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# Locus of control of reinforcement and the learning of personal superstitions

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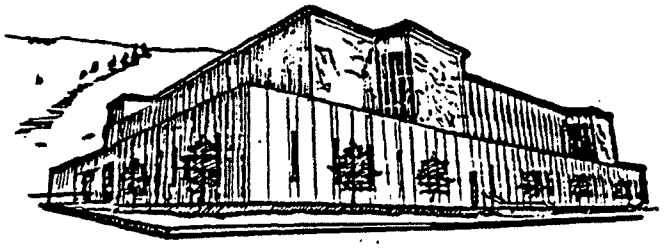

**Locus of Control of Reinforcement**

**and the Learning of Personal Superstitions**

by

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The work on the learning of superstitious behaviors in animals is reviewed, as is the literature on the learning of personal superstitions in humans. Consideration is given to controversies regarding the essential nature of reinforcement. The demographic and personality correlates of superstitious beliefs are reviewed, as is the relationship between superstition and locus of control of reinforcement. It was hypothesized on theoretical and empirical grounds that people with an internal locus of control would be more likely than those with an external locus of control to learn superstitious beliefs and behaviors when exposed to response independent reinforcement in an incidental learning paradigm. Sixty eight undergraduates, balanced for locus of control, were exposed to response independent reinforcement on an IBM microcomputer. Their responses on the keyboard were recorded and analyzed for superstitious behaviors. Superstitious beliefs were assessed via self-report. The major hypothesis was not supported: Externals were more likely than internals to develop superstitious beliefs. No effect was found for superstitious behaviors. The experimental paradigm is critiqued on methodological grounds, and suggestions for further work in the area of superstitious learning in humans are made.

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## Introduction

Everybody knows what superstitions are, but few people can define them with any degree of precision. Most (if not all) of us have had superstitious beliefs or behaviors at some point in our lives. Superstitious beliefs and behaviors have profound potential for affecting our existence. An understanding of superstitions, how they develop, how they can be changed or modified, will help us to understand the human condition, and possibly help us to improve it. In this paper we will address the means by which individuals acquire superstitions, and more specifically, how personal superstitions can be influenced by an individual's locus of control of reinforcement.

We begin by reviewing the work on "superstitious" learning in animals, and consider some of the controversy surrounding the application of this term to animal behavior. We will also allude to the differing opinions as to the nature of reinforcement, a subject which will be dealt with at length later in the paper. From this brief review of the animal literature, we turn to the study of superstitions in human beings. After offering a definition of superstition, we will review the demographic and personality correlates of superstition in the general population, and then address superstition in the world of sport, which has proven to be fertile ground for

investigating these beliefs.

In the third section of the introduction, we address the literature concerning human learning of superstitious behavior. After reviewing some of the early studies, we will consider two controversies connected to the phenomenon of superstitious learning: the ability of human beings to detect contingencies between events, and the essential nature of reinforcement. We will offer a conceptualization of these concerns which will hopefully lay them to rest, or at least render them moot. The third section concludes with a review of recent studies concerning the learning of superstitions in humans.

The fourth section of the introduction is concerned with some of the observed correlates between superstition and an individual's locus of control. We then explore the relationship between locus of control, the illusion of control, and cultural and personal superstitions. This section concludes with an observation that the relationship between incidental learning and locus of control may have a bearing on the learning of personal superstitions. In the fifth section, we explore some of the cognitive differences between internals and externals which may influence incidental learning. The relationship between locus of control and incidental learning is then addressed. In the sixth and final section of the introduction, we explore the hypothesis that an individual's locus of control may

influence their propensity to learn personal superstitions. We also consider some of the implications of finding that there are in fact differences between internals and externals in learning superstitious behaviors. We conclude the introduction by looking at the one published study performed to date in this area.

## Superstitious Behavior in Animals

Work with the response-independent (or noncontingent) reinforcement of behavior is generally conceded to have begun with B.F. Skinner's (1948) work with pigeons. However, Skinner's work was presaged by experiments carried out by E.R. Guthrie and G.P. Horton (1946) in the previous decade. Guthrie and Horton constructed a more elaborate and sophisticated version of E.L. Thorndike's puzzle box with the stated goal of attempting to determine if the behaviors of animals learning to escape from the box conformed to the general learning principle of association by contiguity. Guthrie and Horton believed that the behaviors of cats in escaping from puzzle boxes could be explained on the basis of a learned association between muscular movements (or impulses to movement) and the animal's preceding sense impressions or perceptions. Between 1936 and 1939 they observed and recorded approximately eight hundred escapes from puzzle boxes by laboratory cats. What they observed was that their cats

usually developed highly idiosyncratic and stereotyped patterns of behavior as they operated the lever which opened the door on the puzzle box. Guthrie and Horton noted a distinct tendency for their cats to repeat a series of behaviors in remarkable detail, with some of the behavioral sequences lasting a minute or more in length. They also noted that the the final movements in the series, immediately before the cats activated the door-opening mechanism, tended to be more stable than the preliminary behaviors. They noted that the most accurate prediction of a cat's behavior in the box was the observation of what behavioral sequences the cat displayed on the previous times it found itself in the same situation. Their cats repeated the same sequence of behaviors over long series of trials, with the result that they were able to cause the door of the puzzle box to open, and thus gain egress from the box. Guthrie and Horton interpreted this result as strong support for the concept of learning by association. The stereotyped patterns of behavior which developed came to be associated with escape from the box. Guthrie and Horton also noted that the stability of the final behaviors in the sequence was most likely achieved by virtue of the fact that they were protected from unlearning, since escaping from the box separated the animal from the situation and furnished no opportunity for learning new responses. To their credit, they were astute enough to

point out that although the behavior of cats in the puzzle box was explainable in terms of association, their observations did not rule out other forms of learning which the cats might have employed. Indeed, they held the position that association by contiguity was but one method by which animals learn patterns of behavior, and was perhaps only a relatively minor one. For the purposes of the present paper, it is interesting to note not the fact that the cats learned to escape from the puzzle box, but rather that they developed long and involved stereotypical patterns of behavior which they used to open the doors of the box, when in fact a simple push on the lever mechanism would have sufficed. It was these extraneous patterns of behavior which Skinner (1948) was to call superstitious in his work with pigeons.

Skinner (1948) discovered that when food was presented to pigeons at regular intervals without reference to their behavior they developed operantly conditioned responses, which were generally oriented toward some environmental feature of the operant conditioning chamber. Skinner also discovered that higher rates of reinforcement resulted in stronger conditioning effects. The behaviors that he observed were also highly resistant to extinction. Skinner metaphorically described the idiosyncratic and stereotyped behaviors he observed in pigeons as superstitious. In that original paper, he made an intuitive leap by doubling back

upon his metaphor, using it to explain the development and maintenance of similar behavior in human beings. Skinner (1948, 1953) conceptualized superstitions as arising from erroneous perceptions of causal connections between one's own actions and outside events. The erroneous perceptions are the result of accidental contingencies between behaviors and reinforcements. The organism behaves as if there were a causal relationship between its actions and the reinforcements it receives, despite the fact that no such causal relationship exists. Skinner (1977) believed that a true contingency was not necessary for the development of superstitious behavior, but that the only necessary relationship between the behavior and its reward was one of temporal contiguity; that is, the reward only had to follow closely the behavior in a temporal sequence. As the behavior increased in frequency, repeated adventitious pairings of response and reward strengthened the response. Skinner believed that many human superstitions exemplify conditioned responses arising from these accidental juxtapositions of response and reward. An example from his original (1948) work concerns the gyrations in which bowlers often engage after releasing the ball down the alley. The behaviors cannot affect the course of the ball once it is released, but they are established and persist because they often are followed by desirable outcomes.

Confirmation and controversy soon followed Skinner's (1948) original paper. Kellogg (1949) reported that similar kinds of behavior had already been observed in orangutans and in dogs, although it had not been labeled as superstitious. He objected to describing the types of behaviors observed as superstitious, claiming that the concept was mentalistic and anthropomorphic. Kellogg advocated a conception of the behaviors observed in response-independent reinforcement as an association of a sequence of movements with a reinforcing stimulus, and suggested that they might be regarded as respondent rather than operant conditioning. Calling the behaviors superstitious implied "that the organism 'believes' it is 'causing' the food to appear as a result of its reactions" (Kellogg, 1949, p. 174), when in fact no such belief had been demonstrated.

Despite the early criticism of the theoretical formulation, work in the field continued. Morse and Skinner (1957) described a second type of superstition which they termed sensory superstition. In an experiment in which pigeons were reinforced for keypecks on a variable interval (VI) schedule, sensory stimuli (such as a colored light) presented incidental to the conditioning procedure came to control the pigeon's rate of responding. Presence of the light could increase or decrease the rate of responding, despite the fact that the light did not have

any causal effect on the ability of the pigeons to obtain reinforcement on the VI schedule. In other words, the pigeons acted as if the light influenced their ability to secure reinforcements from the environment, when in fact it did not.

Appel and Hiss (1962) demonstrated that pigeons' rates of responding under response-independent reinforcement were lower than for response-dependent reinforcement (for FT vs. FI schedules), and that responding in the former condition never dropped to zero. They concluded from this result that pigeons were able to distinguish response-dependent from response-independent reinforcement, despite the fact that the response-independent reinforcement continued to exert an influence on the pigeons' behavior.

A common strategy for investigating superstitious responding is to first pre-train organisms in a response-dependent reinforcement paradigm, and then to observe their behavior under response-independent reinforcement once stable responding has been established (Davis & Hubbard, 1972; Eldridge, Pear, Torgrud, & Evers, 1988; Herrnstein, 1966; Ono, 1987). Using this pre-training procedure, Neuringer (1970) was able to maintain superstitious responding in pigeons after training them with as few as three response-dependent reinforcements. The birds on the pre-training schedule pecked at a higher rate than both a response-independent control group, which was not initially

reinforced for pecking but placed directly on a variable time (VT) schedule of reinforcement, and an extinction control group that did not receive additional reinforcement after the three initial training reinforcements. Neuringer's results and conclusions, in general, support Skinner's (1948) original theory that temporal contiguity is sufficient for reinforcement to occur, and more specifically, that temporal contiguity is sufficient for the development of superstitious behaviors. Neuringer also believes that animals often develop superstitious behaviors in the natural state because of: 1) the apparent ease of establishment of superstitious behaviors, and 2) the great probability of numerous incidental pairings of behaviors and reinforcers occurring in the natural environments of animals.

Working with pigeons, Zeiler (1968) compared the pre-training procedure described above with pure response-dependent reinforcement. All of the birds were first trained to keypeck on a response-dependent schedule. Half of the subjects were then switched to a response-independent schedule of reinforcement, while the rest were maintained on the response-dependent schedule. Zeiler found that response-independent schedules of reinforcement maintained the pigeons' keypecking behavior, but at rates below the level maintained by continued response-dependent reinforcement. Rescorla and Skucy (1969) compared the pre-

training procedure with traditional extinction procedures using rats as subjects. They reported that response-independent presentation of food resulted in retarded extinction of previously reinforced bar-pressing, compared with a normal extinction procedure where no food was presented. The behavior did eventually extinguish, however. It is interesting to note that Rescorla and Skucy did not interpret their results in terms of superstitious behavior. Rather, they believed that the retardation in extinction resulted from the fact that delivery of response-independent food preserved more aspects of the original reinforcing situation than did the normal extinction procedure. Their results suggest that a pre-training procedure, despite its relative ease of use, might not be a useful paradigm for investigating superstitious behavior, since the behaviors maintained under response-independent reinforcement following conditioning with response-dependent reinforcement may not be due to superstitious conditioning at all. Indeed, Davis, Hubbard, and Reberg (1973) offer a thoughtful critique of this procedure, and suggest that Skinner's original (1948) method of inculcating superstitious responding in organisms is a more appropriate procedure, despite the greater demands it places on the experimenter.

In reviewing the literature on DRL schedules (differential reinforcement of low rates of responding)

Kramer and Rilling (1970) note that superstitious behavior also develops when animals (and humans) are reinforced on these schedules. On a DRL schedule a response is reinforced only after a minimum interval of time has elapsed since the immediately preceding response. Every response, whether reinforced or not, begins a new time interval. Thus, an organism will receive no reinforcements if it maintains a rate of responding such that the elapsed time between its responses is less than the time interval specified by the DRL schedule (the intertrial response time). Kramer and Rilling maintain that the superstitious behaviors observed on DRL schedules increase in probability because they closely precede reinforced responses. Laties, Weiss, and Weiss (1969) believe that the observed behaviors help the organism gauge the passage of time and distribute its responses so as to obtain the maximum number of reinforcements available under the DRL schedule. This type of behavior has also been termed mediating or collateral behavior (Kramer & Rilling, 1970; Laties et al., 1969) and there is some question as to whether or not it is appropriate to call it superstitious in the same sense that the term is used in the animal literature. (See Lyon, 1982, for a discussion of the differences between superstitious behavior, mediating behavior, collateral behavior, and adjunctive behavior in the realm of operant reinforcement.) In a more recent investigation, Gleeson

and Lattal (1987) found that response rates were lower under a response-independent schedule of reinforcement than under a DRL schedule. Their results were consistent with an emphasis on temporal contiguity as the important factor in response maintenance.

Beginning in the early 1970's serious questions were raised about the adequacy of the explanations of animal superstitions in terms of incidental or adventitious reinforcement by the mechanism of temporal contiguity, as postulated by Skinner (1948, 1953, 1977; see also Herrnstein, 1966). Staddon and Simmelhag (1971) found that response-independent reinforcement does not necessarily produce the idiosyncratic superstitious behaviors observed by Skinner. In replicating Skinner's (1948) work, they reported that two classes of behaviors were reliably produced: terminal responses and interim activities. Terminal responses were behaviors that consistently occurred just before food delivery, such as pecking behavior or orienting the body to face the food hopper. Terminal responses were conceptualized in terms of consummatory responses emitted in anticipation of obtaining a food reward. Interim activities were all those behaviors which preceded terminal responses. Staddon and Simmelhag equated these interim activities with the superstitious behaviors observed by Skinner. Terminal responses occurred almost exclusively just prior to food delivery. Thus, the

temporal contiguity between the superstitious behavior and reinforcement required by Skinner's interpretation rarely happened. Staddon and Simmelhag believed the interim activities that they observed were a type of mediating behavior, behavior which was interposed between two instances of food reward and functioned as a stimulus for the terminal responses, the responses which were actually in close proximity (temporally) to the rewards received. In other words, interim activities helped the pigeons to properly space their terminal responses a few seconds apart. Mediating behavior is often observed in spaced-responding schedules (Lyon, 1982; Staddon and Simmelhag, 1971). Staddon and Simmelhag note that the type of interim activities displayed by an organism are generally specific to that species. In their work, they observed that the type of behaviors which were reliably developed in response to response-independent reinforcement were predictable, based upon a knowledge of the types of behaviors which were common in the species' behavioral repertoire. They propose that the behaviors observed by Skinner and others were actually terminal responses, emitted in anticipation of food, and/or interim activities which occurred just after instances of food delivery, and were not due to superstitious conditioning.

Staddon and Ayres (1975) replicated the work of Staddon and Simmelhag (1971) using rats as subjects, and

found that regular temporal sequences of activities developed during the interfood intervals. After consuming a food pellet, their subjects tended to drink water, run on a running wheel, and then to anticipate delivery of another food pellet by spending time in close proximity to the feeder. The activities at the end of each interval were usually related to the consummatory pattern associated with food, such as pawing and gnawing on the feeder. Staddon and Ayres consider their results to be convincing evidence arguing against the development of superstitious behavior as a result of incidental reinforcement.

Working with pigeons, Timberlake and Lucas (1985) investigated the disparity between the temporal contiguity theory of the development of superstitious behavior (Herrnstein, 1966; Skinner, 1948, 1953, 1977) and the stimulus substitution/elicited behavior interpretation (Staddon and Simmelhag, 1971; Staddon and Ayres, 1975). The consistency of the behavior patterns observed by Timberlake and Lucas argued against the incidental learning by temporal contiguity hypothesis, and they believed that the complexity of the behavior was incompatible with a simple stimulus-substitution account. They concluded that the so-called superstitious behaviors seen under response-independent reinforcement probably developed from species-specific patterns of appetitive behavior related to foraging and feeding, and that contiguity of behavior and

reward appeared unlikely to have been the primary basis of behavior change. In addition, they did not find support for Staddon and Simmelhag's and Staddon and Ayres' classification of behavior into interim activities and terminal responses. Instead, Timberlake and Lucas (1985) argue that "what has been called superstitious behavior in the pigeon actually represents expression of pre-organized response patterns elicited by periodic [response-independent] delivery of food" (p. 295). In short, they view these behaviors as elicited species-specific behaviors related to securing and consuming food.

Despite the serious criticisms raised by Staddon and Simmelhag (1971) and Timberlake and Lucas (1985), many researchers continued work in the area of animal superstition and continued to conceptualize their work as reflecting basic principles of operant reinforcement. Eldridge et al. (1988) obtained feeder wall-directed behavior with their pigeons when they were reinforced on a fixed time (FT) 15 sec schedule, similar to the behavior observed by Timberlake and Lucas. Eldridge et al., however, interpret their results (and the results of Timberlake and Lucas) in light of superstitious responding: Specifically, they point out that "there was an explicit reinforcement contingency for being close to the feeder wall at the time of food delivery: (1) reinforcement was more immediate, and (2) more food could be obtained because

the feeder was available for a limited time during each reinforcement" (Eldridge et al., 1988, p. 283). Thus, although their birds (and those of Timberlake and Lucas and Staddon and Simmelhag) developed similar behavior as a result of response-independent reinforcement, these similarities can be explained on the basis of their utility in gaining access to the food available. Further, Eldridge et al. point out that feeder wall directed behavior could be an artifact of the hopper training to which the birds were subjected prior to participation in the experiment.

Davis and Platt (1983) point out that the differences in the behaviors observed in many of the above cited studies may result from measurement problems inherent in response-independent reinforcement procedures. Under such conditions, the number of behaviors or responses available to an organism is unbounded, as are the potential units of behavior which may be selected for analysis. Researchers may reach differing conclusions depending upon which aspects of the organism's behavior they choose to emphasize. Working with rats, Davis and Platt tried to attenuate this difficulty by suspending a response lever vertically from the ceiling of an operant conditioning chamber. Thus, they were able to specify a class of behaviors (lever pressing) for observation and analysis, but the value of the response, in this case the direction of the lever press throughout 360 degrees, was free to

vary. When food was presented to their rats in response to a lever press but independent of the direction of the press or the position of the subject, the subjects did not develop preferred orientations or directions of presses. However, when Davis and Platt differentially reinforced their subjects for direction of lever pressing, they were then able to maintain this behavior with a response-independent schedule of reinforcement. They interpreted their results as demonstrating that a response-reinforcer contingency was necessary for acquisition of behavior, but that contiguity alone was sufficient for maintenance of behavior. They point out, however, that their results should not be taken as evidence against the sufficiency of a response-reinforcer contiguity in the acquisition of a behavior. They believe that a "response-reinforcer contiguity [may be] a sufficient condition for increasing the frequency of a response, but a contingency may be necessary to ensure reliable temporal contiguity between reinforcer presentations and a particular response" (Davis & Platt, 1983, p. 509). Superstitious conditioning, where response-reinforcer contingencies are absent, might thus be found in situations involving faster acquisition or fewer response alternatives. (The controversy regarding the roles of temporal contiguity and response-reinforcer contingency in the operant conditioning of behavior is a subject which is addressed below in connection with

superstitious learning in human beings.)

Lieberman (1986), working with pigeons, demonstrated a form of sensory superstition involving the marking hypothesis. Pigeons were occasionally reinforced after a ten second delay for pecking a split key. Both sides of the key were reinforced, but pecks to one side of the key which resulted in food delivery were marked with a colored light if they were pecked a second time during the ten second delay initiated by the first keypeck. Under these conditions, pigeons developed a notable preference for pecking either the left or right side of the split key, depending on which side was marked by the colored light, despite the fact that pecks to both sides of the key were reinforced under the same schedule. Lieberman (1986) notes that "there was no contingency between the subjects' choice response and reinforcement--food was presented regardless of which side was pecked--but a strong side preference emerged nevertheless" (p. 349). He interprets this result as strong evidence supporting the key role of contiguity in learning. Contiguity, however, has to be interpreted within the framework of memory. "It is the contiguity between events in working memory that is crucial, rather than contiguity in the real world" (Lieberman, 1986, p. 458). Marking a response makes it more salient in the working memory of the organism, and thus enhances its role in superstitious operant conditioning. "The physical

contiguity of a response and a reinforcer may be important in determining whether the response is remembered and, if it is, whether it will be identified as the causal agent" (Lieberman, 1986, p. 458).

The pattern of conflicting results and interpretations seen in studies of pigeons has been repeated in those studies which have used rats as subjects. Using rats, Davis and Hubbard (1972) replicated the work of Skinner (1948). They observed repeated, stereotyped patterns of behavior under all of the schedules of response-independent food delivery they used. However, superstitious responding emerged more rapidly and was more stable under FT schedules than under VT schedules. Davis and Hubbard also observed a notable change or drift in the topography of the responses obtained under VT schedules, which was accelerated under extinction procedures. They interpreted their results as supportive of the interpretation of superstitious behavior induced via the mechanism of temporal contiguity, in line with the work of Skinner. They further endorse the idea that while temporal contiguity may be sufficient to induce behavior in organisms, contingency may be instrumental in producing reliable contiguities between responses and reinforcements (see also Davis and Platt, 1983, cited above). Davis and Hubbard end their paper with a discussion of the inter-relationships between contiguity, contingency, and the phenomenon of behavioral drift,

concluding that a temporal contiguity is the best evidence an organism has regarding contingencies between responses and rewards. Thus, organisms sometime behave as if a contingency exists between responses and rewards, when in fact one does not. Davis and Hubbard regard this phenomenon, where temporal contiguity is sufficient to reinforce behavior in the absence of a contingency, as the prototypical example of superstitious behavior.

Devenport (1979) and Devenport and Holloway (1980) noted that rats with surgically-induced bilateral hippocampal lesions were much more likely to develop superstitious behaviors than were rats with intact hippocampi. Their intact rats showed a high degree of behavioral drift when exposed to response-independent reinforcement after a pre-training exercise, whereas the hippocampal rats did not. Devenport and Holloway concluded that the hippocampus was instrumental in introducing variation into the rat's behavioral repertoire, variation which was responsible for the drift in behavior observed in intact rats. Devenport and Holloway surmise that the variation in behavior so induced allowed their intact rats to separate contingent relationships between behaviors and environmental reinforcements, on one hand, from mere temporal pairings of behaviors and reinforcements, on the other. As behavioral responses slowly change, any incidental relationships between responses and

reinforcements will be exposed, and the responses, no longer adventitiously reinforced, will fade from the rat's repertoire. Devenport and Holloway surmise that this process operates in all mammals, which have relatively large hippocampi, as opposed to birds, which have small hippocampi. The hippocampus may thus be implicated in the differing propensities to learn superstitious behaviors which are observed between different species.

The most recently published investigation into the area of response-independent reinforcement is that of Justice and Looney (1990), who proposed to investigate the discrepancies between the results of Skinner (1948), Staddon and Simmelhag (1971), and Timberlake and Lucas (1985). Justice and Looney noted that the behavior patterns they obtained differed markedly across subjects. They did not find the terminal pecking behaviors reported by Staddon and Simmelhag, nor did they find the consistent wall-directed behavior reported by Timberlake and Lucas. Justice and Looney (1990) note that their data were "consistent with, though not an adequate test of, Skinner's position" (p. 65). In their discussion, they go on to point out that all three processes proposed to account for superstitious behaviors may have an influence on responding, and that the "behaviors observed may be influenced in an important way by the theoretical view held by the observer" (Justice & Looney, 1990, p. 66). They

note that reinforcers have multiple effects, and it may be that the desired behavioral effect may be achieved by the proper specification of schedules of reinforcement and environmental contingencies. Thus, it may be possible to engender practically any type of behavior in animals that one might wish, by specifying the proper combination of schedules of reinforcement and environmental circumstances.

From this brief review it can be seen that the questions surrounding superstitious behavior in animals have not yet been laid to rest. Controversy continues concerning the basic nature of reinforcement, whether a causal relationship between response and reward is necessary for reinforcement to occur, whether temporal contiguity is sufficient for reinforcement to occur, or whether some other processes are at work as well. This subject will be further addressed below in the context of human superstitious learning. The concept of superstition itself, at least as it applies to animals, continues to be controversial. Indeed, following the lead of Kellogg (1949), one can question whether or not animals can truly be said to have superstitions. We have no firm evidence that animals can form beliefs, despite the fact that they might display behaviors that we would associate with superstitious beliefs in humans.

## The Nature of Superstition in Human Beings

Given the confusion in the animal literature as to the essential nature of the phenomenon of superstition, it is instructive to turn to Webster's Third International (Gove, 1966) for a commonly accepted definition of superstition which would be useful with humans: Superstition is "a belief, conception, act, or practice resulting from ignorance... or a false conception of causation" (p. 2296). An alternative definition is "a fixed irrational idea: a notion maintained in spite of evidence to the contrary" (Gove, 1966, p. 2296). This definition emphasizes the cognitive component of superstition, but acknowledges that a behavioral component also exists. Belief in a superstition presumably leads to superstitious behavior (Plug, 1975b). Since superstition involves *beliefs*, *conceptions*, and *ideas*, it seems inappropriate to use the term in regard to animal behavior, since we are unable to demonstrate convincingly that animals possess these constructs. The conceptions of animal behavior in other terms, noted above, may be more fruitful.

The phenomenon of superstition in human beings has suffered from definitional difficulties (Plug, 1975b), as may be surmised from the definition offered above. A definition of superstition similar to the one quoted above and one that is often cited in the literature is that of

Jahoda (1969): Superstition is an irrational belief that "one's fate is in the hands of unknown external powers governed by forces over which one has no control" (p. 116). This definition, however, is too all-encompassing to properly distinguish superstitions from other beliefs and behaviors which may be similar to superstitions, but which most people would not intuitively classify as such. For example, religious beliefs would generally not be called superstitious, despite the fact that they fit the definitions offered above (Buhrmann & Zaugg, 1983; Herrnstein, 1966; Plug, 1975b). Indeed, Jahoda (1969) notes that "one man's religion is another man's superstition" and "there is no objective means of distinguishing superstition from other types of beliefs and actions" (pp. 2, 9). Eitzen and Sage (1978) draw a useful distinction between superstition and religion. They observe that religion is the reverent worship of deities and supernatural forces which focuses on ultimate, existential issues concerning human existence: the meaning and purpose of life, the question of life after death, the proper moral relationship between an individual and other human beings, etc. Superstition, on the other hand, is a utilitarian attitude which is concerned with achieving practical, secular goals in the everyday life of an individual through the means of manipulation of fate or supernatural forces, and it is used for individual,

practical ends. This distinction is still not clear, for prayer is a religious activity which is often invoked to achieve private, worldly ends (Buhrmann & Zaugg, 1981). Indeed, prayer and other religious practices have at times been defined as superstitious behavior by some investigators (Buhrmann, Brown, & Zaugg, 1982; Buhrmann & Zaugg, 1981, 1983; Gregory, 1975; Gregory & Petrie, 1972, 1975). Other researchers have specifically excluded religious practices from their investigations of superstitious behavior (Neil, Anderson, & Sheppard, 1981), even to the point of suggesting that superstitious and religious practices are separate phenomena (Ellis, 1988). In this context, it is interesting to note that among basketball players in southern Alberta, more frequent church attendance is correlated with a greater likelihood of endorsing superstitious beliefs and practices (Buhrmann & Zaugg, 1983).

Scheibe (1970) offers some interesting insights to the concept of superstition: "A superstition may be said to exist whenever an individual persistently or repeatedly behaves as if his subjective estimate of the result of that behavior is significantly different from an objective (scientific) estimate of the effect of that behavior" (p. 123). He notes that superstitions arise because of an imperfect knowledge of antecedent-consequent relationships. Cause and effect relationships are not something that we

can perceive directly, rather they are inferences based on contiguity: contiguity in space, in time, or both. Given the uncertain state of our knowledge, superstitions act to fill the gap between our subjective estimates of the causal relationships between events and the objective probability reflecting the state of affairs in the external environment. Such beliefs help give us a basis for action, so that we are not paralyzed by doubt and uncertainty. We misrepresent accidental contiguities as essential contingencies and take fortuitous events as causes. Thus, we are able to act in the face of uncertainty.

For the purposes of this study, keeping in mind the conceptual difficulties involved in defining the concept, a superstition will be defined as an irrational belief that a causal relationship exists between one's behavior and obtaining a desired outcome (or avoiding an undesirable outcome), when in fact no such causal relationship exists. Such beliefs are accompanied by corresponding behaviors which reflect the efficacy of the belief. Widely held actions and beliefs generally sanctioned by the culture or subculture in which the individual resides, such as prayer and other religious beliefs, will be specifically excluded from the definition. (See Plug, 1975b, for a more detailed discussion of the definition of superstition.)

At this point it is useful to draw a distinction between personal superstitions and cultural superstitions

(Higgins, Morris, & Johnson, 1989). "Some superstitions are widely held, a social heritage of beliefs taught us by our elders, but others are private convictions arising... from valid personal experiences" (Keller & Schoenfeld, 1950, p. 102). Cultural superstitions are those which are socially transmitted and shared by several (or many) individuals (Herrnstein, 1966; Scheibe, 1970; Skinner, 1953). An example of a cultural superstition is the common one ascribing good luck to four-leaf clovers or to carrying a rabbit's foot. Such superstitions are learned from other individuals in one's society, and may be maintained by cultural beliefs and/or by accidental reinforcement. Personal superstitions, however, are those which are peculiar to the individual, and not generally shared with others (Herrnstein, 1966; Skinner, 1953). Indeed, sometimes sharing personal superstitions is said to cause them to lose their effectiveness (Buhrmann, Brown, & Zaugg, 1982; Womack, 1979). Personal superstitions may be consciously and deliberately adopted by an individual, they may be learned incidentally from accidental contingencies in the environment, or they may be transmitted culturally (Peterson, 1978). The type of superstitions addressed by Skinner (1948) in his discussion of the effects of response-independent reinforcement on behavior are personal superstitions, although some theoreticians believe that some cultural superstitions may arise in the same manner

(Herrnstein, 1966). Jahoda (1969) agrees with Skinner that personal superstitions have their genesis in incidental learning, but he points out that they also have a component of belief. Ferster, Culbertson, & Boren (1975) note that these incidentally learned superstitions can be highly resistant to extinction because of the intermittent reinforcement schedules under which they are learned.

Most investigators believe that superstitions may have adaptive value, as least if they are not too extreme. Superstitions are most often seen in situations of fear and/or uncertainty, and they help to reduce anxiety (Blum & Blum, 1974; Malinowski, 1954; Neil, 1975; Singer & Benassi, 1981; Tupper & Williams, 1986). Superstitious behaviors are more likely to be learned in situations containing high levels of chance occurrences, anxiety, uncertainty, and unpredictability, where the results are greatly desired (Becker, 1975; Ferster, Culbertson, & Boren, 1975; Gregory and Petrie, 1972; Neil, Anderson, & Sheppard, 1981; Womack, 1979). Within any given area of endeavor, those activities which involve higher degrees of chance and more uncertain outcomes are more likely to have superstitions associated with them (Gmelch, 1972). For example, among the Trobriand Islanders, there are are numerous superstitious practices associated with fishing the open ocean, an activity fraught with danger and uncertainty, while there are none associated with fishing in protected lagoons (Malinowski,

1954). Superstitious beliefs and behaviors can give one a feeling of partial control over a situation and thus help to improve self-confidence, self-assurance, and feelings of competence (Becker, 1975; Gmelch, 1978; Neil, 1975).

Superstitions appear to be efforts to gain control over unpredictable situations by engaging in behaviors which appeal to fate, luck, chance, or other forces generally conceived to lie outside causal relationships. The superstitions may thus alleviate feelings of helplessness and anxiety. However, superstitions rarely intrude upon or supplant rational, empirical approaches to problem solving, where such approaches suffice in achieving desired ends (Singer & Benassi, 1981). Social and environmental threat, such as unemployment, financial uncertainty, political unrest, war, etc., can increase the level of superstition in the general population (Padgett & Jorgenson, 1982; Singer & Benassi, 1981).

Most researchers studying superstitions in the general population have failed to draw a distinction between personal and cultural superstitions. The two concepts are usually considered under the same category of common superstitious beliefs. Typical findings in this area of research include the fact that superstition declines with increasing levels of education. Low, negative correlations between intelligence and superstition are commonly reported (Blum & Blum, 1974; Killen, Wildman, & Wildman, 1974; Plug,

1975b). People in lower socio-economic strata tend to endorse more superstitions than people in higher strata (Plug, 1975b). According to Plug (1975b), no firm conclusions can be drawn with respect to the relationship between superstition and age. Some researchers have found increases in superstitiousness with increasing age (e.g., Ramamurti & Jamuna, 1987), some that levels of superstition decline with age (e.g., Plug, 1975a), while others have found no correlation (e.g. Blum & Blum, 1974). Contradictory results in this area may be due to difficulties in defining and measuring superstitions, to the different populations studied, or to confounds with educational level or other factors (Plug, 1975b). Some researchers think that there may be a low-level correlation between psychopathology and belief in superstitions: "there might be some tendency for emotionally unstable people to believe more readily in superstitions" (Plug, 1975b, p. 108). Finally, women have been demonstrated to be more superstitious than men in numerous studies (Blum, 1976; Blum & Blum, 1974; Plug, 1975a, 1975b; Ramamurti & Jamuna, 1987), although in a study of Australian university students Tupper and Williams (1986) found no differences between the two sexes.

One of the most fertile fields for studying superstitions has been the field of sport (as noted by B.F. Skinner in 1948). Although popular accounts of

superstitious behavior by athletes have been in vogue for years, sustained systematic study in the area did not commence until the early 1970's (Buhrmann & Zaugg, 1981; Gregory & Petrie, 1972, 1975; Neil, Anderson, & Sheppard, 1981). Becker (1975) observed the following common sport-related superstitions: the use of "lucky" clothing, charms, or numbers; practices which help prevent or cure injury; and superstitions related to care and use of equipment. Womack (1979) observes that sports participants perceive a direct link between their superstitious behaviors and the outcome of the games in which they are involved. Neil (1975) notes that athletes say that they do what seems to have worked best for them in the past. He considers this observation an endorsement of Skinner's incidental learning paradigm for the learning of superstitions. Neil points out that the partial reinforcement commonly found in superstitiously learned behaviors makes them relatively resistant to extinction. He also notes that "many individual superstitions originate from repetition of acts associated with a previous success or the avoidance of acts associated with previous failures" (Neil, Anderson, & Sheppard, 1981, p. 140). These superstitious behaviors bother players if they are omitted from their behavioral repertoires.

In two separate studies, Gregory and Petrie (1972, 1975) surveyed several hundred college students, both

athletes and non-athletes, and discovered that the more athletes were involved with their sport, the more superstitions they endorsed in regard to that sport. This finding is in accord with the observation that superstitious behaviors are more likely to occur in those areas where the results are important to the individual holding the superstition (Ferster, Culbertson, & Boren, 1975). The more important the result, and the more uncertain the activity, the greater the tendency to superstitious behavior. Buhrmann and Zaugg (1981) and Neil, Anderson, and Sheppard (1981) also report that increasing levels of superstition within a given sport are correlated with increased commitment to that sport. Gregory and Petrie (1972, 1975) also found that athletes held more sport-related superstitions than non-athletes, and fewer general cultural superstitions. They also discovered that women, both athletes and non-athletes, endorsed more cultural superstitions than did men. Men from both groups tended to endorse more sport-related superstitions than did women. Buhrmann and Zaugg (1981) also found that females were more likely to subscribe to superstitious beliefs and behaviors, although Buhrmann, Brown, and Zaugg (1982) were unable to find any differences between men and women in the number of superstitions they endorsed or their overall level of superstitiousness. They do note, however, that females were more likely than males

to endorse the importance of team mascots for bringing luck. Gregory and Petrie found that female athletes endorsed more superstitions relating to personal appearance (e.g. lucky clothing or hair accessories) and socially related functions than did male athletes. Male athletes endorsed more superstitions related to equipment. Gregory and Petrie concluded from the pattern of superstitions they observed that most sport-related superstitions were transmitted within the social structures of each individual sport.

Gmelch (1972, 1978) noted three classes of superstitious behavior in sport: rituals, taboos, and fetishes. A ritual is a prescribed stereotypical series of behaviors in which an individual engages in order to ensure that a desired outcome is achieved. An example might be the baseball player who takes exactly the same route to the baseball stadium on the day of home games and dresses in exactly the same sequence for every game. Womack (1979) observes that rituals help to promote a controlled state of excitement, which may in turn facilitate performance. Taboos are prohibitions on certain behaviors or things before undertaking or during an endeavor (Gmelch, 1972, 1978). Examples include prohibitions on mentioning a no-hitter during a baseball game, allowing bats to cross each other when lying on the ground, or scrupulously avoiding certain foods before playing a game. A fetish is a

material object believed to embody supernatural powers that aid or protect the owner (Gmelch, 1978). Examples are lucky clothing, charms, or equipment. Gmelch observes that superstitions often grow out of associations (due to temporal contiguity) between environmental circumstances and exceptionally poor or exceptionally good performances. He also notes that in baseball, superstitions are most often observed in those areas in which the player is least sure of obtaining desirable outcomes: pitching and hitting. Fielding, where the player has almost complete control over the outcome (Gmelch, 1978), is rarely the subject of superstitious belief or behavior.

## Superstitious Learning in Human Beings

Skinner's conceptualization of superstitions as arising from incidental response-independent reinforcement has been fruitfully applied by several investigators to induce or maintain superstitions (and superstitious behavior) in human beings. Indeed, operant researchers have offered definitions of superstitious behavior based entirely on this conceptualization. Catania (1968) defined superstition as "the modification or maintenance of behavior as a consequence of accidental (also adventitious, incidental, or spurious) relationships between responses and reinforcements, as opposed to those that are either explicitly or implicitly arranged" (p. 347). Ferster,

Culbertson, and Boren (1975) state that superstitious behaviors are behaviors which are established, changed or maintained by an accidental relationship between reinforcers and performance, when these relationships are based on temporal contiguity, and not causal connections. Herrnstein (1966) also holds that superstitions are the result of adventitious reinforcement due to temporal contiguity. In reviewing the research on superstitious behavior with children, Zeiler (1972) defines superstitions as "behaviors which are emitted as if they have environmental consequences, but in fact do not" (p. 2). He believes that the phenomenon of superstitious behavior is the best evidence that temporal relationships between responses and reinforcing stimuli are critical in reinforcement.

In accord with this conception of superstition, and despite serious questions about Skinner's intuitive leap from the idiosyncratic and stereotypical behavior he observed in pigeons to theories about the genesis of such behavior in animals, adventitious or incidental reinforcement has been demonstrated to result in superstitious behavior in humans. For example, investigators have demonstrated superstitious behavior in university undergraduates using concurrent schedules of reinforcement, where distinct key pressing responses were maintained by independent schedules of reinforcement

(Catania & Cutts, 1963). In an incidental learning paradigm where subjects were able to respond to two keys, only one of which was reinforced, superstitious responses were maintained on the key which was not reinforced. Subjects even claimed to have learned, (erroneously) the correct sequence of key strokes on the two keys which resulted in reinforcement, when, in fact, only a single keystroke on one key was rewarded.

Similar results have been obtained by Bruner and Revusky (1961) working with high school students, and by Zeiler (1970) in work with children. Bruner and Revusky reinforced high school students on a DRL schedule of reinforcement for responding on one of four telegraph keys. They obtained concurrent behavior (which they discussed in terms of collateral mediating behavior) on the other three keys, despite the fact that responding on the other three keys was not reinforced. (Randolph, 1965, replicated these results with college students.) Kramer and Rilling (1970) suggest that the behavior obtained by Bruner and Revusky was essentially superstitious in nature, rather than collateral. Some of the patterns of keypresses that Bruner and Revusky obtained from their subjects were maladaptive, in that they included extraneous keypresses on the reinforced key. Of course, extraneous presses occurring early in the intertrial response time under the DRL schedule resulted in the subjects' losing some of the

possible reinforcements. Bruner and Revusky's subjects stated that these sequences of keypresses (even the ones which were less than optimal, in light of the DRL schedule) were necessary for them to obtain reinforcement. The incorporation of keypresses on the reinforced key into their behavior may be taken as a measure of the strength of the reinforcement procedure and its ability to induce superstitious behavior in subjects.

Stein and Landis (1973), in an extension of the work of Bruner and Revusky (1961) and Randolph (1965), demonstrated that suppression of the superstitious behavior developed by human subjects reinforced on DRL schedules resulted in disruptions in their behavior and prevented them from obtaining reinforcements in an efficacious manner. Stein and Landis believe that the superstitious behavior was essential in maintaining efficient performance in those subjects in which it occurred, and that it developed as a result of incidental or adventitious reinforcement. They ascribed to it a regulatory or pacing function which helped the subjects properly space their responses under the DRL schedule, similar to the interpretation of Laties, Weiss, and Weiss (1969) and contrary to the interpretation of Kramer and Rilling (1970), who do not consider this type of behavior to be mediating or collateral behavior. Following Lyon (1982), this disagreement as to the nature of the behavior cannot

be resolved without recourse to experimental procedures not used by Stein and Landis (nor by Bruner and Revusky or Randolph). Lyon suggests that the distinctions between superstitious behavior, mediating behavior, and collateral behavior under a DRL schedule depend on the observation that superstitious behavior continues unabated when the DRL schedule is changed to an FT schedule. Stein and Landis did not include this manipulation in their experimental protocol.

Working with children, Zeiler (1970) demonstrated that DRO schedules of reinforcement can result in superstitious behaviors. A DRO schedule is defined as differential reinforcement of other responding, which, as Zeiler (1970) points out, may be better phrased as "differential reinforcement of pausing" (p. 149). Under a DRO schedule, reinforcement is provided when a specific response is not emitted for a specified period of time. For example, rewards would be given provided that a subject did <u>not</u> press a button for a specified number of seconds. Under such a procedure, Zeiler's subjects ceased responding on a key that controlled the DRO schedule, while at the same time they developed complex, stereotyped sequences of other behaviors. Most of these behaviors involved pressing a key which had no effect on reinforcement (as planned in his experimental design) but also included observation and exploratory behavior. In discussing his results, Zeiler

noted that stereotyped behavior which did not produce reinforcement has been demonstrated under various other schedules of reinforcement (discussed previously). He concluded that the production of such superstitious responses "is not a special characteristic of any schedule but may be a general consequence of reinforcement," and this in turn suggests that "it may be that adventitious reinforcement is at least partially responsible for the individual differences often observed in behavior" (Zeiler, 1970, p. 154).

Weisberg and Kennedy (1969) investigated the effect of response-independent reinforcement in maintaining children's behavior which had been previously established using variable interval (VI) and variable ratio (VR) schedules. The ages of their subjects ranged from 24 to 60 months. In two separate experiments, Weisberg and Kennedy trained their subjects to press a lever to obtain a snack (crackers, marshmallows, chocolate chips, etc.). In the first experiment, subjects were initially reinforced on a VI 30-second schedule with a 10 second limited hold. Subsequently, subjects were exposed to a VT 30-second schedule of response-independent reinforcement. In the second experiment, subjects were reinforced on a VR 15-second schedule, followed by an FT schedule where the exact spacing of reinforcement was based on the average rate of reinforcement obtained under the VR 15 schedule. In both

experiments, some subjects were switched from the pre-training condition directly to an extinction condition. Weisberg and Kennedy discovered that response-independent reinforcement following a pre-training exercise reliably maintained the previously established behavior. Response rates were lower than during acquisition, but higher than during extinction. They concluded that their subjects were less likely to detect a change in the programming contingencies because response-independent reinforcement retained more of the stimulus features of the response-dependent reinforcement condition than did the extinction procedure. Zeiler (1972), discussing these results in terms of superstitious behavior, points out that they "show that stimuli which reinforce behavior when presented according to response-dependent schedules also reinforce behavior when presented independently of responses" (p. 9). Zeiler further notes that decreases in the rates of responding under response-independent schedules following a pre-training exercise can be explained by the phenomenon of behavioral drift, and that this phenomenon is an important difference between response-dependent and response-independent schedules of reinforcement.

In stark contrast to the study by Weisberg and Kennedy (1969), two separate studies by Poresky (1969/1970, 1971, 1975) demonstrated that exposure to a response-independent schedule of reinforcement following a pre-training exercise

resulted in a much lower rate of responding than did a traditional extinction procedure. Poresky was attempting to demonstrate that human beings were capable of detecting causal, contingent relationships between events. (Previous studies, reviewed below, had indicated that humans were not good at making such discriminations.) In a study using infants ranging in age from 10 to 14 months, Poresky (1975) first continuously reinforced subjects for panel-pressing by the sound of a chime and the appearance of a light. After demonstrating acquisition of the panel-pressing behavior, the infants were placed on either a response-independent schedule of reinforcement (VT 10-second) or a classic extinction schedule where no reinforcements were available. Poresky found that the infants' rates of responding were significantly lower under the response-independent reinforcement schedule than under the extinction schedule. He regarded these results as support for the theory that infants are able to detect the presence or absence of causal, contingent relationships between their behaviors and the reinforcements they receive from the environment, and also that they react differently to such perceived contingencies. He also concluded that response-independent reinforcement was a more effective technique for suppressing behavior than classic extinction procedures where all reinforcements are withheld. These results are diametrically opposed to the results observed

by Weisberg and Kennedy (1969) and virtually all other researchers investigating the effects of response-independent reinforcement following previous response-dependent reinforcement (Davis & Hubbard, 1972; Eldridge et al., 1988; Herrnstein, 1966; Neuringer, 1970; Ono, 1987; Rescorla & Skucy, 1969; Zeiler, 1968, 1972). Poresky's results may best be taken as an indication of the plastic nature of behavior and the observation that the effects of reinforcement are highly dependent upon subjects' characteristics, the particular schedules of reinforcement to which they are exposed, and other characteristics of the experimental environment.

In the earlier study, Poresky (1969/1970, 1971) investigated the effects of response-independent reinforcement following a pre-training exercise on female adults (16 to 32 years of age) and female children (7 to 14 years of age). Subjects were told that pushing a button might or might not cause a light to appear, and their task was to determine if their responses were instrumental in causing the light to appear or not. These instructions induced an awareness in the subjects that their actions might not have an effect on causing the light to appear; that is, they were warned in advance that the reward might be independent of their button-pressing responses. Subjects were initially trained on a schedule of response-dependent reinforcement. The first 41 button-presses were

reinforced on an increasing VR 1 to VR 3 schedule. Thereafter, subjects were placed on an extinction schedule alternating with a VT 3-second schedule of response-independent light flashes. These schedules alternated at one minute intervals for up to eight minutes. Under these conditions, thirty of the adults and five of the children reported that they had no control over the light and that their responses did not determine the occurrence of the reinforcement. From these results, Poresky concluded that humans are able to detect noncontingent relationships between their actions and environmental rewards, and that adults are better at detecting such noncontingencies than are children. Further, Poresky observed that rates of responding in his subjects were lower under the VT 3-second schedule of response-independent reinforcement than they were under classic extinction, and from this observation he concluded that response-independent reinforcement was more effective at suppressing behavior than was classic extinction. He ascribed this effect to the fact that response-independent reinforcement presents both the response and the reinforcement to the subject, so that the subject has available more information concerning contingent, causal relationships than is available in the classic extinction procedure, where the reinforcement stimuli are not presented. More information makes it easier to discern that the reinforcement schedule has

changed. One further observation will be of great interest for the purposes of the present study: In his doctoral dissertation, Poresky (1969/1970) hypothesized that individuals with an internal locus of control (Rotter, 1966) would be better at detecting noncontingencies than would individuals with an external locus of control. He reasoned that this might be so based on the assumption that internals are better information processors and more sensitive to their environment than are externals. This hypothesis was not supported; in fact, there was a non-significant trend for externals to be better than internals at detecting response-independent reinforcement. This result is in keeping with the major hypothesis of the present paper.

In discussing his results, Poresky (1969/1970) points out that superstitious behavior is an illustration of an inability on the part of organisms to detect a noncontingent, non-causal relationship between their responses and reinforcing stimuli. Poresky's observation that human adults are quite good at detecting noncontingencies is at variance with the numerous observations that adult humans do, in fact, form superstitious behaviors in some circumstances. The resolution of this seeming paradox may lie in the design parameters of the respective experiments. The instructions in Poresky's experiment indicated to subjects that their

responses might not have an effect on their ability to obtain rewards. As a consequence, some of his subjects were in fact able to determine that their responses were ineffective in causing the light to appear. On the other hand, some of his subjects continued to behave as if their button-pressing responses were instrumental in causing the light to appear. In terms of an interpretation more in line with traditional research on superstitions, it might be said that these subjects displayed superstitious behaviors when exposed to a response-independent schedule of reinforcement. The two interpretations are not mutually exclusive. It can be observed that in almost any experiment of this type, some of the subjects are able to discriminate response-independent from response-dependent reinforcement and do not develop (or maintain) superstitious behaviors under response-independent schedules, while others are <u>not</u> able to make such discriminations and as a consequence <u>do</u> develop superstitious behaviors. The respective phenomena, contingency detection and superstitious behavior, are two sides of the same coin. Researchers may be able to produce whichever effect they desire by the proper specification of experimental design parameters. This consideration may also apply to Poresky's observation that rates of responding were suppressed more under response-independent reinforcement than under classic extinction. This result,

contrary to so many other observations (Davis & Hubbard, 1972; Eldridge et al., 1988; Herrnstein, 1966; Neuringer, 1970; Ono, 1987; Rescorla & Skucy, 1969; Weisberg & Kennedy, 1969; Zeiler, 1968, 1972), may be a consequence of the experimental design used by Poresky. His instructions introducing the task to his subjects indicated that there might not be a relationship between their responses and the rewards they received. In other words, they were alerted in advance of the possible noncontingent nature of the reinforcement schedule.

Leeming, Blackwood, and Robinson (1978) believe that learning is hampered by response-independent reward. They presented both response-dependent and response-independent reward to subjects in an experimental group, while a control group received only response-dependent reinforcement. Reinforcement was provided on one of ten buttons on an experimental console. Subjects were instructed to obtain as many points on a counter as they could by manipulating the buttons. Subjects given both response-dependent and response-independent reinforcement produced fewer responses on the reinforced button and also fewer over-all responses than subjects who received only response-dependent reward. Leeming et al. concluded from these observations that their subjects gradually learned that the rewards were independent of their responses, and this, in turn, reduced both the effect of the contingent

rewards and also incentive. The learned independence of rewards and responses is not the only explanation for this phenomenon. As noted by Leeming et al. (1978), "the possibility of superstitious learning cannot be ruled out" (p. 272). Incidental pairing of rewards and responses could have inadvertently strengthened responses other than the ones which were actually instrumental in securing the reinforcement.

The studies of Poresky (1969/1970, 1971, 1975) and Leeming et al. (1978) should be viewed in a wider context of controversy over the essential nature of reinforcement, and whether or not human beings are able to discriminate between response-dependent and response-independent reinforcement, or detect causal, contingent relationships. A long history of research indicates that humans are not very good at detecting causal relationships. Smedslund (1963) studied the concept of correlation in adults, and found that adults with no training in statistics do not have an adequate grasp of the concept. They tend to judge the amount of correlation between two events based on the number of instances where both events occur in conjunction with one another, and ignore cases where one event occurs in the absence of the other. In other words, people tend to ignore disconfirming cases in making judgments about the degree of correlation between events. In this context, Singer and Benassi (1981) note that when people make

judgments about probabilistic data, they "behave as if they do not possess the concept of probability, basing their estimates on a simple enumeration of positive instances rather than on the ratio of positive to negative instances" (p. 51). Singer and Benassi also point out that when people are asked to identify patterns or correlations in a set of data, they show strong tendencies to perceive order and causality in random arrays where order and causality do not exist. Singer and Benassi attribute this phenomenon to a failure to generate alternate hypotheses to explain the data and a failure to search for disconfirming data.

Working with response-independent schedules of reinforcement, Wright (1962) concluded that superstitious response preferences and patterns are established as a function of the probability of reward, and that the overall density of reward is responsible for reinforcing superstitious behaviors. His subjects were poor at determining contingent, causal relationships. Higher levels of reward resulted in greater levels of superstitious behavior and poorer judgments about the contingent relationship between responses and outcomes. Thus, Wright's subjects' judgments about contingencies were based on how successful they perceived themselves to be at the experimental task based on the number of points they earned, and not on any causal relationship between their responses and the rewards they received.

Jenkins and Ward (1965) asked subjects to make judgments about the degree of contingency between responses and outcomes, where the degree of contingency varied between zero (independent events) and a value well short of one (a determinate or completely dependent relation). They found that "the amount of judged control was a function of the frequency of successful outcomes rather than of the actual dependency of outcomes upon responses" (Jenkins & Ward, 1965, p. 14). In other words, subjects based their judgment of the contingency between outcomes and responses upon how often the two occurred together, and not on any causal relationship between the two. This result was obtained whether the subject was a participant or an observer. Jenkins and Ward (1965) note that "subjects are surprisingly insensitive to the distinction between contingent and noncontingent arrangements. They tend to behave as though outcomes depend on responses... when the events are in fact independent" (p. 4). In the case of superstitious behaviors, where a particular response might accidentally be reinforced early in a learning period, "the predominance of one response (or pattern of responses) together with one outcome will yield an excess of confirming over nonconfirming cases which, in turn, might lead to a spurious belief in control" (Jenkins & Ward, 1965, p. 4) and a strengthening of the superstitious behavior. Jenkins and Ward conclude by suggesting that

erroneous beliefs concerning control may be traced to the absence of a statistical concept of contingency in untutored subjects. Such an inability to detect contingencies (within defined environmental parameters) is at the root of learned superstitious behavior.

The studies reviewed above suggest that human beings are not very good at judging causal relationships, and that they tend to believe that their actions are more effective at securing reinforcements from the environment than is actually the case. Langer (1975) addresses questions concerning this *illusion of control* in human beings. She defines an illusion of control as "an expectancy of a personal success probability inappropriately higher than the objective probability would warrant" (Langer, 1975, p. 313). She believes that skill-related factors may be responsible for inducing an illusion of control. "The more similar a chance situation is to a skill situation, the more likely it is that people approach the chance situation with a skill orientation" (Langer, 1975, p. 323). In other words, if individuals are confronted with a situation in which chance forces are operating (that is to say, there are non-causal or noncontingent relationships between actions and outcomes), they are likely to believe that they do have some control over the situation to the same degree that the situation resembles one where skill-related factors are effective in controlling or influencing

outcomes. Skill and chance factors are often so closely associated in people's experience that it is difficult to discriminate between the two, for "there is an element of chance in every skill situation and an element of skill in almost every chance situation" (Langer, 1975, p. 324). For example, Benassi, Sweeney, and Drevno (1979) conducted a series of experiments on individuals' perceptions of success on a psychokinesis task (mentally influencing dice to display a specific number when thrown). They found that their subjects' estimates of success were independent of their actual performance. Subjects who were actively involved in throwing the dice (as opposed to observing another person throwing them and trying to influence how the dice landed) were more likely to believe that they were successful in influencing the number the dice displayed. Subjects who actively threw the dice (an opportunity to exercise a skill-related manipulation) believed they had more control over them, despite the fact that none of the subjects demonstrated an ability greater than chance in causing particular numbers to come up. When they were actively involved in throwing them, individuals with an internal locus of control were more likely than those with an external locus of control to believe that they had been successful in manipulating the dice. This result is to be expected from social learning theory (Rotter, 1954, 1966, 1975), as internals are more likely to believe that they

are responsible for the reinforcements they receive from the environment and that rewards are contingent on their own behavior. (The relationship between locus of control and illusions of control will also be addressed later in this paper.)

Langer (1975) believes that the illusion of control occurs because individuals are motivated to control their environment, and complete mastery of the environment would include an ability to beat the odds and control chance happenings. Mastery over the environment reduces uncertainty, and thus helps to reduce anxiety. A belief in control over an impending event (even a nonveridical perception of control) helps to reduce the aversiveness of that event. Thus, an illusion of control may be viewed as the inverse of learned helplessness (Seligman, 1975): the learned dependence between actions and outcomes (in the absence of any causal connection) has adaptive value, in that it helps reduce the anxiety caused by uncertainty. One can see an obvious connection between superstitious beliefs and the illusion of control. Superstitions can give individuals a sense that what is happening to them is understandable and explainable, and thus, in a sense, predictable. When an event is predictable, the individual gains some measure of control over it, and this helps to reduce uncertainty and anxiety. This relief from anxiety can be a real phenomenon, despite the fact that the

superstitious belief which gives rise to it is based on an illusory control of the situation. In this connection, it is interesting to note that Tobacyk (1991) believes that "the construction of illusory correlations is a common cognitive process characterizing beliefs in superstition" (p. 512). (The relationship between personal superstitions and the illusion of control will be addressed in the next section.)

Three definitive studies by Wasserman and his colleagues (Chatlosh, Neunaber, & Wasserman, 1985; Wasserman, Chatlosh, & Neunaber, 1983; Wasserman & Neunaber, 1986) bear upon the intertwined questions revolving around the ability of human beings to detect causal relationships, perceived control of the environment, and the nature of reinforcement. In the first of these studies, Wasserman et al. point out that in the 18th century David Hume first expounded the rules by which human beings form cause-effect impressions: (1) causes must precede effects; (2) there must be a close temporal contiguity between cause and effect; and (3) there must be consistency between causes and effects, that is, they must repeatedly occur together, but not singly. Wasserman et al. note that much of the learning literature is consistent with the first two of Hume's rules, but that there is conflicting evidence for the third (some of which has been reviewed above). Wasserman and Neunaber point out that

there are three competing theories concerning the nature of reinforcement: (1) at the molar level, increases in the rate of operant responding bring about increases in the rate of reinforcement; (2) at a more molecular level, operant responses may be strengthened because they immediately precede reinforcers (that is to say, temporal contiguity is sufficient for reinforcement to occur, the second of Hume's rules); and (3) also at a molecular level, the determining factor in the phenomenon of reinforcement may be the local conditional or probabilistic relationship holding between the occurrence/nonoccurrence of operant responding and the presentation/nonpresentation of a reinforcer within relatively small periods of time. This third point is equivalent to saying that at a molecular level there is a causal relationship between responses and reinforcers (the third of Hume's rules). Wasserman and Neunaber note that traditional interval and ratio schedules of reinforcement are ill-suited to discriminating between the effects of these three theories, and new techniques and schedules of reinforcement are needed to demonstrate their relative importance. Teasing out the relative contributions of these three factors is the task set by Wasserman and his colleagues.

Wasserman et al. (1983) and Chatlosh et al. (1985) attempted to devise experiments which would demonstrate the abilities of human beings to form unbiased judgments about

response-outcome correlations, that is, about perceived consistencies between causes and effects. They used probabilistic reinforcement schedules designed by Hammond (1980) to minimize interactions between response rate and outcome probability. "Independence of these two variables was achieved by programming conditional reinforcement probabilities for a 'response' and 'no response' on a second-by-second basis" (Chatlosh et al., 1985, p. 2). These schedules determine whether or not to deliver a reinforcer every *t* seconds, depending upon whether or not a response has occurred within the last *t* seconds. That is, within a given time frame, the probability of reward given a response can be varied independently of the probability of reward given no response. Thus, the probabilistic schedule can be seen as two independent schedules combined into one. One schedule reinforces the subject for responding, another for not responding, and the reinforcement rates of the schedules can be adjusted so that the overall reinforcement rate for either responding or not responding is higher. If the combined probability of reinforcement is greater than zero, the conditional relationship between responses and rewards is positive, and excitatory conditioning should result. If the combined probability of reinforcement is less than zero, the conditional relationship is negative, and inhibitory conditioning should result. If the combined probability of

reinforcement is exactly zero, there is no conditional relationship between responses and rewards, and behavior should be neither strengthened nor weakened. Chatlosh et al. argue that by focusing the probability of reward on small time intervals, probabilistic reinforcement schedules reduce or eliminate the role of temporal contiguity in schedule performance. They demonstrated that telegraph key-pressing behavior, reinforced by points or monetary rewards, can be controlled by probabilistic schedules, and that their subjects' judgments of the relationships between responses and reinforcers were very close approximations of the true probabilistic relationships, whether the relationships were positive, negative, or zero. Chatlosh et al. view this as strong evidence that temporal contiguity is not necessary for the operant reinforcement of behavior, and that humans are able to form accurate judgments as to causal relationships under certain conditions.

Wasserman and Neunaber (1986) directly address the second of Hume's rules of human perception of causation, regarding the role of temporal contiguity in reinforcement and in generating perceptions of causation. They used newly devised schedules of reinforcement (Hineline, 1970, 1977) which determine <u>when</u> to deliver reinforcers, but do not affect the overall rate of reinforcement or determine whether or not the organism is reinforced. As stated in

Wasserman and Neunaber (1986):

> By design, these schedules can guarantee that changes in the rate of operant responding will not entail any corresponding changes in the rate of reinforcement, thereby eliminating the involvement of molar response-reinforcer correlation in schedule performance. Furthermore, depending upon the time interval used for calculation, these schedules may also question the behavioral relevance of the local conditional relationship between response and reinforcer. (p. 16)
>
> These schedules permitted subjects to advance or to delay appetitive or aversive events, without also affecting (a) the probability of the events occurring within a brief time interval or (b) the correlation between response rate and reinforcement rate over more extended periods of time. (p. 17)

Thus, merely by advancing or delaying the presentation of the reinforcing stimuli, these schedules can minimize or eliminate the effects of molar response rates and local conditional probabilities in reinforcing behavior. The only effect left is that of temporal contiguity between responses and rewards. Working with rats, Hineline (1977) demonstrated that when lever-pressing was reinforced by shock delay, responding was maintained even when lever-pressing also <u>increased</u> the number of shocks received, relative to the base-line condition. Such is the strength of the effect of temporal contiguity. Wasserman and Neunaber demonstrated similar effects with human subjects in an experiment using key-tapping as the operant behavior, using both appetitive and aversive stimuli (point gain and point loss). They found that

> Schedules whose sole consequence was moving the time of an inevitable outcome were effective in modifying subjects' key tapping as well as in influencing their later ratings of the prevailing response-outcome contingencies....
>
> When it advanced the time of an appetitive outcome, key tapping was reinforced and subjects gave positive [response-reinforcer contingency] ratings ("tapping caused the light to occur"). These results held whether outcome advance was accompanied by strict response-reinforcer contiguity... or not.... When key tapping advanced the time of an aversive outcome, subjects also gave positive ratings; here, however, key tapping was punished by outcome advance.... When it delayed the time of an aversive outcome, key tapping was reinforced and subjects gave negative ratings ("tapping prevented the light from occurring"...). When key tapping delayed the time of an appetitive outcome, subjects also gave negative ratings; here, however, key tapping was punished by outcome delay. (Wasserman & Neunaber, 1986, p. 30)

Thus, subjects' responses on the telegraph keys could postpone or advance (but not produce or prevent) gains or losses of points. Nevertheless, the schedules were able to influence the subjects' key-tapping behavior and also influence their judgments of causal relationships. Wasserman and Neunaber hold that these results are strong arguments that temporal contiguity is an important factor in the operant reinforcement of behavior in human beings. Combined with the earlier results of Wasserman et al. (1983) and Chatlosh et al. (1985), both temporal contiguity and the existence of causal, contingent relationships (in the form of local conditional probabilities) can be demonstrated to be effective, alone or in combination, in

controlling behavior. They each appear to be independent contributors to operant conditioning and judgments of causal relationships. (Wasserman and Neunaber, 1986, believe that the evidence for the role of molar response-reinforcer correlation is weak.) In discussing these results, Wasserman and Neunaber note that contingent or causal relations are abstract in nature, and that the notion of causation is a psychological phenomenon. They argue that what is important in human behavior is a perception of causality. The temporal pairing of responses and reinforcing stimuli is sufficient to create such a perception, and the perception, in turn, is sufficient to reinforce behavior. Wasserman et al. point out that the history of the disagreement over the respective roles of contingency and contiguity in reinforcement has been a history of attempts to incorporate one phenomenon into the other. Incorporating both phenomena into a single mechanism would be a more parsimonious explanation than considering each to be independent contributors to reinforcement, but such attempts cannot be resolved at the present time. For now at least, it appears that contingency and contiguity are "independent contributors to the psychology of causation" (Wasserman et al., 1983, p. 431).

Taken in their entirety, the studies by Wasserman and his colleagues (Chatlosh, Neunaber, & Wasserman, 1985;

Wasserman, Chatlosh, & Neunaber, 1983; Wasserman & Neunaber, 1986) demonstrate that (1) temporal contiguity is sufficient for reinforcement to occur, and that (2) human beings can make accurate judgments about response-outcome correlations (or contingencies) under the proper circumstances. Response acquisition is exquisitely sensitive to the molecular topography of the reinforcement schedule and to the experimental setting. For this reason, differing procedures can produce different results. Regarding their conclusion that humans are capable of making accurate judgments about causality, Wasserman et al. and Chatlosh et al. explain the discrepancy between their results and previous studies by pointing out differences in the procedures used to investigate judgments of contingencies: (1) The type of response alternatives utilized (whether to respond or not respond, as opposed to choosing between two alternative choices) can affect subjects' abilities to make accurate discriminations. The use of a single response alternative, which subjects can make or not make, as they choose, results in more accurate judgments of contingent relationships. (2) If both positive and negative contingencies are included in an experimental situation, instructing subjects to rate only the magnitude of their control over the situation may mislead them into making erroneous judgments. In such a situation, asking them to rate both the magnitude and the

direction of a relationship may result in more accurate judgments on the part of subjects. (3) Finally, Wasserman and his colleagues maintain that the free-operant techniques of presenting information which they used in their studies result in greater sensitivity in detecting contingencies than do the discrete-trial and continuous-trial procedures used by other researchers working in the area, although the reasons for this difference are unclear.

Building upon this discussion, Wasserman et al. (1983) state "knowing that [artificial] conditions exist under which accuracy is high and bias is nil does not tell us that humans typically bring such sensitivity to everyday causal judgments" (p. 430). Indeed, one might argue that the real-life situations in which people find themselves are not always clear and easily analyzed, even if people were motivated to perform a conscious analysis. Under conditions of ambiguity and uncertainty, people might not be very good at detecting causal relationships between reinforcing stimuli and responses. They might not even consciously consider the situation as one in need of careful analysis. Consequently, the incidental pairing of responses and desired outcomes might easily come to influence their behavior (through the mechanism of temporal contiguity). Superstitious behavior, behavior in which a person acts as if a causal relationship exists between their behavior and a desired outcome when in fact no such

causal relationship exists, could be the result. Superstitious behavior would be supported by the common motivation to control the environment and to control chance happenings, in order to reduce uncertainty and anxiety (Langer, 1975).

In the context of the debate revolving around the nature of reinforcement and whether or not humans are good contingency detectors, many researchers (Chatlosh et al., 1985; Justice & Looney, 1990; Weisberg & Kennedy, 1969) point out that it is best to phrase any discussion of these problems in terms of the temporal parameters which define the schedules of reinforcement in use, the population characteristics representative of the subjects utilized, and the environmental circumstances in which the effects are observed. Researchers can obtain a variety of differing effects by paying proper attention to these three factors. Experiments can be devised where people are adept at detecting the causal relationships between responses and reinforcers, and consequently do not form superstitions. Conversely, experiments in which the learning situations are uncertain, ambiguous, or unclear can also be devised. These experiments may result in superstitious behaviors. The more closely such experiments duplicate the capricious conditions of the real-life environments in which human beings live, the better analogs they are of situations in which people are likely to learn superstitious behaviors.

More recent studies indeed have demonstrated the learning of superstitious behavior as a result of response-independent reinforcement, both in children (Wagner & Morris, 1987) and in adults (Ono, 1987; Stegman & McReynolds, 1978). These results are generally analyzed in terms of Skinner's (1948, 1953, 1977) conceptualization of superstitious behavior as a result of reinforcement due to temporal contiguity. The effects, however, have generally been limited to only a portion of the subjects studied (Ono, 1987; Stegman & McReynolds, 1978; Wagner & Morris, 1987), and the effects have sometimes been unstable, with only transient superstitious behavior displayed by some subjects (Ono, 1987).

Wagner and Morris (1987) attempted to demonstrate acquisition of superstitious behavior through a procedure akin to Skinner's work with pigeons, where the superstitious responses of the subjects were not constrained by the design parameters of the experiment. They note that prior to their work, this design had not been replicated with human subjects. They used children, three-and-a-half through six years of age, and reinforced them on FT 15-second and FT 30-second schedules with marbles delivered through the mouth of a child-sized (90 cm) mechanical clown. Wagner and Morris found that seven of the twelve children exposed to response-independent reinforcement developed clear superstitious behavior which

increased in frequency toward the end of each FT interval. These behaviors included smiling, grimacing, puckering the lips, touching the nose of the clown, touching other parts of the clown's face, kissing the clown's nose, and swinging the hips. The remaining five children developed behaviors which may have been due to incidental reinforcement, but which were open to alternative interpretations. Wagner and Morris (1987) interpreted their results as "evidence that human behavior will emerge and be maintained by contingencies similar to those arranged by Skinner (1948) in his superstitious conditioning paradigm" (p. 482).

Stegman & McReynolds (1978) were able to inculcate superstitious behavior in college students using response-independent negative reinforcement. In a pre-training exercise, subjects were exposed to a moderately aversive (95 decibel) tone in conjunction with a light providing feedback as to whether or not the subjects were successful in stopping the tone. Three experimental groups were used, each differing in the type of pre-training that they received: (1) an escapable-feedback group where tone offset and feedback light onset were contingent upon an FR 4 button-pressing response; (2) a fully yoked, inescapable-feedback group where both tone offset and light onset were controlled by another subject in the escapable-feedback group, such that the yoked subjects' behavior had no effect on tone offset or feedback; and (3) a partially

yoked, inescapable-no-feedback group in which tone offset was determined by a paired subject in the escapable-feedback condition but the feedback light was never illuminated. Subjects in a control group were not given any pre-training. All four groups were then exposed to ten test trials in which an aversive tone could be escaped by an FR 4 button pressing response. Following this manipulation, subjects in the escapable-feedback condition received ten extinction trials where the tone was inescapable and the feedback light was nonfunctional. During the test trials, learned helplessness was displayed by subjects in the inescapable-no-feedback group. Six of ten subjects in the inescapable-feedback group developed behaviors which they identified as being instrumental in averting the aversive tone, contrary to commonly accepted theories of learned helplessness but in keeping with the hypotheses of Stegman and McReynolds. They interpreted the perceived control and persistent superstitious responding displayed by these subjects as resulting from accidental contingencies. They further view learned helplessness in humans as an extinction effect coupled with a failure to detect a change in environmental contingencies. Stegman and McReynolds conclude their paper by suggesting that the superstitious behavior that they observed is a type of *learned obsessiveness* (behavior which is continued despite its ineffectiveness) and is an experimental analog of

obsessive-compulsive neurosis.

Ono (1987) demonstrated superstitious behavior in college students using lever-pulling responses reinforced on FT 30, FT 60, VT 30, and VT 60 schedules of reinforcement. In a design unusual for superstitious conditioning experiments with humans, she presented various colored lights to her subjects in conjunction with response-independent reward in an attempt to induce sensory superstitions (Morse & Skinner, 1957). Three of her twenty subjects developed strong, stable superstitious behavior. One subject developed stable, stereotyped patterns of lever-pulling. A second developed a stylized series of behaviors involving touching various objects in the experimental room. At one point, the behavior of this subject involved jumping in the air and touching the ceiling with her slipper. A third subject developed behavior reminiscent of sensory superstition seen in animals, where responding increased notably during the time that a green light was illuminated. Ono noted that transient superstitious behaviors appeared in most of her other subjects, but that they did not persist to the end of the 40 minute experiment. She noted that for the three subjects who developed stable superstitious behavior, temporal contiguity of responses and reinforcers seemed to play a vital role in producing and maintaining the behavior. In concluding her paper, Ono suggested that

chance juxtapositions of human behavior and external events may often be responsible for the development of superstitious behavior.

The preceding studies all have concerned personal superstitions. In an analog study of cultural superstitions, Higgins, Morris, and Johnson (1989) were able to demonstrate the maintenance of cultural superstitions via response-independent reinforcement once the superstitions had been induced through other means. They attempted to instill superstitious beliefs in preschoolers by both didactic instruction and modeling procedures. Their analog of a cultural superstition was a belief that touching the nose of a mechanical clown would result in the presentation of marbles, which could then be traded for a small toy. Subjects' presses on the nose of the clown in no way affected the delivery of marbles. Behavior inculcated in the subjects was expected to be maintained under response-independent schedules of reinforcement. In the didactic instruction condition, subjects were told that they could make the clown give them marbles by pressing his nose. Two of three subjects in this condition developed stable nose-pressing behavior which was maintained under a VT 15-second schedule. Subjects in a control group, which did not receive instructions indicating that touching the nose of the clown would result in presentation of the marbles, did not

develop the nose-pressing behavior in response to the VT 15-second schedule of reinforcement. In the modeling condition, subjects watched a videotape of the clown dispensing marbles from its mouth while a child pressed on its nose (the videotape was made of a subject interacting with the clown during the didactic instruction portion of the experiment). Two of five children in the modeling condition developed stable nose-pressing behavior which was maintained under a VT 15-second schedule. Subjects in a control group did not develop stable nose pressing-behavior. Higgins et al. regard these results as an example of the incidental or adventitious reinforcement of imitative behavior. Thus, half of the subjects of Higgins et al. maintained superstitious nose-pressing behavior as a result of the beliefs instilled in them by didactic instruction or peer modeling. Higgins et al. contend that responding during the VT schedule can be conceptualized as an example of a superstitious behavior that was initially engendered through social interaction, and thus is analogous to a culturally learned superstition. They conclude that superstitious behavior can be socially transmitted.

In summary, despite the controversy surrounding the question of the nature of reinforcement and questions as to whether human beings are able to detect environmental contingencies, the experiments reviewed above have

demonstrated that superstitious behavior can be induced and/or maintained in humans by several different incidental learning paradigms. What is crucial for the development of any given effect is the selection of the correct schedule of reinforcement and the provision of the necessary environmental circumstances. It should be kept in mind, however, that these studies have their difficulties. Many (Bruner & Revusky, 1961; Catania & Cutts, 1963; Zeiler, 1970) have not used a pure response-independent learning paradigm, as did Skinner (1948), but observed superstitious behavior as a concurrent result of some other (response-dependent) schedule of reinforcement. These other schedules of reinforcement did control some aspects of responding (or not responding), even if they did not control the superstitious behaviors themselves. Most other studies which have used response-independent reinforcement (Higgins, Morris, & Johnson, 1989; Ono, 1987; Stegman & McReynolds, 1978; Wagner & Morris, 1987; Wright, 1962) have often used instructions or experimental designs which have created an intent to learn in their subjects, so that they might not truly be said to be incidental learning paradigms, since incidental learning is "learning which takes place without the intent to learn or in the absence of formal instruction" (Walker, 1991, p. 105). Despite these caveats, the significant results reported by numerous researchers using numerous different paradigms would seem

to support the validity of the concept of superstitious behavior in humans as a result of response-independent reinforcement. The reported beliefs of the subjects support the concept as well.

## Superstition and Locus of Control

Locus of control of reinforcement (Rotter, 1966, 1975) is a construct well known to students of psychology. According to Rotter's formulation, people possess generalized expectancies as to the causal location of the reinforcements they receive from the environment. Individuals may expect that reinforcements come to them due to forces outside their control, or that reinforcements come to them due to their own efforts. The expectancies can be arranged on a continuum, from expectancies attributed to the internal resources and abilities of the individual, through intermediate values, to expectancies focused on forces and circumstances external to the individual. People who attribute responsibility for events in their lives to their own resources, efforts, and abilities are said to have an internal locus of control of reinforcement. People who attribute such responsibility to forces outside of themselves, to fate, luck, chance, powerful others, etc., are said to possess an external locus of control of reinforcement. These two groups are commonly referred to as internals and externals,

respectively. For reviews of research with the locus of control construct, please see Joe (1971), Lefcourt (1966a, 1966b, 1972, 1981, 1982), Phares (1976), and Ryckman (1979).

Superstitions have been studied with respect to individuals' locus of control of reinforcement, but much of this research has been conducted in conjunction with investigations into occult and paranormal belief systems. Several researchers (Belter & Brinkmann, 1981; Randall & Desrosiers, 1980; Scheidt, 1973; Tobacyk & Milford, 1983) have demonstrated varying degrees of positive correlation between externality and belief in the existence of supernatural and paranormal forces (astrology, fortune telling, precognition, etc.). Additionally, these studies have generally indicated that females are more likely than males to endorse a belief in the paranormal. Tobacyk and Milford, however, caution that belief in the paranormal may be a multi-dimensional phenomenon. They developed a seven factor scale to measure belief in the paranormal, and found that each of the subscales measured a different component of belief. They obtained differing results for the effects of locus of control and of sex on responses for each of the seven subscales. Externality was significantly correlated with high scores on the full Paranormal Scale and on the Extraordinary Life Forms subscale, but not with any of the other subscale scores (using the I-E Scale, Rotter, 1966).

Females scored significantly higher on the Traditional Religious Belief and Precognition subscales than did males. Males scored significantly higher than females on the Extraordinary Life Forms subscale. In addition, externals scored higher than internals on the Superstition subscale (measuring common cultural superstitions), but this difference was not significant.

Working with the Paranormal Belief Scale (Tobacyk & Milford, 1983), Tobacyk, Nagot, and Miller (1988) discovered that beliefs in cultural superstitions were positively correlated with an external locus of control, as measured by both the Personal Efficacy and the Interpersonal Control subscales of the Spheres of Control (SOC) Scale (Paulhus, 1983). Tobacyk et al. found that the relationship between superstition and externality was significant for both men and women. Davies and Kirkby (1985) also endorse the idea that belief in the paranormal is a multi-dimensional phenomenon. Working with the Paranormal Belief Scale, they reported that superstition was correlated with externality on both the Personal Efficacy and Sociopolitical subscales of the Paulhus SOC Scale. Thus, externality and superstitious beliefs have been demonstrated in all spheres of endeavor measured by the SOC Scale.

Davies and Kirkby (1985) report a finding contrary to the usual observation that externality and belief in the

paranormal are related to each other. In their study, internal control expectancies on the Personal Efficacy and Interpersonal Control subscales of the SOC were positively correlated with a belief in witchcraft and parapsychological phenomena. McGarry and Newberry (1981) reported a similar correlation working with the I-E Scale (Rotter, 1966). McGarry and Newberry found that increasing levels of belief and involvement with ESP phenomena and psychic readings were correlated with an internal locus of control. They believe that adoption of a paranormal belief system may be one method that individuals use to attain feelings of competence and perceived mastery over the environment.

In addition to the investigations which have considered the relationship between locus of control and superstition in the context of paranormal belief systems, several studies have specifically addressed the relationship between locus of control and common cultural superstitions. These studies have usually demonstrated a positive relationship between superstition and externality. Jahoda (1970) reported a positive correlation between externality and superstitious belief in Ghanaian university students. Plug (1975a) found that externality was correlated with belief in a variety of common cultural superstitions among white South Africans. Jorgenson (1981) discovered that externals are more likely to endorse

beliefs that their behavior is influenced by the lunar cycle. Peterson (1978) found that belief in culturally transmitted superstitions directly pertaining to oneself (e.g. knocking on wood to avert bad luck) was also correlated with externality.

The empirical findings concerning locus of control and superstition have generally supported the view that externality is correlated with superstition. Superstitious beliefs generally reflect an expectancy that fate, luck, or chance is influencing the events that impinge upon an individual. Self-oriented cultural superstitions are concerned with changing one's luck (Peterson, 1978), and may be considered a form of supplication to fate to intercede on the part of the individual. Such findings for culturally learned superstitions are to be expected from social learning theory (Rotter, 1954, 1966). Externals tend to believe that fate, luck, or chance control what happens to them. The prediction for personally learned superstitions is less clear, however. Social learning theory might predict that internals would be more prone to use personal superstitions, since they are learned from the environment and are an attempt to influence the environment. An internal might perceive "an association between his/her own action and an outside consequence, even though the two could not be linked by physical causality" (Peterson, 1978, p. 305). In other words, internals would

tend to profess a belief in their own ability to influence external events and reinforcements, regardless of the logic of such a belief. Such beliefs would be in accord with Langer's (1975) theories regarding the illusion of control. As noted earlier, the illusion of control occurs because individuals are highly motivated to control their environment. Internals are individuals who have come to believe, based on past experience, that their actions are effective in controlling the reinforcements they receive. To the extent that such beliefs are at variance with the objective probabilities that their actions are actually effective in securing reinforcements (that is, to the extent that they are deluded into believing that they actually have some control over events), internals may be said to be utilizing superstitious beliefs. Another way of saying this is that a personal superstition is an illusion that one possesses a greater efficacy in controlling the environment than an objective assessment would warrant. According to this line of argument, internals, who are more likely to believe that they are responsible for the reinforcements they receive from the environment and that rewards are contingent on their own behavior, would be more likely than externals to fall into this illusion, this superstition. Externals, who believe that fate or chance occurrences control the events that happen to them, should be less likely to believe that their own efforts to control

the reinforcements they receive would be effective. Thus, one might expect that internals will be more likely than externals to develop personal superstitious beliefs. On the other hand, Rotter's contention that externals are more concerned than internals with the role of luck influencing their lives suggests that externals would be more likely than internals to employ personal superstitions, just as they are more likely to employ cultural superstitions. Observations about the relationship between internality-externality and incidental learning, however, offer interesting suggestions to resolve this question.

## Locus of Control and Incidental Learning

As noted earlier, incidental learning is learning which takes place without an intent to learn. Some authors believe that individuals with an internal locus of control have cognitive capabilities which make them more likely than externals to learn information and behaviors incidentally. Several studies have shown that internals tend to be more alert and more cognitively active than externals. Internals learn rules more quickly and gather more information about the situations in which they find themselves in attempts to cope with and control outcomes (Lefcourt, 1972, 1982).

> Internals are more cognitively active. They exhibit better learning and acquisition of material, they more actively seek information,

> they show a superior utilization of information or data once it is acquired, they are more attentive, alert, and sensitive than are externals, and they seem to be more concerned with the informational demands of situations than with any presumed social demands....
>
> The superior mastery and coping of internals seems to be accomplished through their superior cognitive processing activities. They seem to acquire more information, make more attempts at acquiring it, are better at retaining it, are less satisfied with the amount of information they possess, are better at utilizing information and devising rules to process it, and generally pay more attention to relevant cues in the situation. (Phares, 1976, p. 78)

In a word association test utilizing sexual double entendres, Lefcourt, Gronnerud, and McDonald (1973) found that internals demonstrated an awareness of the unusual nature of the words earlier in the task than did externals. Lefcourt et al. (1973) concluded that this was an indication that internals were more cognitively aware than externals. Lefcourt (1967) demonstrated that internals need less explication of task cues to perform well on ambiguous tasks. Lefcourt and Wine (1969) found that internals were more likely than externals to search for information derived from eye contact when interviewing people who were acting in an unusual manner (that is, when the people were avoiding eye contact with the interviewer). This effect was not seen when the interviewee was not acting in an ambiguous manner. Lefcourt and Wine concluded that internals were more vigilant when confronted with a person exhibiting unusual behavior, observed more

behaviors, and were more likely to be attentive to informational cues which were of possible assistance in resolving uncertainty. Davis and Phares (1967) found that internals were more likely to actively search for useful information when confronted with a task requiring them to influence another person's opinion. Phares (1968) demonstrated that when the amount of information about other people memorized by internals and externals was the same, internals were more likely to use efficiently the information they had available to make decisions about those people. Lefcourt, Lewis, and Silverman (1968) demonstrated that internals consider more task-relevant and task-irrelevant items in a decision making task and were more effective at deploying their attention to solve the task successfully. DuCette and Wolk (1973) have shown that internals were better than externals at information extraction and utilization in a variety of problem-solving tasks. Phares (1976) believes that the tendency of externals to learn less than internals is a direct consequence of the expectancy that they do not control the relationship between behavior and reinforcement. Ryckman (1979) believes that internals may be more likely to use their cumulative experiences to develop better problem-solving strategies or more accurate and realistic assessments of their capabilities, so that they perform better on a variety of tasks.

Other characteristics of internals and externals may affect their learning ability. Internals are more task-oriented and show greater task persistence than externals (Ryckman, 1979). Internals are more resistant to subtle manipulation than are externals and are harder to condition, while externals tend to be more sensitive to and compliant with experimenter influences (Lefcourt, 1982; Phares, 1976). These effects have been observed in verbal conditioning tasks (Doctor, 1971; Getter, 1966; Strickland, 1970) and in other tasks as well (Biondo & MacDonald, 1971; Cravens & Worchel, 1977). Internals are more trusting of their own judgments than are externals, and are less likely to conform to or comply with influences which violate those judgments (Crowne & Liverant, 1963). Hiroto (1974) demonstrated that externals are more likely to develop learned helplessness than internals when exposed to inescapable aversive events. He believes that learned helplessness and external locus of control of reinforcement are similar concepts. Both are expectancies that responding and reinforcements are separate, that is to say, that one's efforts on one's own behalf are ineffective in averting undesirable consequences. Finally, Ude and Vogler (1969) discovered that internals were better than externals at determining the contingencies of reinforcement in a task requiring prediction of patterns of flashing lights.

The examples cited above support the contention that

relative to externals, individuals with an internal locus of control tend to be more sensitive to the relevant stimulus characteristics of the situations in which they find themselves and are more efficient at gathering and utilizing information from the environment. This, in turn, is hypothesized to make internals more susceptible than externals to the influence of incidental learning situations (Kassin & Reber, 1979; Lefcourt, 1972, 1982; Phares, 1976; Wolk & DuCette, 1974). However, studies designed to investigate the relationship between locus of control and incidental learning have produced mixed results. Some studies have demonstrated that internals are more likely than externals to learn information incidentally, but others have not. Most of the investigations demonstrating greater incidental learning for internals have involved some kind of verbal learning. These experiments have considered incidental learning for prose passages, geometric designs, and for learning an artificial language.

Wolk and DuCette (1974) presented subjects with prose material which was to be scanned for typographical errors. Incidental learning was measured by the amount of content information which was retained. Results indicated that internals were better at finding typographical errors (the intentional task) and at remembering the content of the prose passage (the incidental task). Wolk and DuCette

interpret their results as supportive of the theory that internals are more perceptually sensitive and more efficient at extracting and utilizing information. Contrary results were obtained by Organ (1976). On a task involving proofreading of prose passages, he demonstrated that both externality and anxiety were negatively correlated with intentional performance under anxiety provoking conditions, but under non-stressful conditions there were no significant differences in intentional learning between internals and externals. His overall pattern of results suggests that there were no significant differences in incidental learning between internals and externals under either condition. Organ suggests that anxiety functions as an intervening variable between locus of control and cognitive processes, so that the poorer performances of externals may at least partly be explained by their greater levels of anxiety.

Brooks and McKelvie (1986) had university students read prose passages that had previously been rated to be of high, medium, or low relevance to college students. Subjects in a cued condition were asked to rate the passages for relevance and were told that they would be tested on the material at a later date. Subjects in an uncued condition were told to rate the passages for relevance but were not informed that they would be tested on the material. Twenty-four hours later, all subjects

were tested on their retention of the material. Internals, as opposed to externals, consistently retained more material across all three levels of relevance in both the cued and uncued conditions. In discussing their results, Brooks and McKelvie point out that the superior performance of internals over externals in the uncued condition can be interpreted as supporting the hypothesis that internals are more likely to learn information incidentally. These results (and the experimental design) are similar to earlier findings of Seeman (1963) that prison inmates low in alienation (an internal locus of control) were more likely to learn incidentally and to remember information of high relevance (information pertaining to parole) then were prisoners high in alienation (an external locus of control).

Beaule and McKelvie (1986) replicated the study of Brooks and McKelvie (1986) using more uncued conditions in an attempt to demonstrate differential effects for the relevance of the passages read. However, Beaule and McKelvie failed to find any significant differences in memory for passages between internals and externals in any of the conditions. They point out that their failure to find differences may have resulted from the cover task they used. Rating passages for relevance involves a deep cognitive processing task, that is, it requires that subjects comprehend the material in order to perform the

task. The proofreading tasks used by Wolk and DuCette (1974) only required a shallow degree of processing for task performance. Comprehension of the material was not required. Beaule and McKelvie suggest that differential effects of locus of control may only manifest themselves in conditions where information is subjected to shallow processing, and not in those situations which require deep processing.

Kassin and Reber (1979) related the locus of control to the learning of a complex artificial language. Subjects were asked to scan and memorize a series of examples of a synthetic language (the intentional task). However, success in learning the language was dependent on subjects deducing the abstract grammatical structure of the language from the examples (the incidental task). Kassin and Reber found that internals were more effective than externals in discriminating the underlying grammar of the language. They interpreted this result as supportive of the observation that internals are more likely than externals to learn information incidentally, and that internals utilized that information more effectively.

In a study performed in 1973, Dixon (1977) investigated the *funneling effect* in respect to locus of control. The funneling effect is a term used to describe the observation that intentional learning increases and incidental learning decreases on a task as an individual's

level of motivation increases. Dixon hypothesized that externals would show a funneling effect, but that internals would display consistent high levels of learning under both high and low levels of motivation. He asked subjects to memorize a serial list of twelve geometric forms (six different forms, such as a square, triangle, etc., each appearing twice in the sequence). This was the intentional task. Each geometric form was associated with two of six different colors. The incidental learning task was a recognition test relating the forms with their respective colors. Dixon found that an individual's locus of control was not correlated with their performance on either the intentional or the incidental learning task. Dixon and Cameron (1976) replicated the earlier work of Dixon (1977) and extended it by considering additional personality variables. They also failed to find a correlation between intentional or incidental learning and locus of control.

The characteristics of internals reviewed earlier, the facts that they are more cognitively active, better at information extraction and utilization, more task-oriented and persistent, etc., all may contribute to the supposition that internals tend to be more sensitive to the effects of incidental learning than are externals. Of course, such a conclusion is tentative, given the contradictory results of the studies reviewed above. However, since some personal superstitions are learned incidentally, and people with an

internal locus of control may be more susceptible to the influence of incidental learning, it seems possible that people with a high degree of internality would be more susceptible to the learning of personal superstitions than would those with a high degree of externality.

**Locus of Control and Learned Personal Superstitions**

Given that individuals with an internal locus of control have a higher level of belief in their own ability to control reinforcements than do people with an external locus of control, internals should display higher levels of such a belief (and concomitant behaviors) in most learning situations. Since internals are more cognitively active and tend to believe that they are in control of the reinforcements that they receive from the environment, it is believed that they will be more likely to attempt to manipulate the environment in order to obtain the desired reinforcements, and to believe that they have been successful in such attempts. In addition, since they also seem to be more prone than externals to learn behaviors and beliefs incidentally, and since at least some personal superstitions appear to be learned incidentally, people with a high degree of internality should be more prone to learn personal superstitious beliefs and behaviors when exposed to an incidental learning situation. People with a high degree of externality should show fewer effects from

incidental learning. When placed in a superstitious conditioning experiment where behavior is reinforced on a response-independent schedule, internals should be more likely to actively explore the experimental environment. Through this exploration, they should come to associate their actions with whatever rewards they are able to secure from the environment, and thus come to develop superstitious beliefs and behaviors. Externals, on the other hand, should be more likely to relax and passively let the experiment unfold of its own accord. Thus, externals should be more likely to discover the response-independent nature of the schedule of reinforcement. This statement is equivalent to saying that externals will be more likely than internals to detect the fact that a noncontingent relationship exists between responses and rewards. As mentioned earlier, this is exactly the effect observed by Poresky (1969/1970) in his study on noncontingency detection, although the effect in that study was not significant.

In this connection, one should note that Lefcourt (1982) states that individuals with an internal locus of control should readily perceive contingencies between their actions and outcomes, presumably even if the contingencies are spurious. Externals, on the other hand, should tend to perceive no contingency between their actions and environmental outcomes.

A greater propensity to develop personal superstitions on the part of internals may have adaptive significance. Since superstitions are believed to help in controlling anxiety, personal superstitions used by internals should serve to reduce their levels of anxiety. Internals should be better at learning a strategy or belief which is effective in reducing anxiety, making them less anxious than externals. As noted above, of course, internals tend to be less anxious than externals in general. The use of learned personal superstitions may be one of the factors behind the lower observed anxiety of internals.

As in many other adaptive behaviors, however, overuse of a coping strategy as outlined above might become counter-productive. If it is true that internals are more prone than externals to the learning of personal superstitions in the manner hypothesized, it is possible that internals might be more prone to learn pathological behaviors incidentally as well. Thus, a demonstration that internals are more likely than externals to learn personal superstitions might have important implications for our understanding of the etiology (and possibly the treatment) of some maladaptive behaviors and certain types of psychopathology, such as agoraphobia, obsessive compulsive disorder, and other anxiety disorders. For example, Thyer (1986) believes that the polyphobic behavior and antipanic rituals associated with agoraphobia may be at least

partially the result of superstitious conditioning. He states:

> Superstitious conditioning may occur during the interval between the onset of panic and its remission. If during that time, the individual flees the situation associated with the onset of panic, avoidance behavior or any other activity which the individual engages in may be strongly negatively reinforced through the association of flight with panic relief. Remission of panic, however, is <u>not</u> contingent upon avoidance; the individual will obtain relief in a few minutes in most cases regardless of what they do....
>
> Avoidance behavior is particularly susceptible to such a process of negative reinforcement since, if the panic occurs in a public place, the panic-stricken individual is inclined to leave to avoid social embarrassment. (Thyer, 1986, p. 98)

In this context, it should be noted that avoidance behavior is especially hard to extinguish (Ferster, Culbertson, & Boren, 1975), and it can be established in humans with a single adventitious reinforcement (Ferster & De Myer, 1961). If in fact agoraphobic behavior is superstitiously learned, as Thyer believes, and if internals are more likely than externals to learn superstitious behaviors, then internals may be more likely than externals to develop agoraphobia. Such an idea is highly speculative, of course (not to mention controversial), since numerous studies have linked <u>externality</u> with agoraphobia (Hoehn-Saric & McLeod, 1985; Van der Molen, Van den Hout, & Halfens, 1988). However, it may be possible that while an internal locus of control might be a factor in the learning of agoraphobic behavior, one's locus of control could shift in a more

external direction after one became afflicted with the disorder. A study into this possible relationship would be most fascinating.

An interesting study performed by Van Raalte, Brewer, Nemeroff, and Linder (1991) addresses the issue raised above concerning the hypothesized tendency of internals to be more susceptible to the learning of personal superstitions. Van Raalte et al. believe that athletes who are highly involved in their sport would be susceptible to the learning of personal superstitions as a means of coping with anxiety. They devised a laboratory experiment using a golf putting green in which the situational and personality factors in sport-related superstitions could be explored under controlled conditions. Van Raalte et al. utilized this particular paradigm because (a) it is a valid task for investigating sport-related superstitions, (b) putting involves a high degree of uncertainty, and (c) putting lends itself to a particular form of superstition which is easily measured: the use of a "lucky ball." In addition, the use of a lucky ball is a behavior that is not explainable as an aid to concentration or as a motor priming sequence designed to improve physical performance. In their experiment, subjects were asked to make 50 putts on an indoor putting green, 3.5 meters from the hole. Subjects were free to choose from a selection of four different colored balls for each putt. Superstitious

behavior was defined as a tendency to use the same colored ball on any given putting attempt after having successfully made a putt on the previous attempt using that color ball. Subjects were seen as attempting to capture the luck inherent in any given ball by using it again after having made a putt with it.

Van Raalte et al. (1991) expected that personal sport-related superstitions would be most likely to develop in situations where performance outcomes were uncertain among athletes who had high levels of ego-involvement and internal orientations. They classified subjects into internals and externals based on their responses to the Chance subscale of the Levenson Locus of Control Scales (Levenson, 1972, 1981). Subjects scoring high on the Chance subscale were classified as externals, while those scoring low on the subscale were classified as internals. Van Raalte et al. found that internals were significantly more likely than externals to use a lucky ball in their putting paradigm. The correlation coefficient between use of a lucky ball and the Chance subscale was $r = -.30$ ($p = .035$). Van Raalte et al. did not find a significant relationship between gender and superstitious behavior.

The results obtained by Van Raalte et al. (1991) are strong evidence that individuals with an internal locus of control are more likely to learn a personal superstition than are individuals with an external locus of control. In

addition, it should be noted that the procedure used by Van Raalte et al. was a true incidental learning paradigm. As outlined previously, the analog experimental designs traditionally used to investigate the learning of superstitious behavior in humans are not true incidental learning situations, since the instructions generally indicate that the subject is to determine (or learn) how to receive reinforcements within the experimental environment. The instructions are generally couched in terms of learning to solve a problem. True incidental learning occurs in the absence of an intent to learn. The strength of the experiment by Van Raalte et al. is that they were able to engender superstitious behavior in their subjects without suggesting to them that there was a behavior to be learned within the golf putting task. They avoided this problem by using a situation in which subjects were to demonstrate a skill, putting, without introducing an intent to learn any new behaviors or skills. The superstitious response which developed, the use of a lucky ball, was truly independent of the reinforcement received, success at sinking putts. Thus, the incidental learning paradigm used by Van Raalte et al. is not as vulnerable to some of the criticisms which have been leveled at the traditional paradigms used in studies of superstitions with humans, and may be considered the stronger procedure.

The purpose of the present experiment is to replicate

and extend the findings of Van Raalte, et al. (1991) by using a more traditional method of inculcating superstitions in human beings, and to investigate the effects of extinction upon learned personal superstitious behavior. Parallel significant experimental results between the present study and the golf putting paradigm of Van Raalte et al. would accomplish two important goals: First, it would furnish further support for the theory that personal superstitions are learned incidentally, and for the hypothesis that internals are more likely than externals to learn personal superstitions. Second, it would also help to validate both experimental paradigms as legitimate methods of investigating the learning of personal superstitions. Validation of the more traditional analog problem-solving design for inducing superstitious behaviors in humans would be especially gratifying, given the previously outlined criticisms of such procedures and the controversies regarding the essential nature of reinforcement. Significant results would also serve to enhance our knowledge of the effects of response-independent reinforcement on human beings and how it is affected by locus of control.

## Hypotheses

Specific hypotheses for the present experiment are as follows: Given an incidental learning situation where subjects are furnished response-independent reinforcement for keypresses on a micro-computer keyboard:

1) Internals will be more likely than externals to report a superstitious belief that the stereotyped patterns of keypresses that they developed were responsible for their obtaining reinforcement from the computer.

2) Internals will be more likely than externals to develop stable, stereotyped patterns of keypresses on the computer keyboard (superstitious behavior).

3) The superstitious response patterns of internals will be longer than those of externals.

4) The superstitious response patterns of internals will be more complex than those of externals.

5) Externals will take longer periods of time to develop superstitious patterns of responses than will internals.

6) The superstitious response patterns of internals will be more resistant to extinction than those of externals.

7) Internals should display lower levels of anxiety than externals. (The superstitious behaviors that internals develop to help them earn points in the computer game should help reduce any anxiety that might result from the experimental procedure.)

8) Internals will be more likely than externals to develop superstitious behaviors in the absence of superstitious beliefs, since internals are more likely to be motivated to act upon their environment in an attempt to control it. (Even though they may know at an intellectual level that their keypresses will have no effect on the reinforcements they receive, internals should continue to attempt to manipulate the computer in an attempt to control their environment. Actions do not always follow stated beliefs. At a non-intellectual level, internals are hypothesized to continue to believe that they can control the outcome of the experiment, to continue to be motivated to control their environment. Such actions should help to alleviate anxiety, because they are able to do something. Such activity helps to create at least the illusion that they are able to do something to control their fate, and this in turn helps to reduce anxiety.)

## Methods

*Subjects*: Subjects were 68 undergraduate students from the University of Montana human subject pool: 12 male internals, 17 male externals, 22 female internals, and 17 female externals. Two hundred eighty three potential subjects were screened early in the Spring quarter, 1992, using Levenson's (1972, 1981) three-part Locus of Control Scale.

Levenson's (1971, 1981) Locus of Control Scale was used to classify subjects because of its demonstrated validity and reliability. Rotter's (1966) I-E Scale, originally believed to be a unidimensional scale measuring a bipolar factor, has been demonstrated to be multidimensional, with anywhere from two factors (Abramowitz, 1973; Joe & Jahn, 1973; Mirels, 1970; Reid & Ware, 1973) to four factors (Collins, 1974). Collins determined that individuals could score externally on the I-E Scale because they believe that (a) the world is difficult, (b) the world is unjust, (c) the world is governed by luck, or (d) the world is politically unresponsive. Two-factor solutions seem to favor one factor loading on an individual's tendency to assign greater or lesser importance to ability and hard work as opposed to luck as influences on outcomes, and a second factor loading on an individual's acceptance or rejection

of the notion that they can exert some measure of political control over events (Abramowitz, 1973; Joe & Jahn, 1973; Mirels, 1970).

Other problems exist with Rotter's (1966) I-E Scale. Hjelle (1971) suggests that the I-E Scale may be contaminated by social desirability and as a consequence its validity may be questionable. Lamont and Brooks (1973) suggest that the I-E Scale is contaminated by a response bias related to mood level. They found that for subjects who had a change in mood over a six week period, I-E scores correlated -.51 with the change in mood, accounting for about 25% of the variance in the I-E scores. Some authors (Hersch & Scheibe, 1967; Klockars & Varnum, 1975) suggest that not only is the I-E Scale multidimensional, but the concept of locus of control of reinforcement itself is multidimensional as well. Hersch and Scheibe note that most of the heterogeneity is accounted for in the concept of externality, and suggest that this reflects a diversity in the psychological meaning of externality. In this context, Gregory (1978) noted that locus of control for positive events (attainment of a positive reinforcer) and for negative events (escape or avoidance of an aversive event) can be independent of one another. He found that the Rotter I-E Scale was better at predicting locus of control for negative events. Similarly, Levine and Uleman (1979) demonstrated that the I-E Scale is better at

predicting attributions to unsuccessful outcomes than it is to successful outcomes.

Building on the concept of multidimensionality within the locus of control construct, Levenson (1972, 1981) developed a new scale with three independent subscales. The Powerful Others and Chance subscales are designed to differentiate between two types of externals: those who believe the world is ordered and predictable but that powerful others are in control, and those who believe that the world is basically unordered and random. The Internal subscale measures the degree to which people believe that they are in control of the reinforcements that they receive from the environment. Theoretically, an individual could score high on all three scales, or low on all three scales, or any combination in between. In practice, the Chance and Powerful Others scales tend to show modest positive correlations with each other, and negative correlations with the Internal scale. This pattern of responses is consistent with the multidimensional construct of locus of control, as measured by the scales (Levenson, 1972, 1981). The Levenson scale has been demonstrated to have adequate validity and reliability in studies with psychiatric patients (Levenson, 1973a), prison inmates (Levenson, 1975), college students (Levenson, 1973b, 1974; Levenson & Miller, 1976), and members of the general public (Levenson, 1974). The Levenson scale was chosen for use on the basis

of the apparent validity of the Internal and Chance scales for the purposes of the present study.

Subjects were classified as either internals or externals on the basis of their responses to the Internal and Chance scales by means of the following criteria: Those individuals scoring in the top third of the Internal scale and the bottom third of the Chance scale were classified as internals. Those scoring in the top third of the Chance scale and the bottom third of the Internal scale were classified as externals. Cutting points were determined by reference to representative national norms, as described below. Subjects classified as internals and externals were contacted by telephone and asked to take part in the experiment.

As national normative data for Levenson's Locus of Control Scale does not currently exist, artificial norms were calculated based on a representative sample of studies cited in Levenson (1981). Data from six separate studies utilizing a total of 762 adults and undergraduate college students as subjects were averaged. The results are presented in Table 1, along with normative data for the University of Montana subjects. As can readily be seen, the male subjects at the University of Montana were significantly less internal and significantly more chance oriented than were males in the national sample. This disparity created difficulty in procuring sufficient male

*Table 1.* Mean Scores (and Standard Deviations) on the Internal and Chance Subscales of the Levenson Locus of Control Scale.

| | | Internal Scale | Chance Scale | n |
|---|---|---|---|---|
| National Sample: | Males | 36.6 (6.4) | 15.7 (8.5) | 333 |
| | Females | 35.0 (7.1) | 16.1 (8.5) | 429 |
| University of Montana Sample: | Males | 34.1 (7.1)* | 17.9 (7.3)* | 135 |
| | Females | 35.0 (6.4) | 16.8 (8.5) | 148 |

*These values differ from the national sample at or beyond the .002 level.

internals for the present study. Consequently, more available female internals were used in the experiment to maintain an even balance between internals and externals.

*Apparatus:* The experimental manipulation occurred in a small room where individual subjects were isolated from distractions and from other people. An IBM XT micro-computer was programmed to furnish response-independent reinforcement to subjects and to record their responses on the keyboard (see Appendix 1, Protocol). Reinforcement, displayed on the computer screen, consisted of points earned for playing a "game" on the computer. Reinforcements were furnished on a VT 5 second schedule (ten points per interval), providing that the subject made at least one keystroke within any given experimental session prior to receiving any reinforcement. Subsequently, reinforcement was independent of any response (or lack of response) the subject made. The experiment consisted of five two-minute periods of response-independent reinforcement, followed by a four minute extinction period in which no reinforcements were available. Subjects were able to control the length of the rest break between each period. Subjects' keystrokes on the keyboard were recorded and later analyzed for stable patterns of responding.

*Procedures:* The same procedure was administered to all subjects. They were told that the experiment was a

computer controlled problem solving experiment designed to investigate some basic principles in human learning and that it was designed to try to determine how many different ways people devise to solve a particular problem (see Appendix 1, Protocol). Further instructions were deliberately vague to avoid the introduction of unnecessary expectations in the subjects. The experimental manipulation was administered by the microcomputer with the subject isolated in the experimental room. After the manipulation, subjects were asked if they had learned the pattern of keystrokes which resulted in earning the maximum number of points, and what that pattern was (see Appendix 2, Exit Interview). Subsequently, they were administered measures of several possible confounding variables, and finally, debriefed (see Appendix 3, Debriefing).

*Response Measures*: Superstitious behavior, defined as relatively stable patterns of keypresses on the computer keyboard, was assessed in terms of responses on the keyboard: whether or not stable patterns of responses developed, the length and complexity of the responses, the length of time which passed before development of the stable superstitious response, and its resistance to extinction. Superstitious belief was assessed by verbal report of the subject at the end of the experiment.

The main dependent measures were as follows: The subjects' verbal reports were used to assess the

development of a superstitious belief as to the efficaciousness of their behavior in obtaining reward. The development of stable superstitious behavior was assessed by the presence or absence of repeating patterns of keypresses in the data files recorded by the microcomputer. For the purposes of this study, a stable superstitious response was defined as a distinct, recognizable pattern of keypresses which was repeated three or more times and was the dominant mode of responding at the end of the fifth period of the experiment and was also repeated at the beginning of the extinction period. The strength of the superstitious response was assessed in the following four ways: (1) the length of the response, in number of characters; (2) the complexity of the response, defined in terms of either the presence of repeating patterns of characters within individual discrete responses or as the presence or absence of progressive, rotating higher order patterns of responding (see below); (3) the length of time which passed before development of the stable superstitious response, with shorter development times representing stronger superstitious behavior; and (4) the resistance to extinction of the superstitious response, with more persistent behavior (longer elapsed times to the cessation of the behavior) representing stronger superstitious behavior. (See Appendix 4 for a formal scoring protocol for evaluating superstitious

beliefs and behaviors.)

Response complexity is not readily amenable to analysis by merely counting the number of response characters, as subjects can be quite creative (and unpredictable) in generating solutions to the problem presented by the experimental protocol. For example, during initial pilot work, one subject stated that she used a rotating sequence of number keys to obtain the reinforcements available on the computer game; that is, she pressed the 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0 (zero) keys in a rotating sequence. Furthermore, she paused approximately four seconds between each response, timing her responses by counting cursor flashes on the computer screen. Such *higher order* responses have been reported by other investigators using response-independent reinforcement. Wright (1962) noted a pattern of systematic rotation of responses in some of his subjects (similar to the subject discussed above). Wright ascribed this behavior to the instances of nonreward which his subjects experienced throughout the course of the experiment. For purposes of analysis in the present experiment, each such instance of a higher order superstitious response was classified as a complex response. In addition, repeating patterns of characters within individual discrete responses (such as "thth, thth...") were also classified as complex. (See Appendix 4, Scoring Protocol, for a detailed discussion of

the determination of response complexity.)

As some degree of judgment is involved in determining the presence or absence of superstitious behaviors and beliefs, two raters were trained to evaluate the main dependent measures discussed above. A formal scoring protocol was developed, and was used by each rater to evaluate the presence or absence of superstitious behaviors and beliefs, as well as the length and complexity of the superstitious response, the time it was established, and also the time it took to extinguish (see Appendix 4). The judgments of the two raters were subjected to an inter-rater reliability analysis in an attempt to demonstrate the stability (and the teachability) of the concept of superstitious behavior and belief, as conceived and applied within the current experimental paradigm.

Additional measures which were used to evaluate possible confounding variables included: age, typing ability, level of perceived frustration before and after the extinction trial, and the State-Trait Anxiety Inventory, the Profile of Mood States, and the Computer Anxiety Rating Scale.

Internals frequently exhibit higher levels of frustration than do externals in ambiguous learning situations (Libb & Serum, 1974; Miller, 1978). Since frustration was a possible confounding variable in the present experiment, subjects were asked to rate their

perceived level of frustration (on a scale of one to five) immediately before and immediately after the extinction session. Both questions were posed during the exit interview after the completion of the experiment (see Appendix 2, Exit Interview).

Anxiety was also a possible confounding factor in the present experiment. Externals have demonstrated higher levels of debilitating anxiety and lower levels of facilitating anxiety when compared to internals (Butterfield, 1964; Spielberger, 1966). Externals display higher levels of trait anxiety (DeMan & Simpson-Housley, 1985; Johnson & Sarason, 1978; Lusk, 1983) and state anxiety (Hoehn-Saric & McLeod, 1985; Phares, 1976) than do internals. In addition, externals have demonstrated higher levels of anxiety in situations perceived as threatening (Joe, 1971; Lefcourt, 1972), and such anxiety has been shown to have a detrimental effect on incidental learning (Spielberger, 1966). Because of these apparent differences in anxiety between internals and externals, measures of anxiety and emotionality were administered after the end of the experiment to check for possible differences in affect between the experimental groups. The Profile of Mood States (POMS) (McNair, Lorr, & Droppleman, 1992) and the State-Trait Anxiety Inventory (STAI) (Spielberger, 1983) were administered during the exit interview to check for differences in generalized state anxiety, trait anxiety,

and other possible emotional states (see Appendix 2, Exit Interview).

In addition, externals have been demonstrated to have higher levels of computer anxiety than internals (Harrington, 1988; Igbaria & Parasuraman, 1989; Parasuraman & Igbaria, 1990), where computer anxiety is defined as a negative affective response involving fear, apprehension, intimidation, hostility, and/or worries that one will be embarrassed or look stupid when using a computer, resulting in resistance to and avoidance of computer technology (Heinssen, Glass, & Knight, 1987). The Computer Anxiety Rating Scale (CARS) (Heinssen et al., 1987; Meier & Lambert, 1991; Zakrajsek, Waters, Popovich, Craft, & Hampton, 1990) was administered to all subjects after the completion of the experiment to check for possible confounding effects of this construct (see Appendix 2, Exit Interview).

## Results

*Interrater Reliability.* Interrater agreement coefficients are presented in Table 2. Cohen's κ for the main dependent measures of the presence or absence of superstitious beliefs and behaviors were .78 and .74, respectively, which is an acceptable level of agreement. Cohen's κ for the complexity of the superstitious response was not calculated as only four records were available for analysis. The Pearson Product Moment Correlations (PMC) for the length of the superstitious response and for the time it took for the superstitious response to become established and to extinguish were not calculated for the same reason. When judging for the presence or absence of a superstitious behavior, the two raters agreed that such behaviors existed in only four of the twenty records which were jointly rated. Superstitious behaviors turned out to be such low probability behaviors that sufficient numbers of cases were not generated to produce a meaningful Cohen's κ or Pearson PMC for the four measures which were dependent on their presence. An n of four would have yielded unacceptable accuracy for these statistics, and thus the calculations were not attempted. Of the four records rated by both judges which contained superstitious behaviors, the judges were in 75% agreement as to the length of the superstitious response, the complexity of the response, and

*Table 2.* Interrater Reliability Statistics for Superstitious Beliefs and Behaviors: Percent agreement and Cohen's Kappa (κ) for Nominal Data, Adjusted for the Value Under Chance (n=20).

| | | |
|---|---|---|
| Superstitious Belief | κ = .78 | 90% agreement |
| Superstitious Behavior | κ = .74 | 90% agreement |

the time it took for the response to become established. The raters were in 50% agreement on the time it took for the superstitious response to extinguish.

In considering the difficulty of judging the presence or absence of superstitious beliefs and behaviors, it should be noted that even with the use of a formal scoring protocol, some judgment was necessary in determining the presence or absence of superstitious beliefs and behaviors and in evaluating the other related variables. The formal scoring protocol used to define superstitious behaviors operationally probably led to some behaviors being classified as superstitious when in fact they were not. For example, some subjects stated that they ran through typing drills to pass the time after discovering that nothing they did on the computer keyboard allowed them to affect the number of points that were awarded. One subject practiced typing musical scales. Some of these behaviors were no doubt coded as superstitious, despite the fact that the subjects stated that nothing they did affected their ability to obtain points from the computer. In this regard, the operational definition of a superstitious behavior employed by Van Raalte et al. (1991), the tendency to use a lucky ball in their golf putting paradigm, was much cleaner and much easier to evaluate than the repeating patterns of keypresses used in the present experiment. In addition to these definitional and evaluation problems, one

of the raters made two unequivocal errors in scoring the time to extinction of the superstitious response. Other outright errors may have occurred as well. All of these factors contributed to difficulties in obtaining agreement between the two raters for these variables.

*Main Dependent Measures.* There were no significant effects for the sex of the subject on any of the dependent measures, nor were there any significant interactions for sex and locus of control for any of the dependent measures (see data analysis in Appendix 5). The percentage of internals and externals developing superstitious beliefs and behaviors is presented in Table 3. Significantly more externals than internals developed a superstitious belief that their efforts on the keyboard were effective in altering their ability to obtain points from the computer. This finding is in direct opposition to the major hypothesis of this study, that is, that internals would be more likely to develop such beliefs. In addition, externals were also more likely than internals to develop superstitious patterns of responding on the keyboard, directly contrary to the second hypothesis. This effect, however, was not significant (see Appendix 5, Data Analysis).

Means for the length of the superstitious responses which were generated, for the time it took for the superstitious response to become established, and for the

*Table 3*. Percent of Internals and Externals Displaying Superstitious Beliefs and Behaviors (n in parentheses).

| | Internals (34) | Externals (34) |
|---|---|---|
| Belief | $26.5\%_a$ (9) | $52.9\%_b$ (18) |
| Behavior | 17.6% (6) | 26.5% (9) |

Within each row, figures with different subscripts differ from one another at the .05 level.

time to extinction of the superstitious response are presented in Table 4. A description of the complexity of the superstitious responses generated by internals and externals is presented in Table 5. There were no significant effects for locus of control (or sex of the subject) for any of these variables (see Appendix 5, Data Analysis). Thus, hypotheses three, four, five, and six were not supported. The superstitious response patterns of internals were not longer than those of externals, nor were they more complex. Externals did not take longer to develop superstitious responses. The superstitious responses of internals were not more resistant to extinction than were those of externals.

*Ancillary Dependent Measures*. Means for several ancillary dependent measures are presented in Table 6. Hypothesis seven was supported. Externals displayed significantly higher levels of both state anxiety and trait anxiety, as measured by the State-Trait Anxiety Inventory (STAI). Externals also achieved higher scores on the Computer Anxiety Rating Scale (CARS). Although the latter effect was not significant, it was in the predicted direction of externality being correlated with higher levels of anxiety.

Externals also scored significantly higher on the C-scale (Confusion-Bewilderment) of the Profile of Mood States (POMS) and significantly lower than internals on the

*Table 4.* Means for Main Dependent Measures for Female and Male Internals and Externals Who Developed Stable Superstitious Behaviors.

| | Females | | Males | |
|---|---|---|---|---|
| | Internals | Externals | Internals | Externals |
| Length of Response (no. of characters) | 2.0 | 2.3 | 2.0 | 2.8 |
| Length of Time for Response to Become Established (sec) | 243.7 | 294.9 | 148.2 | 228.9 |
| Time to Extinction of Response (sec) | 15.5 | 12.9 | 12.6 | 14.1 |

None of these values differ significantly from one another at the .05 level.

*Table 5.* Percent of Internals and Externals Represented in Each of Four Response Complexity Categories (Only for Those Developing Superstitious Behaviors; n in parentheses).

| | Internals (6) | Externals (9) |
|---|---|---|
| Short Simple | 0.0% (0) | 44.4% (4) |
| Short Complex | 50.0% (3) | 11.1% (1) |
| Long Simple | 0.0% (0) | 0.0% (0) |
| Long Complex | 50.0% (3) | 44.4% (4) |

None of these values differ significantly from one another at the .05 level.

*Table 6.* Means for Ancillary Dependent Measures for Female and Male Internals and Externals.

| | Females | | Males | |
|---|---|---|---|---|
| | Internals | Externals | Internals | Externals |
| CARS score | 35.14 | 45.71 | 40.17 | 39.71 |
| STAI State score | $32.64_a$ | $37.53_b$ | $32.75_a$ | $41.00_b$ |
| STAI Trait score | $35.82_a$ | $40.94_b$ | $30.17_a$ | $42.41_b$ |
| POMS T-scale score | 6.00 | 6.35 | 6.25 | 8.94 |
| POMS D-scale score | 3.86 | 2.53 | 2.42 | 5.82 |
| POMS A-scale score | 3.00 | 2.82 | 5.58 | 4.76 |
| POMS V-scale score | $16.55_a$ | $13.35_b$ | $15.42_a$ | $12.12_b$ |
| POMS F-scale score | 7.27 | 5.59 | 3.00 | 7.71 |
| POMS C-scale score | $6.50_a$ | $8.35_b$ | $4.83_a$ | $9.88_b$ |
| Frustration Before Extinction Trial | $1.76_a$ | $2.53_b$ | $2.00_a$ | $2.18_b$ |
| Frustration After Extinction Trial | $2.52_a$ | $3.65_b$ | $3.08_a$ | $3.41_b$ |
| Age of Subject | 24.09 | 21.65 | 27.00 | 21.88 |
| Typing Ability (1 to 10 scale) | 6.09 | 5.41 | 4.50 | 5.24 |

Within each row, figures with different subscripts differ from one another at the .05 level.

POMS V-scale (Vigor-Activity). Thus, externals were more likely to be confused about what they were doing in the experiment, to be less sure of their actions, and to pursue those actions with less enthusiasm and energy. Internals, on the other hand, were more likely to feel as if they had a clear idea of what was going on in the experiment and what was expected of them, and to display higher energy levels in their approach to the experiment. Results for the POMS T-scale (Tension-Anxiety), D-scale (Depression-Dejection), A-scale (Anger-Hostility), and F-scale (Fatigue-Inertia) did not display any significant differences for either locus of control or for sex.

Externals reported significantly more frustration than did internals both before and after the extinction trial, when no points were available on the computer (see Table 6). While no specific hypothesis was formulated relative to frustration, one might have expected internals to have reported higher levels of frustration in this experiment, since internals frequently exhibit higher levels of frustration than do externals in ambiguous learning situations (Libb & Serum, 1974; Miller, 1978). The level of frustration experienced by both internals and externals increased over the course of the extinction period, so that both groups felt significantly more frustrated at the end of the period than at the beginning (see Frustration Repeated Measures ANOVA in Appendix 5, Data Analysis).

The effects for age of the subject and for self-reported typing ability (on a scale of one to ten) did not differ significantly across sex or locus of control (see Table 6). Nor were there significant differences for whether or not the subject knew how to type using typing fingering (see Table 7) or for the kind of fingering used to manipulate the keyboard (typing fingering vs. "hunt and peck;" see Table 8).

Hypothesis eight stated that internals would be more likely than externals to develop superstitious behaviors in the absence of a superstitious belief. This hypothesis was not supported by the data. Only four subjects developed such behaviors in the absence of a corresponding superstitious belief, and internals were no more likely than externals to develop such behaviors (see Table 9).

*Table 7.* Percent of Internals and Externals Stating that they Possessed the Ability to Type (Using Typing Fingering; n in parentheses).

| | Internals (34) | Externals (34) |
|---|---|---|
| Possess Typing Ability | 94.1% (32) | 91.2% (31) |
| Unable to Type | 5.9% (2) | 8.8% (3) |

None of these values differ significantly from one another at the .05 level.

*Table 8.* Percent of Internals and Externals Using Typing Fingering vs. "Hunt and Peck" Method of Manipulating the Computer Keyboard (n in parentheses).

| | Internals (34) | Externals (34) |
|---|---|---|
| Typing Fingering | 14.7% (5) | 14.7% (5) |
| Hunt and Peck | 67.6% (23) | 79.4% (27) |
| Both | 17.6% (6) | 5.9% (2) |

None of these values differ significantly from one another at the .05 level.

*Table 9.* Percent of Internals and Externals Displaying a Superstitious Behavior Without a Corresponding Belief (n in parentheses).

| | Internals (25) | Externals (16) |
|---|---|---|
| Presence of a Superstitious Behavior in the Absence of a Corresponding Belief | 4.0% (1) | 18.8% (3) |
| Lack of a Superstitious Behavior in the Absence of a Corresponding Belief | 96.0% (24) | 81.3% (13) |

None of these values differ significantly from one another at the .05 level.

## Discussion

None of the main hypotheses regarding the differential effects of locus of control were supported by the results of this experiment. In this setting, internals were not more likely to develop superstitious beliefs or behaviors than were externals. In fact, the main finding of this experiment was that subjects with an external locus of control were more likely to have developed a superstitious belief than were those with an internal locus of control, directly contrary to the hypothesized effect. It seems likely that this result was a consequence of the experimental paradigm employed.

As outlined in the introduction, the analog experimental designs traditionally used to investigate the learning of superstitious behavior in humans are not true incidental learning paradigms, since the instructions generally indicate that the subject is to determine (or learn) how to receive reinforcements within the experimental environment. The instructions are generally couched in terms of learning to solve a problem. The instructions for the present experiment fit this description. A problem-solving bias was introduced by the instructions accompanying the experimental protocol when subjects were asked to figure out how to obtain reinforcements (points) from the computer. Internals took

these instructions to heart and were in fact better at determining that reinforcement was not contingent on whatever responses they might make on the keyboard. This line of reasoning is consistent with the work reviewed earlier on noncontingency detection conducted by R.H. Poresky (1969/1970, 1971, 1975). In fact, Poresky (personal communication, January 17, 1992) believes that internals would be more likely than externals to detect the lack of contingency between their responses and the reinforcements that they receive, based on the speculation that internals would be more aware of their environment and also more willing to admit that there were portions of the environment that they could not control. Indeed, one way of conceptualizing the results of the present experiment is that given the particular experimental paradigm employed, internals were better contingency detectors than were externals, and thus were less likely to act as if (or believe) that causal contingencies existed between their behaviors and the rewards they received from the computer game. This line of reasoning is consistent with the observations outlined earlier that internals tend to be more cognitively aware, more cognitively active, more attentive to informational cues in uncertain situations, more task-oriented, better at information extraction and utilization in problem-solving tasks and better problem-solvers in general, more resistant to subtle manipulation

and harder to condition, more trusting of their own judgments and less likely to conform to influences which violate those judgments, and of course, better than externals at determining the contingencies of reinforcement (Crowne & Liverant, 1963; DuCette & Wolk, 1973; Lefcourt, 1982; Lefcourt et al., 1973; Lefcourt & Wine, 1969; Phares, 1976; Ryckman, 1979; Ude & Vogler, 1969). In the present experiment, internals were better at detecting the contingencies of reinforcement than were externals, most likely because subjects were told they were to solve the problem of how to receive reinforcements from the computer. Apparently, internals paid close attention to these instructions and then proceeded to solve the problem correctly. In other words, by introducing an intent to learn, the present experimental paradigm created an environment which was not truly an incidental learning situation, since true incidental learning occurs in the absence of an intent to learn. Instead, the instructions induced a problem-solving bias in the subjects. This flaw is inherent in most of the experimental paradigms used to investigate the learning of superstitious behaviors by humans, and to the extent that these experiments necessarily create an intent to learn in their subjects, they are more or less flawed. The golf putting paradigm of Van Raalte et al. (1991) avoids the intent to learn problem since it purports to measure a pre-existing skill and does

not ask subjects to try to learn anything. In addition, the superstitious response which developed in their experiment, the use of a lucky ball, was truly independent of the reinforcement received, success at sinking putts. From this reasoning, and following the line of argument developed earlier in the introduction, it seems that the paradigm used by Van Raalte et al. is the better vehicle for investigating the learning of personal superstitions.

In the introduction to this paper it was pointed out that the acquisition of behavior is often exquisitely sensitive to the molecular topography of the reinforcement schedule and to the experimental setting used in any given project. For this reason, differing procedures can produce different results even when investigating ostensibly similar phenomena. In questions concerned with human learning, Wasserman and his colleagues (Chatlosh, Neunaber, & Wasserman, 1985; Wasserman, Chatlosh, & Neunaber, 1983; Wasserman & Neunaber, 1986) point out that it is best to phrase any discussion of problems with differential experimental results within any given field of investigation in terms of the temporal parameters which define the schedules of reinforcement in use, differences in environmental or procedural circumstances, or differences in the populations from which subjects are drawn. In line with the above argument, Justice and Looney (1990) also note that reinforcers have multiple effects,

and that desired behavioral effects may be achieved by the proper specification of schedules of reinforcement and environmental contingencies. By paying attention to these factors, researchers can obtain a variety of differing effects for their manipulations. Experiments can be devised which inadvertently favor one outcome over another. This is apparently what happened in the present circumstance. By introducing an intent to learn in the subjects, the environmental conditions necessary for a true incidental learning situation were violated. In addition, problem-solving conditions were fostered which favored the superior cognitive abilities of internals, so that they were able to decipher the true contingencies between responses and reinforcers within the experimental design, and thus avoid developing superstitious beliefs. Externals, on the other hand, were less likely to solve the problem correctly, and consequently to develop a superstitious belief that they were affecting the delivery of reinforcements in some fashion.

As hypothesized, externals displayed a higher degree of anxiety than did internals. This effect was seen on both the State and Trait forms of the STAI. As superstitious beliefs can help to reduce anxiety and uncertainty, it is perhaps not surprising that in this paradigm (which apparently was not truly an incidental learning paradigm) externals were more likely to develop

superstitious beliefs than were internals. Following the lines of reasoning contained in Rotter's (1954, 1966) social learning theory, in the absence of any effects from incidental learning, one would expect that externals would be more likely to develop and endorse superstitious beliefs, as in the present experiment. Interestingly, externals also displayed higher levels of frustration. One might have expected internals to have been more frustrated, since internals frequently exhibit higher levels of frustration than do externals in ambiguous learning situations (Libb & Serum, 1974; Miller, 1978). One possible explanation for the contrary result is that internals at least did not find the learning situation in the present experiment to be ambiguous. Externals may also have felt more frustrated than internals because externals felt less in control of the situation, as might be expected since they were not as adept as internals at discovering the correct solution to the problem presented by the experimental paradigm. These conjectures are also supported by the observed differences between internals and externals on the Profile of Mood States (POMS). Externals were more likely to be confused about what they were doing in the experiment, to be less sure of their actions, and to pursue those actions with less enthusiasm and energy. Internals, on the other hand, were more likely to feel as if they had a clear idea of what was going on in the

experiment and what was expected of them, and to display higher energy levels in their approach to the experiment. These differences could have resulted in a differential mobilization of the cognitive resources needed to successfully solve the puzzle presented by the experimental paradigm, with the end result that internals were better than externals at avoiding developing a superstitious belief as to their own efficacy at securing reinforcements from the computer.

In summary, the contradiction in results obtained by Van Raalte et al. (1991), that internals were more likely to learn personal superstitions, and the present study, that externals were more likely to learn personal superstitions, serves as an excellent illustration of the observation presented earlier, that experimenters can often design experiments which enhance certain effects at the expense of other effects. The design of the present experiment, since it was not a true incidental learning paradigm and since it induced a problem-solving bias in the subjects, inadvertently made it more likely that internals would put their problem-solving skills to full use and determine that their actions did not in fact affect the reinforcements they received from the computer. Externals, on the other hand, seemed muddled and confused by the experiment, as well as frustrated, and as an apparent consequence they were more likely to develop a

superstitious belief to help them cope with the situation in which they found themselves. Thus, the present experimental design is lacking in manipulative power and in validity as an incidental learning paradigm to the same extent that it introduces a problem-solving bias in the subjects. The same criticism applies to other experimental paradigms used in the field of superstitious learning in humans. The golf-putting paradigm of Van Raalte et al., being a true incidental learning paradigm, did in fact produce more superstitious behavior in internals than in externals. This is, of course, the effect hypothesized on both theoretical and empirical grounds in both papers. The major conclusion of this paper is that the golf-putting paradigm is a better vehicle for investigating the learning of personal superstitions in human beings and that traditional methods of inculcating superstitious beliefs and behaviors are less than adequate.

APPENDIX 1

**PROGRAM FOR PROTOCOL**

Display the following statement: "Please enter subject identification _____" (file INS.0B).

Create a data file using subject's identification for the root. Each of the six separate periods will create a new data file with the same root and an extension corresponding to the period for which the data is being recorded (1-6).

Display file INS.1B

When the subject presses the space bar, award points on a VT 5 sec schedule after a keypress on any key on the keyboard, and display accumulated points in the center of the screen. The variable time (VT) schedule will range from 3 to 7 seconds, so that the average of all time intervals equals 5 seconds. Record all keystrokes on the keyboard in the data file, along with the elapsed time from the beginning of the experimental session, in seconds, and the elapsed time from the previous keystroke. Also record the actual time (in seconds, from the start of the session) that each 10 point reinforcement was received. Data file in four rows: top row the keystroke; second and third rows the elapsed time since the start of the session and the elapsed time since the previous keystroke, respectively, for the keystroke recorded in the first row; fourth row the time each 10 point reinforcement was received.

At the end of 120 seconds, display file INS.2B, along with the total number of points earned in the first period (in the appropriate spot). When the subject presses the space bar, begin the second period, following the protocol in the above paragraph.

At the end of each period (through period 5), repeat the cycle.
Display file INS.3B at the end of the second period,
file INS.4B at the end of the third period,
file INS.5B at the end of the fourth period, and
file INS.6B at the end of the fifth period
along with the points accumulated for each period.

When the subject presses the space bar to begin the sixth period, record all keystrokes as per the above protocol, but do not award any points. At the end of 240 seconds display file INS.7B for 60 seconds, then exit program after one minute.

File INS.1B:

WELCOME TO INVESTIGATION OF LEARNING

This experiment is a computer controlled problem solving experiment designed to investigate some basic principles in human learning. We are trying to determine how many different ways people devise to solve a particular problem. There is no right or wrong way to solve this problem, just different possible methods. The experiment is set up in the form of a game. When the experiment starts, you will be able to accumulate points by manipulating the ten number keys across the top of the character keys on the keyboard, that is, on the 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0 (zero) keys. During the experiment none of the other keys will have any effect on what the computer does or on your ability to earn points. Your task is to figure out how to win points. Try to win as many points as possible. Press only one key at a time. Do not hold any key down after pressing it.

The experiment is divided into six different periods, each of which is approximately two minutes in length. You may rest for a short while before beginning the next period. Accumulated points for each period will be displayed in the center of the computer screen. The counter will reset to zero at the beginning of each period. If you have any questions about the procedure, please ask the experimenter at this time. Press the space bar when you are ready to begin. Good luck and have fun.

File INS.2B:

Congratulations. You have won points
in the first period of the experiment.

Press the space bar
when you are ready to begin the second period.

File INS.3B:

Congratulations. You have won points
in the second period of the experiment.

Press the space bar
when you are ready to begin the third period.

File INS.4B:

Congratulations. You have won points
in the third period of the experiment.

Press the space bar
when you are ready to begin the fourth period.

File INS.5B:

Congratulations. You have won points
in the fourth period of the experiment.

---

Press the space bar
when you are ready to begin the fifth period.

File INS.6B:

Congratulations. You have won points
in the fifth period of the experiment.

Press the space bar
when you are ready to begin the sixth period.

File INS.7B:

Congratulations. You have won 0 points
in the sixth period of the experiment.

The experiment is now over.
Please call the experimenter for your debriefing.

Thank you for helping out with our experiment.
Please do not tell anyone about what you did here today;
we do not want to contaminate our future results.
Thank you.

*APPENDIX 2*

**EXIT INTERVIEW**

After the end of the extinction trial (when the experiment has been completed) each subject will be asked if they learned what pattern of responses was necessary for them to earn points during each period of the program. They will be asked to describe what they believed they had to do to earn the points, and what pattern of keystrokes they believed were responsible for the reinforcements that they received.

Next, the following statement will be made to each subject: "Many people find it frustrating to work with a computer, especially when they don't really know how to make it do what they want. Also, some people find the last period of the experiment frustrating when they can't get any more points. Try to put yourself back to the time just before the last period of the experiment. On a scale of 1 to 5, with 1 being not frustrated at all and 5 being extremely frustrated, can you tell me how frustrated you felt? How frustrated were you at the very end of the experiment?" A card containing a five point rating scale for frustration, similar to the scale on page 2 of this appendix, will be placed in front of the subject to help them formulate their answer.

Each subject will then be asked their age and whether or not they know how to type. If they know how to type, they will be asked to rate their perceived level of typing ability, on a scale of 1 to 10, and whether they used typing fingering to make keystrokes or just used the "hunt and peck" method.

Each subject will then be administered the Profile of Mood States (POMS), the Computer Anxiety Rating Scale (CARS), and the State-Trait Anxiety Inventory (STAI), in that order.

Subjects will then be debriefed.

DEBRIEFING FORM

Subject ID _____

What did you have to do to earn points on the computer? (list any actions or patterns of keystrokes the subject describes)

---

How much frustration did you feel <u>before</u> the last period began?

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| none | a little | moderate amount | quite a lot | extreme |

How much frustration did you feel at the end of the experiment?

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| none | a little | moderate amount | quite a lot | extreme |

Age:

Can you type?

Typing ability, on a scale of 1 to 10:

Did you use typing fingering during this experiment, or did you just use the "hunt and peck" method to press the keys?

Other notes and observations:

APPENDIX 3

**DEBRIEF**

Subjects will be told that what we were interested in measuring was the length and complexity of the responses that they developed to earn "points" on the computer game. There were no right or wrong ways to earn points, just different methods devised by different people. Subjects were chosen on the basis of their responses to the scales that they filled out during the group screening at the beginning of the term. We expected people who had different characteristics (as measured by the screening) to develop different patterns of responding on the computer game.

If people inquire about the characteristics that we used to choose subjects, they will be told that they were chosen on the basis of their locus of control, and this concept will be briefly explained to them if they do not know what it is. If they request more specific information they will be told that we expected to find that people with an internal locus of control were more likely to develop longer and more complex solutions to the computer game than were people with an external locus of control. This information will only be furnished to subjects who specifically inquire about details of the experiment.

Subjects will not be told that the computer automatically awarded "points" independently of subjects' responding on the keyboard, as such a revelation would be too damaging to the experiment if it became general knowledge. (If subjects learn this information for themselves during the course of the experiment we will, of course, verify it during the debriefing.) All subjects will be told that there were no points available during the last period of the experiment. If subjects have any further questions that the experimenter cannot answer (such as an individual subject's locus of control) they will be referred to Guy Bateman for further information. Mr. Bateman's name and phone number will be offered to all subjects in case they have any further questions.

The debriefing will conclude with an appeal to the subjects to keep the procedures and purpose of the experiment confidential, because we do not want to have the results contaminated.

APPENDIX 4

## SCORING PROTOCOL

### Criteria for Assessing Superstitious Beliefs

The subjects' verbal reports from the exit interview will be used to assess the development of a superstitious belief as to the efficaciousness of their behavior in obtaining reward. A superstitious belief is a verbal statement that: (1) the subject had to perform some specific action to obtain points on the computer, or (2) that something that they did affected their ability to receive points in some fashion.

Examples of the first type of belief would be statements of the following nature:

I entered my name on the keyboard.

I just typed in the number of points that were showing on the computer screen.

I typed in "10" because that's the number of points I got each time.

I typed the next number that I expected to get, that is, if I had 120 points, I would type in "130."

Nine worked. I typed nine and waited for the points to come up on the screen.

I typed in even sequences of numbers. 2, 4, 6, 8, etc. I also typed in his sequence backwards.

I typed in 12. If I did this several times I would get ten points, then I would type it in some more.

Examples of the second type of belief would include statements such as the following:

I just pressed any number key a large number of times in a row.

Any number worked to get points, but some worked better than others. Six worked best.

I counted the cursor flashes and then typed in a number. Any number worked if I waited at least 10 flashes.

I just waited four seconds between punching in a number. I counted to four in my head.

I'm sure that there was some kind of number pattern or a time pattern, but I couldn't figure out exactly what it was.*

Sequences of numbers were important in getting points. It didn't matter what sequence, as long as you typed three or more numbers in a row.

It didn't matter what I pressed, but I had to press the zero key to get the game started.*

I just punched in odd numbers.

* These beliefs are unlikely to have any corresponding superstitious behaviors.

## SCORING PROTOCOL

### Criteria for Assessing Superstitious Behaviors

Presence or absence of stable superstitious behavior: The development of stable superstitious behavior will be assessed by the presence or absence of repeating patterns of keypresses in the data files recorded by the microcomputer. A stable superstitious response is defined as a distinct, recognizable pattern of keypresses which is: A) repeated three or more times at the end of the fifth period of the experiment; and B) is also repeated at least once at the beginning of the extinction period. Assessment of the presence of a stable response will initially be done without reference to the subject's stated belief. If a stable response cannot be identified on the basis of the information contained in the data files alone, the subject's stated belief (from the exit interview) will be used as a clue to search for stable patterns of keypresses. It is possible that stable patterns of superstitious behavior (in the form of repeating patterns of keypresses) will be present in the data files in the absence of a stated belief, and it is also possible that a stated superstitious belief will be present in the absence of evidence in the data files of stable superstitious behavior.

The presence of a repeating pattern of keypresses will first be assessed by visual inspection of the responses the subject made at the end of the fifth period of the experiment. The responses will generally be one, two, or three characters long. For example, a subject might type "12, 12, 12," etc. A commonly seen pattern is for the subject to type in the number which is shown on the screen, or to type in the number that they anticipate will show up on the screen next. For example, if the screen displays the number "210," the subject may enter either "210" or "220" on the keyboard. Instances may arise where it is unclear what sequence of keys the subject may be pressing, for example, if they press a sequence of nines: "999999999999999," etc. This may be a series of nines, a series of ninety-nines, or a series of nine hundred and ninety-nines, etc. These ambiguous instances will be resolved by referencing the times that have elapsed between successive keystrokes. For example, if .3 sec elapsed between the the first and the second nine in the example above, but 4.0 sec elapsed between the second and third, and this pattern repeated throughout the sequence of keypresses, it is apparent that the subject typed "99, 99, 99," etc. Conversely, if .3 sec elapsed between the first and second nine and also the second and third, but 4.0 sec elapsed between the third and the fourth nine, it is

apparent that the subject typed "999, 999, 999," etc. This technique of examining the elapsed time between successive keystrokes can be applied to any ambiguous sequence of keystrokes where uncertainty exists as to what the subject was typing on the keyboard.

If a pattern of keypresses is identified as being present at the end of the fifth period, it must be verified as being present at the beginning of the extinction period before it can be classified as stable. If stable superstitious behaviors cannot be detected by an initial examination of the data file, reference will be made to the subject's stated superstitious belief (if any), and the files re-examined in the light of such a stated belief, as indicated above.

Assessing the strength of the superstitious behavior: The strength of the superstitious response will be assessed in the following ways: (1) the length of the response, (2) the complexity of the response, (3) the length of time which passed before development of the stable superstitious response, and (4) the resistance to extinction of the superstitious response.

The length of the response will be assessed by counting the number of characters in the response. A response with one character will receive a score of 1, a response with three characters will receive a score of 3, etc. If the subjects uses a higher order response pattern (see below) the length of their response will be based on the longest discrete response emitted in the higher order response sequence. Scores can range from one to a very large number somewhat short of infinity.

The complexity of the response will be assessed by classifying responses into long or short categories and into complex or simple categories. Crossing the two categories will result in a total of four separate complexity ratings: long complex responses, short complex responses, long simple responses, and short simple responses. A short response will be one that is one or two characters in length. A long response will be one that is three or more characters in length. Complex responses will be: (1) all higher order responses (see below), and (2) all responses which display repeating patterns of characters within individual discrete responses. For example, a response of "thth, thth," etc., would be classified as complex because the sequence "th" is repeated within an individual response. A response of "99" would also be classified as complex. Responses which do not fall into either of the two categories above will be classified as simple. For example, "8, 8, 8, 8," etc. would be a simple response.

The presence of progressive, rotating higher order patterns of responding is to be expected. As noted above,

subjects often enter into the computer the number which is displayed (or which they anticipate to be displayed) on the computer screen. As further examples of rotating higher order patterns of responding, one subject stated that they used a rotating sequence of number keys to obtain the reinforcements available on the computer game, that is, they pressed the 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0 (zero) keys in a rotating sequence, pausing after each keypress until they had received a reinforcement. Another subject stated that they paused approximately four seconds between each response that they made, timing their responses by counting cursor flashes on the computer screen and then typing in a "5." Each such instance of a higher order superstitious response will be classified as a complex response. Whether or not a higher order response is classified as long or short will be based on the length of the longest discrete response emitted by the subject. For example, if the subject used the series "0, 10, 20, 30, 40,... 200, 210, 220, 230, 240," the length of their complexity score would be based on the responses "230, 240," etc. This example would be classified as a long complex response. The other two examples cited above (counting cursor flashes between responses and entering "1, 2, 3, 4, 5, 6, 7, 8, 9, 0," and then starting over) would be classified as short complex responses.

The length of time which passed before the development of a stable superstitious response will be determined from reference to the responses in the data file. The point in time at which a stable superstitious response has developed will be defined as that point at which the response represents at least 90% of the responses the subject makes on the keyboard, from the point the response stabilizes until the end of the fifth experimental period. The length of time it takes for the stable superstitious response to develop will be defined as follows: The time, measured in seconds, that elapses between start of the experiment and the first keystroke of the first instance of the stable superstitious response that marks the beginning of the period in which the stable response represents at least 90% of the responses on the keyboard, exclusive of the times the subject rested between experimental periods. For example, if the subject begins typing the number that is displayed on the computer screen 30.4 seconds into the third experimental period, and if this response constitutes at least 90% of their responses for the rest of the experiment up to the end of the fifth period of the experiment, the length of time which has passed is calculated as 270.4 seconds (120 seconds from the first period, 120 seconds from the second period, and 30.4 seconds from the third period).

The resistance to extinction of the superstitious

response will be measured, in seconds, from the beginning of the extinction period until the last keystroke of the last response emitted in the extinction period which is characteristic of the stable superstitious response in which the subject was engaging at the end of the fifth period of the experiment. For example, if the subject was using a rotating sequence of keypresses by typing the number of points displayed on the computer screen, at the end of the fifth period they might type "210, 220, 230, 240." The expected pattern of keypresses at the beginning of the extinction period would be "0, 10, 20," etc., if reinforcement continued. If the subject types "0" several times, this would be construed as a perseveration in superstitious behavior in expectation of obtaining additional reinforcements from the computer. However, if the subject begins typing "9, 9, 9, 9, 9," or "6, 6, 6, 6," or "1, 2, 3, 4," or any other pattern of keystrokes not identical with their previous superstitious response pattern, or if they cease responding entirely, it can be said that their superstitious behavior has extinguished. If they emitted the last "0" in the sequence of superstitious responding 20.9 seconds into the experimental period, this time would be taken as the measure of resistance to extinction.

Note that some specific beliefs may be very difficult to discern in the data files. For example, if a subject says that that they just typed in any number, but had to wait at least four seconds between numbers, a specific pattern of keystrokes would not be readily apparent in the data record. In this instance, the presence of a superstitious behavior could be verified if the data files indicated that the subject had in fact waited four seconds between successive keystrokes.

**Coding System**

Belief: 1 = presence of belief 0 = absence

Behavior: 1 = presence of behavior 0 = absence

Length: (metric) number of characters

Complexity: 1 = short simple 2 = short complex
3 = long simple 4 = long complex

Time to establishment of the superstitious behavior:
(metric) number of seconds

Time to extinction of the superstitious behavior:
(metric) number of seconds

# APPENDIX 5: DATA ANALYSIS

## Coding for Data Analysis

(1) Sex: 1 = female 2 = male

(2) LOC: 1 = internal 2 = external

(3) Levenson Internal scale score (metric)
(4) Levenson Chance scale score (metric)
(5) Levenson Powerful Others scale score (metric)

(6) Superstitious belief 1 = presence 0 = absence

(7) Superstitious behavior 1 = presence 0 = absence

(8) Length of superstitious behavior (metric) 1 to 6

(9) Complexity of superstitious behavior
1 = short simple 2 = short complex
3 = long simple 4 = long complex

(10) Time to establishment of the superstitious behavior: (metric) number of seconds
(11) Time to extinction of the superstitious behavior: (metric) number of seconds

(12) CARS (metric)

(13) STAI - State (metric)
(14) STAI - Trait (metric)

(15) POMS - T scale (metric)
(16) POMS - D scale (metric)
(17) POMS - A scale (metric)
(18) POMS - V scale (metric)
(19) POMS - F scale (metric)
(20) POMS - C scale (metric)

(21) and (22) Frustration before and after the extinction period, respectively (metric) 1 to 5

(23) Age (metric)

(24) Presence of typing ability 1=present 0=absent

(25) Typing ability (metric) 1 to 10

(26) Method of manipulating the keyboard:
1 = "hunt and peck" 2 = typing fingering
3 = both

CHI-SQUARE ANALYSIS: SUPERSTITIOUS BELIEF by SEX
SUPERSTITIOUS BELIEF BY LOC

BELIEF by SEX

| BELIEF | Count / Exp Val | SEX 1 | SEX 2 | Row Total |
|---|---|---|---|---|
| 0 | | 25 | 16 | 41 |
| | | 23.5 | 17.5 | 60.3% |
| 1 | | 14 | 13 | 27 |
| | | 15.5 | 11.5 | 39.7% |
| Column Total | | 39 | 29 | 68 |
| | | 57.4% | 42.6% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Continuity Correction | .24381 | 1 | .62147 |

BELIEF by LOC

| BELIEF | Count / Exp Val | LOC 1 | LOC 2 | Row Total |
|---|---|---|---|---|
| 0 | | 25 | 16 | 41 |
| | | 20.5 | 20.5 | 60.3% |
| 1 | | 9 | 18 | 27 |
| | | 13.5 | 13.5 | 39.7% |
| Column Total | | 34 | 34 | 68 |
| | | 50.0% | 50.0% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Continuity Correction | 3.93135 | 1 | .04739 |

CHI-SQUARE ANALYSIS: SUPERSTITIOUS BEHAVIOR by SEX
SUPERSTITIOUS BEHAVIOR by LOC

BEHAVIOR by SEX

| BEHAVIOR | Count / Exp Val | SEX 1 | SEX 2 | Row Total |
|---|---|---|---|---|
| | 0 | 33 | 20 | 53 |
| | | 30.4 | 22.6 | 77.9% |
| | 1 | 6 | 9 | 15 |
| | | 8.6 | 6.4 | 22.1% |
| | Column Total | 39 | 29 | 68 |
| | | 57.4% | 42.6% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Continuity Correction | 1.54650 | 1 | .21365 |

BEHAVIOR by LOC

| BEHAVIOR | Count / Exp Val | LOC 1 | LOC 2 | Row Total |
|---|---|---|---|---|
| | 0 | 28 | 25 | 53 |
| | | 26.5 | 26.5 | 77.9% |
| | 1 | 6 | 9 | 15 |
| | | 7.5 | 7.5 | 22.1% |
| | Column Total | 34 | 34 | 68 |
| | | 50.0% | 50.0% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Continuity Correction | .34214 | 1 | .55860 |

CHI-SQUARE ANALYSIS: COMPLEXITY OF RESPONSE by SEX
COMPLEXITY OF RESPONSE by LOC

COMPLEXITY by SEX

| COMPLEX | Count / Exp Val | SEX 1 | SEX 2 | Row Total |
|---|---|---|---|---|
| | 1 | 3 | 1 | 4 |
| | | 1.6 | 2.4 | 26.7% |
| | 2 | 1 | 3 | 4 |
| | | 1.6 | 2.4 | 26.7% |
| | 4 | 2 | 5 | 7 |
| | | 2.8 | 4.2 | 46.7% |
| | Column Total | 6 40.0% | 9 60.0% | 15 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Pearson | 2.79762 | 2 | .24689 |

COMPLEXITY by LOC

| COMPLEX | Count / Exp Val | LOC 1 | LOC 2 | Row Total |
|---|---|---|---|---|
| | 1 | 0 | 4 | 4 |
| | | 1.6 | 2.4 | 26.7% |
| | 2 | 3 | 1 | 4 |
| | | 1.6 | 2.4 | 26.7% |
| | 4 | 3 | 4 | 7 |
| | | 2.8 | 4.2 | 46.7% |
| | Column Total | 6 40.0% | 9 60.0% | 15 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Pearson | 4.73214 | 2 | .09385 |

CHI-SQUARE ANALYSIS: PRESENCE OF TYPING SKILLS by SEX
PRESENCE OF TYPING SKILLS by LOC

PRESENCE OF TYPING SKILL by SEX

| TYPING | Count / Exp Val | SEX 1 | SEX 2 | Row Total |
|---|---|---|---|---|
| | 0 | 2 | 3 | 5 |
| | | 2.9 | 2.1 | 7.4% |
| | 1 | 37 | 26 | 63 |
| | | 36.1 | 26.9 | 92.6% |
| | Column Total | 39 | 29 | 68 |
| | | 57.4% | 42.6% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Continuity Correction | .11929 | 1 | .72980 |

PRESENCE OF TYPING SKILL by LOC

| TYPING | Count / Exp Val | LOC 1 | LOC 2 | Row Total |
|---|---|---|---|---|
| | 0 | 2 | 3 | 5 |
| | | 2.5 | 2.5 | 7.4% |
| | 1 | 32 | 31 | 63 |
| | | 31.5 | 31.5 | 92.6% |
| | Column Total | 34 | 34 | 68 |
| | | 50.0% | 50.0% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Continuity Correction | .00000 | 1 | 1.00000 |

CHI-SQUARE ANALYSIS: METHOD OF MANIPULATING KEYBOARD by SEX
METHOD OF MANIPULATING KEYBOARD by LOC

METHOD OF MANIPULATING KEYBOARD by SEX

| METHOD | Count / Exp Val | SEX 1 | SEX 2 | Row Total |
|---|---|---|---|---|
| | 1 | 28<br>28.7 | 22<br>21.3 | 50<br>73.5% |
| | 2 | 6<br>5.7 | 4<br>4.3 | 10<br>14.7% |
| | 3 | 5<br>4.6 | 3<br>3.4 | 8<br>11.8% |
| | Column Total | 39<br>57.4% | 29<br>42.6% | 68<br>100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Pearson | .15271 | 2 | .92649 |

METHOD OF MANIPULATING KEYBOARD by LOC

| METHOD | Count / Exp Val | LOC 1 | LOC 2 | Row Total |
|---|---|---|---|---|
| | 1 | 23<br>25.0 | 27<br>25.0 | 50<br>73.5% |
| | 2 | 5<br>5.0 | 5<br>5.0 | 10<br>14.7% |
| | 3 | 6<br>4.0 | 2<br>4.0 | 8<br>11.8% |
| | Column Total | 34<br>50.0% | 34<br>50.0% | 68<br>100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Pearson | 2.32000 | 2 | .31349 |

ANOVA: LENGTH OF SUPERSTITIOUS RESPONSE

LENGTH by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 1.531 | 2 | .766 | .203 | .820 |
| A | .420 | 1 | .420 | .111 | .745 |
| B | 1.253 | 1 | 1.253 | .332 | .576 |
| 2-Way Interactions | .252 | 1 | .252 | .067 | .801 |
| A B | .252 | 1 | .252 | .067 | .801 |
| Explained | 1.783 | 3 | .594 | .157 | .923 |
| Residual | 41.550 | 11 | 3.777 | | |
| Total | 43.333 | 14 | 3.095 | | |

ANOVA: TIME TO ESTABLISHMENT OF SUPERSTITIOUS RESPONSE

TIME TO ESTABLISHMENT by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 43128.805 | 2 | 21564.403 | .367 | .701 |
| A | 21101.427 | 1 | 21101.427 | .359 | .561 |
| B | 17254.627 | 1 | 17254.627 | .294 | .599 |
| 2-Way Interactions | 725.208 | 1 | 725.208 | .012 | .914 |
| A B | 725.208 | 1 | 725.208 | .012 | .914 |
| Explained | 43854.013 | 3 | 14618.004 | .249 | .861 |
| Residual | 646294.880 | 11 | 58754.080 | | |
| Total | 690148.893 | 14 | 49296.350 | | |

ANOVA: TIME TO EXTINCTION

SCORE
TIME TO EXTINCTION by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | .415 | 2 | .208 | .002 | .998 |
| A | .413 | 1 | .413 | .005 | .947 |
| B | .015 | 1 | .015 | .000 | .990 |
| 2-Way Interactions | 14.249 | 1 | 14.249 | .158 | .698 |
| A B | 14.249 | 1 | 14.249 | .158 | .698 |
| Explained | 14.664 | 3 | 4.888 | .054 | .982 |
| Residual | 990.009 | 11 | 90.001 | | |
| Total | 1004.673 | 14 | 71.762 | | |

ANOVA: CARS

CARS by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 579.488 | 2 | 289.744 | 1.630 | .204 |
| A | 8.767 | 1 | 8.767 | .049 | .825 |
| B | 579.098 | 1 | 579.098 | 3.258 | .076 |
| 2-Way Interactions | 493.711 | 1 | 493.711 | 2.777 | .101 |
| A B | 493.711 | 1 | 493.711 | 2.777 | .101 |
| Explained | 1073.198 | 3 | 357.733 | 2.012 | .121 |
| Residual | 11377.316 | 64 | 177.771 | | |
| Total | 12450.515 | 67 | 185.829 | | |

ANOVA: STAI STATE SCALE

STAI STATE by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 794.636 | 2 | 397.318 | 3.391 | .040 |
| A | 56.754 | 1 | 56.754 | .484 | .489 |
| B | 662.653 | 1 | 662.653 | 5.655 | .020 |
| 2-Way Interactions | 45.729 | 1 | 45.729 | .390 | .534 |
| A B | 45.729 | 1 | 45.729 | .390 | .534 |
| Explained | 840.365 | 3 | 280.122 | 2.391 | .077 |
| Residual | 7499.576 | 64 | 117.181 | | |
| Total | 8339.941 | 67 | 124.477 | | |

ANOVA: STAI TRAIT SCALE

STAI TRAIT by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 1108.919 | 2 | 554.460 | 6.002 | .004 |
| A | 60.551 | 1 | 60.551 | .655 | .421 |
| B | 1100.618 | 1 | 1100.618 | 11.915 | .001 |
| 2-Way Interactions | 205.833 | 1 | 205.833 | 2.228 | .140 |
| A B | 205.833 | 1 | 205.833 | 2.228 | .140 |
| Explained | 1314.752 | 3 | 438.251 | 4.744 | .005 |
| Residual | 5911.998 | 64 | 92.375 | | |
| Total | 7226.750 | 67 | 107.862 | | |

ANOVA: POMS T SCALE

POMS T by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 76.550 | 2 | 38.275 | 1.059 | .353 |
| A | 35.241 | 1 | 35.241 | .975 | .327 |
| B | 29.956 | 1 | 29.956 | .829 | .366 |
| 2-Way Interactions | 22.186 | 1 | 22.186 | .614 | .436 |
| A B | 22.186 | 1 | 22.186 | .614 | .436 |
| Explained | 98.735 | 3 | 32.912 | .911 | .441 |
| Residual | 2313.074 | 64 | 36.142 | | |
| Total | 2411.809 | 67 | 35.997 | | |

ANOVA: POMS D SCALE

POMS D by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 28.809 | 2 | 14.405 | .419 | .659 |
| A | 17.280 | 1 | 17.280 | .503 | .481 |
| B | 7.506 | 1 | 7.506 | .219 | .642 |
| 2-Way Interactions | 91.212 | 1 | 91.212 | 2.656 | .108 |
| A B | 91.212 | 1 | 91.212 | 2.656 | .108 |
| Explained | 120.022 | 3 | 40.007 | 1.165 | .330 |
| Residual | 2198.213 | 64 | 34.347 | | |
| Total | 2318.235 | 67 | 34.601 | | |

ANOVA: POMS A SCALE

POMS A by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 82.410 | 2 | 41.205 | 1.088 | .343 |
| A | 82.175 | 1 | 82.175 | 2.169 | .146 |
| B | 3.339 | 1 | 3.339 | .088 | .767 |
| 2-Way Interactions | 1.673 | 1 | 1.673 | .044 | .834 |
| A B | 1.673 | 1 | 1.673 | .044 | .834 |
| Explained | 84.083 | 3 | 28.028 | .740 | .532 |
| Residual | 2424.446 | 64 | 37.882 | | |
| Total | 2508.529 | 67 | 37.441 | | |

ANOVA: POMS V SCALE

POMS V by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 220.700 | 2 | 110.350 | 2.533 | .087 |
| A | 22.818 | 1 | 22.818 | .524 | .472 |
| B | 174.254 | 1 | 174.254 | 4.000 | .050 |
| 2-Way Interactions | .046 | 1 | .046 | .001 | .974 |
| A B | .046 | 1 | .046 | .001 | .974 |
| Explained | 220.746 | 3 | 73.582 | 1.689 | .178 |
| Residual | 2788.018 | 64 | 43.563 | | |
| Total | 3008.765 | 67 | 44.907 | | |

ANOVA: POMS F SCALE

POMS F by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 27.396 | 2 | 13.698 | .290 | .749 |
| A | 14.161 | 1 | 14.161 | .300 | .586 |
| B | 17.281 | 1 | 17.281 | .366 | .547 |
| 2-Way Interactions | 165.711 | 1 | 165.711 | 3.512 | .066 |
| A B | 165.711 | 1 | 165.711 | 3.512 | .066 |
| Explained | 193.107 | 3 | 64.369 | 1.364 | .262 |
| Residual | 3020.011 | 64 | 47.188 | | |
| Total | 3213.118 | 67 | 47.957 | | |

ANOVA: POMS C SCALE

POMS C by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 174.721 | 2 | 87.360 | 4.298 | .018 |
| A | .000 | 1 | .000 | .000 | .997 |
| B | 170.802 | 1 | 170.802 | 8.403 | .005 |
| 2-Way Interactions | 41.451 | 1 | 41.451 | 2.039 | .158 |
| A B | 41.451 | 1 | 41.451 | 2.039 | .158 |
| Explained | 216.172 | 3 | 72.057 | 3.545 | .019 |
| Residual | 1300.814 | 64 | 20.325 | | |
| Total | 1516.985 | 67 | 22.642 | | |

ANOVA: FRUSTRATION BEFORE THE EXTINCTION TRIAL

FRUSTRATION BEFORE by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 4.348 | 2 | 2.174 | 2.191 | .120 |
| A | .087 | 1 | .087 | .087 | .769 |
| B | 4.348 | 1 | 4.348 | 4.382 | .040 |
| 2-Way Interactions | 1.405 | 1 | 1.405 | 1.416 | .239 |
| A B | 1.405 | 1 | 1.405 | 1.416 | .239 |
| Explained | 5.753 | 3 | 1.918 | 1.933 | .133 |
| Residual | 62.515 | 63 | .992 | | |
| Total | 68.269 | 66 | 1.034 | | |

ANOVA: FRUSTRATION AFTER THE EXTINCTION TRIAL

FRUSTRATION AFTER by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 11.095 | 2 | 5.548 | 3.116 | .051 |
| A | .320 | 1 | .320 | .180 | .673 |
| B | 10.071 | 1 | 10.071 | 5.657 | .020 |
| 2-Way Interactions | 2.541 | 1 | 2.541 | 1.427 | .237 |
| A B | 2.541 | 1 | 2.541 | 1.427 | .237 |
| Explained | 13.636 | 3 | 4.545 | 2.553 | .063 |
| Residual | 112.155 | 63 | 1.780 | | |
| Total | 125.791 | 66 | 1.906 | | |

ANOVA: AGE OF SUBJECT

AGE by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 228.289 | 2 | 114.145 | 2.107 | .130 |
| A | 37.171 | 1 | 37.171 | .686 | .411 |
| B | 212.499 | 1 | 212.499 | 3.922 | .052 |
| 2-Way Interactions | 29.010 | 1 | 29.010 | .535 | .467 |
| A B | 29.010 | 1 | 29.010 | .535 | .467 |
| Explained | 257.299 | 3 | 85.766 | 1.583 | .202 |
| Residual | 3467.465 | 64 | 54.179 | | |
| Total | 3724.765 | 67 | 55.594 | | |

ANOVA: TYPING ABILITY

TYPING ABILITY by A (SEX)
B (LOC)

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Main Effects | 12.519 | 2 | 6.260 | 1.372 | .261 |
| A | 11.799 | 1 | 11.799 | 2.586 | .113 |
| B | .108 | 1 | .108 | .024 | .878 |
| 2-Way Interactions | 8.118 | 1 | 8.118 | 1.779 | .187 |
| A B | 8.118 | 1 | 8.118 | 1.779 | .187 |
| Explained | 20.638 | 3 | 6.879 | 1.508 | .221 |
| Residual | 291.995 | 64 | 4.562 | | |
| Total | 312.632 | 67 | 4.666 | | |

CHI-SQUARE ASSOCIATION: BELIEF BY BEHAVIOR

BELIEF by BEHAVIOR

| BELIEF | Count / Exp Val | BEHAVIOR 0 | BEHAVIOR 1 | Row Total |
|---|---|---|---|---|
| 0 | | 37 | 4 | 41 |
| | | 32.0 | 9.0 | 60.3% |
| 1 | | 16 | 11 | 27 |
| | | 21.0 | 6.0 | 39.7% |
| | Column Total | 53 | 15 | 68 |
| | | 77.9% | 22.1% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Continuity Correction | 7.37753 | 1 | .00660 |

REPEATED MEASURES ANOVA: FRUSTRATION

Cell Means and Standard Deviations:

Variable .. Frustration Before the Extinction Trial (B1)

| FACTOR | CODE | Mean | St Dev | N | 95% Conf Int |
|---|---|---|---|---|---|
| A1 LOC | Internal | 1.848 | .939 | 33 | 1.515 2.182 |
| A2 | External | 2.353 | 1.041 | 34 | 1.990 2.716 |
| For entire sample | | 2.104 | 1.017 | 67 | 1.856 2.353 |

Variable .. Frustration After the Extinction Trial (B2)

| FACTOR | CODE | Mean | St Dev | N | 95% Conf Int |
|---|---|---|---|---|---|
| A1 LOC | Internal | 2.727 | 1.376 | 33 | 2.240 3.215 |
| A2 | External | 3.529 | 1.285 | 34 | 3.081 3.978 |
| For entire sample | | 3.134 | 1.381 | 67 | 2.798 3.471 |

* A N A L Y S I S O F V A R I A N C E -- DESIGN 1 *

Tests of Between-Subjects Effects.

AVERAGED Tests of Significance for B using UNIQUE sums of squares

| Source of Variation | SS | DF | MS | F | Sig of F |
|---|---|---|---|---|---|
| WITHIN CELLS | 125.80 | 65 | 1.94 | | |
| A | 14.29 | 1 | 14.29 | 7.39 | .008 |

* A N A L Y S I S O F V A R I A N C E -- DESIGN 1 *

Tests involving 'B' Within-Subject Effect.

AVERAGED Tests of Significance for B using UNIQUE sums of squares

| Source of Variation | SS | DF | MS | F | Sig of F |
|---|---|---|---|---|---|
| WITHIN CELLS | 53.23 | 65 | .82 | | |
| B | 35.37 | 1 | 35.37 | 43.19 | .000 |
| A BY B | .74 | 1 | .74 | .91 | .345 |

CHI-SQUARE ANALYSIS:
SUPERSTITIOUS BEHAVIORS WITHOUT BELIEFS by SEX
SUPERSTITIOUS BEHAVIORS WITHOUT BELIEFS by LOC

BEH W/O BEL by SEX

| BEH W/O BEL | Count / Exp Val | SEX 1 | SEX 2 | Row Total |
|---|---|---|---|---|
| | 0 | 23 | 14 | 37 |
| | | 22.6 | 14.4 | 90.2% |
| | 1 | 2 | 2 | 4 |
| | | 2.4 | 1.6 | 9.8% |
| | Column Total | 25 | 16 | 41 |
| | | 61.0% | 39.0% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Continuity Correction | .00000 | 1 | 1.00000 |

BEH W/O BEL by LOC

| BEH W/O BEL | Count / Exp Val | LOC 1 | LOC 2 | Row Total |
|---|---|---|---|---|
| | 0 | 24 | 13 | 37 |
| | | 22.6 | 14.4 | 90.2% |
| | 1 | 1 | 3 | 4 |
| | | 2.4 | 1.6 | 9.8% |
| | Column Total | 25 | 16 | 41 |
| | | 61.0% | 39.0% | 100.0% |

| Chi-Square | Value | DF | Significance |
|---|---|---|---|
| Continuity Correction | 1.02656 | 1 | .31097 |

**References**

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