

## Reaction to Punishment, Reflectivity, and Passive Avoidance Learning in Extraverts

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Passive avoidance learning occupies a central role in accounts of disinhibited behavior, ranging from psychopaths' persistent criminality (Hare, 1970) to extraverts' gregariousness (Gray, 1972). To explore the mechanism underlying passive avoidance deficits, we assessed the relation of extraversion, neuroticism, and response latency after punishment to passive avoidance learning by using two successive go/no go discrimination tasks. The tasks were designed to examine two aspects of subjects' reactions to punishment: response speed on trials immediately following punishment (Experiment 1) and time to terminate punishment feedback between successive trials (i.e., reflectivity; Experiment 2). Consistent with previous findings, the results of Experiment 1 showed that extraverts commit more passive avoidance errors than introverts do (Newman, Widom, & Nathan, 1985) and fail to pause following punished errors (Nichols & Newman, 1986). In Experiment 2, only neurotic extraverts displayed this pattern of performance differences. In both experiments, longer pausing following punishment predicted better learning from punishment for both introverts and extraverts. These results suggest that, in the presence of salient cues for reward, extraverts' characteristic reaction to punishment interferes with processing punished errors and may contribute to their more general propensity for impulsive, nonreflective action.

Gorenstein and Newman (1980) proposed a model for research on impulsive, disinhibited behavior based on the behavioral syndrome exhibited by animals following damage to the septum. According to the model, disinhibited individuals such as extraverts and psychopaths share a psychological diathesis that may be elucidated by reference to the septal syndrome. Passive avoidance learning has been a major focus of research on this psychological diathesis for two reasons: First, deficient passive avoidance is one of the most reliable behavioral findings in rats with septal lesions and in syndromes of disinhibition (see Gorenstein & Newman, 1980). Second, such learning is often considered fundamental to socialization (e.g., Trasler, 1978). Thus, setting out the processes mediating passive avoidance in disinhibited individuals may help to identify fundamental elements of their psychological predisposition as well as clarify aspects of their social behavior.

Passive avoidance learning involves the inhibition of a response that has on prior occasions resulted in punishment. Tra-

ditionally, explanations of extraverts' and psychopaths' deficient passive avoidance learning have focused on their so-called diminished response to punishment (e.g., Gray, 1972, 1981; Hare, 1970, 1978). In contrast, Gorenstein and Newman (1980) used the term *response perseveration* to highlight the importance of ongoing approach behavior in disrupting their passive avoidance. This alternative follows from the septal model: Rats with septal lesions usually perform as well or better than controls do on avoidance learning tasks that do not involve reward, but are usually deficient when avoidance requires inhibition of a dominant-approach response (McCleary, 1966).

Analogous findings have been reported for disinhibited individuals. Newman, Widom, and Nathan (1985) investigated passive avoidance with a successive go/no go discrimination task in which subjects had to press a button when any of 6 S+s appeared (go) and withhold responding when any of 6 S-s appeared (no go). Extraverts' passive avoidance was at least as good as introverts' when punishment provided the only incentive for correct responding. However, extraverts committed significantly more passive avoidance errors on the identical task when it involved reward for correct responses as well as punishment for incorrect ones. Similar findings have been obtained with adolescent and adult psychopaths (see Newman & Kosson, 1986; Newman et al., 1985).

The mechanism by which availability of reward disrupts extraverts' passive avoidance learning is unclear, but a recent study by Nichols and Newman (1986) indicates that, when they are responding for reward, extraverts exhibit a distinctive response style following punished responses. In particular, extraverts responded faster following punishment than following reward, whereas introverts' responses following punishment were slower than those following reward. Moreover, no such differences in response time were apparent under conditions involv-

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ing reward-only or punishment-only feedback. Thus, punishment was relatively ineffective at interrupting extraverts' approach responding. Whereas introverts were more likely to display response inhibition when punished, extraverts were more likely to show response facilitation (see also Pearce-McCall & Newman, 1986). Because Nichols and Newman (1986) used noncontingent reinforcement to ensure that all subjects received identical sequences of rewards and punishments, learning could not be assessed. However, Nichols and Newman suggested that extraverts' paradoxical reaction might interfere with learning from punishment in tasks with response-contingent feedback. That is, if extraverts do not pause after being punished, they cannot process adequately the effects of their maladaptive behavior.

Nichols and Newman's (1986) proposal is also consistent with recent theory concerning the influence of the septum on behavior. According to Gray (1982), the septo-hippocampal system underlies the functioning of a hypothetical behavioral inhibition system that mediates individuals' reactions to punishment. The proposed function of this system is to react to mismatches between actual environmental conditions and an organism's expectations by interrupting ongoing behavior, increasing generalized arousal,<sup>1</sup> and initiating a thorough analysis of current environmental stimuli. The adaptive functions of this system are likely to include the interruption of ongoing actions that may result in aversive consequences, preparation for active coping (i.e., fight or flight), and association of environmental cues with such actions so that on subsequent occasions cues for punishment will more readily interrupt or inhibit these maladaptive behaviors.

### Experiment 1

The purpose of Experiment 1 was to determine (a) whether extraverts would display their paradoxical response style under circumstances involving response-contingent reinforcement and (b) whether such a reaction to punishment would interfere with passive avoidance learning. To explore these questions, we adopted a computerized version of the go/no go discrimination task used by Newman et al. (1985). Following Nichols and Newman (1986), we also measured subjects' response times after reward and punishment feedback. We predicted that, relative to introverts, extraverts would commit more passive avoidance errors and respond more quickly on trials following punishment than on trials following reward. Finally, we predicted a specific association between response times after punishment and passive avoidance, namely that behavioral inhibition (i.e., slower response times) following punishment would predict successful passive avoidance learning.

### Method

**Subjects.** The subjects for this experiment were 40 male undergraduates (20 introverts and 20 extraverts) at the University of Wisconsin who volunteered to participate in the study in exchange for extra credit points toward their grade in introductory psychology. Men scoring 15 or lower on the Extraversion scale of the Eysenck Personality Questionnaire (EPQ; Eysenck & Eysenck, 1975) were designated introverts, and men scoring above 15 were designated extraverts. Mean extraversion scores for the two groups were 10.75 and 17.70, respectively.<sup>2</sup> Neuroti-

cism-scale scores were also obtained from the EPQ. Men scoring 12 or above ( $M = 16.50$ ) were considered high in neuroticism (neurotic), and men scoring below 12 ( $M = 6.67$ ) were considered low in neuroticism (stable).

**Task and apparatus.** The presentation and pacing of the learning task were controlled by an Apple II Plus computer and Atlantic Data Products monitor (Model ADP 120A). The task was a successive go/no go discrimination with six positive stimuli ( $S+$ s) and six negative stimuli ( $S-$ s). Subjects' task was to press a button whenever an  $S+$  appeared on the monitor and to inhibit responding whenever an  $S-$  appeared. Each correct response was rewarded with presentation of a chip worth 5 cents and each incorrect response was punished by the loss of a chip worth 5 cents. There were no monetary consequences (or feedback) when the subject did not respond. All subjects began the task with \$1.

All stimuli were two-digit numbers chosen so that no characteristic of the number (i.e., odd or even digits in first or second position; high or low digits in either position; numbers greater or less than 50) was differentially associated with either  $S-$ s or  $S+$ s. Stimuli were presented for 3 s or until subjects responded. The intertrial interval was 1 s. Response times following reward and punishment were obtained by recording subjects' speed of response on each trial and then dividing response times into those immediately preceded by reward and those preceded by punishment. Two sets of 12 numbers were used. Subjects were assigned to receive one of the two stimulus sets on an alternating basis.

All subjects received 114 trials. The first 18 trials served as a pretreatment consisting of one presentation of each  $S-$  and two presentations of each  $S+$ . These 18 trials were intended to establish a dominant-approach (i.e., go) response set by temporarily increasing the probability that responding would lead to reward. Subjects' data from the pretreatment were not included in analyses. The next 96 trials consisted of 8 blocks of trials during which each  $S+$  and  $S-$  were presented once per block. Order of stimulus presentation within each block was determined using randomization procedures, precluding the occurrence of more than three consecutive  $S+$  or  $S-$  stimuli.

**Procedure.** After choosing to participate, subjects completed the EPQ and then performed the behavioral task. Behavioral testing was conducted individually in a small room. Subjects sat at a table on which were positioned a computer monitor, stereo headphones, a response box, and a pile of plastic poker chips. Each chip was worth 5 cents. Instructions informed subjects that they would view a series of numbers on the monitor and that their task was to learn, by trial and error, when to press the response button and when not to press so as to earn as much money as possible. The process of trial-and-error learning was demonstrated through the use of examples. Subjects were not informed that response times were being recorded. A male undergraduate read the instructions and remained in the room to present and withdraw poker chips. During the task, he wore headphones through which low and high tones signaled the correctness of subjects' responses.

### Results

Results supported predictions regarding passive avoidance learning, response times after reward and punishment, and the

<sup>1</sup> In this article we use the term *general arousal* to signify the likely multiple psychophysiological changes that subserve overt behavioral changes. We recognize that the unitary notion of psychophysiological arousal has been abandoned in favor of multiple arousal systems. However, in the case of reaction to punishment, the specific arousal components have yet to be identified.

<sup>2</sup> This criterion is being used in all of our research on extraversion because it approximates the median extraversion score of the more than 2,500 men at the University of Wisconsin who have completed the Eysenck Personality Questionnaire during the last 4 years.

Table 1  
*Experiment 1: Means and Standard Deviations for Passive Avoidance Errors (PAEs), Omission Errors (OEs), and Response Times After Reward and Punishment*

Group	n	Errors		Response times after	
		PAEs	OEs	Reward	Punishment
Neurotic extraverts	8				
<i>M</i>		16.13	7.88	1,036	889
<i>SD</i>		4.09	7.12	302	246
Stable extraverts	12				
<i>M</i>		17.33	8.25	1,037	944
<i>SD</i>		6.54	4.61	338	348
Neurotic introverts	14				
<i>M</i>		13.57	12.00	940	945
<i>SD</i>		5.49	4.52	226	187
Stable introverts	6				
<i>M</i>		10.67	4.67	991	1,118
<i>SD</i>		5.61	7.23	208	285

Note. Response times are given in milliseconds.

relation between response times after punishment and passive avoidance learning.

Preliminary analyses indicated that one of the two sets of numbers used was associated with more correct responses to *S+s* than was the other set,  $F(1, 32) = 6.70, p < .02$ . As stimulus set did not interact with any other variable in analyses for errors or for response times, it was included as a covariate in the analyses to be reported for learning and response times. In addition, because neuroticism-scale scores have been theorized (e.g., Gray, 1981) and demonstrated to affect subjects' reactions to reward and punishment (Nichols & Newman, 1986), level of neuroticism was included as a factor in each of the analyses.

**Learning.** Following Newman et al. (1985), subjects' errors were divided into two types: those involving failure to inhibit responding in the presence of a cue for punishment (i.e., passive avoidance errors) and those involving failure to respond in the presence of a cue for reward (i.e., omission errors). Separate analyses were conducted for each type of error. For passive avoidance errors (PAEs), a two-way analysis of covariance (ANCOVA) with extraversion and neuroticism as the factors and stimulus set as the covariate yielded a significant effect for extraversion,  $F(1, 35) = 6.07, p < .02$ . Neither the effect for neuroticism,  $F(1, 35) < 1$ , nor the Extraversion  $\times$  Neuroticism interaction,  $F(1, 35) = 1.18$ , approached significance. As predicted, extraverts made significantly more PAEs than did introverts. Means and standard deviations for PAEs and omission errors (OEs) are shown in Table 1.

A comparable ANCOVA for OEs yielded significant effects for stimulus set,  $F(1, 35) = 6.79, p < .02$ , and for the Extraversion  $\times$  Neuroticism interaction,  $F(1, 35) = 5.05, p < .05$ , as well as a trend for neuroticism,  $F(1, 35) = 3.30, p < .10$ . Subsequent comparisons revealed the nature of the interaction: The only significant difference indicated that neurotic introverts made more OEs than did stable introverts,  $p < .01$ , although neurotic extraverts made nonsignificantly fewer OEs than did stable extraverts. As predicted, the main effect for extraversion was nonsignificant,  $F(1, 35) < 1.0$ .

**Response times.** Following Nichols and Newman (1986), two median response times were computed for each subject: one for trials in which the subject responded following punishment and one for trials in which the subject responded following reward. The relation between extraversion and response times following reward and punishment was assessed using a mixed-model ANCOVA with extraversion and neuroticism as between-subjects factors, type of feedback as the within-subjects factor, and stimulus set as the covariate. With the exception of an Extraversion  $\times$  Type of Feedback interaction,  $F(1, 36) = 4.70, p < .05$ , and a significant effect for the covariate,  $F(1, 35) = 4.73, p < .05$ , none of the main effects or interactions approached significance. As predicted, the Extraversion  $\times$  Type of Feedback interaction indicated that introverts responded more slowly after punishment than after reward, whereas extraverts responded more quickly after punishment than after reward. Means and standard deviations for response times after reward and punishment are shown in Table 1. Planned comparisons were conducted to describe the nature of the interaction. Although extraverts tended to respond faster than introverts after punishment,  $t(36) = 1.83, p < .10$ , neither of the between-group planned comparisons was significant at the .05 level. Thus, the significant Extraversion  $\times$  Type of Feedback interaction was highly symmetrical.

**Response times and learning.** The association between subjects' response times following punishment and passive avoidance learning was investigated using both Pearson correlations and hierarchical multiple regression. To assess the relation between slowing down following punishment and learning, we first subtracted subjects' response times after reward from their response times after punishment. The correlation between this difference score and the number of PAEs was  $r(38) = -.47, p < .01$ . As predicted, responding more slowly after punishment than after reward was associated with fewer passive avoidance errors.

To provide a more precise estimate of the relation between passive avoidance and response times following punishment, a hierarchical multiple regression analysis was conducted in which response time following punishment was entered only after extraversion, neuroticism, and response time following reward. The total equation including interactions accounted for 34.9% of the variance in PAEs. The increases in  $R^2$  attributable to extraversion, neuroticism, response time after reward, and response time after punishment were .128, .003, .006, and .148, respectively. Thus, after partialing out the variance accounted for by all other variables, response time after punishment accounted for a significant percentage of the variance in passive avoidance errors,  $F(1, 38) = 7.23, p < .025$ . This analysis also revealed the aforementioned relation between extraversion and passive avoidance learning,  $F(1, 38) = 5.55, p < .025$ .

To determine the relation of the two personality variables to learning after partialing out the effects associated with the two response-time measures, we repeated the regression analysis with the variables entered in the following order: The increments in  $R^2$  attributable to response time after reward, response time after punishment, extraversion, and neuroticism were .017, .208, .057, and .002, respectively. The increment in variance accounted for by response time after punishment was significant at the .005 level,  $F(1, 38) = 9.92$ . However, the incre-

ment in variance accounted for by extraversion after partialing out the effects associated with response time was no longer significant,  $F(1, 38) = 2.86, p < .10$ , though still sizable. Thus, subjects' response times following reward and punishment may represent an important component of the relation between extraversion and passive avoidance errors, but it does not appear to account for the entire relation.

*Relation of learning to general response speed.* Although this experiment was concerned with the relation between response time following punishment and learning from punishment, our measure of response time following punishment was also subjects' response time to the next stimulus. A relatively faster general response rate associated with a relatively greater error rate is indicative of a response criterion that emphasizes speed over accuracy (i.e., a speed-accuracy trade-off; see MacKay, 1982). Because speed-accuracy trade-offs have proven relevant in the interpretation of performance differences associated with the dimensions of impulsivity and anxiety (e.g., Leon & Revelle, 1985), it is of some interest whether the relation between speed and learning observed in this study could be a function of differences in subjects' response criterion.

Because instructions did not mention response speed, and subjects were never told that their response times were recorded, it seems unlikely that subjects would decide to emphasize speed instead of accuracy. Moreover, the significant relation between response time following punishment and passive avoidance errors, after partialing out the effect of response time following reward, makes it unlikely that general response speed is a crucial factor mediating this association. Nevertheless, we computed several correlations to determine whether the relation between response times after punishment and learning could be explained by a speed-accuracy trade-off. General response speed, as measured by subjects' average reaction time, was virtually independent of total errors,  $r(38) = -.02$ . The correlation between general reaction time and PAEs was also small,  $r(38) = .06$ . The correlation between speed of responding and OEs was  $-.09$ . Though not implicated by usual interpretations of the speed-accuracy trade-off, we also computed the correlation between reaction time to  $S-s$  and PAEs,  $r(38) = -.18$ , and the correlation between reaction times to  $S+s$  and OEs,  $r(38) = .07$ . These correlations provide no evidence that subjects engaged in speed-accuracy trade-offs in this task.

### Discussion

The results of this study support all three hypotheses. First, these findings replicate those of Newman et al. (1985) and provide further evidence that, in comparison to introverts, extraverts are deficient in passive avoidance learning when avoidance requires inhibition of the same behavior that often leads to reward. In addition, despite the use of response-contingent reinforcement in this study, the results for response times following reward and punishment feedback are similar to those reported by Nichols and Newman (1986). In both experiments, the significant Extraversion  $\times$  Type of Feedback interactions indicated that introverts responded more slowly after punishment than after reward, whereas extraverts failed to slow down following punishment and, if anything, actually responded faster after punishment than after reward.

The third set of analyses examined the relation between passive avoidance learning and response times following punishment to determine whether a failure to pause following punishment might interfere with learning from punishment. After partialing out variance due to speed of response after reward, regression analyses collapsing across groups indicated a general relation between speed of responding on trials following punishment and passive avoidance learning. Consistent with this result, Gray (1982) has theorized that subjects' tendency to interrupt approach behavior in response to aversive stimuli will be associated with inspection of salient environmental stimuli and that this process facilitates inhibition of punished responses on subsequent presentations of negative discriminative stimuli.

Integration of our pattern of results with earlier findings suggests a four-step mechanism to account for extraverts' passive avoidance deficit. First, when provided with an opportunity to obtain reward, extraverts adopt a response set for reward that is resistant to interruption (Newman & Kosson, 1984; Newman et al., 1985). Second, the occurrence of an unexpected event such as punishment serves to increase subjects' general level of arousal. That is, following Gray (1982), we assume that such a generalized increment in arousal is an inevitable consequence of punishment. Third, this increment in arousal subserves either (a) inspection of environmental factors associated with the unexpected event or (b) continuation of motor behavior in accord with the original response set. In contrast to introverts, whose reaction to punishment involves interruption of approach behavior and stimulus processing, extraverts' reaction to punishment, as a result of their more persistent response set for reward, is invigoration of their original goal-directed behavior. Fourth, to the extent that extraverts maintain their readiness to respond, they fail to process adequately, and therefore fail to learn, the cues for punishment that are a prerequisite for successful passive avoidance.

The proposed mechanism provides a working framework for investigating the processes mediating deficient passive avoidance in extraversion and other syndromes of disinhibition. However, further research is needed to partition our measure of subjects' reaction to punishment into its component processes. For instance, response time as used in this study is likely a composite of several processes, not simply the amount of time that subjects spent processing the feedback. Nevertheless, the measure provided an unobtrusive means of assessing the way in which introverts' and extraverts' reactions to punishment affected learning without significantly altering the administration or appearance of our standard passive avoidance task (e.g., Newman et al., 1985).

### Experiment 2

The results of Experiment 1 provided further evidence that extraverts engaged in approach behavior have an active rather than an inhibitory reaction to punishment. Taken together, the results of Experiment 1 and those of Nichols and Newman (1986) formed a basis for hypothesizing about the cognitive processes associated with extraverts' response style. We propose that extraverts' failures to inhibit responses that result in punishment are linked to a lack of reflection on the negative consequences of prior experiences with punishment. The specific

purposes of Experiment 2 were to investigate (a) whether extraverts' reaction to punishment would shorten the amount of time they reflect on punishment feedback and (b) the relation between time spent reflecting and learning from punished errors. As such, this study represents the next step toward elucidating the information-processing aspects of extraverts' distinctive reaction to punishment.

Interestingly, researchers interested in impulsive behavior in children have focused on similar cognitive issues. Kagan and his associates described a dimension of reflection-impulsivity (Kagan, Rosman, Day, Albert, & Phillips, 1964) to relate children's cognitive styles to differences in problem-solving competence that could not be explained by IQ or verbal ability. Children were classified on the basis of performance on the Matching Familiar Figures Test (Kagan, 1966): Fast and inaccurate responders were designated impulsive, whereas slow and accurate children were designated reflective. The individual prone to reflect will do so when several response alternatives are at once available and uncertainty as to the correct response is high; this individual's response latency suggests a process of carefully choosing one's response. Hence, Kagan's notion of reflection may be characterized as a prospective (i.e., anticipatory), contemplative cognitive process. In our conceptualization of the cognitive concomitants of the introversion-extraversion dimension, reflectivity refers primarily to a retrospective contemplative process. This shift in emphasis follows from our interest in individuals' different reactions to negative feedback and their ability to benefit from that feedback: Learning from mistakes involves reflecting on the consequences of one's behavior.

Although slower response times on trials following punishment predicted better passive avoidance learning in Experiment 1, the paradigm used in Experiment 1 was not designed to measure reflectivity. Furthermore, the use of response time on trials following punishment as a measure of reflectivity has several disadvantages. First, response time following punishment was measured as the latency of response to the next stimulus, thus incorporating a variety of anticipatory processes in addition to the process of pausing after feedback. Second, because each stimulus was removed immediately after the response, it was not available for further inspection. Third, because subjects were not required to respond on each trial, many punished errors were followed by no response, making measurement of reaction to punishment impossible on such trials.

To assess more directly the relation of reflectivity to learning in a passive avoidance situation, a new version of the successive go/no go discrimination task was designed. Specifically, the new task incorporated a 5-s-maximum feedback interval and required subjects to press a button when they wished to terminate the feedback interval and advance to the next trial. Because subjects controlled the duration of feedback (in this variable-feedback condition), we assumed that the length of this interval would be directly related to the amount of time that subjects engaged in stimulus processing. Thus, the variable interval following each response was our operationalization of subjects' degree of reflectivity. In addition to providing a measure of reflectivity, this response requirement enabled an assessment of subjects' reaction to incentives after every response. In a second (comparison) condition, the interval following responses was fixed at 5 s, thus requiring subjects to view the feedback for that

duration. This fixed-feedback condition was designed to be a manipulation of reflectivity.

In light of the preceding discussion, the following specific predictions were made. First, for all subjects, shorter response latencies following punishment feedback (that is, less reflection) would be associated with poorer passive avoidance learning. In addition, we hypothesized that, in comparison to introverts, extraverts would reflect less after punishment feedback than after reward feedback and would commit more passive avoidance errors. These last two hypotheses follow directly from those of Experiment 1. Finally, for the fixed-feedback condition we expected no differences in learning between introverts and extraverts because both groups would have equal time to process feedback.

### Method

*Subjects.* Participants were selected as in Experiment 1. Originally, 24 subjects were to be placed into each of the four cells (formed by 2 levels of extraversion and 2 conditions). However, the semester ended before this goal could be realized. Random assignment of subjects to experimental conditions resulted in 24 extraverts being placed in each condition; 22 introverts were placed in the variable-feedback condition and 21 in the fixed-feedback condition.

*Task and apparatus.* The only difference between this task and the one used in Experiment 1 involved the feedback component of the current task. In Experiment 2, feedback was visual, auditory, and monetary. Monetary feedback was given just as in Experiment 1. In addition, the high and low tones were presented by a small speaker for both the subject and the experimenter to hear. High tones indicated a correct response, low tones an incorrect response. Visual feedback included the previous stimulus number and either "CORRECT!" or "WRONG!" displayed concurrently. In the variable-feedback condition, visual feedback was present for a maximum of 5 s. Subjects could shorten the feedback interval by responding to start the next trial, or they could view the feedback for 5 s, after which the feedback was removed and the computer prompted them to press the button to initiate the next trial. Responses following the computer prompt were assigned a reflectivity value of 5 s. In the fixed-feedback condition, feedback was presented for exactly 5 s. The same stimuli were presented for the same number of total trials and with the same pretreatment as in Experiment 1.

*Procedure.* The procedure was essentially the same as that of Experiment 1, except that two women served as experimenters and the experiment was conducted in a two-room suite nearly identical to the one used in Experiment 1. The computer program used in Experiment 1 was modified to incorporate the additional feedback and the measure of reflectivity.

Instructions were identical to those used in Experiment 1 with the following exceptions. Subjects in the variable-feedback condition were told that after each trial they could press the button when they were ready for the next trial to begin. Subjects who had not pressed the button within 5 s were prompted by the computer to do so. After the second response, the next trial began. Subjects in the fixed-feedback condition were simply told that once the feedback disappeared the next number would be presented.

### Results

Several sets of analyses, similar to those of Experiment 1, were conducted to test the hypotheses regarding passive avoidance learning, reflectivity following punishment feedback, and the relation between reflectivity and passive avoidance learning. Overall, the hypotheses regarding group differences in passive

avoidance learning and the relation of reflection to passive avoidance received support. The hypotheses regarding group differences in reaction to reward and punishment and the condition effect received only partial support. Support for group differences in learning and in reaction to feedback increased considerably when the interaction between extraversion and neuroticism was considered. Initial analyses indicated that the counterbalancing variable, stimulus set, yielded no significant main effects or interactions and therefore was not used subsequently. As in Experiment 1, data from the pretreatment phase were not included in the analysis.

**Learning.** As in Experiment 1, separate analyses were conducted for the two types of errors (passive avoidance errors—PAEs—and omission errors, OEs). For PAEs, a three-factor analysis of variance (ANOVA) was conducted with extraversion, neuroticism, and condition. The main effect for extraversion was statistically significant,  $F(1, 83) = 6.36, p < .02$ , as was the main effect for condition,  $F(1, 83) = 5.70, p < .02$ . Overall, subjects in the variable-feedback condition made more passive avoidance errors ( $M = 15.19$ ) than did subjects in the fixed-feedback condition ( $M = 11.53$ ). There was no main effect for neuroticism,  $F(1, 83) = 1.53$ .

As predicted, planned comparisons indicated that extraverts made significantly more passive avoidance errors ( $M = 17.21$ ) than did introverts ( $M = 13.09$ ) in the variable-feedback condition,  $t(83) = 2.02, p < .05$ , but not in the fixed-feedback condition, in which extraverts averaged 13.17 PAEs and introverts averaged 9.90 PAEs,  $t(83) = 1.60, p > .10$ . Nevertheless, contrary to prediction, the Extraversion  $\times$  Condition interaction was not significant,  $F(1, 83) < 1.0$ .

This analysis of learning also revealed a significant Extraversion  $\times$  Neuroticism interaction,  $F(1, 83) = 6.93, p = .01$ , suggesting that the main effect of extraversion differed as a function of neuroticism. Therefore, additional comparisons were conducted to test the hypotheses within the two levels of neuroticism. In the variable condition, neurotic extraverts made significantly more PAEs than did neurotic introverts,  $t(83) = 3.11,$

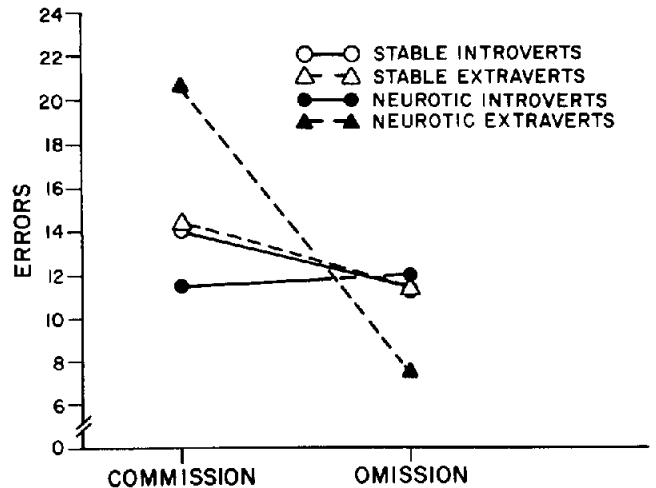


Figure 1. Commission and omission errors in the variable-feedback condition as a function of extraversion and neuroticism.

$p < .01$ . Similarly, in the fixed condition, neurotic extraverts made significantly more PAEs than did neurotic introverts,  $t(83) = 2.11, p < .05$ . There were no significant differences between stable introverts and stable extraverts.

For omission errors, an identical three-factor ANOVA was conducted. This analysis yielded no significant main effects or interactions. Means and standard deviations for passive avoidance errors and omission errors are presented in Table 2. Figure 1 illustrates the relations among extraversion, neuroticism, and passive avoidance errors in the variable-feedback condition.

**Reflectivity.** To compare introverts' and extraverts' reflection times after reward ( $Rf+$ ) and after punishment ( $Rf-$ ), we conducted a three-factor ANOVA with extraversion and neuroticism as between-subjects factors and type of feedback as the within-subjects factor. Neither the main effect for extraversion,  $F(1, 41) = 1.55$ , nor the main effect for neuroticism,  $F(1, 41) = 2.45$ , was significant. There was an unexpected main effect for type of feedback; all subjects responded significantly more slowly following punishment feedback ( $M = 2,052$  ms) than following reward feedback ( $M = 1,542$  ms),  $F(1, 41) = 15.89, p < .001$ . The Extraversion  $\times$  Type of Feedback interaction,  $F(1, 41) < 1.27$ , and the Neuroticism  $\times$  Type of Feedback interaction,  $F(1, 41) < 1.0$ , were nonsignificant, but the Extraversion  $\times$  Neuroticism  $\times$  Type of Feedback interaction was significant,  $F(1, 41) = 5.45, p < .025$ .

The fact that the Extraversion  $\times$  Type of Feedback interaction was nonsignificant (contrary to prediction) is important. That is, although extraverts spent less time reflecting following punishment than introverts did,  $t(41) = 3.18, p < .01$ , they also reflected less following reward,  $t(41) = 2.06, p < .05$ . Thus, relative to introverts, extraverts showed a general tendency to initiate the next trial more quickly (i.e., less reflectivity overall). As with passive avoidance errors, however, the relation of extraversion to reflectivity appeared to depend on subjects' neuroticism levels. Therefore, we again compared introverts' and extraverts'  $Rf+$ s and  $Rf-$ s within each level of neuroticism. For neurotic extraverts and neurotic introverts, the Group  $\times$  Type of Feedback interaction was significant,  $t(41) = 3.49, p < .005$ , with

Table 2  
Experiment 2: Means and Standard Deviations for Passive Avoidance Errors (PAEs), Omission Errors (OEs)

Group	n	Variable-feedback condition		n	Fixed-feedback condition	
		PAEs	OEs		PAEs	OEs
Neurotic extraverts	11			13		
M		20.64	7.46		15.54	9.46
SD		7.57	6.52		7.53	6.67
Stable extraverts	13			11		
M		14.31	11.38		10.36	8.46
SD		7.45	4.35		3.93	5.39
Neurotic introverts	8			14		
M		11.50	12.00		9.36	13.29
SD		8.07	4.84		6.82	8.61
Stable introverts	14			7		
M		14.00	11.36		11.00	8.57
SD		6.31	11.21		6.73	4.35

Note. Maximum number of errors of either type = 48.

**Table 3**  
*Means and Standard Deviations for Median Reflection Times in the Variable-Feedback Condition*

Group	After punishment feedback	After reward feedback
Neurotic extraverts		
<i>M</i>	1,222	1,171
<i>SD</i>	1,154	899
Stable extraverts <sup>a</sup>		
<i>M</i>	2,250	1,518
<i>SD</i>	1,240	1,333
Neurotic introverts		
<i>M</i>	2,267	1,269
<i>SD</i>	1,519	1,597
Stable introverts		
<i>M</i>	2,411	2,010
<i>SD</i>	1,080	1,382

*Note.* Values are for groups' median reflection times in milliseconds; maximum latency = 5,000 ms.

<sup>a</sup> Because one stable extravert made no passive avoidance errors,  $n = 12$  for this mean and standard deviation.

neurotic extraverts displaying significantly less reflectivity after punishment,  $t(41) = 3.85$ ,  $p < .001$ , and no less reflectivity after reward,  $t(41) < 1.0$ . None of the comparisons involving stable extraverts and stable introverts was statistically significant. Means and standard deviations for  $Rf^-$  and  $Rf^+$  within each of the quadrants defined by extraversion and neuroticism are shown in Table 3. Figure 2 shows the relations among personality and reflectivity in the variable-feedback condition.

*Reflectivity and learning.* Because  $Rf^-$  represents the amount of reflection after punishment, it was not necessary to calculate a difference score to compute the Pearson correlation between reflectivity after punishment and passive avoidance errors. The Pearson  $r(44)$  equaled  $-.533$ , indicating that passive avoidance errors decreased as reflection times increased. Thus, there appeared to be a strong relation between  $Rf^-$  and PAEs. Because  $Rf^-$  and  $Rf^+$  were highly correlated,  $r(44) = .741$ ,  $p < .001$ , and extraverts'  $Rf^+$ s as well as  $Rf^-$ s were significantly faster than introverts', we were concerned that the relation of  $Rf^-$  to PAEs might reflect the effect of an overall rapid-response style rather than reflection after punishment per se. Thus, both  $Rf^-$  and  $Rf^+$  were included in the following regression analysis.

Using PAEs as the dependent variable, the independent variables were entered in the following order, each one occupying a separate level:  $Rf^+$ ,  $Rf^-$ , extraversion, and neuroticism, their set of two-way interactions, their set of three-way interactions, and the four-way interaction. All together, these variables and their interactions accounted for 58.72% of the variance in PAEs. The incremental increases of unique variance added by the four main effects were .056, .285, .040, and .001, in order. Supporting the hypothesized relation between learning and reflection,  $Rf^-$  accounted for a significant proportion of the variance in PAEs (28.5%),  $F(1, 43) = 18.54$ ,  $p < .001$ . None of the other three factors accounted for a significant portion of the variance in PAEs. Thus, as in Experiment 1, the relation of extraversion to PAEs was nonsignificant when entered after  $Rf^-$  in the regression. The relation of  $Rf^+$  to PAEs was also nonsignificant, further suggesting that the relation of PAEs to reflectivity is spe-

cific to  $Rf^-$  and not the result of overall faster responding. Finally, the interaction between extraversion and  $Rf^-$  was nonsignificant,  $F(1, 43) < 1.0$ , indicating that the general relation of learning and  $Rf^-$  held equally for both introverts and extraverts.<sup>3</sup> This relation is shown in Figure 3.

The comparable hierarchical multiple regression analysis for omission errors indicated no significant relations between learning cues for reward and  $Rf^+$ , extraversion, or neuroticism.

*Learning and general response speed.* In addition to recording subjects' reflection times, subjects' response times to each  $S^-$  and  $S^+$  were recorded. To examine the possibility of a speed-accuracy trade-off, we again computed several pertinent correlations. We restricted these computations to the variable-feedback condition to maintain parallelism with the available correlations for reflectivity. Correlations for mean general response time with total errors,  $r(44) = -.10$ , with passive avoidance errors,  $r(44) = .11$ , and with omission errors,  $r(44) = -.23$ , were all nonsignificant. As in Experiment 1, we also computed correlations between specific reaction times and learning. The correlation of reaction times to  $S^-$ s and passive avoidance errors,  $r(44) = -.01$ , and the correlation for reaction times to  $S^+$ s and omission errors,  $r(44) = .06$ , were also nonsignificant. As in Experiment 1, these correlations provide no evidence that a speed-accuracy trade-off occurred.<sup>4</sup>

In summary, in the variable-feedback condition, faster termination of punishment feedback was associated with poorer learning for all subjects. Extraverts responded faster to terminate punishment feedback and made more passive avoidance errors than did introverts. Neurotic extraverts, however, displayed the fastest reflection times following punishment and, in both conditions, the most passive avoidance errors.

## Discussion

The results of Experiment 2 corroborated those of Experiment 1 in several respects, though not entirely. Differences in the results of the two experiments appear to be due to the operational differences between the two tasks and are discussed more fully in the General Discussion section. Indeed, Experiment 2 was designed to focus directly on that portion of the relation between extraversion and passive avoidance errors involving reflectivity.

In Experiment 2, we examined the relation between reflectivity and errors from two perspectives: by assessing the amount

<sup>3</sup> Further inspection of this analysis revealed one additional significant result. An unpredicted three-way interaction involving extraversion, neuroticism, and  $Rf^+$  was found,  $F(1, 32) = 6.91$ ,  $p < 0.025$ . Because this interaction may complicate unnecessarily the interpretation of lower-order effects, a second three-way regression analysis was done without  $Rf^+$  and its interaction terms. The results for this analysis were virtually identical to the analysis including  $Rf^+$ . With  $Rf^-$  entered first in the hierarchy, it accounted for 28.4% of the variance in passive avoidance errors,  $F(1, 43) = 17.08$ ,  $p < .001$ .

<sup>4</sup> In addition, we conducted a three-way analysis of variance (Extraversion  $\times$  Neuroticism  $\times$  Condition) with response times as the dependent variable. The main effect for extraversion was nonsignificant,  $F < 1$ , and, if anything, anticipatory response times for neurotic extraverts were actually slower than for other groups.

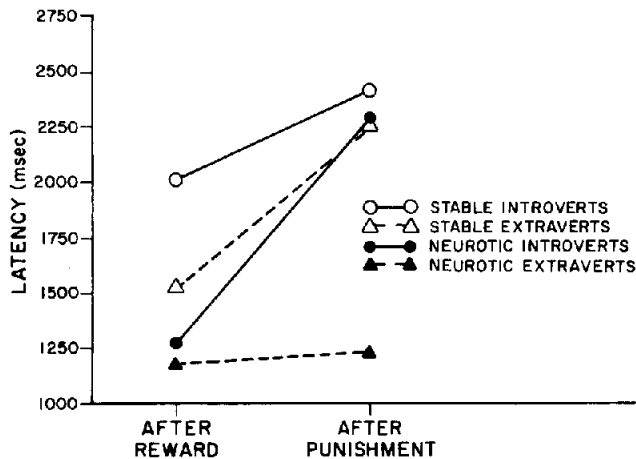


Figure 2. Response latencies after feedback in the variable-feedback condition as a function of extraversion and neuroticism.

of time subjects chose to reflect in the variable-feedback condition and by manipulating the length of the feedback interval in the fixed-feedback condition. Our hypothesis concerning the association between learning from punishment and reflection received strong support from both the measure and the manipulation of reflection. As time spent reflecting on mistakes increased, the tendency to make passive avoidance errors decreased. This relation was equally apparent for introverts and extraverts in the variable-feedback condition, as evidenced by the lack of an interaction between groups and reflectivity after punishment in the regression analysis. In addition, all subjects made fewer passive avoidance errors in the fixed-feedback condition than in the variable-feedback condition. Thus, it appears that pausing to reflect after transgressions is strongly related to the subsequent inhibition of maladaptive responses, at least in the context of the passive avoidance task used here.

Although reflectivity after punishment and avoidance learning were strongly associated in both extraverts and introverts, extraverts reflected on punishment feedback for significantly less time, on average, than did introverts. However, contrary to prediction and to the results of Experiment 1, extraverts also reflected less on reward feedback. Importantly, though, regression analyses indicated that reflection after reward bore no significant relation to passive avoidance errors, suggesting that reflectivity after punishment, rather than impulsive responding per se, was mediating their poor passive avoidance learning. Moreover, the finding that extraverts made more passive avoidance errors than introverts parallels the results reported by Newman et al. (1985) and replicates the results of Experiment 1, providing convergent evidence that, in comparison to introverts, extraverts have difficulty learning to inhibit a response that may lead to reward in order to avoid punishment.

The presence of a significant Extraversion  $\times$  Neuroticism interaction in the analyses for passive avoidance errors and reflection after punishment indicates that neuroticism was an important factor mediating the effect of extraversion in this task. In fact, the group differences found for both passive avoidance errors and reflection after punishment expected for extraverts (versus introverts) were specific to neurotic extraverts. Whereas

stable as well as neurotic extraverts in Experiment 1 showed poorer passive avoidance learning and less slowing down after punishment, only neurotic extraverts showed deficient passive avoidance and a lack of reflectivity following punishment in Experiment 2. In contrast to other groups in Experiment 2, neurotic extraverts showed almost no inclination to reflect more after punishment, and they were most deviant in passive avoidance (see Figures 2 and 3).

In light of these results, the hypothesis about the relation between reflectivity and passive avoidance errors can be examined further. The reflectivity manipulation (fixed feedback) was powerful, but its impact on passive avoidance errors was not a function of individual differences. The fixed delay was designed to interrupt extraverts' ongoing, reward-seeking behavior, allowing them to reflect on their mistakes. Our expectation was that extraverts would then make fewer errors, resulting in both introverts and extraverts making roughly equal numbers of passive avoidance errors. This enforced interruption was not expected to have an appreciable effect on introverts because of their hypothesized predisposition to pause for reflection on their passive avoidance errors. Introverts paused for about 2.5 s after punishment in the variable-feedback condition. Introverts' superior passive avoidance performance in the fixed-feedback condition presumably indicates that they reflected even more given a 5-s reflection interval. The fact that all subjects were aided by the interruption underscores, in effect, the relation between extent of interruption (and, presumably, time spent reflecting on feedback) and passive avoidance learning found in the variable-feedback condition.

In general, it is reasonable to speculate that, across a variety of situations involving reward, extraverts must shift their attentional focus voluntarily in order to perform as well as introverts. That is, to be able to profit from punishment, extraverts must shift their attention from approach to punishment cues. For extraverts in the fixed-feedback condition, an interruption of their reward-seeking behavior was enforced externally, but it appears that this delay was not accompanied by an adequate shift in

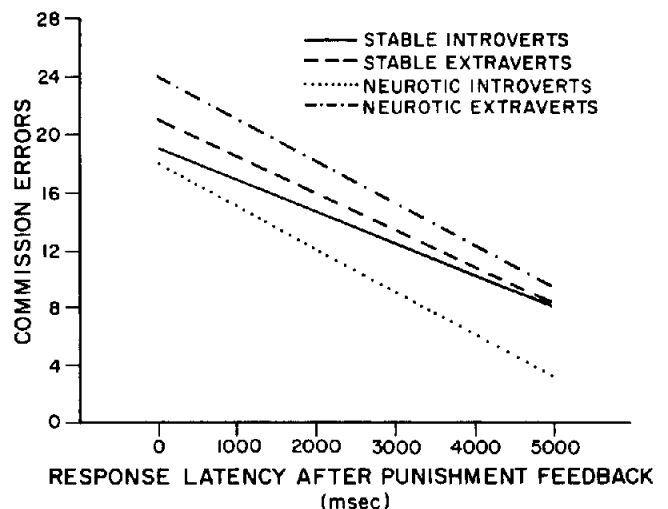


Figure 3. The relation of passive-avoidance errors and reflectivity following punishment as a function of extraversion and neuroticism.

attention to cues for punishment, at least for neurotic extraverts. Because interruption of behavior and reflection on prior behavior are different processes, an enforced interruption of 5 s is not necessarily accompanied by an equal amount of time reflecting for both extraverts and introverts. In other words, the feedback provided in the fixed-feedback condition ensured a long interruption but could not ensure equally long reflection. Thus, we cannot assume that the 5-s delay in the fixed condition would have an effect equivalent to an equal delay in the variable-feedback condition. Manipulations that alter the global incentive context (e.g., by removing reward) instead of or in addition to an enforced pause may reduce the probability of a dominant approach response in extraverts and, as a result, may be more effective in promoting adequate attention to punishment cues (see Newman et al., 1985, for an example).

Unlike the pattern of results demonstrating a consistent relation between reflection time after punishment and passive avoidance errors, no such pattern was observed between reflection time following reward and omission errors. Consistent with the weak relation between reflection time following reward feedback and the learning of cues for reward, the enforced feedback interruption changed neither introverts' nor extraverts' ability to obtain reward. This lack of association between retrospective reflection time after reward and learning cues for reward stands in sharp contrast to the strong relation observed between reflection time following punishment and learning cues for punishment. This difference suggests the possibility of different mechanisms underlying the learning of cues for reward and the learning of cues for punishment. One possibility is that the process of learning cues for reward is primarily anticipatory in nature. That is, associations between reward cues and positive incentives may be formed via the confirmation or disconfirmation of an expectation concerning their relation, with confirmation of the expectation requiring little additional processing. Learning associations between cues for punishment and aversive outcomes may rely more importantly on retrospective reflection that serves to update incorrect expectations that could lead to another maladaptive response.

### General Discussion

The experiments reported here were designed to shed light on extraverts' failure to learn from punishment. Specifically, we proposed that differences in introverts' and extraverts' characteristic reactions to punishment may account for group differences in learning from punishment. Results from both experiments are in accord with this proposal; for all subjects, slower response times following punishment were associated with better passive avoidance learning.

Because these experiments addressed the relation between learning and the speed with which subjects respond, some may wish to interpret the results within the framework of a speed-accuracy trade-off. However, none of the correlations involving anticipatory response speeds and errors approached significance, providing no basis for speculation regarding a speed-accuracy trade-off in either passive avoidance task. Indeed, the cognitive processes involved in retrospective reflection may be substantially different from those involved in anticipatory reflection (cf. Patterson & Newman, 1986). In the go/no go dis-

crimination paradigm used here, extraverts' poorer learning of (response-generated or stimulus) cues for punishment follows from their failure to pause after punishment rather than from their proclivity for rapid responding per se.

In addition to exploring the relation of reflectivity to learning, these experiments provided an opportunity to replicate previous findings using laboratory tasks that were substantially different from those used to establish the findings initially. Though largely consistent with earlier findings, the results also highlight the importance of situational parameters. Experiment 1, which was designed to integrate our work on introverts' and extraverts' reactions to punishment and passive avoidance learning while retaining the timing of our original passive avoidance task (e.g., Newman et al., 1985), yielded results consistent with previous findings (cf. Newman et al., 1985, for errors and Nichols & Newman, 1986, for response speed). In contrast, Experiment 2 incorporated an important structural change to permit a more direct assessment of reflectivity. Whereas subjects in Experiment 1 were provided with another opportunity to earn reward or punishment immediately after feedback, subjects in Experiment 2 were required to make a response that initiated the next trial. Thus, in addition to interrupting the rapid flow of trials, subjects' reflection times in Experiment 2 could not be contaminated by anticipatory motivations (e.g., to approach or inhibit) elicited by the presence of stimuli for following trials. Perhaps as a consequence of these procedural differences, all subjects (i.e., introverts and extraverts) in Experiment 2, unlike those in Experiment 1, responded more slowly after punishment than after reward, and only neurotic extraverts displayed the expected pattern of failing to pause after punishment and making more passive avoidance errors.

The finding that differences associated with the rate of trial presentation can alter the relative importance of neuroticism is consistent with a recent study of the psychophysiological reactions of introverts and extraverts. Following Fowles' (1980) suggestion that heart rate (HR) acceleration reflects activation of a behavioral approach system, Howland and Newman (1985) measured HR acceleration as one index of reaction to feedback in a passive avoidance paradigm similar to the fixed-feedback condition of Experiment 2. As predicted, punishment failed to reduce the HR acceleration of extraverts to the same extent as for introverts. Furthermore, the response pattern of neurotic extraverts was particularly distinctive. They were the only group to show greater HR acceleration after punishment than after reward, and their HR acceleration following punishment was especially prolonged, lasting throughout an entire 8-s intertrial interval. Thus, data for subjects' psychophysiological responses converge with behavioral evidence regarding introverts' and extraverts' reactions to punishment. Assuming that HR acceleration reflects behavioral activation (Fowles, 1980) and that subjects' speed of responding reflects their level of response activation (Gray, 1971; see also Nichols & Newman, 1986), then both sets of data suggest that punishment fails to interrupt the response activation of extraverts to the same extent as for introverts and that response activation following punishment is especially pronounced for neurotic extraverts.

Results of previous experiments indicate that extraverts can perform a go/no go discrimination task as well as introverts

can in the absence of a salient reward contingency. Thus, their poorer passive avoidance is not the result of a general lack of inhibitory control, inability to learn, or lack of motivation to perform (Newman et al., 1985) but is specific to situations that focus subjects on earning reward. Given such a motivational context involving salient rewards as well as punishments, punishment appears less likely to interrupt extraverts' approach behavior (e.g., Nichols & Newman, 1986; the present Experiment 1) or to promote reflection (Experiment 2). Furthermore, extraverts' failure to pause and learn following punished errors appears to vary as a function of situational parameters. In particular, stable extraverts' deficit was apparent when punished errors were followed immediately by another opportunity for reward or punishment (Experiment 1) but not apparent when subjects' response to feedback was assessed in the absence of cues for reward (Experiment 2). On the other hand, neurotic extraverts' failure to learn cues for punishment appears less dependent on the presence of salient reward cues at the moment of punishment or in its immediate aftermath. Thus, two aspects of the experimental situation appear to be critical in mediating extraverts' disinhibition and passive avoidance learning deficit: the overall motivational context and the opportunity to resume approach behavior immediately after punishment.

Together, the aforementioned findings provide considerable insight into the nature of extraverts' disinhibitory predisposition and their difficulties with passive avoidance learning. In the presence of reward incentives, extraverts are prone to maintain an approach response set. Consequently, the increment in arousal associated with punishment is more likely to facilitate their approach behavior than to elicit interruption and reflectivity. Without adequate reflection, extraverts fail to associate punishment with the incorrect response and are therefore less likely to inhibit that response on subsequent occasions. In contrast to stable extraverts, whose disinhibited reaction to punishment appears to depend on the presence of cues for reward, the reaction of neurotic extraverts appears to be less situationally determined. To the extent that this disinhibited reaction to punishment interferes with learning and subsequent inhibition, we might expect that stable extraverts' insensitivity to punishment will be more situation specific than neurotic extraverts'. Although additional research is needed to clarify further the mechanism and the influences of motivational factors, the proposed mechanism (see *Discussion* section, Experiment 1) provides a framework for generating and testing hypotheses about the processes mediating impulsive behavior.

Furthermore, we maintain that the proposed mechanism may have more general applicability. By demonstrating an association between extraverts' active response to punishment and their failure to process information, the results of these experiments serve to link extraverts' approach tendencies with their relative insensitivity to cues for punishment. Cues for punishment not only mediate passive avoidance learning but serve to modulate approach behavior in general. Shapiro (1965), for instance, described the impulsive individual as prone to act without the benefit of affective associations that might serve to inhibit their behavioral intentions. Whereas reflectivity is often considered the opposite of impulsivity and used to refer to action that is planned and well-considered, this study suggests a more complex relation between impulsivity and reflectivity. If

retrospective reflection following punishment is short-circuited by a propensity to continue some goal-directed activity, then the associative network that accrues to punishment under such conditions will be limited and therefore less likely to modulate subsequent responding. In other words, impulsivity or the failure to consider inhibitory cues before responding might reflect a prior failure to associate the anticipated response and stimulus context with punishment.

Finally, depending on the situation, insensitivity to punishment cues while pursuing reward may have advantages as well as disadvantages. For instance, a disinclination to shift attention from immediate goals to process cues for punishment may also contribute to extraverts' greater persistence (versus perseveration) and apparent optimism in the face of failure. With a scanty network of associations for punishment, adaptive persistence may prevail over maladaptive helplessness. Although some evidence exists concerning the advantageous aspects of extraverts' behavioral and cognitive style (e.g., Pearce-McCall & Newman, 1986; Tigemann, Winefield, & Brebner, 1982), it remains, along with the intricacies of their deficient passive avoidance learning, a topic worthy of further research.

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