3 of Table 1. Subjects were provided with ample situational information for determining the cause of the responses, but presumably their prior expectations about the causes of these hypothetical behaviors were weak, at best. Under these circumstances, subjects made causal attributions that appropriately reflected the situational information unbiased by prior beliefs.

Expectation-based processing. In many situations, however, immediately available data are insufficient for making an assessment of the covariation between an event and its possible causes. How do people make causal attributions under these circumstances? Kelley (1972, 1973) suggested that in such situations people invoke causal schemata. A causal schema can be conceptualized as an assumed pattern of data about covariation between an event and its possible causes. In other words, a causal schema represents a person's theories or beliefs about the way in which causes and effects in the world covary with each other. Thus, according to Kelley, when the data are insufficient for making a statistically based causal inference, the naive scientist conducts an ANOVA employing an assumed pattern of data instead.

Orvis et al. (1975) provided support for the notion that people expect certain configurations of consensus, consistency, and distinctiveness information to correspond to particular causal attributions. In a paradigm similar to McArthur's (1972), subjects were presented with incomplete patterns of consensus, consistency, and distinctiveness and were required to make causal attributions. In addition, some subjects were also asked to judge the level of missing information. Both attributions and completions reflected the tendency of subjects to associate certain patterns of consensus, consistency, and distinctiveness (i.e., those a priori predicted by Kelley's theory) with particular attributions. Other studies examining people's causal attributions under the conditions of Cell 2 also typically find that causal inferences are direct reflections of generalized beliefs about causality (e.g., Ickes & Layden, 1978; Rizley, 1978; Ross, Greene, & House, 1977; Seligman, Abramson, Semmel, & von Baeyer, 1979; Weiner & Kukla, 1970; Wortman, Costanzo, & Witt, 1973). Based on work on schematic processes in memory, Metalsky and Abramson (1981) suggested the interesting possibility that people in Cell 2 circumstances may even mistakenly recall the presence of situational information supporting the causal attribution favored by their generalized beliefs.

The joint influence of expectation- and data-based processing. Although Kelley's characterization of people as naive scientists has proved to be a useful conceptual tool for understanding the causal attribution process, it is inadequate in one important respect. This view emphasizes that people are likely to make rational or data-based attributions when situational information is sufficient to make a statistically based inference and are more likely to make expectation-based attributions when such situational information is unavailable. In fact, even a scientist does not draw causal inferences solely on the basis of the empirical data that he or she has collected; rather, the implications of data can only be understood in light of the scientist's preexisting theories, hypotheses, or organized descriptive systems. Recently, attribution theorists have provided evidence for the influence of generalized expectations or beliefs on causal attributions even in situations in which there is sufficient information to conduct a complete causal analysis. Ross (1977), for example, pointed out a number of ways in which the lay attributor distorts systematically his or her interpretation of behavioral events in the direction of implicit theories about human nature and situational forces.

First, Ross (1977) cited the ubiquity of the fundamental attribution error, or the tendency to overestimate the importance of dispositional factors relative to environmental factors as causes of behavior (Heider, 1958; Jones & Nisbett, 1971; Kelley, 1972). In this sense, the *intuitive psychologist* is a personality theorist who gathers and interprets data in light of the theory that human behavior is in large part a function of individual differences. In Kelley's (1972, 1973) causal schema terms, this personality theory would consist of an assumed pattern of high-consistency and low-distinctiveness information. Even when situational information pointing to the importance of environmental factors as a cause of behavior is encountered, this information is interpreted only in light of the attributor's assumed pattern of covariation data. Such inconsistent situational information may be given relatively little weight in the judgment process because it represents only one instance of contrary evidence against a large background of experiential data summarized by the causal schema (see also Nisbett & Ross, 1980).

Another source of error that Ross postulates for the intuitive psychologist is the behaviorist bias, the tendency to attend only to occurrences when making inferences, seriously disregarding information conveyed in nonoccurrences of behaviors or events. It may be that occurrences of events are more vivid or salient than nonoccurrences, and therefore command more attention, analogous to the manner in which *figure* stands out from *ground* in perceptual phenomena. Indeed, evidence from concept-learning and hypothesis-testing tasks attests to the tendency of people to overlook and underutilize negative instances relative to positive instances (Arkes & Harkness, 1983; Bruner, Goodnow, & Austin, 1956; Hovland & Weiss, 1953; Levine, 1969; Mynatt, Doherty, & Tweeney, 1977, 1978; Schustack & Sternberg, 1981; Smoke, 1933; Snyder & Cantor, 1979; Snyder & Swann, 1978a, 1978b; Wason & Johnson-Laird, 1972). Interestingly enough, by psychologically eliminating statistically relevant data about nonoccurrences, the behaviorist bias might actually transform situations in which covariation information is sufficient to make accurate causal inferences into situations in which information is insufficient to do so.

McArthur (1972) noted an additional bias in the data-based attribution process. People consistently underutilize consensus (i.e., base rates) relative to consistency and distinctiveness information (see also Ajzen, 1977; Hansen & Donoghue, 1977; Hansen & Lowe, 1976; Kahneman & Tversky, 1973; Nisbett & Borgida, 1975; Nisbett, Borgida, Crandall, & Reed, 1976; Tversky & Kahneman, 1978; Wells & Harvey, 1977). To explain the underutilization of consensus effect, Kassin (1979b) introduced a distinction between explicit base rates or consensus information and implicit base rates or normative expectancies. Implicit base rates consist of knowledge or beliefs about the behavior of others that may be derived from everyday experiences as well as from cultural transmissions. According to Kassin, if explicitly presented consensus information is either highly redundant with or highly inconsistent with an individual's implicit base rates, the explicit information tends to be underutilized. Kassin (1979b) suggests several cognitive strategies by which this might occur. Explicit consensus that is highly redundant with an individual's normative expectancies may be underutilized because it provides little or no information over and above that provided by no explicit consensus (Nisbett et al., 1976; Wells & Harvey, 1977). On the other hand, an individual may discount explicit consensus that is highly inconsistent with his or her normative expectancies by assuming that this information is derived from a biased or small, and therefore unrepresentative, sample (Kassin, 1979a; Wells & Harvey, 1977).

Apparently, the causal attribution process is neither purely data based nor purely expectation based. Instead, the research and theory on people's use of covariation information in causal attribution indicates that there is an interaction between data and expectations with preconceptions serving to bias or distort presumably more rational or data based processing. If both generalized expectations and situational information point to the same causal attribution (Case 1 of Cell 4), the lay attributor can make a causal attribution with extreme confidence. If, however, generalized expectations and situational information converge on different causal attributions (Case 2 of Cell 4), the lay attributor must either reinterpret, misremember, or discount contradictory situational information and make an attribution in line with generalized expectations, or set aside strongly held beliefs about causality in favor of situational information instead. Evidence from both cognitive and social psychology (Nisbett & Ross, 1980; Ross, 1977) indicates that people faced with this dilemma generally reinterpret situational information favoring the attribution suggested by their generalized expectations. If, however, a substantial amount of contradictory evidence has accumulated (Bruner & Postman, 1949; Nisbett & Ross, 1980; Schustack & Sternberg, 1981) or if this evidence is particularly strong or salient (Nisbett & Ross, 1980), expectations or beliefs about causality may be overwhelmed in favor of the attribution indicated by the situational evidence.

Detection of covariation: The joint influence of expectations and data. In the previous section we reviewed people's use of covariation information in making causal attributions. In these tasks, as already noted, subjects are presented with configurations of information about covarying cues rather than the task of detecting the covariation between potential causes and effects themselves. Rarely, in the real world, does covariation information come in such prepackaged form. Below, we review basic laboratory research on the covariation judgment process itself. It is surprising that although people appear to be accurate detectors under certain circumstances, much of the time they misjudge event relationships systematically. As in the causal attribution process, it appears that both accurate and inaccurate perceptions of covariation are a joint function of prior beliefs and experiential data.

Studies that indirectly examine people's detection of covariation. Two groups of studies have examined people's behavior in situations in which rewards are presented independently of their actions or pairs of events are presented in uncorrelated fashion. In these studies, investigators have drawn inferences about people's knowledge of the experimental contingencies based on indirect behavioral measures or expectancies of success.

In the first group of studies, conducted during the 1950s and 1960s, researchers were interested in *superstitious* responding by humans in noncontingent situations. For example, in an operant conditioning paradigm, Bruner and Revusky (1961) instructed college students to maximize delivery of rewards (nickels) by pressing any of four telegraph keys. In reality, reward could be obtained only by pressing one of the keys with a specified interresponse time. Pressing the other three keys was noncontingently related to the delivery of rewards. Bruner and Revusky found that all of the subjects developed systematic patterns of responding that involved at least one of the nonfunctional keys. In addition, in interviews after the experiment, all of the students stated that these superstitious patterns of responding were necessary to procure rewards. No student believed that rewards were dependent on the simple passage of time.

Similarly, Wright (1962) showed that superstitious response patterns are more likely at high than at low levels of noncontingent reward, and Catania and Cutts (1963) demonstrated that temporal contiguity contributes to the maintenance of superstitious responding as well. These studies suggest that people often act as though rewards are dependent on their actions when, objectively, they are not. Hake and Hyman (1953) found that people also sometimes act as though one event can be predicted from another when, objectively, it cannot. When presented with two different stimulus events in a random series, subjects' predictions as to which of the two events would appear on any given trial were quite orderly and consistent, leading Hake and Hyman to infer that subjects believed that the two stimuli covaried in a predictable manner. Note that in the studies by Bruner and Revusky (1961) and Catania and Cutts (1963) there was, in fact, some dependency between responses and outcomes because some responding was required for the rewards to be delivered. However, there was no contingency between presses on the nonfunctional buttons and rewards in these studies, yet subjects exhibited superstitious responding on these nonfunctional buttons as well.

The second group of studies that indirectly examine people's assessments of covariation comes from social psychology. Similar to the studies of the human learning tradition, these studies also focus on people's behavior in situations in which experimental outcomes occur noncontingently. Langer (1975) investigated the effects of introducing features charcteristic of skill tasks into objectively uncontrollable or chance-determined tasks on expectancies of success. She found that introducing competition, choice, or practice into an obviously chance-determined task inappropriately increased subjects' expectancies of success on the task. Control subjects for whom features characteristic of skill situations were not introduced gave expectancies of success that were more realistic reflections of the objective probability of success. In addition, Langer and Roth (1975) found that early successes and late failures in a coin-tossing task produced higher expectancies of success than early failures and late successes or a random sequence of successes and failures. Although Langer's (1975; Langer & Roth, 1975) findings are compatible with those of the human learning studies, their interpretation is unclear. Expectancies of success may reflect factors other than people's beliefs about the degree of contingency between their responses and outcomes (cf. Abramson & Alloy, 1980; Alloy & Abramson, 1980; Alloy & Seligman, 1979); most notably, they may reflect beliefs about the stability of causes that produced past successes.

Wortman (1975) reported that other elements of skill situations, such as personal involvement and foreknowledge of the goal, also increased subjective feelings of control in an objectively chance-determined task. Taken together, the social psychology and superstition experiments consistently point to a tendency of humans to treat noncontingent events as if they were contingent. These studies suggest that humans may not be good transducers of objective covariation information, at least in the case of noncontingency.

Studies that directly examine people's detection of covariations. Experiments that directly ask people to judge the degree of contingency between events are somewhat more encouraging about humans' covariation detection abilities. These studies indicate that under some conditions, people accurately perceive the covariations between events. However, in many instances, the findings are consistent with those of the indirect studies reviewed above and show that people systematically misjudge event relationships.

Several investigations have examined judgments of covariations between continuous variables. These studies generally compare naive estimates of covariations with statistical estimates based on the Pearson *r*. Erlick (1966) and Erlick and Mills (1967), for instance, presented subjects with different series of pairs of dial locations resulting in 21 different Pearson *r*s ranging from −1.00 to +1.00 in increments of .10. They found that subjective estimates of correlation were quite sensitive to the objective degree of correlation in the stimuli, although subjects' judgments showed greater error for negative than for positive relationships. Similarly, Beach and Scopp (1966) presented subjects with pairs of numbers ranging between 1 and 10 and representing Pearson *r*s of ±.14, ±.15, ±.50, and ±.85. They found that covariation estimates were conservative; subjects reported less confidence in their judgments of the direction of the relationship between numbers than that justified by Bayesian statistics (see Jennings, Amabile, & Ross, 1982, for another example of conservative covariation estimates). However, the probability that subjects gave optimal inferences increased as the magnitude of the objective correlations increased. Crocker (1981) has pointed out that the Pearson *r* may be an unrealistic standard for naive covariation judgments and that a more realistic standard is that subjective judgments be highly correlated with the product–moment correlation. According to this standard, subjective judgments of correlation for nonbinary events appear to be remarkably sensitive to objective degrees of correlation.

The results of studies that directly investigate covariation judgments for binary or dichotomous events are more mixed, supporting the appropriateness of subjective judgments under some circumstances and the inappropriateness of such judgments under other circumstances. Jenkins and Ward (1965, Experiment 1), for example, presented subjects with a series of contingency problems in an instrumental learning situation. For each problem, subjects received 60 trials on which a choice between two responses (Button 1 or Button 2) was followed by one of two outcomes (score or no score). The contingency problems differed both in the objective degree of contingency between responses and outcomes and in the frequency with which the score outcome occurred. In one condition (score instructions), the subject was instructed to obtain the score outcome as often as possible, whereas in the other condition (control instructions), the subject was instructed to learn how to produce each outcome at will. In addition, subjects were either active participants in the task or merely spectators. At the end of each contingency problem, subjects were asked to rate, on a 0 to 100 scale, the degree of control (contingency) that their responses exerted over the outcomes.

Jenkins and Ward (1965) found that their subjects were often grossly inaccurate in judging the experimental contingencies. Ratings of control correlated highly with the number of successful trials (i.e., the number of trials on which the desired outcome occurred) and were totally unrelated to the objective degree of control. This was true for spectators as well as for actors and for the control condition as well as for the score condition. Moreover, erroneous judgments of contingency persisted despite remedial efforts (Experiment 3). Jenkins and Ward attempted to increase the accuracy of ratings of control by presenting subjects with exemplars of contingent and noncontingent response–outcome sequences and by providing them with the correct judgments of these problems in advance. In the critical condition, subjects received pretraining examples chosen so that the number of successes would not vary with the correct values for judged control. Although pretraining broke up the correlation between ratings of control and number of successes, subjective judgments still did not show a significant correlation with objective degree of control. Based on these findings, Jenkins and Ward (1965) argued that people do not have an abstract concept of contingency. Similar conclusions have been reached in studies of the *illusory correlation* phenomenon in diagnostic settings (e.g., Chapman & Chapman, 1967, 1969; Smedslund, 1963).

Alloy and Abramson (1979) questioned the generality of Jenkins and Ward's conclusion about people's lack of a concept of contingency. They found that under certain conditions subjects can make accurate judgments about response–outcome relationships (see Alloy & Abramson, 1979, for potential factors leading to erroneous judgments in Jenkins and Ward's, 1965, study and Allan & Jenkins, 1980, for substantiation of their criticism). In a series of four experiments, Alloy and Abramson (1979) presented depressed and nondepressed college students with one of a series of contingency problems. Each problem consisted of 40 trials on which the subject made one of two possible responses (pressing or not pressing a button) and received one of two possible outcomes (a green light or no green light). At the end of the problem, the subject judged the degree of contingency between responses and green light onset on a 0 to 100 scale. Across different experiments and experimental conditions, Alloy and Abramson varied the objective degree of contingency between 0% and 75% and also varied the frequency and hedonic valence of green light onset.

Surprisingly, Alloy and Abramson (1979) found that depressed students accurately judged the degree of control their responses exerted over green light onset in all conditions of all experiments. Nondepressed students, on the other hand, judged control accurately for contingent problems in which the green light was a neutral outcome (Experiment 1) but overestimated their control over green light onset when it was noncontingently related to responses, but frequent (Experiment 2) and/or positive (winning money, Experiment 3). They underestimated their control over green light onset when it was contingently related to responses, but negative (losing money, Experiment 4). (See below for a discussion of depressive accuracy in judging contingencies.)

Ward and Jenkins (1965) also found that under certain specialized conditions, people could judge contingencies accurately. One group received information about cloud seeding and rainfall in serial fashion (i.e., trial by trial); a second group received the information in an organized numerical summary table; and a third group received the information serially followed by an organized summary. Only the subjects who received information about the relationship between cloud seeding and rainfall in organized summary form alone judged the covariation between the events accurately. Subjects who received a numerical summary preceded by trial-by-trial information or trial-by-trial information alone were inaccurate and often appeared to rely on the frequency of positive confirming cases (cloud seed-rain cases) as the basis for their judgments (see also Schustack & Sternberg 1981; Smedslund, 1963).

Peterson (1980) hypothesized that subjects' failure to recognize noncontingency in many studies is due in part to expectations that subjects bring to psychology experiments that preclude randomness as a potential description of the experimental task. In Peterson's study, subjects were shown a random sequence of two binary events in a procedure patterned after Hake and Hyman (1953). Peterson attempted to introduce the hypothesis of noncontingency for some experimental groups either directly through instructions or indirectly by providing a prior comparison sequence that was rule governed and not random. Peterson found that correct description of the random sequence occurred when either method of introducing the hypothesis of noncontingency was employed. Subjects who did not receive either of these manipulations did not correctly describe the sequence as random. It is interesting to note that Alloy and Abramson (1982) also found that prior experience with a contingent relationship between responses and one outcome facilitated accurate judgments of a noncontingent relationship between responses and a different outcome even under conditions in which individuals normally misjudge the noncontingent relationship as contingent.

Our examination of the work on humans' covariation detection abilities demonstrates that under some conditions, people detect event contingencies accurately. These findings suggest that the conclusion of some investigators (e.g., Chapman & Chapman, 1967, 1969; Jenkins & Ward, 1965; Smedslund, 1963) that people do not have an abstract concept of contingency is probably overstated. People are quite sensitive to a wide range of correlations between continuous, nonbinary events (Beach & Scopp, 1966; Erlick, 1966; Erlick & Mills, 1967). They accurately detect the covariation between dichotomous events if the contingency is positive and the events are neutral (Alloy & Abramson, 1979) or if the information is presented in summary form (Ward & Jenkins, 1965). In addition, people accurately detect noncontingent relationships among dichotomous events if the events (a) do not occur too frequently (Alloy & Abramson, 1979; Bruner & Revusky, 1961; Jenkins & Ward, 1965; Wright, 1962) or in close temporal contiguity (Catania & Cutts, 1963), (b) are not associated with success (Alloy & Abramson, 1979) or with elements characteristic of skill situations (Langer, 1975), or (c) are preceded by prior experience with a contingent event relationship or by the knowledge that randomness is a plausible hypothesis (Alloy & Abramson, 1982; Peterson, 1980). On the other hand, the clear picture that emerges from the work on human covariation detection is that people frequently misjudge systematically event relationships if the aforementioned factors are absent.

The joint influence of expectations and data on covariation judgment. How can we account both for the accuracies and inaccuracies of people's covariation detection? Several theorists have recently suggested that people's expectations or schemata about the nature of the relationships between events biases their judgments of covariation (cf. Abramson & Alloy, 1980; Alloy & Tabachnik, 1983; Crocker, 1981; Jennings et al., 1982; Nisbett & Ross, 1980). These theorists argue that information concerning the objective contingency between events is often distorted by an individual's own cognitive contributions to the situation. As in our discussion of the use of covariation information in the causal attribution process, however, we wish to emphasize that judgments of covariation are influenced jointly by a priori expectations and objective situational information. Whether an individual detects any particular event relationship accurately depends on the nature of the interaction between available data and extant expectations. Perhaps, then, the most concise summary of the empirical work on covariation detection is that judgments of covariation are relatively accurate when people lack strong beliefs about the event relationship in question (Cell 3 of Table 1) or when the situational information concerning the objective correlation between the events is congruent with people's preconceptions about the event relationship (Case 1 of Cell 4, Table 1). When objective data and preconceptions are incongruent (Case 2 of Cell 4, Table 1), judgments of covariation are frequently erroneous and biased in the direction of initial expectations. All of the studies that examine people's covariation detection abilities can be interpreted in these terms.

Experiments that examine judgments of correlation for continuous events (Beach & Scopp, 1966; Erlick, 1966; Erlick & Mills, 1967) find that people are quite sensitive to the actual correlation between the events and do not make systematic errors. These studies have in common the fact that they used stimulus events (e.g., pairs of numbers or locations on dials) for which subjects presumably have no relevant expectations (i.e., Cell 3 of Table 1). In the absence of strong biasing preconceptions about the event relationships, subjects rely on the available situational information in making their judgments and, thus, subjective judgments of correlation mirror objective correlations.

In contrast, studies that examine covariation judgments for dichotomous stimulus events have involved situations for which subjects can reasonably be expected to have relevant preconceptions. Ward and Jenkins (1965), for instance, had subjects estimate the covariation between cloud seeding and rainfall and found that subjects relied on the frequency of cases in which cloud seeding was followed by rain and possibly on those cases in which the absence of cloud seeding was followed by no rain. It is common knowledge that cloud seeding is at least partially effective in producing rain, so it is reasonable to assume that Ward and Jenkins' subjects expected cloud seeding to be followed by rain and absence of cloud seeding to be followed by no rain. Thus, the use of expectation-confirming cases offers a plausible account of the Ward and Jenkins data. Note that subjects' judgments were relatively accurate when the programmed experimental contingencies were consistent with a priori expectations. Similarly, Peterson (1980) found that subjects only detected a noncontingent relationship between two stimuli if the unexpected hypothesis of noncontingency was introduced into the experimental setting.

Finally, a large number of studies reviewed above investigated people's ability to detect relationships between their own responses and outcomes. Abramson and Alloy (1980) and Langer (1975) have argued that the use of responses and outcomes as the events in judgment of contingency studies is likely to bring into play strong, well-articulated schemata about personal control over events. According to Abramson and Alloy (1980), such control schemata are based on a substantial amount of prior experience suggesting that one's own behavior produces outcomes when (a) outcomes follow responses closely in time, (b) features such as practice, choice, and foreknowledge of the goal are associated with responding, and (c) outcomes are frequent and desirable. Such control schemata may also include expectations that one's own behavior does *not* control outcomes when responses are *not* followed closely in time by outcomes, when elements such as practice, choice, and foreknowledge of the goal are *not* associated with responding, and when outcomes are infrequent and undesirable. Of course, these factors are precisely those whose presence influenced the level of accuracy of subjects' judgments in this group of covariation detection studies. It is important to realize, however, that the presence of the aforementioned factors was associated with accurate judgments when the objective contingencies presented by the experimenters happened to match expectations about personal control (Case 1 of Cell 4, see Table 1) as well as with erroneous judgments when the objective contingencies were inconsistent with expectations of personal control (Case 2 of Cell 4, Table 1). For example, Alloy and Abramson (1979) found that nondepressed subjects detected response–outcome noncontingency accurately if the experimental outcome occurred infrequently and/or was a negative event (control schema-consistent) but overestimated the degree of contingency if the experimental outcome occurred frequently and/or was a positive event (control schema-inconsistent). In addition, when the experimental outcome was negative but subjects actually exerted control over the outcome (control schema-inconsistent), nondepressed subjects underestimated the degree of contingency. Similar arguments regarding the joint influence of objective covariation data and biasing control expectations can be advanced to explain the results of the remaining response–outcome covariation detection studies (e.g., Bruner & Revusky, 1961; Catania & Cutts, 1963; Jenkins & Ward, 1965; Langer, 1975; Langer & Roth, 1975; Wortman, 1975; Wright, 1962).

Our analysis of prior empirical work on covariation detection is, of course, almost entirely post hoc. However, several recent studies explicitly measured or manipulated subjects' expectations about event relationships and, thus, provide more direct support for the interaction of expectations and situational information on judgments of covariation.

Jennings et al. (1982) presented undergraduates with two types of covariation detection tasks in a within-subjects design. In one task, subjects judged the relationship between pairs of continuous variables (e.g., between positions of letters in the alphabet and durations of musical notes) for which they had no relevant expectations (Cell 3 of Table 1). In the second task, subjects made judgments solely on the basis of their preconceptions or theories in the absence of any experimentally presented covariation data (e.g., between two different measures of honesty—Cell 2 of Table 1). Jennings et al. found that covariation estimates for the data-based tasks were, on the whole, quite sensitive to the actual correlation between the stimuli but were often conservative (see Crocker, 1981, for a discussion of whether Jennings et al.'s data really represent conservatism). On the other hand, theory-based covariation estimates in the absence of immediately available data often represented large overestimations of the objective correlations between the stimuli. It is of interest that despite subjects' tendency to overestimate contingencies for theory-based stimuli, their judgments did show a rough correspondence with the objective correlations.

Jennings et al.'s study is less than ideal for investigating the interaction of generalized beliefs and objective evidence in covariation judgments because they did not examine the case in which both expectations and objective data are simultaneously available (i.e., Cell 4 of Table 1) and independently varied. In addition, they failed to actually measure subjects' expectations about the covariations between the experimental events and, thus, failed to provide direct evidence for the biasing influence of a priori expectations on judgments of covariation. Four additional covariation detection studies remedy these problems.

In an attempt to understand the nature of illusory correlation among psychodiagnosticians, Chapman and Chapman (1967) presented naive subjects with a series of Draw-a-Person (DAP) pictures, each paired arbitrarily with a set of statements about the symptoms of the patient who allegedly drew the picture. After inspecting 45 pairings of drawings and symptom statements, subjects were asked to determine which DAP responses had been associated with particular patient characteristics. It is surprising that naive subjects, on the basis of their observations of symptom statements paired *noncontingently* with patient characteristics, rediscovered illusory correlates that were virtually identical to those of clinicians surveyed earlier (see also Smedslund, 1963). Of particular interest is the additional finding that illusory correlates corresponded to people's a priori expectations about test-sign–symptom relationships (Chapman & Chapman, 1967, Experiment 3). Even when a group of subjects were not shown any stimulus materials but were asked about the relationship between test signs and symptom statements, their data-less judgments closely resembled the judgments of clinicians and subjects who had been given an opportunity to carefully examine relevant data.

In an even more elegant series of studies than their first, Chapman and Chapman (1969) found that naive subjects who were given the opportunity to observe a random relationship between patient characteristics and Rorschach test signs, consistently underestimated the contingency between symptoms and clinically valid signs having a low degree of associative strength and/or consistently overestimated the relationship between symptoms and clinically invalid but popular test signs having a high degree of associative strength. Again, the illusory correlates reported by naive subjects corresponded to the invalid test signs that had previously been reported by clinicians.

It is possible to examine the work on illusory correlation in psychodiagnosis with respect to Table 1. Subjects in the typical illusory correlation experiment (and by implication, clinicians) are faced with a Cell 4 (i.e., Case 2 of Cell 4) cognitive dilemma. Whereas the situational information presented to subjects in test-sign–symptom pairings indicates that there is no relationship between any particular test sign and symptom, subjects have strong expectations that certain signs and symptoms are, in fact, associated. In many of the illusory correlation experiments, subjects seem to resolve this cognitive dilemma by interpreting or recalling the situational evidence in line with their prior beliefs. However, under conditions in which belief-inconsistent information is more salient or compelling (e.g., when a negative correlation between illusory correlates or contrived validities between valid test signs and symptom statements are built into the stimulus materials or when subjects are allowed to organize stimulus materials in the way they want—Chapman & Chapman, 1967, 1969), although subjects still resolve their cognitive dilemmas in favor of their prior beliefs, their tendency to do so is greatly attenuated (see Alloy & Tabachnik, 1983, and Tabachnik & Alloy, in press, for a detailed discussion of covariation assessment in psychodiagnostic judgments).

In a similar study, Crocker and Taylor (1978) presented undergraduates with a covariation that was either consistent or inconsistent with their measured expectations. In addition, half of the subjects were told before they saw the relevant instances, and half were told afterward, what covariation question they were to answer. Subjects detected an expectation-consistent relationship more readily than an expectation-inconsistent relationship. This result appeared to be a function of a tendency to overestimate the frequency of expectation-consistent instances and to underestimate the frequency of expectation-inconsistent instances. However, subjects only appeared to use the frequency of expectation-consistent instances as the basis for their judgments if they learned what covariation they were to assess beforehand. Subjects who learned what covariation they were to assess afterwards used a statistically appropriate strategy for judging covariation.

In a video game, Dickinson, Shanks, and Evenden (1983) asked subjects to judge the contingency between the firing of a shell and tank destruction when the two events were either unrelated (Experiment 2) or positively related (Experiment 3). Half of the subjects observed a positive covariation between another event, mine explosions, and the occurrence of tank destruction prior to observing the shell–tank destruction contingency. This prior exposure to the mine–tank destruction contingency blocked subjects' detection of the shell–tank destruction contingency, leading to lower judgments of control by these subjects than by subjects who were not exposed to the first covariation. Although Dickinson et al. (1983) interpreted their findings as consistent with a conditioning model derived from animal learning, they also suggested that their results indicated that subjects' expectations that the mines were an effective cause of destruction interfered with their perceptions of the shell's effectiveness. That is, prior mine-destruction expectations biased interpretation of subsequent situational information indicating shell-destruction covariation.

Coppel and Smith (1980) examined the detection of stimulus outcome (S–S*) and response–outcome (R–S*) contingencies by individuals with an internal or external locus of control (e.g., Lefcourt, 1972; Phares, 1976; Rotter, 1966). The locus of control concept reflects individuals' generalized expectancies regarding the extent to which reinforcements are contingent on their own behavior (internal locus) versus contingent on external factors such as luck, chance, or powerful others (external locus). Coppel and Smith predicted that internal locus of control subjects (internals), who presumably have a set to perceive relationships between their behavior (R) and its consequences (S*), would detect R–S* contingencies more rapidly than S–S* contingencies and would be superior to external locus-of-control subjects (externals) in R–S* contingency detection. In contrast, externals, who view outcomes (S*) as contingent on external events (S), were predicted to perceive S–S* covariations more readily than R–S* covariations and more readily than would internals. Although internals and externals did not differ in their ability to identify contingencies overall, internals were more successful in detecting R–S* contingencies than S–S* contingencies, whereas externals were more successful in assessing S–S* as compared to R–S* contingencies in line with the predictions. Moreover, also as predicted, internals were superior to externals in R–S* contingency detection, whereas externals were superior to internals in S–S* contingency detection.

The covariation judgment process. By what mechanisms do preconceptions about event relationships exert their influence on covariation judgments? A useful way of approaching the issue of mechanism is to examine the cognitive steps or processes that may lead to subjective estimates of contingency. Crocker (1981) has described in detail five separate steps of the normative or statistically appropriate model of how covariation judgments ought to be made (see also Nisbett & Ross, 1980). Expectation-based errors or biases might arise at any of these cognitive steps (but see the discussion below for problems involved with comparing intuitive covariation judgments to normative models).

Step 1. Deciding how much and what kinds of data are relevant to the covariation judgment. The first step in making a covariation judgment may involve a decision about what information one needs to make the estimate. To determine the covariation between two binary events, one must know the number of cases that fall into each cell of a 2 × 2 contingency table (see Table 2). Cells a and d constitute *confirming cases* (i.e., cases that confirm there is a relationship between Events 1 and 2 because when one of these events is absent, the other is also absent). Cells b and c constitute *disconfirming cases* (i.e., cases in which the relationship does not hold).

Research from concept formation (e.g., Bruner et al., 1956; Hovland & Weiss, 1953; Levine, 1969; Smoke, 1933) and hypothesis-testing tasks (Mynatt et al., 1977; 1978; Schustack & Sternberg, 1981; Snyder & Cantor, 1979; Snyder & Swann, 1978a, 1978b; Wason & Johnson-Laird, 1972) suggests that people may regard information that can confirm, rather than disconfirm, their expectations as more relevant to covariation judgments. In particular, Crocker (1982) and Schustack and Sternberg (1981) have found that people overwhelmingly regard positive confirming cases (Cell a cases) as most relevant to answering a covariation question, whereas negative confirming cases (Cell d cases) are regarded as less relevant (see also Arkes & Harkness, 1983). In addition, individuals may be likely to seek out less situational information when they have strong preconceptions about event relationships than when they have weak preconceptions, because less information is needed to confirm strong preconceptions (see also Metalsky & Abramson, 1981).

Step 2. Sampling cases. Once an individual has decided which data are relevant to making a covariation judgment, he or she must sample instances to be used as evidence from all potentially available information. Crocker (1981) has noted two sources of bias likely to occur in people's sampling of evidence. First, the events that serve as a data base for a covariation judgment are likely to be a nonrandom sample because the events that any individual is exposed to are not a random sample. Second, research from other judgment tasks has shown that people seem to be unaware that the smaller

Table 2
Four Types of Evidence Relevant to Judging the Covariation Between Two Events

	Event 1	
Event 2	Present	Absent
Present	Cell a	Cell b
Absent	Cell c	Cell d

the sample, the more likely it is to be atypical of the general population from which it is drawn (Kahneman & Tversky, 1972; Tversky & Kahneman, 1971; but see Kassin, 1979a, for an exception to this finding). People's ignorance of the law of large numbers may lead them to sample fewer cases than is statistically necessary for making an accurate covariation estimate. People may be especially likely to undersample if they have strong preconceptions about the nature of the covariation in question. In all of the covariation detection studies reviewed above, possible biases in information search (Step 1) and sampling (Step 2) were eliminated because subjects were presented with a sample of relevant cases selected by the experimenter.

Step 3. Classifying instances. Once instances have been sampled, they must be interpreted and classified as confirming or disconfirming cases. Extant expectations may also bias such interpretation and classification processes (Crocker, 1981). Ambiguous instances are usually perceived to be congruent with a priori beliefs (e.g., Allport, 1954; Bower et al., 1979; Bruner & Postman, 1949; Bugelski & Alampay, 1961; Leeper, 1935; Nisbett & Ross, 1980; Posner & Keele, 1968), whereas evidence that contradicts one's expectations may be discredited either by attributing its occurrence to unstable or external factors (e.g., Bell, Wicklund, Manko, & Larkin, 1976; Deaux, 1976; Deaux & Emswiller, 1974; Feldman-Summers & Kiesler, 1974; Hayden & Mischel, 1976; Taylor & Jaggi, 1974) or by regarding the sample from which it was drawn as unrepresentative of the general population (e.g., Hansen & Donoghue, 1977; Kassin, 1979a, 1979b; Wells & Harvey, 1977).

Bruner and Revusky's (1961) and Catania and Cutts's (1963) findings may represent examples of people's tendency to interpret ambiguous cases as consistent with preconceptions. Recall that these investigators found that subjects believed that presses on nonfunctional response manipulanda were contingently related to reward attainment when, in fact, they were objectively unrelated to the occurrence of rewards. Subjects in these studies may have assumed that such response manipulanda would not be present in the experimental situation unless they were important in obtaining rewards (see Peterson, 1980, for a similar argument). Thus, presses on these nonfunctional manipulanda that were followed closely in time by the occurrence of rewards might have been interpreted by subjects as consistent with this assumption and, thus, might be coded as confirming the presence of a response–reward covariation.

Step 4. Recalling the evidence and estimating the frequencies of confirming and disconfirming cases. Once relevant evidence has been sampled and interpreted, it must be recalled and the totals of confirming and disconfirming cases estimated. Many studies in cognitive and social psychology have demonstrated that information that is consistent with an individual's schemata or expectations is more likely to be recalled than information that is irrelevant to or inconsistent with the individual's schemata (see section above on Current Perspectives in Cognitive and Social Psychology). In addition, studies of recognition memory have often found that people intrude events that are consistent with their schemata but were never actually observed (e.g., Bartlett, 1932; Bower et al., 1979; Bransford, Barclay, & Franks, 1972; Cantor & Mischel, 1977; Johnson, Bransford, & Solomon, 1973; Owens, Bower, & Black, 1979; Woll & Yopp, 1978). Thus, covariation judgments may be biased by a tendency to overrecall expectation-consistent instances relative to inconsistent instances (the Crocker & Taylor, 1978, study is an example) as well as by a tendency to remember expectation-consistent instances that never occurred.

It is interesting that Ward and Jenkins's (1965) finding that subjects' covariation assessments were less accurate when information was presented in serial rather than in summary form, may reflect in part such biased memorial processes. Presentation of information in summary form eliminates the necessity of relying on one's memory for estimating the frequency of confirming and disconfirming cases.

Along these lines, Shaklee and Mims (1982) demonstrated that increasing memory demands in a judgment of covariation task does lead to reduced accuracy by two mechanisms. First, memory demands led to errors in estimating the frequency of cases in the four cells of the 2 × 2 contingency table, particularly in Cells c and d. Second, memory demands increased subjects' tendency to utilize simple but invalid rules for judging covariation (e.g., reliance on Cell a cases) rather than complex rules (e.g., delta coefficient utilizing all four cells), thus compromising judgment accuracy (see also Arkes & Harkness, 1983, Experiments 4 and 5).

Step 5. Combining the evidence to make a judgment. The final step in making a covariation judgment involves combining the recalled frequencies of observed cases into a covariation estimate. For continuous variables, the statistically appropriate method for assessing covariation involves computing a Pearson *r*. Whereas it is highly unlikely that people actually calculate a Pearson *r*, our review of covariation detection studies involving continuous variables suggested that intuitive judgments are highly related to the Pearson *r*, although they are not the optimal estimates predicted by the normative model (see above).

For binary variables there are several statistical methods for combining evidence into a covariation estimate, including the chi-square statistic, phi, delta, or association coefficient. All of these metrics have in common that they utilize all four cells of the 2 × 2 contingency table (see Table 2). In combining available situational information into a covariation judgment, people may rely on the frequency of cases that fit their expectations. All of the studies reviewed above that have reported reliance on confirming cases can be interpreted in this manner (Alloy & Abramson, 1979; Crocker & Taylor, 1978; Jenkins & Ward, 1965; Smedslund, 1963; Ward & Jenkins, 1965). It is interesting that Arkes and Harkness (1983, Experiment 6) found that people's tendency to use some types of disconfirming evidence (Cell b cases in Table 2) and thus, the accuracy of their covariation estimates, could be increased by enhancing the salience of this type of situational evidence.

Individual differences in assessment of covariation. Whereas we have reviewed evidence suggesting that, in many cases, people's covariation judgments are inaccurate, one group of individuals appears to be less susceptible to errors in covariation detection. Contrary to the cognitive models of depression (e.g., Abramson, Seligman, & Teasdale, 1978; Beck, 1967, 1976; Seligman, 1975) that emphasize that depressed people's assessments of covariation are unrealistic and distorted, recent findings suggest that depressive subjects[2] are more accurate than nondepressive subjects in assessing certain contingencies (Abramson & Alloy, 1981; Abramson, Alloy, & Kossman, in press; Abramson, Alloy, & Rosoff, 1981; Alloy & Abramson, 1979, 1982; Alloy, Abramson, & Musson, 1983; Alloy, Abramson, & Viscusi, 1981; Martin, Abramson, & Alloy, 1984). Whereas depressed individuals accurately judge the contingency between their responses and outcomes, nondepressed individuals overestimate the contingency between their responses and noncontingent but frequent or positive outcomes and underestimate the contingency between their actions and contingent but negative outcomes (e.g., Alloy & Abramson, 1979).

Abramson and Alloy (1980) have suggested that these individual differences in covariation detection accuracy may be attributable to differential strengths of relevant expectations held by depressed and nondepressed people (see also Schwartz, 1981; Tabachnik & Alloy, in press). Whereas nondepressed people appear to have strong schemata concerning their personal control over events including the belief that

[2] It is important to emphasize that in all of the studies described in this section, subjects were classified as depressed on the basis of their scores on the Beck Depression Inventory (BDI; Beck, 1967), a self-report instrument that assesses the severity of depressive symptoms, rather than on the basis of meeting diagnostic criteria for the clinical syndrome of depression. Thus, the majority of depressed subjects in these studies were in the upper quartile of the normal range of variation on the BDI and exhibited mild depressive symptoms. However, approximately one third of each sample of depressed subjects were moderately to severely depressed according to BDI cutpoints for severity of depressive symptoms established by Kovacs and Beck (1977). Moreover, Hammen (1980) has reported that the majority of individuals scoring in the moderate to severe range of the BDI do, in fact, meet the Research Diagnostic Criteria (RDC; Spitzer, Endicott, & Robins, 1978) for a major or a minor depressive disorder.

they control positive events but that negative events are caused by other people or circumstances out of their control, depressed individuals may not be characterized by such control schemata. In the absence of strong preconceptions of this kind, depressive subjects' processing of action–outcome covariations would be likely to be relatively distortion free.

In line with our theoretical framework, Abramson et al. (in press) reasoned that people would be less likely to have strong a priori expectations about the relationship between a red light and a green light than about the relationship between their own responding and a green light. Thus, they presented depressed and nondepressed subjects with contingency problems identical to those employed in their earlier studies (Alloy & Abramson, 1979, Experiments 1, 2, and 3), with the exception that a red light was substituted for subjects' responding as the antecedent event in the contingency learning problem. In the absence of strong expectations about personal control and with sufficient objective covariation data available, subjective judgments would be expected to be isomorphic with the objective contingencies. The predictions were borne out; subjects' judgments of predictability were reasonably accurate both for contingent and noncontingent relations. Moreover, nondepressed individuals no longer showed an illusion of contingency when green light onset was noncontingent but frequent or positive, as they had in the judgment of control situation. Conversely, Martin et al. (1984) found that when depressed individuals' expectations about response–outcome contingencies were contradicted by the situational information, their judgments of contingency were also biased in the direction of initial expectations. Consistent with their beliefs that others are more able to control positive outcomes than are they themselves (Abramson et al., 1978; Beck, 1967; Garber & Hollon, 1980), depressed subjects tended to succumb to the illusion of control for others but not for themselves (see also Golin, Terrell, & Johnson, 1977).

Alloy, Crocker, and Tabachnik (1980) explicitly measured depressed and nondepressed students' expectations about various event relationships and examined the influence of these expectations on subsequent data-based covariation judgments. These studies independently varied both initial expectations and objective covariation information, and thus the interaction of expectations and situational information in determining covariation judgments could be examined directly. Consistent with our interactional framework, Alloy et al. found that nondepressed subjects' judgments showed greater bias when they had strong expectations about the event relationships to be judged than when they had weak expectations. It is surprising that depressed subjects showed the opposite pattern of bias in covariation judgments. Depressive subjects' judgments showed greater bias when they had weak rather than strong expectations about the event relationships. Moreover, Alloy et al. found that expectation-based biases in information search (Step 1 of Crocker's model) and recall (Step 4) accounted, in large part, for the patterns of errors in subjects' covariation judgments.

A consideration of all of the studies examining humans' covariation detection abilities taken together supports the idea that situational information about objective contingencies between events interacts with personal beliefs about event relationships to determine covariation judgments. Our review of this work suggests that Nisbett and Ross (1980) may have overstated their case when they argued that "perception of covariation in the social domain is largely a function of preexisting theories and only very secondarily a function of true covariation. In the absence of theories, people's covariation detection capacities are extremely limited" (p. 111). On the contrary, in the absence of theories, people's judgments of covariation are quite sensitive to actual covariation and even in the presence of theories, situational information in the form of true-event covariation exerts an important influence on covariation judgments. Of course, humans' judgments of covariation are frequently inaccurate and are biased in the direction of their initial preconceptions. Future research and theorizing will have to consider the interaction of beliefs, motives, moods, and situational information in the covariation judgment process.[3]

[3] Although our theoretical framework has emphasized the interaction of expectations and situational information in covariation assessment, needs and wishes are also likely

Animal Studies

Like humans' covariation assessments, animals' perceptions of contingencies may also be viewed as the joint product of prior expectations and objective situational information. Numerous Pavlovian and instrumental conditioning phenomena can be integrated with the work on human covariation detection by viewing these phenomena in light of the interactional framework summarized in Table 1. We believe that such an interactional analysis of animal learning phenomena has both theoretic and heuristic value in that it leads one to postulate basic contingency learning processes common to humans and animals[4] and suggests new research questions designed to investigate the role of prior expectations and environmental information in determining animal covariation detection. Note that it is not our intention to provide a comprehensive review of all of the animal learning work relevant to covariation assessment. Such a review could constitute a long article in its own right. Instead, we attempt to demonstrate the usefulness of viewing animal contingency learning with the same expectation by situational information interactional analysis as human covariation assessment by reviewing illustrative animal findings. Before proceeding with this analysis, however, two important conceptual issues need to be addressed.

The first issue has to do with whether animals have representations of contingencies with subjective reality. Current experimental knowledge does indeed suggest that animals are sensitive to the presence and absence of covariations between stimuli and/or responses and reinforcers, in the sense that their behavior is often a function of such contingencies (e.g., Baum, 1973; Bloomfield, 1972; Dweck & Wagner, 1970; Gibbon, Berryman, & Thompson, 1974; Hammond, 1980; Mackintosh, 1973; Maier & Seligman, 1976; Rescorla, 1968, 1969; Tarpy, 1982). Whereas contemporary learning theorists are in general agreement about the need for a concept of contingency in theoretical accounts of animal learning, the role of subjective representations of contingencies in such learning is still the subject of much debate. Rescorla and Wagner (1972), for example, in their model of Pavlovian conditioning have developed a molecular theoretical formulation to explain the functional relation between conditioning and objective conditional stimulus (CS)—unconditional stimulus (US) correlations, which does not incorporate a concept of contingency with subjective reality. Instead, the Rescorla-Wagner model employs a simpler contiguity mechanism to explain the finding that pairings of CS and US in the absence of a correlation between the two are insufficient to produce conditioning. Their analysis assumes that the animal is unaware of the actual covariation between CS and US during correlated or uncorrelated presentations of the two. Theorists such as Bolles (1972), Mackintosh (1973,

to play an important role in the contingency judgment process. Indeed, Alloy et al.'s (1980) studies of covariation judgments provide a vivid example of the role of conative processes in covariation assessment. Information search and recall strategies as well as covariation judgments themselves depended both on the mood states of subjects and on the emotional or motivational content of the experimental events about which judgments were to be made. Belief-based information processing may not be identical for hedonically neutral versus hedonically potent events. Indeed, a growing body of research indicates that people's general tendency to attribute positive events to internal factors such as ability, and negative events to external factors such as bad luck, usually referred to as the "self-serving attributional bias," may stem from a motivation to protect and/or enhance self-esteem (Bradley, 1978; Miller, 1976, 1978; Miller & Ross, 1975; Snyder, Stephan, & Rosenfield, 1978; Weary, 1980).

[4] Our contingency detection analysis of animal learning is meant to apply only to animals with intact nervous systems. Presumably, conditioning obtained in decerebrate organisms (Buerger & Dawson, 1968, 1969; Patterson, Cegavske, & Thompson, 1973) is mediated by processes more basic than those proposed here. Similarly, we do not know precisely how far down the phylogenetic scale the capacity for covariation detection may extend. We believe that our analysis may apply, at least, to vertebrate learning because many of the conditioning phenomena exhibited by these organisms bear such a striking similarity to covariation assessment findings obtained in humans. More generally, although some of the conditioning phenomena reviewed in this section could be based on associative mechanisms simpler than contingency learning, this does not imply that covariation detection is not also an important mediator of conditioning phenomena in animals with this capacity. We hope that the arguments raised in this article support the theoretic and heuristic value of analyzing the animal work with the same interactional covariation assessment framework as the human work.

1974), Maier and Seligman (1976), and Tarpy (1982), on the other hand, argue that objective contingencies are represented cognitively by animals and that it is these cognitive representations (perceptions, expecptations) of experienced contingencies that mediate animals' behavior in learning situations.

Alloy and Seligman (1979) suggested that a demonstration of contingency perception in animals might be provided by a signal detection paradigm similar to that used by Killeen (1978) in which objective contingency functions as a discriminative stimulus for behavior. To demonstrate covariation perception, the experimenter would need to ensure that the animal had no other means of discriminating between experimental conditions other than on the basis of the differential contingencies operative in the conditions. (The problem in the Killeen study was that discrimination was possible on the basis of differential time intervals as well as differential contingencies between responses and outcomes—see Alloy & Seligman, 1979.)

Whereas it is very difficult to demonstrate convincingly that animals have cognitive representations of contingencies, we are sympathetic to the theoretical stance adopted by Bolles, Mackintosh, Maier and Seligman, and Tarpy. We view perceptions of contingencies as explanatory hypothetical constructs whose presence can only be inferred by indirect observations of relevant behavior. Many of the animals learning results discussed below, when taken together, may be parsimoniously explained by assuming mediation by covariation perception particularly when their similarity to the human covariation assessment findings is considered. However, a resolution of the issue of the subjective reality of contingency perception is unnecessary for the purposes of this article (but see Alloy & Seligman, 1979, for a more detailed discussion of this issue). All that is necessary is that the reader be willing to assume that animals confronted with objective covariations among stimuli, responses, and reinforcers form associations of some kind among these events, an assumption congenial to most animal learning theorists.

The second issue is related to the first and concerns the sufficient criteria for inferring the perception of (or association based on) objective contingencies in animals. In humans, the ability to state the degree of covariation between two events is typically viewed as sufficient for inferring a cognitive representation of that covariation (but see Nisbett & Wilson, 1977, for an argument that verbalized cognitions do not necessarily reflect actual cognitive processes). In animals, of course, methods of inferring contingency detection other than verbalized or written judgments must be employed. In our discussion of animal learning work below, we infer that a subject has accurately detected an objective contingency encountered in its environment if its conditioning behavior is congruent with the objective contingency. For example, if a rat is presented with a tone CS and a shock US correlated with one another, we infer that the rat has detected this positive contingency if it exhibits fear conditioning to the tone as measured in conventional ways (e.g., heart rate acceleration, suppression of ongoing operant behavior). On the other hand, if the rat experiences uncorrelated presentations of tone and shock yet exhibits fear at asymptote to the tone anyway, we infer that the rat has not detected the objective noncontingency present and has exhibited an illusion of contingency similar to that seen in humans (e.g., Alloy & Abramson, 1979; Jenkins & Ward, 1965).

Because we wish to show that animals' covariation assessments, like humans', can be viewed as the joint product of their prior expectations about event relations and current situational information regarding the objective relations between these events, a similar problem concerns our criteria for inferring the presence and content of prior expectations about contingencies. For the purposes of this article, we assume that experimentally naive animals have no relevant expectations (unless past experiences in their preexperimental environment or biological predispositions are likely to have provided them with relevant expectations—see section on preexperimental expectations below). In contrast, animals presented with objective event contingencies in one phase of an experiment, are assumed to have acquired expectations in line with these contingencies that then may bias their perception of new contingencies in a subsequent phase of the experiment.

Data-Based Processing

Since the time of Pavlov's (1927) and Thorndike's (1898, 1911) pioneering work on animal associative processes, literally hundreds of classical and instrumental learning experiments have demonstrated that when a *naive* animal is confronted with an experimentally arranged contingency between a stimulus and a reinforcer or between a response and a reinforcer, the animal acquires a conditioned response or the rate of an already existing response is changed. This change in the animal's behavior is usually taken to imply that the animal has learned an association between the relevant events or, in more cognitive terms, perceived the relevant contingency. The phenomena of Pavlovian or instrumental acquisition represent Cell 3 of Table 1: Situational information regarding the objective contingency between CS and US or between response and reinforcer is abundant, but prior expectations about such covariations are absent. Under such conditions, animals, like humans, utilize this salient situational data and evince behavior congruent with the objective contingencies.

Perhaps the paradigm demonstration of animals' sensitivity to the degree of objective contingency between CS and US is an experiment conducted by Rescorla (1968). Rescorla exposed 10 groups of rats to extensive conditioning involving different correlations between a tone CS and a footshock. Test sessions followed in which the tone CS was repeatedly presented while the rats were bar pressing for food. Rescorla found that conditioning decreased as the correlation between tone and shock decreased. In addition, those groups exposed to a zero contingency (equal probabilities of shock in the presence and absence of the tone) showed almost no conditioning. Evidence for the symmetrical point, that inhibitory conditioning increases with increasing degrees of negative CS–US correlations, was subsequently presented by Rescorla (1969; see also Witcher & Ayres, 1980). Similar demonstrations of the covariation between acquisition of instrumental responses and objective response-reinforcer contingencies have also been provided (e.g., Gibbon et al., 1974; Hammond, 1980; Seligman, Maier, & Solomon, 1971).

It is interesting that when animals are confronted with relatively weak situational information regarding the events involved in objective correlations, acquisition is correspondingly retarded. If the reinforcer is relatively weak in intensity or of small magnitude (e.g., Annau & Kamin, 1961; Crespi, 1942; Likely, 1970; Meltzer & Brahlek, 1968; Ost & Lauer, 1965; Smith, 1968; Wagner, Siegel, Thomas, & Ellison, 1964; Zeaman, 1949), occurs with less than 100% probability as in partial reinforcement procedures (e.g., Brogden, 1939; Ferster & Skinner, 1957; Fitzgerald, 1963; Kimble, 1961; Wagner et al., 1964; but see Brimer & Dockrill, 1966, and Weinstock, 1958), or is delayed (e.g., Ellison, 1964; Fowler & Trapold, 1962; Gormezano, 1972; Kamin, 1965; Kimble, 1961; Logan, 1960; Pavlov, 1927; Wolfe, 1934), acquisition typically suffers (see Mackintosh, 1974, for a review of the effects of these conditioning parameters). When the impact of the reinforcer is reduced in any of these ways, co-occurrences between the reinforcer and antecedent stimuli or responses may be missed. Conditioning procedures utilizing both naive subjects and reinforcers of low magnitude or intensity, low probability, and delayed in time represent instances of Cell 1 (see Table 1). Under such conditions, animals like people, appear to forgo making strong covariation inferences (associations) at all.

Expectation-Based Processing

When people are confronted with insufficient situational information for making an accurate covariation judgment but have strong expectations about the event relationships in question (Cell 2 of Table 1), they typically make confident judgments in the face of weak evidence. A similar analysis may apply to the phenomenon of generalization. As a consequence of prior conditioning experience with one stimulus, another stimulus, never itself correlated with reinforcement, may also be able to elicit a conditioned response. The effectiveness of novel stimuli in eliciting a generalized CR increases in proportion to their similarity to the previously trained CS+ (cf. Mackintosh, 1974). From a covariation perspective, an organism exposed to pairings of a CS and US may perceive the correlation between the two and form a generalized expectation that this particular CS as well as the class of stimuli of which this CS is a member lead to the US. This generalized expectation may then be evoked by a novel, but similar, stimulus belonging to the same class, leading to the occurrence of the CR even though the organism has received no information about the relationship between the novel stimulus and the US.

A more vivid example of expectation-based processing in animal contingency learning (Cell 2 of Table 1) may be provided by work with the truly random control (TRC) procedure. In a TRC procedure, CSs and USs are uncorrelated (Rescorla, 1967) and the general finding is that with sufficient exposure to the procedure (i.e., at asymptote), animals detect the noncontingency present and exhibit neither excitatory nor inhibitory conditioning. With insufficient situational information (i.e., preasymptotic exposure to the TRC), however, animals often do show excitatory conditioning (e.g., Ayres, Benedict, & Witcher, 1975; Benedict & Ayres, 1972; Keller, Ayres, & Mahoney, 1977; Kremer, 1974; Kremer & Kamin, 1971; Quinsey, 1971; Rescorla, 1968, 1972).

It is quite striking that a number of the variables that determine the magnitude and duration of this preasymptotic excitatory conditioning in the TRC procedure have parallels in the variables shown to produce overestimations of contingency by humans. For example, Rescorla (1972) demonstrated that the greater the overall frequency of the US in a TRC procedure, the greater the magnitude of preasymptotic conditioning. This finding is analogous to those of Alloy and Abramson (1979), Jenkins and Ward (1965), and Wright (1962), in which human subjects overestimated the contingency between their responses and outcomes when the outcome of interest was noncontingent but occurred with high frequency. Second, Quinsey (1971) has shown that the greater the magnitude or intensity of the US in a TRC procedure, the greater the initial excitatory conditioning that is obtained. One can view intensity as one of many factors that would influence the salience of the US. Human subjects are also more likely to exhibit illusions of control when outcomes are unrelated to their responses but salient (Alloy & Abramson, 1979, Experiment 3), although it should be noted that in the human case, salience was manipulated by varying the valence, rather than the intensity, of the outcomes. Another variable that affects preasymptotic conditioning in the TRC procedure is the number of initial CS–US pairings: the greater the number of initial pairings, the greater the excitatory conditioning (Benedict & Ayres, 1972). Analogously, Langer and Roth (1975) found that people are more likely to exhibit an illusion of control in an objectively uncontrollable situation when they receive a large number of initial successes. Increased density of CSs and USs in a TRC procedure also enhances excitatory conditioning preasymptotically (Kremer & Kamin, 1971; Quinsey, 1971) similar to Catania and Cutts's (1963) finding that greater density of responses and rewards enhances superstitious responding in college students. Finally, the effect of valence on humans' judgments of contingency and attributions has a parallel in the work on animal superstitious conditioning (Skinner, 1948) in operant situations. Just as people are more likely to exhibit illusions of control or to make self-attributions when these outcomes are positive rather than negative (e.g., Alloy & Abramson, 1979, Experiments 3 and 4; Bradley, 1978; Miller & Ross, 1975), the vast majority of demonstrations of superstitious behavior in animals have been in appetitive rather than in aversive paradigms (see Herrnstein, 1966, and Staddon & Simmelhag, 1971).

The striking parallels between animals and humans in contingency learning situations suggest that there may be some fundamental processes underlying covariation perception across species. Similar to humans, frequent, intense, or positive CSs and frequent or dense CS–US pairings may induce expectations of contingency in animals leading to excitatory conditioning prior to sufficient exposure to the information provided about the noncontingency by the TRC procedure. Moreover, the parallel effects of these variables on animal and human contingency learning emphasize the heuristic value of considering contingency perception across species in the same expectation by situational information conceptual framework. Our framework suggests new research to determine whether other variables shown to affect the magnitude and duration of preasymptotic conditioning in the TRC procedure with animals, such as length of exposure to the noncontingency, salience of the CS, proportion of the session occupied by the CS, and number of unpaired USs similarly affect illusion of contingency in humans.

The Joint Influence of Expectation- and Data-Based Processing

Experimentally established expectations. Our review of work on people's attributional and covariation judgments indicated that when situational information is sufficient to permit an accurate judgment but people also have strong opposing expectations regarding the event relationships (Cell 4, Case 2 of Table 1), their judgments are influenced by both the data and their expectations but typically are biased in the direction of the expectations. A similar analysis appears to apply to a number of animal learning phenomena.

In a typical extinction procedure, for example, an animal previously exposed to a positive CS–US (S–S*) or response–reinforcer (R–S*) correlation is then confronted with the CS or response alone, information indicating that the positive correlation no longer holds. Extinction leads to a gradual decrease in the probability of a CR with increasing exposure to the new contingency. Thus, the data provided about the objective S–S* or R–S* contingency in the extinction procedure clearly influences animals' behavior; however, the rapidity with which conditioned responding ceases in extinction depends in part on the strength of the expectation of reinforcement established during acquisition (cf. Mackintosh, 1974).

According to our interactional framework, factors that enhance the strength of a subject's expectation of contingency should retard the rate of extinction. On the other hand, variables that weaken the expectation of a positive contingency or enhance the salience of positive contingency disconfirming information provided by nonreinforcement in the extinction procedure itself should increase the rate of extinction. Empirical evidence tends to support both of these predictions. For example, increasing the number of acquisition trials or exposures to the positive S–S* or R–S* contingency prior to extinction is likely to strengthen expectations of contingency and is generally found to increase resistance to extinction (e.g., Harris & Nygaard, 1961; Hull, 1943; Perin, 1942; Uhl & Young, 1967; but see Tombaugh, 1967). On the other hand, when experimental conditions involving intertrial interval (e.g., Capaldi & Minkoff, 1966; Sheffield, 1950), the stimulus context (e.g., Azrin & Holz, 1966), and trial duration (e.g., Capaldi, 1966; Hulse, 1958) are changed between acquisition and extinction, expectations of a positive contingency are likely to be weaker and resistance to extinction is usually decreased.

Factors that may be seen as modulating the salience of situational information provided by nonreinforcement in extinction also influence rate of extinction. Extinction is slowed when animals are exposed to partial reinforcement during acquisition. Much of the partial reinforcement effect (PRE) is attributable to the fact that subjects are exposed to nonreinforced trials during acquisition similar to those encountered during extinction (cf. Mackintosh, 1974). Such exposure to nonreinforcement during acquisition may decrease the salience of nonreinforcement during extinction and ensure that a greater number of extinction trials are needed to disconfirm subjects' expectations of a positive contingency formed during acquisition. Similarly, delayed reinforcers during acquisition also usually retard the rate of extinction (e.g., Capaldi & Bowen, 1964; McCain & Bowen, 1967; Schoonard & Lawrence, 1962; Tombaugh, 1966) perhaps because they also decrease the salience of nonreinforcement encountered in extinction.

Perhaps some of the best evidence for the idea that when faced with conflicting expectations and environmental information about event covariations (Cell 4, Case 2 of Table 1), animals' responses like humans' judgments are influenced by both expectations and data, although biased in the direction of their preconceptions, are the parallel phenomena of learned irrelevance (Mackintosh, 1973) and learned helplessness (Overmier & Seligman, 1967; Seligman & Maier, 1967). Learned irrelevance is a Pavlovian conditioning effect in which prior exposure to uncorrelated CS–US presentations retard excitatory or inhibitory conditioning when the two stimuli are subsequently positively or negatively correlated with one another, respectively (e.g., Baker &

Mackintosh, 1977, Gamzu & Williams, 1971, 1973; Mackintosh, 1973; Tomie, Murphy, Fath, & Jackson, 1980; Wasserman, Franklin, & Hearst, 1974). Learned irrelevance is specific to the US used in conditioning (Mackintosh, 1973) and is not reducible to the sum of the retarding effects of exposure to CS or US alone (e.g., Baker & Mackintosh, 1979). The learned irrelevance effect suggests that animals may specifically learn that a particular CS and US are uncorrelated and form an expectation that they will continue to be unrelated in the future. This expectation may then interfere with the formation of an association between the two either because the animal learns to ignore the CS, because it predicts no change in the probability of the US (Mackintosh, 1973, 1975; Step 3 of Crocker's model), or because the positive correlation experienced in conditioning is inconsistent with the previously established expectation of noncontingency (Baker, 1976) and is thus not well recalled (Step 4 of Crocker's model).

The learned helplessness effect is the analogous phenomenon in instrumental learning and refers to the interference with instrumental conditioning produced by prior experience with response–outcome independence (see Maier & Seligman, 1976, for a review). Unlike learned irrelevance, learned helplessness is general across different situations, reinforcers, and response requirements (e.g., Altenor, Kay, & Richter, 1977; Braud, Wepman, & Russo, 1969; Caspy, Frommer, Weiner, & Lubow, 1979; Caspy & Lubow, 1981; Goodkin, 1976; Rosellini, 1978; Rosellini & Seligman, 1975; Seligman, Rosellini, & Kozak, 1975). According to the learned helplessness hypothesis (e.g., Alloy & Seligman, 1979; Maier & Seligman, 1976; Seligman, 1975), organisms exposed to response–outcome independence learn that these outcomes are uncontrollable and acquire the general expectation of continued action–outcome independence. This expectation produces a cognitive or associative deficit consisting of difficulty in learning in new situations that responses and reinforcers are contingently related. The associative deficit is a relative effect, not an absolute one. That is, animals that have experienced uncontrollable reinforcers are predicted to have greater difficulty perceiving subsequent response–outcome dependencies than are animals that have experienced an equivalent number and pattern of controllable reinforcers or animals with no experience with these reinforcers.

Historically, it has been difficult to demonstrate the existence of the cognitive deficit in helpless animals (or humans) that is independent of motivational or motor activity effects of experience with uncontrollable outcomes (cf. Alloy & Seligman, 1979; Maier & Jackson, 1979). Critics of the learned helplessness theory have proposed a variety of hypotheses that involve differences in activity level or learned motor patterns as explanatory mechanisms for the effects of uncontrollable outcomes (e.g., Anisman, 1975; Anisman, deCatanzaro, & Remington, 1978; Anisman & Waller, 1973; Bracewell & Black, 1974; Glazer & Weiss, 1976a, 1976b; Levis, 1976; Weiss, Glazer, & Pohorecky, 1976). However, several recent studies (Alloy & Ehrman, 1981; Baker, 1976; Jackson, Alexander, & Maier, 1980; Jackson, Maier, & Rapaport, 1978) have successfully demonstrated the existence of the associative effect unconfounded by motivational or activity effects. Thus, the cognitive component of the learned helplessness phenomenon appears to be an ideal example of covariation detection in animals biased in the direction of initial expectations when expectations and situational information conflict (Case 2 of Cell 4, Table 1). When exposed to a zero response–outcome contingency, animals are less likely to subsequently perceive a positive response–outcome contingency.

A prediction deriving from our interactional view of covariation detection (see also Alloy & Abramson, 1979; Alloy & Ehrman, 1981; Alloy & Seligman, 1979; Testa, Juraska, & Maier, 1974) is that an expectation of R–S* independence should not only interfere with subsequent learning of R–S* dependence (Case 2 of Cell 4, Table 1) but should also facilitate subsequent learning of R–S* independence (Case 1 of Cell 4, Table 1) because prior expectations and current situational information are congruent. Both Alloy and Ehrman (1981) and Testa et al. (1974) have supported this prediction. For example, Alloy and Ehrman examined the effect in rats of experience with response–shock dependence (escapable shock) or independence (inescapable shock) on preasymptotic excitatory conditioning when subsequently exposed to a zero, tone–shock contingency (TRC procedure). In line with the prediction that an expectation of noncontingency would facilitate subsequent perception of noncontingency, they found that inescapably shocked rats acquired less conditioning in the TRC procedure than did escapably shocked or nonshocked rats.

Consistent with our interactional framework, whether the learned helplessness effect occurs depends on whether an expectation of R–S* noncontingency or contingency is formed first. Several studies have demonstrated that animals can be immunized, at least to some extent, against the deleterious effects of uncontrollable reinforcers by prior experience with response–reinforcer dependence (e.g., Seligman & Maier, 1967; Seligman et al., 1975; Williams & Maier, 1977). Presumably, the initial experience with controllable outcome establishes an expectation of R–S* contingency that interferes with the subsequent perception of the R–S* noncontingency, thus preventing the usual helplessness effect.

Although learned helplessness appears to be an extreme case of expectation-based covariation detection; in fact, the helplessness effect is influenced by situational information, too. Seligman, Maier, and Geer (1968) and Seligman et al. (1975) found that learned helplessness could be reversed in dogs or rats by forcibly exposing the helpless animals to a positive response–reinforcer contingency. Such forced exposure may have increased the salience of the information provided by the positive contingency and thus enhanced the information's influence on the animals' contingency detection. Similarly, Maier and Testa (1975) found that a 1-s interruption of shock following the first crossing of a shuttlebox, where two crossings were required to terminate shock, prevented the usual helplessness interference effect in rats previously exposed to response–shock independence. They argued that this shock interruption made the positive contingency between shuttling and shock termination more salient and, hence, easier to perceive. Conversely, Maier and Testa (1975) found that arranging a less salient covariation between shuttling and shock termination by interposing a delay between one crossing of the shuttlebox and shock offset led to the helplessness effect in rats previously exposed to uncontrollable shock under conditions in which it normally would not occur. It appears then that whether the helplessness effect occurs and with what magnitude depends on a careful titration of prior expectations about response–outcome contingencies and current environmental information regarding such contingencies.

Several additional Pavlovian conditioning phenomena may also be assimilated within our interactional covariation detection framework. Blocking (Kamin, 1968, 1969), latent inhibition (Lubow & Moore, 1959), and the US preexposure effect (e.g., Randich & LoLordo, 1979a) may also represent expectation-biased processing of S–S* correlations in the face of conflicting situational information (Case 2 of Cell 4, Table 1). In blocking, prior conditioning with one stimulus (CS_A) prevents or blocks any conditioning from accruing to a second stimulus (CS_B), following the first conditioning trial, when the two stimuli are subsequently presented in compound (*AB*) and paired with the US (Mackintosh, 1978). If, however, the US is changed in any way between the two phases of training, blocking does not occur on later trials (e.g., Dickinson, Hall, & Mackintosh, 1976; Dickinson & Mackintosh, 1979; Mackintosh, Bygrave, & Picton, 1977; Mackintosh, Dickinson, & Cotton, 1980). Although two major theoretical accounts have been proposed as explanations of blocking (Mackintosh, 1975; Rescorla & Wagner, 1972), recent evidence (e.g., Dickinson et al., 1976; Dickinson & Mackintosh, 1979; Mackintosh et al., 1977, 1980) tends to support Mackintosh's (1975) view that blocking is attributable to the fact that the added stimulus (CS_B) is redundant and signals no change in reinforcement and, thus, is actively ignored (Step 3 of Crocker's model). In a blocking experiment, animals may come to expect that CS_A perfectly predicts the occurrence of the US based on their pretraining experience and this expectation then interferes with the perception of the CS_B–US correlation present in the compound conditioning phase. On the other hand, if the animal is surprised on the first trial of the compound conditioning phase by a change in the US (i.e., the salience of the situational information is enhanced), the prior expectation is overridden and conditioning to CS_B occurs.

The latent inhibition effect in which presentations of CS alone retard subsequent excitatory or inhibitory conditioning is also usually understood as a consequence of animals actively learning to ignore the CS because it previously was uncorrelated with changes in reinforcement (cf. Mackintosh, 1974). As expected from our theoretical framework, variables that would be predicted to enhance an animal's expectation that the CS predicts no change in reinforcement, such as a greater number of CS only presentations, increase the magnitude of the latent inhibition effect (e.g., Lubow, 1965; Siegel, 1969).

Finally, the US preexposure effect refers to the finding that experience with the US alone prior to its pairing with the CS retards excitatory conditioning. Much current research activity is devoted to discovering the mechanisms underlying this effect (e.g., Baker, Mercier, Gabel, & Baker, 1981; Domjan & Best, 1980; Hinson, 1982; Randich, 1981; Randich & LoLordo, 1979b; Tomie et al., 1980), and two general types of associative explanations have been proposed: cognitive information processing accounts and contextual blocking accounts (cf. Hinson, 1982). Cognitive explanations have been offered in terms of the learned irrelevance and learned helplessness phenomena discussed above. These accounts suggest that animals learn that the US is uncorrelated with other stimuli or responses during US preexposure and that this is incompatible with the learning of the CS–US contingency during the subsequent conditioning period. The contextual blocking hypotheses suggest that conditioning of the nominal CS is blocked in the CS–US pairing phase by prior conditioning of the environmental context during the US preexposure phase. Results of several recent studies suggest that the US preexposure effect may involve both contextual blocking and learned irrelevance or learned helplessness (e.g., Baker et al., 1981; Cannon, Berman, Baker, & Atkinson, 1975; Domjan & Best, 1980; Hinson, 1982; Randich & LoLordo, 1979b). Because it has been argued above that both the blocking and the learned irrelevance/helplessness phenomena are examples of contingency detection biased toward expectations despite conflicting situational information, the US preexposure effect, if based on one or on a combination of these other phenomena, may also be viewed reasonably as conforming to our interactional framework. Like these other phenomena, the magnitude of the US preexposure effect, as predicted by our conceptual framework, is increased by parameters that may enhance the strength of expectations (Cannon et al., 1975; Cappell & LeBlanc, 1975, 1977; Elkins, 1974; Hobson, 1968; Kamin, 1961; LeBlanc & Cappell, 1974; Mis & Moore, 1973; Vogel, 1974) and decreased by parameters that may enhance the salience of expectation-incongruent situational information (Cannon et al., 1975; LeBlanc & Cappell, 1974).

Preexperimental expectations. Recent examples of stimulus–reinforcer selectivity in associative learning may provide evidence demonstrating that expectations established prior to an animal's participation in an experiment, like those formed within the first phase of an experimental situation, bias subsequent contingency detection. The classic demonstration of selective associations in Pavlovian conditioning was provided by Garcia and Koelling (1966). They found that when a compound CS consisting of a taste stimulus and an audiovisual stimulus was paired with x-radiation-produced gastrointestinal illness, only the taste component subsequently controlled avoidance of drinking. In contrast, when the compound CS was paired with electric shock, only the audiovisual component controlled the aversion to drinking. Since Garcia and Koelling's original demonstration, a multitude of taste-aversion experiments have been conducted (see Barker, Best, & Domjan, 1977; Garcia, McGowan, & Green, 1972; Revusky, 1977; Seligman & Hager, 1972; and Shettleworth, 1972, for reviews). Although the clearest examples of the specificity of stimulus to reinforcer have come from these studies of taste aversion learning, the principle is of greater generality (e.g., LoLordo, 1979).

The important feature of these studies is that they indicate that certain CS–US covariations are easier for animals to detect than are others. Given the same objective contingency between CS_A and a US (e.g., taste and poison) and CS_B and the US (e.g., light and poison), some animals (e.g., rats) find it easier to learn about the former contingency whereas others (e.g., birds) find it easier to learn about the latter (cf. Brower, 1969; Capretta, 1961; Wilcoxon, Dragoin, & Kral, 1971). Such selectivity in conditioning may best be explained by assuming that animals come into learning experiments with basic preexperimental expectations about which stimuli tend to covary. Although most learning theorists tend to agree on this point, there is much controversy surrounding the issue of the origin of such preexperimental expectations (e.g., Garcia et al., 1972; Revusky, 1977; Seligman, 1970; Testa, 1974; Testa & Ternes, 1977). Most discussions of selective associations assume that they arise from natural selection pressures over the evolutionary history of a species (e.g., Garcia et al., 1972; Rozin & Kalat, 1971). However, it is equally plausible that predispositions to associate certain classes of stimuli and reinforcers are not wired into animals' nervous systems as suggested by the adaptational view but rather are formed during animals' developmental histories. If an animal's natural environment is constrained in such a way as to consistently expose the animal to correlations between only certain classes of stimuli and reinforcers (e.g., tastes and visceral states), such preexperimental expectations may be acquired within the animal's own lifetime during its natural commerce with the environment (e.g., Mackintosh, 1974; Testa, 1974).[5] Whether preexperimental expectations about plausible event covariations are biological or experiential in orgin, when confronted with objective CS–US contingencies in an experiment, accurate contingency perception (as evidenced by conditioning) is probable if the contingency information is congruent with preexperimental expectations (i.e., Case 1 of Cell 4, Table 1), as in the case of taste–poison associations for rats. If, however, the information provided within the experimental context is inconsistent with a priori expectations (Case 2 of Cell 4, Table 1), covariation perception is less likely, as in the case of taste–shock or light–poison associations for rats.

An Alternative Model for Integrating Human and Animal Covariation Assessment

A major goal of our article has been to integrate human and animal covariation detection within a single theoretical framework, and thus we have proposed an expectation by situational information interactional model to this end. Dickinson et al. (1983) have suggested an alternative theoretical model for this purpose based on contemporary theories of animal conditioning, in particular the Rescorla-Wagner model (Rescorla & Wagner, 1972) and its variants (Mackintosh, 1975; Pearce & Hall, 1980). These conditioning theories suggest that change in associative strength of a stimulus is the result of the outcome on each trial involving that stimulus. Specifically, the Rescorla-Wagner model is summarized by the equation

$$\Delta V_A = \alpha_A \beta(\lambda - V_{AX}),$$

which states that change in associative strength (ΔV) of a CS (A) to a US on a given trial will vary as a function of the salience of the CS (α), the effectiveness of the outcome or reinforcer (β), the maximum amount of associative strength that can be supported by the particular reinforcer used (λ), and the associative strength already present (V) to the CS and other stimuli present (X) when the trial occurs. The value of associative strength is then assumed to determine an animal's conditioned response to the CS, or in Dickinson et al.'s application of the model to humans, a person's judgment of the contingency between stimulus and outcome. Positive and negative associative strengths yield judgments of positive and negative correlation, respectively.

The Rescorla-Wagner model employs a simple contiguity plus selective learning mechanism to account for organisms' sensitivity to event contingencies and assumes that the organism is unaware of the actual relationship between the events. That is, unlike our expectation by situational informational framework, it postulates no cognitive representation of covariation. The Rescorla-Wagner model, because of its origin in animal learning work, explains well most of the animal research described in this article. In addition, the model is consistent with many of the human covariation studies reviewed here as well, in-

[5] Recent evidence from human fear conditioning studies (e.g., Hugdahl & Öhman, 1977; Öhman, Eriksson, & Olofsson, 1975; Öhman, Erixon, & Löfberg, 1975; Öhman, Frederickson, Hugdahl, & Rimmö, 1976) documents selectivity in people's contingency perception as well. Moreover, similar to the animal learning work, much controversy exists about whether the origin of people's selective predispositions are phylogenetic or ontogenetic in origin.

cluding some of the studies demonstrating the biasing effects of prior expectations. In fact, the Rescorla-Wagner model suggests a possible mechanism by which expectations may form.

However, we believe that our expectation by situational information interactional framework has several advantages that recommend it over the Rescorla-Wagner model and other conditioning theories. First, because they depend on trial-by-trial changes in associative strength, these conditioning models can only, in principle, account for covariation assessments based on real time interaction with events. In contrast, our model can account for covariation perceptions based on abstract representations and summaries of event co-occurrences (e.g., Shaklee & Mims, 1982; Schustack & Sternberg, 1981; Smedslund, 1963; Ward & Jenkins, 1965) and causal attributions based on prepackaged covariation information as well. Given that these summary information and attributional studies yield findings consistent with those presenting events in sequential fashion, our model may be more comprehensive and parsimonious in uniting all of the animal and human work in one theoretical framework. Second, in the conditioning theories, associative strength and therefore, judgment or behavior, is reinforcer-specific. That is, these models can account for the biasing influence of prior expectations on subsequent covariation judgments only if these expectations involve the exact outcome encountered in the subsequent event relationship. Given that a number of human attributional and covariation studies find effects of generalized or abstract preconceptions (cf. Chapman & Chapman, 1967; Jennings et al., 1982; Langer, 1975; Peterson, 1980; Ross, 1977; Wortman, 1975) and animal learned helplessness studies find cross-reinforcer generality (Altenor et al., 1977, Braud et al., 1969; Caspy et al., 1979; Caspy & Lubow, 1981; Goodkin, 1976; Rosellini, 1978; Rosellini & Seligman, 1975), this feature of conditioning models also limits their generality. Third, the conditioning models do not readily explain the complete pattern of depressed–nondepressed differences in contingency judgment (see section on individual differences, after Step 5 above), for example, nondepressives' underestimation of control for a positive response–outcome contingency with a negative outcome (Alloy & Abramson, 1979). Finally our interactional framework is consistent with the recent developments in cognitive psychology emphasizing the need for constructs like *expectations* or *schemata* in understanding perception, comprehension, and interpretation processes (e.g., Neisser, 1967, 1976).

To date, we know of only two studies that have attempted to test the viability of conditioning accounts of human covariation assessments. Dickinson et al. (1983) reported findings supportive of the conditioning models, although their results are also completely compatible with our expectation by situational information model. Kossman (1982) found only equivocal support for the conditioning models. We believe that the conditioning models are intriguing—although not as comprehensive as our own model—and may provide a viable alternative account of some of the covariation assessment findings. Thus, we await future research designed specifically to pit the two theories against one another.

The Accuracy Versus Rationality of Covariation Assessments

Throughout this article, we have argued that both accurate and erroneous perceptions of covariation may be understood on the basis of the convergence or divergence prior expectations and objective situational information about event relationships. An important issue, however, concerns the criterion for determining the accuracy of covariation perceptions. Within the covariation detection literature, researchers have utilized the concept of accuracy in two ways. In one use of the concept, subjects' perceptions of contingency are compared to a statistical estimate of the objective contingency between events: to the Pearson r if the events are continuous or to one of several statistical measures of association based upon the four cells of a 2×2 contingency table (e.g., chi-square, phi, delta, or association coefficient) if the events are dichotomous. To the degree that organisms' judgments of contingency (as evidenced by conditioning in the case of animals) differ from the value obtained by applying one of these statistics, their judgments are in error. This is the sense in which we have utilized the accuracy concept throughout this article. Given that the mathematical metrics named above are the commonly accepted methods for quantifying the degree of relationship between events, it seems quite appropriate to state that humans' and animals' judgments of covariation are often in error (but see Crocker, 1981, for a caution that an exact match between subjective judgments and statistical estimates of contingency may be an unrealistically strict criterion of accuracy). Moreover, we have argued that covariation judgment errors are not random but rather are influenced systematically by prior expectations.

The second way in which the concept of accuracy is sometimes used is to compare subjective judgments to a normative or ideal model for assessing covariations (e.g., Crocker, 1981; Nisbett & Ross, 1980). For example, Crocker (1981) proposed a five-step normative model of how people ought to make covariation judgments and identified ways in which errors could occur at each step of the model (see section on the covariation judgment process, before Step 1 above). Normative models are really process models and as such they are heuristically useful for generating hypotheses about the cognitive mechanisms involved in the covariation assessment process. We would argue that by comparing subjective judgments to a normative model, one is actually testing the adequacy of a theory about subjects' inferential strategies, not determining the accuracy of subjective perceptions. If people's (or animals') judgments do not match those predicted by a normative model, this may say more about the need for revising the theory to more closely describe subjects' cognitive processes than it says about the adequacy of those processes (see also Braine, 1978; Cohen, 1979; Einhorn & Hogarth, 1978). Normatively inappropriate inferential strategies can produce accurate covariation perceptions in a variety of situations, whereas normatively appropriate strategies can sometimes lead to errors. In essence, we believe that researchers who utilize a normative model as a criterion for accuracy are confusing the concept of accuracy with that of rationality.

The issue of whether humans' or animals' covariation assessment processes are rational is very difficult. In determining the relative rationality of an organism's strategies for assessing contingencies, it is important to consider which strategies lead to accuracy over the long run in the organism's everyday environment as well as accuracy over the short run in the laboratory. In the present article, we have suggested that it is the balance between an organism's reliance on expectations versus current information that influences accuracy in the first sense described above. However, when is it rational for organisms to tip the balance in favor of their expectations or in favor of situational information when assessing event relationships?

In an extensive discussion of the concepts of accuracy and rationality, Abramson and Alloy (1981) argued that when individuals' expectations accurately reflect the contingencies encountered in their natural environments (or, perhaps, in an early phase of an experiment—see section on animal studies), it is not irrational for them to assimilate incoming information about covariation between events to these expectations. Reliance on such an inferential strategy would normally yield veridical judgments of contingency except in short-run circumstances (like those encountered in many laboratory experiments) in which situational covariation information conflicts with prior expectations. Because covariation information provided in an experiment may represent only one piece of conflicting evidence against the background of the large body of data about event covariations summarized by an expectation, it would be normatively appropriate for organisms to weight their expectations more heavily than situational information in the covariation judgment process. If, however, a person or an animal were required to spend the rest of their lives in the laboratory, it would be normatively appropriate or rational for them to revise their inferential strategies to accurately reflect the contingencies of their new environment. Thus, organisms' errors in judging contingencies may represent a misapplication of a generally rational inferential strategy that over the long run generally yields accurate detection of contingencies in the everyday environment. Conversely, successes in contingency perception in the laboratory may reflect the use of a generally irrational strategy that would often lead to erroneous perceptions of covariations in real life.

According to Abramson and Alloy (1981), an ultimate determination of the rationality of organisms' covariation judgment processes requires an assessment of (a) the content and strength of relevant expectations, (b) the relative fit of these expectations to the everyday contingencies organisms encounter, and (c) the accommodation of these expectations to situational information that is incongruent with them, and the development of a normative model of covariation assessment that provides appropriate weights for expectations and current information in different environmental contexts. Until such time as new normative models can be developed (see Shafer, 1976), it may be difficult to decide whether humans' and animals' perceptions of covariation are sometimes irrational as well as erroneous (see Abramson & Alloy, 1981, for an extended discussion of the concepts of error, irrationality, and maladaptiveness in covariation assessment).

Summary and Conclusion

Our goal in this article was to develop a theoretical framework for summarizing and understanding humans' and animals' use and detection of event covariations. In reviewing the work on covariation detection, the theme that emerged was that although humans' and animals' perceptions of event relations are influenced by objective environmental covariations, they often are not isomorphic with objective contingencies. We argued that the covariation assessment process could be best conceptualized as an interaction between prior expectations about event relationships and currently available situational information. Whether an organism detects any particular relationship accurately depends on the relative strength of relevant expectations and objective situational information as well as on the degree to which these two sources of information converge. The incorporation of both the human and the animal data into the same interactional framework has theoretic value in that it leads to parallel research strategies designed to assess the joint influence of expectations and situational information in animals and human learning. Such research may contribute to a greater understanding of the ways in which people's and animals' covariation assessment processes are both similar and dissimilar. In sum, organisms both assimilate incoming situational information to their preexisting expectations and accommodate their expectations to the objective data of experience. That is, they both make sense of and impose sense upon the world, simultaneously.

References

Abelson, R. P. (1975). Concepts for representing mundane reality in plans. In D. G. Bobrow & A. Collins (Eds.), *Representation and understanding: Studies in cognitive science.* New York: Academic Press.

Abramson, L. Y., & Alloy, L. B. (1980). Judgment of contingency: Errors and their implications. In A. Baum & J. Singer (Eds.), *Advances in environmental psychology* (Vol. 2). Hillsdale, NJ: Erlbaum.

Abramson, L. Y., & Alloy, L. B. (1981). Depression, nondepression, and cognitive illusions: A reply to Schwartz. *Journal of Experimental Psychology: General, 110,* 436–447.

Abramson, L. Y., Alloy, L. B., & Kossman, D. (in press). The judgment of predictability in depressed and nondepressed students. In J. B. Overmier & R. F. Brush (Eds.), *Affect, conditioning, and cognition: Essays on the determinants of behavior.* Hillsdale, NJ: Erlbaum.

Abramson, L. Y., Alloy, L. B., & Rosoff, R. (1981). Depression and the generation of complex hypotheses in the judgment of contingency. *Behaviour Research and Therapy, 19,* 35–45.

Abramson, L. Y., Seligman, M. E. P., & Teasdale, J. (1978). Learned helplessness in humans: Critique and reformulation. *Journal of Abnormal Psychology, 87,* 49–74.

Ajzen, I. (1977). Intuitive theories of events and the effects of base-rate information on prediction. *Journal of Personality and Social Psychology, 35,* 303–314.

Allan, L. G., & Jenkins, H. M., (1980). The judgment of contingency and the nature of the response alternative. *Canadian Journal of Psychology, 34,* 1–11.

Alloy, L. B., & Abramson, L. Y. (1979). Judgment of contingency in depressed in nondepressed students: Sadder but wiser? *Journal of Experimental Psychology: General, 108,* 441–485.

Alloy, L. B., & Abramson, L. Y. (1980). The cognitive component of human helplessness and depression: A critical analysis. In J. Garber & M. E. P. Seligman (Eds.), *Human helplessness: Theory and application.* New York: Academic Press.

Alloy, L. B., & Abramson, L. Y. (1982). Learned helplessness, depression, and the illusion of control. *Journal of Personality and Social Psychology, 42,* 1114–1126.

Alloy, L. B., Abramson, L. Y., & Musson, R. F. (1983). *Who distorts?: Predictors of the illusion of control.* Manuscript in preparation, Northwestern University.

Alloy, L. B., Abramson, L. Y., & Viscusi, D. (1981). Induced mood and the illusion of control. *Journal of Personality and Social Psychology, 41,* 1129–1140.

Alloy, L. B., Crocker, J., & Tabachnik, N. (1980, August). *Depression and covariation judgments: Expectation-based distortions in information search and recall.* Paper presented at the meeting of the American Psychological Association, Montreal, Canada.

Alloy, L. B., & Ehrman, R. N. (1981). Instrumental to Pavlovian transfer: Learning about response–reinforcer contingencies affects subsequent learning about stimulus-reinforcer contingencies. *Learning and Motivation, 12,* 109–132.

Alloy, L. B., & Seligman, M. E. P. (1979). On the cognitive component of learned helplessness and depression. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 13). New York: Academic Press.

Alloy, L. B., & Tabachnik, N. (1983). *Clinical inference in psychodiagnosis and psychotherapy: Expectation-based biases in assessments of covariation.* Manuscript under editorial review.

Allport, G. W. (1954). *The nature of prejudice.* Cambridge, MA: Addison-Wesley.

Altenor, A., Kay, E., & Richter, M. (1977). The generality of learned helplessness in the rat. *Learning and Motivation, 8,* 54–62.

Anisman, H. (1975). Time-dependent variations in aversively motivated behaviors: Nonassociative effects of cholinergic and catecholaminergic activity. *Psychological Review, 82,* 359–385.

Anisman, H., de Catanzaro, D., & Remington, G. (1978). Escape performance following exposure to inescapable shock: Deficits in motor response maintenance. *Journal of Experimental Psychology: Animal Behavior Processes, 4,* 197–218.

Anisman, H., & Waller, T. G. (1973). Effects of inescapable shock on subsequent avoidance performance: Role of response repertoire changes. *Behavioral Biology, 9,* 331–355.

Annau, Z., & Kamin, L. J. (1961). The conditioned emotional response as a function of intensity of the US. *Journal of Comparative and Physiological Psychology, 54,* 428–432.

Arkes, H. R., & Harkness, A. R. (1983). Estimates of contingency between two dichotomous variables. *Journal of Experimental Psychology: General, 112,* 117–135.

Averill, J. R. (1973). Personal control over aversive stimuli and its relationship to stress. *Psychological Bulletin, 80,* 286–303.

Ayres, J. J., Benedict, J. O., & Witcher, E. S. (1975). Systematic manipulation of individual events in a truly random control in rats. *Journal of Comparative and Physiological Psychology, 88,* 97–103.

Azrin, N. H., & Holz, W. C. (1966). Punishment. In W. K. Honig (Ed.), *Operant behavior: Areas of research and application.* New York: Appleton-Century-Crofts.

Baker, A. G. (1976). Learned irrelevance and learned helplessness: Rats learn that stimuli, reinforcers, and responses are uncorrelated. *Journal of Experimental Psychology: Animal Behavior Processes, 2,* 130–142.

Baker, A. G., & Mackintosh, N. J. (1977). Excitatory and inhibitory conditioning following uncorrelated presentations of CS and UCS. *Animal Learning & Behavior, 5,* 315–319.

Baker, A. G., & Mackintosh, N. J. (1979). Preexposure to the CS alone, US alone, or CS and US uncorrelated: Latent inhibition, blocking by context or learned irrelevance. *Learning and Motivation, 10,* 278–294.

Baker, A. G., Mercier, P., Gabel, J., & Baker, P. A. (1981). Contextual conditioning and the UCS preexposure effect in conditioned fear. *Journal of Experimental Psychology: Animal Behavior Processes, 7,* 109–128.

Bandura, A. (1969). *Principles of behavior modification.* New York: Holt, Rinehart & Winston.

Bandura, A. (1977). Self efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84,* 191–215.

Barker, L. M., Best, M. R., & Domjan, M. (Eds.). (1977). *Learning mechanisms in food selection.* Waco, TX: Baylor University Press.

Bartlett, F. C. (1932). *Remembering.* Cambridge, England: Cambridge University Press.

Baum, A., & Singer, J. (Eds.). (1980). *Advances in environmental psychology* (Vol. 2). Hillsdale, NJ: Erlbaum.

Baum, W. M. (1973). The correlation-based law of effect. *Journal of the Experimental Analysis of Behavior, 20,* 137–153.

Beach, L. R., & Scopp, T. S. (1966). Inferences about correlations. *Psychonomic Science, 6,* 253–254.

Beck, A. T. (1967). *Depression: Clinical, experimental, and theoretical aspects.* New York: Harper & Row.

Beck, A. T. (1976). *Cognitive therapy and the emotional disorders.* New York: International Universities Press.

Bell, L. G., Wicklund, R. A., Manko, G., & Larkin, C. (1976). When unexpected behavior is attributed to the environment. *Journal of Research in Personality, 10,* 316–327.

Benedict, J. O., & Ayres, J. J. B. (1972). Factors affecting conditioning in the truly random control procedure in the rat. *Journal of Comparative and Physiological Psychology, 78,* 323–330.

Bindra, D. (1972). A unified account of classical conditioning and operant training. In A. H. Black & W. F. Prokasy (Eds.), *Classical conditioning II: Current research and theory.* New York: Appleton-Century-Crofts.

Bloomfield, T. M. (1972). Contrast and inhibition in discrimination learning by the pigeon: Analysis through drug effects. *Learning and Motivation, 3,* 162–178.

Bobrow, D. G., & Norman, D. A. (1975). Some principles of memory schemata. In D. G. Bobrow & A. Collins (Eds.), *Representation and understanding: Studies in cognitive science.* New York: Academic Press.

Bolles, R. C. (1972). Reinforecement, expectancy, and learning. *Psychological Review, 79,* 394–409.

Bower, G. H., Black, J. B., & Turner, T. J. (1979). Scripts in memory for text. *Cognitive Psychology, 11,* 177–120.

Bracewell, R. J., & Black, A. H. (1974). The effects of restraint and noncontingent pre-shock on subsequent escape learning in the rat. *Learning and Motivation, 5,* 53–69.

Bradley, G. W. (1978). Self-serving biases in the attribution process: A reexamination of the fact or fiction question. *Journal of Personality and Social Psychology, 36,* 56–71.

Braine, M. D. S. (1978). On the relation between the natural logic of reasoning and standard logic. *Psychological Review, 85,* 1–21.

Bransford, J. D., Barclay, J. R., & Franks, J. J. (1972). Sentence memory: A constructive versus interpretive approach. *Cognitive Psychology, 3,* 193–209.

Bransford, J. D., & Johnson, M. K. (1972). Contextual prerequisites for understanding: Some investigations of comprehension and recall. *Journal of Verbal Learning and Verbal Behavior, 11,* 717–726.

Bransford, J. D., & Johnson, M. K. (1973). Considerations of some problems of comprehension. In W. G. Chase (Ed.), *Visual information processing.* New York: Academic Press.

Braud, W., Wepman, B., & Russo, D. (1969). Task and species generality of the "helplessness" phenomenon. *Psychonomic Science, 16,* 154–155.

Brimer, C. J., & Dockrill, F. J. (1966). Partial reinforcement and the CER. *Psychonomic Science, 5,* 185–186.

Brogden, W. J. (1939). The effect of frequency of reinforcement upon the level of conditioning. *Journal of Experimental Psychology, 24,* 419–431.
Brower, L. P. (1969). Ecological chemistry. *Scientific American, 220,* 22–29.
Bruner, A., & Revusky, S. H. (1961). Collateral behavior in humans. *Journal of the Experimental Analysis of Behavior, 4,* 349–350.
Bruner, J. S., Goodnow, J. J., & Austin, G. A. (1956). *A study of thinking.* New York: Wiley.
Bruner, J. S., & Postman, L. (1949). On the perception of incongruity: A paradigm. *Journal of Personality, 18,* 206–223.
Buerger, A. A., & Dawson, A. M. (1968). Spinal kittens: Long-term increases in electromyograms due to a conditioning routine. *Physiology and Behavior, 3,* 99–103.
Buerger, A. A., & Dawson, A. M. (1969). Spinal kittens: Effect of clamping of the thoracic aorta on long-term increases in electromyograms due to a conditioning routine. *Experimental Neurology, 23,* 457–464.
Bugelski, B. R., & Alampay, D. A. (1961). The role of frequency in developing perceptual sets. *Canadian Journal of Psychology, 15,* 205–211.
Cannon, D. S., Berman, R. F., Baker, T. B., & Atkinson, C. A. (1975). Effects of preconditioning unconditioned stimulus experience on learned taste aversions. *Journal of Experimental Psychology: Animal Behavior Processes, 1,* 270–284.
Cantor, N., & Mischel, W. (1977). Traits as prototypes: Effects on recognition memory. *Journal of Personality and Social Psychology, 35,* 38–48.
Cantor, N., & Mischel, W. (1979). Prototypes in person perception. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 12). New York: Academic Press.
Capaldi, E. J. (1966). Partial reinforcement: A hypothesis of sequential effects. *Psychological Review, 73,* 459–477.
Capaldi, E. J., & Bowen, J. N. (1964). Delay of reward and goal box confinement time in extinction. *Psychonomic Science, 1,* 141–142.
Capaldi, E. J., & Minkoff, R. (1966). Change in the stimulus produced by non-reward as a function of time. *Psychonomic Science, 6,* 321–322.
Cappell, H., & LeBlanc, A. E. (1975). Conditioned aversion by amphetamine: Rates of acquisition and loss of attenuating effects of prior exposure. *Psychopharmacology, 43,* 157–162.
Cappell, H., & LeBlanc, A. E. (1977). Parametric investigations of the effects of prior exposure to amphetamine and morphine on conditioned gustatory aversion. *Psychopharmacology, 51,* 265–271.
Capretta, P. J. (1961). An experimental modification of food preferences in chickens. *Journal of Comparative and Physiological Psychology, 54,* 238–242.
Caspy, T., Frommer, R., Weiner, I., & Lubow, R. E. (1979). Generality of US preexposure effects: Effect of shock or food preexposure on water escape. *Bulletin of the Psychonomic Society, 4,* 15–18.
Caspy, T., & Lubow, R. E. (1981). Generality of US preexposure effects: Transfer from food to shock or shock to food with and without the same response requirements. *Animal Learning & Behavior, 9,* 524–532.
Catania, A. C., & Cutts, D. (1963). Experimental control of superstitious responding in humans. *Journal of the Experimental Analysis of Behavior, 6,* 203–208.
Chapman, L. J., & Chapman, J. P. (1967). Genesis of popular but erroneous psychodiagnostic observations. *Journal of Abnormal Psychology, 72,* 193–204.
Chapman, L. J., & Chapman, J. P. (1969). Illusory correlation as an obstacle to the use of valid psychodiagnostic signs. *Journal of Abnormal Psychology, 74,* 271–280.
Cohen, L. J. (1979). On the psychology of prediction: Whose is the fallacy? *Cognition, 7,* 385–409.
Coppel, D. B., & Smith, R. E. (1980). Acquisition of stimulus–outcome and response–outcome expectancies as a function of locus of control. *Cognitive Therapy and Research, 4,* 179–188.
Crespi, L. P. (1942). Quantitative variation of incentive and performance in the white rat. *American Journal of Psychology, 55,* 467–517.
Crocker, J. (1981). Judgment of covariation by social perceivers. *Psychological Bulletin, 90,* 272–292.
Crocker, J. (1982). Biased questions in judgment of covariation studies. *Personality and Social Psychology Bulletin, 8,* 214–220.
Crocker, J., & Taylor, S. E. (1978, August). *Theory-driven processing and the use of complex evidence.* Paper presented at the meeting of the American Psychological Association, Toronto, Canada.
Deaux, K. (1976). Sex: A perspective on the attribution process. In J. H. Harvey, W. J. Ickes, & R. F. Kidd (Eds.), *New directions in attribution research* (Vol. 1). Hillsdale, NJ: Erlbaum.
Deaux, K., & Emswiller, T. (1974). Explanations for successful performance on sex-linked tasks: What is skill for the male is luck for the female. *Journal of Personality and Social Psychology, 29,* 80–85.
Dickinson, A., Hall, G., & Mackintosh, N. J. (1976). Surprise and the attenuation of blocking. *Journal of Experimental Psychology: Animal Behavior Processes, 2,* 313–322.
Dickinson, A., & Mackintosh, N. J. (1979). Reinforcer specificity in the enhancement of conditioning by posttrial surprise. *Journal of Experimental Psychology: Animal Behavior Processes, 5,* 162–177.
Dickinson, A., Shanks, D., & Evenden, J. (1983). *Judgment of act-outcome contingency: The role of selective attribution.* Manuscript submitted for publication.
Domjan, M., & Best, M. R. (1980). Interference with ingestional aversion learning produced by preexposure to the unconditioned stimulus: Associative and nonassociative aspects. *Learning and Motivation, 11,* 522–537.
Dweck, C. S., & Wagner, A. R. (1970). Situational cues and correlation between CS and US as determinants of the conditioned emotional response. *Psychonomic Science, 18,* 145–147.
Einhorn, H. J., & Hogarth, R. M. (1978). Confidence in judgment: Persistence of the illusion of validity. *Psychological Review, 85,* 395–416.
Elkins, R. L. (1974). Bait-shyness acquisition and resistance to extinction as functions of US exposure prior to conditioning. *Physiological Psychology, 2,* 341–343.
Ellison, G. D. (1964). Differential salivary conditioning to traces. *Journal of Comparative and Physiological Psychology, 57,* 373–380.
Erlick, D. E. (1966). Human estimates of statistical relatedness. *Psychonomic Science, 5,* 365–366.
Erlick, D. E., & Mills, R. G. (1967). Perceptual quanti-

fication of conditional dependency. *Journal of Experimental Psychology, 73,* 9–14.

Feldman-Summers, S., & Kiesler, S. B. (1974). Those who are number two try harder: The effect of sex on attributions of causality. *Journal of Personality and Social Psychology, 30,* 846–855.

Ferster, C. B., & Skinner, B. F. (1957). *Schedules of reinforcement.* New York: Appleton-Century-Crofts.

Fitzgerald, R. D. (1963). Effects of partial reinforcement with acid on the classically conditioned salivary response in dogs. *Journal of Comparative and Physiological Psychology, 56,* 1056–1060.

Fowler, H., & Trapold, M. A. (1962). Escape performance as a function of delay of reinforcement. *Journal of Experimental Psychology, 63,* 464–467.

Gamzu, E., & Williams, D. R. (1971). Classical conditioning of a complex skeletal response. *Science, 171,* 923–925.

Gamzu, E., & Williams, D. R. (1973). Associative factors underlying the pigeon's keypecking in autoshaping procedures. *Journal of the Experimental Analysis of Behavior, 19,* 225–232.

Garber, J., & Hollon, S. D. (1980). Universal versus personal helplessness in depression: Belief in uncontrollability or incompetence. *Journal of Abnormal Psychology, 89,* 56–66.

Garber, J., & Seligman, M. E. P. (Eds.). (1980). *Human helplessness: Theory and application.* New York: Academic Press.

Garcia, J., & Koelling, R. A. (1966). Relation of cue to consequence in avoidance learning. *Psychonomic Science, 4,* 123–124.

Garcia, J., McGowan, B. K., & Green, K. F. (1972). Biological constraints on conditioning. In A. H. Black & W. F. Prokasy (Eds.), *Classical conditioning II: Current research and theory.* New York: Appleton-Century-Crofts.

Gibbon, J., Berryman, R., & Thompson, R. L. (1974). Contingency spaces and measures in classical and instrumental conditioning. *Journal of the Experimental Analysis of Behavior, 21,* 585–605.

Glazer, H. I., & Weiss, J. M. (1976a). Long-term and transitory interference effects. *Journal of Expermental Psychology: Animal Behavior Processes, 2,* 191–201.

Glazer, H. I., & Weiss, J. M. (1976b). Long-term interference effect: An alternative to "learned helplessness." *Journal of Experimental Psychology: Animal Behavior Processes, 2,* 201–213.

Golin, S., Terrell, F., & Johnson, B. (1977). Depression and the illusion of control. *Journal of Abnormal Psychology, 86,* 440–442.

Goodkin, F. (1976). Rats learn the relationship between responding and environmental events: An expansion of the learned helplessness hypothesis. *Learning and Motivation, 7,* 382–393.

Gormezano, I. (1972). Investigations of defense and reward conditioning in the rabbit. In A. H. Black & W. F. Prokasy (Eds.), *Classical conditioning II: Current research and theory.* New York: Appleton-Century-Crofts.

Hake, H. W., & Hyman, R. (1953). Perception of the statistical structure of a random series of binary symbols. *Journal of Experimental Psychology, 45,* 64–74.

Hammen, C. L. (1980). Depression in college students: Beyond the Beck Depression Inventory. *Journal of Consulting and Clinical Psychology, 48,* 126–128.

Hammond, L. J. (1980). The effect of contingency upon the appetitive conditioning of free-operant behavior. *Journal of the Experimental Analysis of Behavior, 34,* 297–304.

Hansen, R. D., & Donoghue, J. M. (1977). The power of consensus: Information derived from one's own and others' behavior. *Journal of Personality and Social Psychology, 35,* 294–302.

Hansen, R. D., & Lowe, C. A. (1976). Distinctiveness and consensus: The influence of behavioral information on actors' and observers' attributions. *Journal of Personality and Social Psychology, 34,* 425–433.

Harris, P., & Nygaard, J. E. (1961). Resistance to extinction and number of reinforcements. *Psychological Reports, 8,* 233–234.

Harris, R. J., & Monaco, G. E. (1978). Psychology of pragmatic implication: Information processing between the lines. *Journal of Experimental Psychology: General, 107,* 1–22.

Hastie, R. (1981). Schematic principles in human memory. In E. T. Higgins, P. Herman, & M. P. Zanna (Eds.), *Social cognition.* Hillsdale, NJ: Erlbaum.

Hayden, T., & Mischel, W. (1976). Maintaining trait consistency in the resolution of behavioral inconsistency: The wolf in sheep's clothing? *Journal of Personality, 44,* 109–132.

Heider, F. (1958). *The psychology of interpersonal relations.* New York: Wiley.

Herrnstein, R. J. (1966). Superstition: A corollary principle of operant conditioning. In W. K. Honig (Ed.), *Operant behavior: Areas of research and application.* New York: Appleton-Century-Crofts.

Hinson, R. E. (1982). Effects of UCS preexposure on excitatory and inhibitory rabbit eyelid conditioning: An associative effect of conditioned contextual stimuli. *Journal of Experimental Psychology: Animal Behavior Processes, 8,* 49–61.

Hobson, G. N. (1968). Effects of UCS adaptation upon conditioning in low and high anxiety men and women. *Journal of Experimental Psychology, 76,* 360–363.

Hovland, C. I., & Weiss, W. (1953). Transmission of information concerning concepts through positive and negative instances. *Journal of Experimental Psychology, 45,* 175–182.

Hugdahl, K., & Öhman, A. (1977). Effects of instruction on acquisition and extinction of electrodermal responses to fear-relevant stimuli. *Journal of Experimental Psychology: Human Learning and Memory, 3,* 608–618.

Hull, C. L. (1943). *Principles of behavior.* New York: Appleton-Century-Crofts.

Hulse, S. H., Jr. (1958). Amount and percentage of reinforcement and duration of goal confinement in conditioning and extinction. *Journal of Experimental Psychology, 56,* 48–57.

Ickes, W., & Layden, M. A. (1978). Attributional styles. In J. Harvey, W. Ickes, & R. Kidd (Eds.), *New directions in attribution research* (Vol. 2). Hillsdale, NJ: Erlbaum.

Jackson, R. L., Alexander, J. H., & Maier, S. F. (1980). Learned helplessness, inactivity, and associative deficits: Effects of inescapable shock on response choice escape learning. *Journal of Experimental Psychology: Animal Behavior Processes, 6,* 1–20.

Jackson, R. L., Maier, S. F., & Rapaport, P. M. (1978). Exposure to inescapable shock produces both activity

and associative deficits in the rat. *Learning and Motivation, 9,* 69–98.
Jenkins, H. M., & Ward, W. C. (1965). Judgment of contingency between responses and outcomes. *Psychological Monographs, 79* (1, Whole No. 594).
Jennings, D. L., Amabile, T., & Ross, L. (1982). Informal covariation assessment: Data-based versus theory-based judgments. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgment under uncertainty: Heuristics and biases.* Cambridge, England: Cambridge University Press.
Johnson, M. K., Bransford, J. D., & Solomon, S. K. (1973). Memory for tacit implications of sentences. *Journal of Experimental Psychology, 98,* 203–225.
Jones, E. E., & Nisbett, R. E. (1971). The actor and the observer: Divergent perceptions of the causes of behavior. In E. E. Jones, D. E. Kanouse, H. H. Kelley, R. E. Nisbett, S. Valins, & B. Weiner (Eds.), *Attribution: Perceiving the causes of behavior.* Morristown, NJ: General Learning Press.
Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness. *Cognitive Psychology, 3,* 430–454.
Kahneman, D., & Tversky, A. (1973). On the psychology of prediction. *Psychological Review, 80,* 237–251.
Kamin, L. J. (1961). Apparent adaptation effects in the acquisition of a conditioned emotional response. *Canadian Journal of Psychology, 15,* 176–188.
Kamin, L. J. (1965). Temporal and intensity characteristics of the conditioned stimulus. In W. F. Prokasy (Ed.), *Classical conditioning: A symposium.* New York: Appleton-Century-Crofts.
Kamin, L. J. (1968). "Attention-like" processes in classical conditioning. In M. R. Jones (Ed.), *Miami symposium on the prediction of behavior: Aversive stimulation.* Miami: University of Miami Press.
Kamin, L. J. (1969). Predictability, surprise, attention and conditioning. In B. A. Campbell & R. M. Church (Eds.), *Punishment and aversive behavior.* New York: Appleton-Century-Crofts.
Kassin, S. M. (1979a). Base rates and prediction: The role of sample size. *Personality and Social Psychology Bulletin, 5,* 210–213.
Kassin, S. M. (1979b). Consensus information, prediction, and causal attribution: A review of the literature and issues. *Journal of Personality and Social Psychology, 37,* 1966–1981.
Keller, R. J., Ayres, J. J., & Mahoney, W. J. (1977). Brief versus extended exposure to truly random control procedures. *Journal of Experimental Psychology: Animal Behavior Processes, 3,* 53–65.
Kelley, H. H. (1967). Attribution theory in social psychology. In D. Levine (Ed.), *Nebraska Symposium on Motivation* (Vol. 15). Lincoln: University of Nebraska Press.
Kelley, H. H. (1972). Causal schemata and the attribution process. In E. E. Jones, D. E. Kanouse, H. H. Kelley, R. E. Nisbett, S. Valins, & B. Weiner (Eds.), *Attribution: Perceiving the causes of behavior.* Morristown, NJ: General Learning Press.
Kelley, H. H. (1973). The process of causal attribution. *American Psychologist, 28,* 107–128.
Killeen, P. R. (1978). Superstition: A matter of bias, not detectability. *Science, 199,* 88–90.
Kimble, G. A. (1961). *Hilgard and Marquis' conditioning and learning* (2nd ed.). New York: Appleton-Century-Crofts.
Kossman, D. (1982). *Depressive versus nondepressive judgments of contingency: The Rescorla-Wagner model.* Unpublished manuscript, University of Pennsylvania.
Kovacs, M., & Beck, A. T. (1977). Empirical-clinical approach toward a definition of childhood depression. In J. G. Schulterbrandt & A. Raskin (Eds.), *Depression in childhood: Diagnosis, treatment, and conceptual models.* New York: Raven.
Kremer, E. F. (1974). The truly random control procedure: Conditioning to the static cues. *Journal of Comparative and Physiological Psychology, 86,* 700–707.
Kremer, E. F., & Kamin, L. J. (1971). The truly random control procedure: Associative or nonassociative effects in rats. *Journal of Comparative and Physiological Psychology, 74,* 203–210.
Langer, E. J. (1975). The illusion of control. *Journal of Personality and Social Psychology,* 1975, *32,* 311–328.
Langer, E. J., & Roth, J. (1975). Heads I win, tails it's chance: The illusion of control as a function of the sequence of outcomes in a purely chance task. *Journal of Personality and Social Psychology, 32,* 951–955.
LeBlanc, A. E., & Cappell, H. (1974). Attenuation of punishing effects of morphine and amphetamine by chronic prior treatment. *Journal of Comparative and Physiological Psychology, 87,* 691–698.
Leeper, R. (1935). A study of a neglected portion of the field of learning—the development of sensory organization. *Journal of Genetic Psychology, 46,* 41–75.
Lefcourt, H. M. (1972). Recent developments in the study of locus of control. In B. A. Maher (Ed.), *Progress in experimental personality research* (Vol. 6). New York: Academic Press.
Levine, M. (1969). Neo-continuity theory. In G. H. Bower & J. T. Spence (Eds.), *The psychology of learning and motivation* (Vol. 3). New York: Academic Press.
Levis, D. J. (1976). Learned helplessness: A reply and an alternative S–R interpretation. *Journal of Experimental Psychology: General, 105,* 47–65.
Likely, D. (1970). *Patterning of instrumental responding to sequences of varied food and sucrose rewards.* Paper presented at the Eastern Psychological Association Meeting, Atlantic City.
Logan, F. A. (1960). *Incentive.* New Haven: Yale University Press.
LoLordo, V. M. (1979). Selective associations. In A. Dickinson & R. A. Boakes (Eds.), *Mechanisms of learning and motivation.* Hillsdale, NJ: Erlbaum.
Lord, C. G., Ross, L., & Lepper, M. R. (1979). Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *Journal of Personality and Social Psychology, 37,* 2098–2109.
Lubow, R. E. (1965). Latent inhibition: Effects of frequency of nonreinforced preexposure of the CS. *Journal of Comparative and Physiological Psychology, 60,* 454–459.
Lubow, R. E., & Moore, A. U. (1959). Latent inhibition: The effect of nonreinforced preexposure to the conditioned stimulus. *Journal of Comparative and Physiological Psychology, 52,* 415–419.
Mackintosh, N. J. (1973). Stimulus selection: Learning to ignore stimuli that predict no change in reinforcement.

In R. A. Hinde & J. Stevenson-Hinde (Eds.), *Constraints on learning*. London: Academic Press.

Mackintosh, N. J. (1974). *The psychology of animal learning*. London: Academic Press.

Mackintosh, N. J. (1975). A theory of attention: Variations in the associability of stimuli with reinforcement. *Psychological review, 82,* 276-298.

Mackintosh, N. J. (1978). Cognitive or associative theories of conditioning: Implications of an analysis of blocking. In S. H. Hulse, H. Fowler, & W. K. Honig (Eds.), *Cognitive processes in animal behavior.* Hillsdale, NJ: Erlbaum.

Mackintosh, N. J., Bygrave, D. J., & Picton, B. M. B. (1977). Locus of the effect of a surprising reinforcer in the attenuation of blocking. *Quarterly Journal of Experimental Psychology, 29,* 327-336.

Mackintosh, N. J., Dickinson, A., & Cotton, M. M. (1980). Surprise and blocking: Effects of the number of compound trials. *Animal Learning & Behavior, 8,* 387-391.

Maier, S. F., & Jackson, R. L. (1979). Learned helplessness: All of us were right (and wrong): Inescapable shock has multiple effects. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 13). New York: Academic Press.

Maier, S. F., & Seligman, M. E. P. (1976). Learned helplessness: Theory and evidence. *Journal of Experimental Psychology: General, 105,* 3-46.

Maier, S. F., & Testa, T. J. (1975). Failure to learn to escape by rats previously exposed to inescapable shock is partly produced by associative interference. *Journal of Comparative and Physiological Psychology, 88,* 554-564.

Markus, H. (1977). Self-schemata and processing information about the self. *Journal of Personality and Social Psychology, 35,* 63-78.

Martin, D., Abramson, L. Y., & Alloy, L. B. (1984). The illusion of control for self and others in depressed and nondepressed college students. *Journal of Personality and Social Psychology, 46,* 125-136.

McArthur, L. A. (1972). The how and what of why: Some determinants and consequences of causal attribution. *Journal of Personality and Social Psychology, 22,* 171-193.

McArthur, L. A. (1976). The lesser influence of consensus than distinctiveness information on causal attributions: A test of the person-thing hypothesis. *Journal of Personality and Social Psychology, 33,* 733-742.

McCain, G., & Bowen, J. (1967). Pre- and postreinforcement delay with a small number of acquisition trials. *Psychonomic Science, 7,* 121-122.

Meltzer, D., & Brahlek, J. A. (1968). Quantity of reinforcement and fixed-interval performance. *Psychonomic Science, 12,* 207-208.

Metalsky, G. I., & Abramson, L. Y. (1981). Attributional styles; Toward a framework for conceptualization and assessment. In P. C. Kendall & S. D. Hollon (Eds.), *Assessment strategies for cognitive-behavioral interventions.* New York: Academic Press.

Miller, D. T. (1976). Ego-involvement and attributions for success and failure. *Journal of Personality and Social Psychology, 34,* 901-906.

Miller, D. T. (1978). What constitutes a self-serving attributional bias? A reply to Bradley. *Journal of Personality and Social Psychology, 36,* 1221-1223.

Miller, D. T., & Ross, M. (1975). Self-serving biases in the attribution of causality: Fact or fiction? *Psychological Bulletin, 82,* 213-225.

Minsky, M. (1975). A framework for representing knowledge. In P. H. Winston (Ed.), *The psychology of computer vision.* New York: McGraw-Hill.

Mis, R. W., & Moore, J. W. (1973). Effects of preacquisition UCS exposure on classical conditioning of the rabbit's nictitating membrane response. *Learning and Motivation, 4,* 108-114.

Mischel, W. (1973). Toward a cognitive social learning reconceptualization of personality. *Psychological Review, 80,* 252-283.

Mynatt, C. R., Doherty, M. E., & Tweeney, R. D. (1977). Confirmation bias in a simulated research environment: An experimental study of scientific inference. *Quarterly Journal of Experimental Psychology, 29,* 85-95.

Mynatt, C. R., Doherty, M. E., & Tweeney, R. D. (1978). Consequences of confirmation and disconfirmation in a simulated research environment. *Quarterly Journal of Experimental Psychology, 30,* 395-406.

Neisser, U. (1967). *Cognitive psychology.* New York: Appleton-Century-Crofts.

Neisser, U. (1976). *Cognition and reality: Principles and implications of cognitive psychology.* San Francisco: Freeman.

Nisbett, R. E., & Borgida, E. (1975). Attribution and the psychology of prediction. *Journal of Personality and Social Psychology, 32,* 932-943.

Nisbett, R. E., Borgida, E., Crandall, R., & Reed, H. (1976). Popular induction: Information is not always informative. In J. S. Carrol & J. W. Payne (Eds.), *Cognition and Social behavior, 2,* 227-236.

Nisbett, R. E., & Ross, L. (1980). *Human inference: Strategies and shortcomings of social judgment.* Englewood Cliffs, NJ: Prentice-Hall.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84,* 231-259.

Öhman, A., Eriksson, A., & Olofsson, C. (1975). One trial learning and superior resistance to extinction of autonomic responses conditioned to potentially phobic stimuli. *Journal of Comparative and Physiological Psychology, 88,* 619-627.

Öhman, A., Erixon, G., & Löfberg, I. (1975). Phobias and preparedness: Phobic versus neutral picture as conditioned stimuli for human autonomic responses. *Journal of Abnormal Psychology, 84,* 41-45.

Öhman, A., Frederickson, M., Hugdahl, K., & Rimmö, P. (1976). The premise of equipotentiality in human classical conditioning: Conditioned electrodermal responses to potentially phobic stimuli. *Journal of Experimental Psychology: General, 105,* 313-337.

Orvis, B. R., Cunningham, J. D., & Kelley, H. H. (1975). A closer examination of causal inference: The roles of consensus, distinctiveness, and consistency information. *Journal of Personality and Social Psychology, 32,* 605-616.

Ost, J. W. P., & Lauer, D. W. (1965). Some investigations of classical salivary conditioning in the dog. In W. F. Prokasy (Ed.), *Classical conditioning: A symposium.* New York: Appleton-Century-Crofts.

Overmier, J. B., & Seligman, M. E. P. (1967). Effects of inescapable shock upon subsequent escape and avoidance learning. *Journal of Comparative and Physiological Psychology, 63,* 23–33.

Owens, J., Bower, G. H., & Black, J. B. (1979). The "soap opera" effect in story recall. *Memory & Cognition, 7,* 185–191.

Patterson, M. M., Cegavske, C. F., & Thompson, R. F. (1973). Effects of a classical conditioning paradigm on hind-limb flexor nerve response in immobilized spinal cats. *Journal of Comparative and Physiological Psychology, 84,* 88–97.

Pavlov, I. P. (1927). *Conditioned reflexes.* Oxford, England: Oxford University Press.

Pearce, J. M., & Hall, G. (1980). A model for Pavlovian learning: Variations in the effectiveness of conditioned but not of unconditioned stimuli. *Psychological Review, 87,* 532–552.

Perin, C. T. (1942). Behavior potentiality as a joint function of the amount of training and degree of hunger at the time of extinction. *Journal of Experimental Psychology, 30,* 93–113.

Peterson, C. R. (1980). Recognition of noncontingency. *Journal of Personality and Social Psychology, 38,* 727–734.

Phares, E. J. (1976). *Locus of control in personality.* Morristown, NJ: General Learning Press.

Piaget, J. (1952). *The origins of intelligence in children.* New York: International University Press.

Piaget, J. (1954). *The construction of reality in the child.* New York: Basic Books.

Posner, M. I., & Keele, S. W. (1968). On the genesis of abstract ideas. *Journal of Experimental Psychology, 77,* 353–363.

Quinsey, V. L. (1971). Conditioned suppression with no CS–US contingency in the rat. *Canadian Journal of Psychology, 25,* 69–82.

Randich, A. (1981). The US preexposure phenomenon in the conditioned suppression paradigm: A role for conditioned situational stimuli. *Learning and Motivation, 12,* 321–341.

Randich, A., & LoLordo, V. M. (1979a). Associative and nonassociative theories of the UCS preexposure phenomenon: Implications for Pavlovian conditioning. *Psychological Bulletin, 86,* 523–548.

Randich, A., & LoLordo, V. M. (1979b). Preconditioning exposure to the unconditioned stimulus affects the acquisition of a conditioned emotional response. *Learning and Motivation, 10,* 245–277.

Rescorla, R. A. (1967). Pavlovian conditioning and its proper control procedures. *Psychological Review, 74,* 71–79.

Rescorla, R. A. (1968). Probability of shock in the presence and absence of the CS in fear conditioning. *Journal of Comparative and Physiological Psychology, 66,* 1–5.

Rescorla, R. A. (1969). Pavlovian conditioned inhibition. *Psychological Bulletin, 72,* 77–94.

Rescorla, R. A. (1972). Informational variables in Pavlovian conditioning. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 6). New York: Academic Press.

Rescorla, R. A., & Wagner, A. R. (1972). A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement. In A. H. Black & W. F. Prokasy (Eds.), *Classical conditioning II: Current research and theory.* New York: Appleton-Century-Crofts.

Revusky, S. (1977). Learning as a general process with an emphasis on data from feeding experiments. In N. W. Milgram, L. Krames, & T. M. Alloway (Eds.), *Food aversion learning.* New York: Plenum Press.

Rizley, R. (1978). Depression and distortion in the attribution of causality. *Journal of Abnormal Psychology, 87,* 32–48.

Rosellini, R. A. (1978). Inescapable shock interferes with the acquisition of an appetitive operant. *Animal Learning & Behavior, 6,* 155–159.

Rosellini, R. A., & Seligman, M. E. P. (1975). Learned helplessness and escape from frustration. *Journal of Experimental Psychology: Animal Behavior Processes, 1,* 149–158.

Ross, L. (1977). The intuitive psychologist and his shortcomings. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 10). New York: Academic Press.

Ross, L., Greene, D., & House, P. (1977). The false consensus phenomenon: An attributional bias in self-perception and social perception processes. *Journal of Experimental Social Psychology, 13,* 279–301.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs, 80,* (1, Whole No. 609).

Rozin, P., & Kalat, J. W. (1971). Specific hungers and poisoning as adaptive specializations of learning. *Psychological Review, 78,* 459–486.

Rumelhart, D. E. (1975). Notes on a schema for stories. In D. G. Bobrow & A. Collins (Eds.), *Representation and understanding: Studies in cognitive science.* New York: Academic Press.

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals and understanding: An inquiry into human knowledge structures.* Hillsdale, NJ: Erlbaum.

Schoonard, J., & Lawrence, D. H. (1962). Resistance to extinction as a function of the number of delay of reward trials. *Psychological Reports, 11,* 275–278.

Schustack, M. W., & Sternberg, R. J. (1981). Evaluation of evidence in causal inference. *Journal of Experimental Psychology: General, 110,* 101–120.

Schwartz, B. (1981). Does helplessness cause depression or do only depressed people become helpless? A comment on Alloy and Abramson, 1979. *Journal of Experimental Psychology: General, 110,* 429–435.

Seligman, M. E. P. (1970). On the generality of the laws of learning. *Psychological Review, 77,* 406–418.

Seligman, M. E. P. (1975). *Helplessness: On depression, development and death.* San Francisco: Freeman.

Seligman, M. E. P., Abramson, L. Y., Semmel, A., & von Baeyer, C. (1979). Depressive attributional style. *Journal of Abnormal Psychology, 88,* 242–247.

Seligman, M. E. P., & Hager, J. L. (1972). *Biological boundaries of learning.* New York: Appleton-Century-Crofts.

Seligman, M. E. P., & Maier, S. F. (1967). Failure to escape traumatic shock. *Journal of Experimental Psychology, 79,* 1–9.

Seligman, M. E. P., Maier, S. F., & Geer, J. (1968). The alleviation of learned helplessness in the dog. *Journal of Abnormal Psychology, 73,* 256–262.

Seligman, M. E. P., Maier, S. F., & Solomon, R. L. (1971). Unpredictable and uncontrollable aversive events. In F. R. Brush (Ed.), *Aversive conditioning and learning.* New York: Academic Press.

Seligman, M. E. P., Rosellini, R. A., & Kozak, M. (1975). Learned helplessness in the rat: Reversibility, time course, and immunization. *Journal of Comparative and Physiological Psychology, 88,* 542–547.
Shafer, G. (1976). *A mathematical theory of evidence.* Princeton, NJ: Princeton University Press.
Shaklee, H., & Mims, M. (1982). Sources of error in judging event covariations: Effects of memory demands. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 8,* 208–224.
Sheffield, V. F. (1950). Resistance to extinction as a function of the distribution of extinction trials. *Journal of Experimental Psychology, 40,* 305–313.
Shettleworth, S. J. (1972). Constraints on learning. In D. S. Lehrman, R. A. Hinde, & E. Shaw (Eds.), *Advances in the study of behavior.* New York: Academic Press.
Siegel, S. (1969). Effect of CS habituation on eyelid conditioning. *Journal of Comparative and Physiological Psychology, 68,* 245–248.
Skinner, B. F. (1948). Superstition in the pigeon. *Journal of Experimental Psychology, 38,* 168–172.
Sklar, L. S., & Anisman, H. (1981). Stress and cancer. *Psychological Bulletin, 89,* 369–406.
Smedslund, J. (1963). The concept of correlation in adults. *Scandinavian Journal of Psychology, 4,* 165–173.
Smith, M. C. (1968). CS–US interval and US intensity in classical conditioning of the rabbit's nictitating membrane response. *Journal of Comparative and Physiological Psychology, 66,* 679–687.
Smoke, K. L. (1933). Negative instances in concept learning. *Journal of Experimental Psychology, 16,* 583–588.
Snyder, M., & Cantor, N. (1979). Testing hypotheses about other people: The use of historical knowledge. *Journal of Experimental Social Psychology, 15,* 330–342.
Snyder, M., & Swann, W. B., Jr. (1978a). Hypothesis-testing processes in social interaction. *Journal of Personality and Social Psychology, 36,* 1202–1212.
Snyder, M., & Swann, W. B., Jr. (1978b). Behavioral confirmation in social interaction: From social perception to social reality. *Journal of Experimental Social Psychology, 14,* 148–162.
Snyder, M., & Uranowitz, S. W. (1978). Reconstructing the past: Some cognitive consequences of person perception. *Journal of Personality and Social Psychology, 36,* 941–950.
Snyder, M. L., Stephan, W. G., & Rosenfield, D. (1978). Attributional egotism. In J. H. Harvey, W. J. Ickes, & R. F. Kidd (Eds.), *New directions in attribution research* (Vol. 2). Hillsdale, NJ: Erlbaum.
Spitzer, R. L., Endicott, J., & Robins, E. (1978). Research diagnostic criteria. *Archives of General Psychiatry, 35,* 837–845.
Staddon, J. E. R., & Simmelhag, V. L. (1971). The "superstition" experiment: A reexamination of its implications for the principles of adaptive behavior. *Psychological Review, 78,* 3–43.
Tabachnik, N., & Alloy, L. B. (in press). Clinician and patient as aberrant actuaries: Expectation-based distortions in assessment of covariation. In L. Y. Abramson (Ed.), *Attribution processes and clinical psychology.* New York: Guilford.
Tarpy, R. M. (1982). *Principles of animal learning and motivation.* Glenview, IL: Scott, Foresman.
Taylor, D. M., & Jaggi, V. (1974). Ethnocentrism and causal attribution in a South Indian context. *Journal of Cross-Cultural Psychology, 5,* 162–171.
Taylor, S. E., & Crocker, J. (1981). Schematic bases of social information processing. In E. T. Higgins, P. Herman, & M. Zanna (Eds.), *Social cognition.* Hillsdale, NJ: Erlbaum.
Testa, T. J. (1974). Causal relationships and the acquisition of avoidance responses. *Psychological Review, 81,* 491–505.
Testa, T. J., Juraska, J. M., & Maier, S. F. (1974). Prior exposure to inescapable electric shock in rats effects extinction behavior after the successful acquisition of an escape response. *Learning and Motivation, 5,* 380–392.
Testa, T. J., & Ternes, J. W. (1977). Specificity of conditioning mechanisms in the modification of food preferences. In L. M. Barker, M. R. Best, & M. Domjan (Eds.), *Learning mechanisms in food selection.* Waco, TX: Baylor University Press.
Thompson, S. C. (1981). Will it hurt less if I can control it? A complex answer to a simple question. *Psychological Bulletin, 90,* 89–101.
Thorndike, E. L. (1898). Animal intelligence: An experimental study of the associative processes in animals. *Psychological Monographs, 2* (4, Whole No. 8).
Thorndike, E. L. (1911). *Animal intelligence: Experimental studies.* New York: Macmillan.
Thorndyke, P. W. (1977). Cognitive structure in comprehension and memory of narrative discourse. *Cognitive Psychology, 9,* 77–110.
Tombaugh, T. N. (1966). Resistance to extinction as a function of the interaction between training and extinction delays. *Psychological Reports, 19,* 791–798.
Tombaugh, T. N. (1967). The overtraining extinction effect with a discrete-trial bar-press procedure. *Journal of Experimental Psychology, 73,* 632–634.
Tomie, A., Murphy, A. L., Fath, S., & Jackson, R. L. (1980). Retardation of autoshaping following pretraining with unpredictable food: Effects of changing the context between pretraining and testing. *Learning and Motivation, 11,* 117–134.
Tversky, A., & Kahneman, D. (1971). Belief in the law of small numbers. *Psychological Bulletin, 76,* 105–110.
Tversky, A. & Kahneman, D. (1978). Causal thinking in judgment under uncertainty. In B. Butts & J. Hintikka (Eds.), *Logic, methodology, and philosophy of science.* Dordrecht, Holland: D. Reidel.
Uhl, C. N., & Young, A. G. (1967). Resistance to extinction as a function of incentive, percentage of reinforcement, and number of nonreinforced trials. *Journal of Experimental Psychology, 73,* 556–564.
Vogel, J. R. (1974, November). *Prior exposure to a drug (US) attenuates learned taste aversion.* Paper presented at the meeting of the Psychonomic Society, Boston.
Wagner, A. R., Siegel, S., Thomas, E., & Ellison, G. D. (1964). Reinforcement history and the extinction of a conditioned salivary response. *Journal of Comparative and Physiological Psychology, 58,* 354–358.
Ward, W. D., & Jenkins, H. M. (1965). The display of information and the judgment of contingency. *Canadian Journal of Psychology, 19,* 231–241.
Wason, P. C., & Johnson-Laird, P. N. (1972). *Psychology of reasoning: Structure and content.* London: D. T. Batsford.

Wasserman, E. A., Franklin, S. R., & Hearst, E. (1974). Pavlovian appetitive contingencies and approach vs withdrawal to conditioned stimuli in pigeons. *Journal of Comparative and Physiological Psychology, 86,* 616–627.

Weary, G. (1980). Examination of affect and egotism as mediators of bias in causal attributions. *Journal of Personality and Social Psychology, 38,* 348–357.

Weiner, B., & Kukla, A. (1970). An attibutional analysis of achievement motivation. *Journal of Personality and Social Psychology, 15,* 1–20.

Weinstock, S. (1958). Acquisition and extinction of a partially reinforced running response at a 24-hour intertrial interval. *Journal of Experimental Psychology,* 46, 151–158.

Weiss, J. M., Glazer, H. I., & Pohorecky, L. A. (1976). Coping behavior and neurochemical changes: An alternative explanation for the original "learned helplessness" experiments. In G. Serban & A. King (Eds.), *Animal models in human psychobiology.* New York: Plenum.

Wells, G. L., & Harvey, J. H. (1977). Do people use consensus information in making causal attributions? *Journal of Personality and Social Psychology, 35,* 279–293.

Wilcoxon, H. C., Dragoin, W. B., & Kral, P. A. (1971). Illness-induced aversions in rat and quail: Relative salience of visual and gustatory cues. *Science, 171,* 826–828.

Williams, J. L., & Maier, S. F. (1977). Transsituational immunization and therapy of learned helplessness in the rat. *Journal of Experimental Psychology: Animal Behavior Processes, 3,* 240–252.

Witcher, E. S., & Ayres, J. J. B. (1980). Systematic manipulation of CS-US pairings in negative CS-US correlation procedures in rats. *Animal Learning & Behavior, 8,* 67–74.

Wolfe, J. B. (1934). The effect of delayed reward upon learning in the white rat. *Journal of Comparative and Physiological Psychology, 17,* 1–21.

Woll, S., & Yopp, H. (1978). The role of context and inference in the comprehension of social action. *Journal of Experimental Social Psychology, 14,* 351–362.

Wortman, C. B. (1975). Some determinants of perceived control. *Journal of Personality and Social Psychology, 31,* 282–294.

Wortman, C. B., Costanzo, P. R., & Witt, T. R. (1973). Effects of anticipated performance on the attributions of causality to self and others. *Journal of Personality and Social Psychology, 27,* 372–381.

Wright, J. C. (1962). Consistency and complexity of response sequences as a function of schedules of noncontingent reward. *Journal of Experimental Psychology, 63,* 601–609.

Zadny, J., & Gerard, H. B. (1974). Attributed intentions and information selectivity. *Journal of Experimental Social Psychology, 10,* 34–52.

Zeaman, D. (1949). Response latency as a function of the amount of reinforcement. *Journal of Experimental Psychology, 39,* 446–483.

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