



Superstitious perception: Response-independent reinforcement and punishment as determinants of recurring eccentric interpretations

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ABSTRACT

This study provided controlled observations of a potential mechanism for the determination of the repetitive, aberrant perceptions or interpretations of everyday events that figure prominently in a range of psychological disorders: the adventitious reinforcement of acts of cognition by the actual consequences of concurrent motor acts. Adults made a series of two-choice brightness discriminations; on 60% of trials, choosing the brighter stimulus produced a “correct” signal while errors produced an aversive sound. On 40% of trials, the choice stimuli did not in fact differ in brightness; the consequences of responding on these “identical stimuli” trials differed across blocks of trials. Thus, on these trials perceptual judgments were directly followed by events that they did not produce. When all choices on identical stimuli trials were punished with the “error” sound, subjects showed little preference for the left-side or right-side identical stimuli, but when all choices of identical stimuli were reinforced with the “correct” light, individual preferences for the left-side or the right-side stimuli substantially increased. As the consequences of responding on identical stimuli trials were independent of the stimuli chosen, these findings provide evidence for superstitious perception, the reinforcement of perceptual acts by events that do not depend upon their occurrence.

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The behavior of persons who satisfy the diagnostic criteria for a variety of psychological disorders is characterized by recurring idiosyncratic perceptions or interpretations of everyday objects and events. Paranoia is perhaps the most obvious example, but in the anxiety disorders a person's frequent perceptions of threat are judged by others to be disproportionate to reality, whereas mood disorders, narcissistic personality disorder, and eating disorders (among others) are characterized by repetitive unrealistic self-appraisal. The relation of such behaviors to antecedent and consequent conditions is often difficult to specify; in consequence, they are often attributed to an underlying pathology that is unobserved independent of the behaviors that it is said to cause. The present report provides experimental evidence for the existence of a behavioral process that might contribute to the development and maintenance of unconventional, stereotypic perceptions of everyday circumstances: their adventitious strengthening by events that repeatedly follow upon their emission, but are not produced by them.

In the behavior analytic approach, the process in which the consequences of cognitive or motor acts increase the frequency of

occurrence of similar acts is called *reinforcement*. When behavior is reinforced by an event that it *produces*, the process is called *positive reinforcement* and the event a positive reinforcer, whereas when behavior is reinforced by the *termination* of an event, the process is called *negative reinforcement* and the event a negative reinforcer. But behavior might be positively or negatively reinforced by events that succeed it, even when the behavior does not bring them about. The positive or negative reinforcement of behavior by events that do not depend upon its occurrence is called *adventitious* or *response-independent* reinforcement. Behavior might also be *adventitiously punished*, as when a negative reinforcer follows upon the emission of an act that did not produce it.

For a hypothetical example of the adventitious reinforcement and punishment of interpretations or perceptions, imagine a man who is experiencing great discomfort on a blind dinner date. During a particularly awkward lull in conversation, he finds himself gripping the arms of his chair, and suddenly discerns that this surface might have been contaminated by a previous patron. He excuses himself and retires to the men's room, where he washes his hands at length. Despite his concern for his own health, he immediately feels relief from the termination of contact with his date. It was his *movement* towards the men's room that freed him from an uncomfortable social situation, eliciting relief, but the termination of aversive stimulation *followed upon his perception* that his hands

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might be contaminated. Although this specific perception of events was not itself instrumental, it might be strengthened by the termination of aversive circumstances that followed upon its emission, an example of adventitious negative reinforcement. Finally, his return to the threatening social situation follows shortly upon the perception that his freshly-washed hands are free of contamination. It was his *movement* towards the table that produced the upsetting sight of his dinner date, but this aversive event also *followed upon* his judgment that his hands were germ-free. As the perception did not in fact produce the aversive event, this might be considered an example of the adventitious punishment of an act of cognition.

The man's initial movement away from the table would have been equally effective in terminating contact with his date if it had been preceded by the perception that he might be needed at work, that he was unworthy of his date's attention, or that she was unworthy of his; indeed, his movement would have terminated contact with this potent negative reinforcer even if he was not thinking *at all* as he rose from the table. But if, as B. F. Skinner (1948, 1978) maintained, reinforcing events can increase the probability of emission of any form of behavior that they happen to follow, the fact that he was thinking about the possibility of contamination when the social threat ended means that the next time a similarly threatening social situation occurs, a similar interpretation might be more likely to be emitted, contemporaneously with an instrumental movement towards a source of soap and water, such that this type of impression is once again adventitiously reinforced by the concurrent termination of a threatening event. Indeed, while the judgment that his hands were sterile was adventitiously punished by the stimuli produced by his return to his date, a realization that he might have become contaminated again when he closed the tap would be adventitiously reinforced once more by the consequences of a second retreat to the men's room. Thus, the strengthening of behavior resulting from one adventitious event might make similar coincidences more probable, determining, in the long run, the form and the content of perceptions or interpretations that precede instrumental escape from aversive circumstances.

Skinner first observed the generation of such repetitive, idiosyncratic non-instrumental *movements* by fixed-time positive reinforcement in pigeons six decades ago (Skinner, 1948). A number of researchers have adapted Skinner's original procedure for human subjects, repeatedly presenting positive reinforcers with the passage of fixed-time intervals independently of the subjects' behavior; fixed-time positive reinforcement has been observed to produce idiosyncratic, non-instrumental movements in a minority of both adult and child subjects (Ono, 1987; Wagner & Morris, 1987). However, three considerations suggest that fixed-time presentations of positive reinforcers might provide an inadequate analogue of the role of adventitious reinforcement in developing and maintaining idiosyncratic perceptions or interpretations of everyday events in human psychopathology. First, as Aeschleman, Rosen, and Williams (2003) have suggested, eccentric and apparently functionless human behavior often appears to be related to adventitious *negative* reinforcement (response-independent *termination* of aversive stimuli) rather than to the adventitious *positive* reinforcement (response-independent *presentation* of appetitive stimuli) used in most experimental preparations to date. These researchers found a response-independent negative reinforcement procedure to be superior to a response-independent positive reinforcement procedure in maintaining instructed keyboard pressing (see also Bloom, Venard, Harden, & Seetharaman, 2007).

Second, in the world outside the psychological laboratory, it would appear that reinforcing events do not often occur repeatedly independent of the emission of some form of instrumental behavior. As such, the long-term effects of adventitious

reinforcement might be limited to *incidental* or *coincidental* aspects of behaviors that actually alter environmental circumstances (Herrnstein, 1966). Thus, while previous studies with fixed-time positive reinforcement have produced apparently *novel*, eccentric movements and postures in human subjects, in everyday life the aspects of behavior that are most likely to be reinforced adventitiously might be those that have been instrumental in other contexts. The adventitious strengthening of behaviors that were prepotent because they had been effective in other contexts has been observed in a number of experiments with both human (Lee, 1996; Weisberg & Kennedy, 1969) and nonhuman subjects (Gleeson, Lattal, & Williams, 1989; Neuringer, 1970).

Finally, while prior experiments have generally focused on the adventitious reinforcement of *movements*, in human behavior in natural contexts, impressions, perceptions and other *cognitions* might be more likely to be reinforced adventitiously, because the emission of such non-skeletal acts is generally more compatible with the simultaneous occurrence of a wide range of effective instrumental movements. Recall that in our hypothetical example of adventitious negative reinforcement, it was the man's *perception* that his hands were contaminated that was negatively reinforced by the termination of distressing contact with his date, despite the fact that the termination itself was effected by his simultaneous movements towards the men's room, and subsequently maintained by his repetitive hand-washing. In contrast, a majority of *motor* acts that are likely to occur in this threatening situation (such as remaining seated, relating an anecdote or suggesting a dance) could not be adventitiously reinforced in this manner, because they cannot co-occur with movements that terminate the unsettling contact with his new acquaintance.

Species perceptions of this type have been produced in controlled studies by adventitious covariation between environmental conditions and the *positive* reinforcement of behavior. Consider, for example, an experiment in which pigeons' keypecks were reinforced on a variable-interval 30-min schedule (Morse & Skinner, 1957). Once an hour for 4 min, the color of the lighted response key changed from orange to blue; this color change was unrelated to the availability of food for key pecking. However, when keypecks happened to produce food in the presence of the blue light, and also happened *not* to produce food for an extended period in the presence of the orange light, a stimulus discrimination developed; keypecks were more frequently emitted in the presence of the blue light than they were in the presence of the orange (see also Kello, Innis, & Staddon, 1975 and Starr & Staddon, 1982). These species discriminations, which Morse and Skinner called "sensory superstitions," later reversed when keypecks happened to be reinforced in the presence of the orange light and not in the blue. Similarly, Ono (1987) observed six of 20 adults to pull levers more often in the presence of signal lights (i.e., as if the lights signaled the availability of reinforcers for lever pulls) despite the fact that reinforcers (points on a counter) were presented independently of both the subjects' behavior and the status of the signal lights. Thus, there is limited evidence to suggest that in human subjects, the response-independent presentation of positive reinforcers can create discriminations of antecedent stimulus events that occur independently of both behavior and of reinforcer delivery. However, we know of no controlled observations of the effects of the adventitious termination of negative reinforcers on perceptual behavior, or of the adventitious punishment of perceptual judgments of environmental circumstances, in any species.

Given these considerations, a more precise analogue of human superstitious perception might provide for the adventitious positive and *negative* reinforcement, as well as the adventitious *punishment*, of *non-instrumental* aspects of instrumental *perceptual judgments*, where these non-instrumental aspects are prepotent

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