

BEHAVIORAL INHIBITION AND TEST ANXIETY:
AN EMPIRICAL INVESTIGATION OF GRAY'S THEORY

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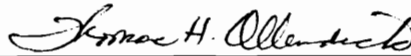
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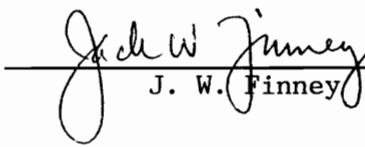
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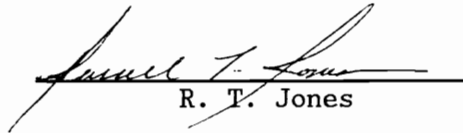
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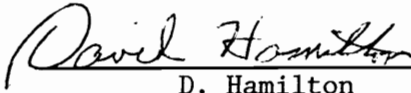
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(ABSTRACT)

The effects of test anxiety on behavioral inhibition were examined using three computerized behavioral tasks. High test anxious subjects demonstrated more behavioral inhibition than low test anxious subjects, according to frequency measures on two of the three behavioral tasks. Group differences in latency measures were not found, however. High test anxious subjects reported higher levels of state anxiety than low test anxious subjects. Increased behavioral inhibition was greater for the Punishment condition, which involved the loss of points and negative audio-visual feedback for incorrect responses, than for the Non-Reward condition. Contrary to initial predictions, group differences were found to be greater in the Non-Reward condition than in the Punishment condition.

The findings support Gray's theory that anxiety is associated with activity of the Behavioral Inhibition System (BIS), as inferred from measures of behavioral inhibition. Over-sensitivity of the BIS was viewed as a bias or tendency to respond to ambiguous or unfamiliar stimuli as though they were more likely to result in aversive rather than appetitive consequences. Research examining behavioral inhibition to the unfamiliar in infants and children was discussed and related to Gray's theory of behavioral inhibition. It was suggested that BIS over-sensitivity may be a risk factor in anxiety-based psychopathology which develops in transactional interactions between genetic and environmental factors.

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Behavioral Inhibition and Test Anxiety:

An Empirical Investigation of Gray's Theory

The experimental study of individual differences has a long and rich tradition. Pavlov identified basic properties of nervous system activity such as the strength, equilibrium, and excitability of the processes of excitation and inhibition through which individual differences were described (see Teplov, 1964). Eysenck's work served as an exemplar of an empirically-based personality theory, garnering broad-based support for the dimensions of introversion-extraversion and neuroticism-stability. Eysenck's view that introverts were generally more conditionable than extraverts was qualified by one of his students, J. A. Gray. Gray (1970) argued that introverts were more conditionable only in aversive situations, namely those situations involving punishment and non-reward; whereas extraverts were more conditionable under conditions of reward. This qualification appears to have served as a stimulus for much of Gray's work over the next two decades.

Drawing from the fields of psychopharmacology, neuroanatomy, neuropsychology, and behavioral psychology, Gray (1977, 1982, 1987) proposed a theory of anxiety which specifically addressed the issue of individual differences in anxiety proneness. The extensive literature on animal learning and motivation, the selective behavioral effects of anti-anxiety drugs, and the seminal animal lesion studies formed the basis from which Gray's theory was derived. Before examining the theory in more detail, a brief synopsis will be presented.

Gray proposed the Behavioral Inhibition System (BIS), a system activated primarily by signals of aversive stimulation; once activated

the serves to suppress ongoing behavior. The specific stimuli which activate this system are signals of punishment, signals of non-reward, innate fear stimuli, and novel or unfamiliar stimuli. In addition to inhibiting behavior, the BIS produces increments in arousal and orienting responses.

Since the BIS is inferred and is assumed to be located in the central nervous system, Gray viewed it as part of what Hebb (1946, cited in Gray, 1987) referred to as the **Conceptual Nervous System (CNS)**. In addition to the BIS, this CNS consists of systems which mediate other types of responses to other classes of stimuli. Gray also described the **Fight/Flight System (FFS)** as distinct from the BIS in that it mediates responses of escape or aggression to direct punishment and direct non-reward. Expanding on Gray's work, Fowles (1980, 1987) proposed that responses to appetitive stimuli are mediated by yet another system, the **Behavioral Activating System (BAS)**.

These subsystems are viewed as distinct, yet interactive. From this CNS, a general theory of motivation and individual differences is derived. The BIS and the BAS are proposed to interact in a reciprocally antagonistic way. One system inhibits behavior, while the other activates behavior. When the systems are not in equilibrium, an over-sensitivity to a certain class of stimuli will result. This, in turn, is associated with an increase in the behaviors typically evoked by those stimuli. According to Gray (1982, 1987), an over-sensitive BIS would be associated with high trait anxiety. Quay (1988) proposed that an under-sensitive BIS may be associated with Attention Deficit-Hyperactive Disorder in children; while an over-sensitive BAS

may be associated with Conduct Disorder. According to Newman's (1987) theory of disinhibitory psychopathology, psychopaths (similar to Conduct Disorder children) may have an over-sensitive BAS and an under-sensitive BIS. Based on this cursory overview, it is apparent that Gray's theory of anxiety and the functioning of the BIS have been broadened and applied to other types of psychopathology. The primary focus of this discussion will be on anxiety and the functioning of the BIS.

Learning and Motivation

In Gray's early conceptualization of the BIS, he described a two-process theory of learning (Gray, 1975) based on Mowrer's (1960) work. The two processes of this theory are, of course, those of classical and instrumental conditioning. Instrumental learning and behavior are the outcomes of interactions between classical and instrumental conditioning. The process of classical conditioning is responsible for neutral stimuli acquiring reinforcing and punishing properties. Instrumental conditioning then guides and shapes behavior so that reinforcement is maximized while punishment is minimized.

Fundamental distinctions in Gray's theory of anxiety are made between systems mediating responses to **appetitive** stimuli versus systems mediating responses to **aversive** stimuli, and between responses to **signals** of these events versus responses to the **events** themselves. Given that anxiety is viewed as an aversive state, let us begin with a discussion of the aversive stimuli of punishment and non-reward. Table 1 is provided as a guide for this discussion.

Table 1.

Signals of Punishment and Non-Reward Versus Direct Punishment and Non-Reward

Presentation of Stimuli	
Signal	Direct
<hr/>	
Pun-CS	-----> Pun-UCS
S-delta	--> Response --> Punishment
Signal of Punishment	--> PASSIVE AVOIDANCE
<hr/>	
NonRew-CS	-----> NonRew-UCS
S-delta	--> Response --> Non-Reward
Signal of Non-Reward	--> EXTINCTION
<hr/>	

Before proceeding, a brief explanation of the organization of Table 1 will be provided. The first column represents signals of punishment and non-reward in classical then instrumental conditioning terms. The second column represents direct punishment and non-reward. In accordance with two-process theory, a neutral stimulus acquires reinforcing or punishing properties through classical conditioning. A conditioned stimulus for punishment (Pun-CS) or for non-reward (NonRew-CS) can become an S-delta when punishment or non-reward are contingent upon a response. Instrumental processes then guide behavior so that punishment and non-reward are minimized through passive avoidance and extinction of the response, respectively.

Punishment. Within a classical conditioning framework, a distinction is drawn between the effects of the unconditioned stimulus for punishment (Pun-UCS) and the effects of the Pun-CS by which it is preceded. In general, a Pun-UCS (e.g., foot shock) results in an increase in activity in the form of jumping, running, and escape if possible (unconditioned response; UCR). If another animal or suitable object is present during the presentation of the Pun-UCS, aggression becomes a likely UCR. This increase in activity level stands in sharp contrast to the responses evoked by a CS which has been paired with a Pun-UCS. Typically, the presentation of the Pun-CS will produce a freezing or startle response (conditioned response; CR), followed by an increase in activity once the Pun-UCS is delivered. This CR is nearly opposite to the UCR to which it, at least according to basic classical conditioning notions, should be similar.

Myer (1971) has suggested that these different responses reflect differences in the nature of the stimuli. Aversive proximal stimuli come in direct contact with sensory receptors producing pain. These aversive stimuli which produce pain and activate behavior are, by definition, Pun-UCSs. Distal stimuli do not come in direct, physical contact with sensory receptors. When distal stimuli signal aversive stimuli, behavioral inhibition occurs. This conceptualization makes intuitive sense. When in contact with a predator or some pain-producing event, attack or escape may be necessary. When a predator is seen, heard, or smelled, however, freezing may be an adaptive way to avoid detection (Gray, 1987).

Myer's conceptualization appears valid at a neuroanatomical level as well. The anatomical locus of the BIS, according to Gray, is in the vicinity of the septo-hippocampal system. This area of the limbic system receives projections from the sensory systems which would analyze distal as opposed to proximal stimuli (Gray, 1987). Regardless of the conceptualization, signals (a Pun-CS) that warn of direct aversive stimulation (a Pun-UCS) result in the initial suppression of behavior.

The suppressing effect of signals of punishment is also evident within positive instrumental and negative classical conditioning interactions (see Henton, 1978). Estes and Skinner (1941) were the first to report what has come to be known as "conditioned suppression" and the "conditioned emotional response" (CER). Essentially, they found that when a Pun-CS is non-contingently presented during instrumental responding, suppression of the instrumental response will occur. This

phenomenon has been the focus of extensive research and several conceptualizations have been offered (see Henton, 1978).

In classical conditioning terms, signals of punishment (Pun-CS) result in the inhibition of behavior, while direct punishment (Pun-UCS) results in an increment in activity. Returning to the perspective of Gray's two-process theory (and Table 1), instrumental approach behavior is inhibited by signals of contingent punishment (Pun-CS or S-delta). This inhibition of instrumental behavior, evoked by signals of punishment is termed **passive avoidance**. According to Gray (1987), this inhibition of behavior to avoid punishment is associated with the emotional states of **fear** or **anxiety**.

The findings presented thus far argue that different behavioral systems mediate responses to signals of punishment and direct punishment. As already mentioned, the BIS is viewed as mediating responses of passive avoidance to signals of punishment. The Fight/Flight System, on the other hand, mediates responses of aggression and escape to direct punishment.

Non-Reward. The classical conditioning distinction between NonRew-CS and NonRew-UCS, based on the different responses they typically evoke, is less clear-cut than the distinction between Pun-UCS and Pun-CS in the case of punishment (Gray, 1975). Nonetheless, a case is made that the effects of NonRew-CSs evoke different responses than NonRew-UCSs (Gray, 1975, 1987). As with a Pun-UCS, if another organism or suitable object is present, aggression may occur in response to a NonRew-UCS. The responses evoked by signals of non-reward, however, are less clear. In instrumental conditioning non-reward produces an initial

increase in rate and vigor of responding, presumably reflecting an internal state termed **frustration** (Amsel, 1962, cited in Gray, 1987). Over time, however, responding will decrease and eventually cease.

It is important to note that non-reward must be viewed in the context of an expectation of reward. If a signal of non-reward is presented during operant responding, some suppression of ongoing behavior will occur (see Henton, 1978). In terms of Gray's two-process theory, instrumental approach behavior is inhibited by signals of contingent non-reward (NonRew-CS or S-delta). This inhibition of instrumental behavior, evoked by signals of non-reward, to avoid the non-occurrence of expected reward is termed **extinction** (see Table 1).

Additional understanding of non-reward can be obtained through an analysis of the relationship between non-reward and punishment. Both these types of stimuli are viewed as aversive in that their occurrence will produce escape. Furthermore, both contingent punishment and non-reward will decrease the likelihood of a recurrent response. Signals of punishment (Pun-CS or S-delta) and signals of non-reward (NonRew-CS or S-delta) result in passive avoidance and extinction - both inhibiting instrumental responding.

Gray (1987) has conceptualized these similarities within what he calls the **fear = frustration hypothesis**. According to this hypothesis, the general functional, physiological, and emotional properties of the states produced by signals of punishment and non-reward are essentially the same. Fear may be distinguished from frustration primarily in terms of the intensity of the aversiveness. A detailed discussion of this hypothesis and the supporting empirical evidence is provided elsewhere

(see Gray, 1987; McAllister & McAllister, 1971). For purposes of this discussion, the key point is that signals of these aversive events evoke similar responses, and are similarly affected by drugs (discussed below). Thus, they can be viewed as activating the same aversive, inhibitory motivational system - the BIS. The signals of punishment may activate the BIS more than signals of non-reward, and thus may result in greater behavioral inhibition. The stimuli activating the BIS are presented in the Signal column of Table 1.

One clear strength in Gray's work is the broad-based support from multiple levels of analysis. Thus far in our discussion, the BIS has been examined at the behavioral level. Let us now turn to the findings obtained from studies examining the effects of drugs on the behaviors discussed above. Subsequently, converging evidence from animal lesion studies will be mentioned briefly.

The Effects of Anxiolytic Drugs

A basic premise of Gray's theory is that the nature of anxiety can be inferred from the action of anti-anxiety agents (Gray, 1982). This premise is based on three assumptions. The first assumption is simply that there is a class of pharmacological agents which reduces anxiety in humans. Within this large class of anxiolytic agents are three classes of drugs: the benzodiazepines, the barbiturates, and alcohol. Although they are chemically distinct, have different modes of action, and have numerous effects, they are similar in terms of their anxiolytic action.

The second assumption is that the effects of these drugs are specific to anxiety and not other emotions or states. At high doses, however, these drugs (especially alcohol and the barbiturates) have a

sedative effect impairing motor coordination in addition to reducing anxiety. Furthermore, some anti-anxiety drugs reduce depression, and some anti-depressants reduce anxiety. One explanation offered by Gray (1982) is that this occurs in cases where the anxiety and depression are not distinct. This explanation is certainly questionable. The reader is referred to Gray (1987) for a detailed discussion of this issue. Given that anxiety and depression tend to co-occur and appear related, strict adherence to the second assumption in the case of depression may not be necessary or appropriate.

The final assumption is that animals experience an emotional state similar to what is referred to as anxiety in humans. This assumption is based on the similarity of responding among mammals to signals of aversive stimulation. Furthermore, the effects of anxiolytic agents on anxiety in animals are assumed to be similar to their effects on humans. This is an important assumption given that only animal research was reviewed by Gray (1977). More recent research investigating the effects of anxiolytic drugs on humans has been conducted and is generally consistent with the animal literature and Gray's conclusions (e.g., O'Boyle, Harris, Barry, & Cullen, 1986). Some of these findings will be presented later.

Anxiolytic drugs counteract several specific responses to specific classes of stimuli. Behavioral inhibition, increased arousal and increased attention, which are the responses to signals of punishment and signals of non-reward, are reduced by anxiolytic drugs. According to numerous animal studies reviewed by Gray (1977), CRs of freezing and startle following a Pun-CS have been shown to be reduced by anxiolytic

drugs. These drugs also appear to reduce the suppression of instrumental behavior during the presentation of a non-contingent signal of punishment. In sum, these drugs disinhibit the suppressed responses in passive avoidance and extinction situations (Fowles, 1987); they also disinhibit conditioned suppression (or CER) in positive instrumental - negative classical interactions (see Millenson & Leslie, 1974).

The increases in activity due to direct punishment and non-reward, on the other hand, are not altered by anxiolytic drugs. Furthermore, anxiolytic drugs do not affect responses to appetitive stimuli. Finally, analgesic drugs, which reduce the effects of direct punishment resulting in pain, do not alter the responses to signals of punishment (Gray, 1987b).

Animal Lesion Research

Based on a review of animal lesion studies, Gray (1982, 1987) places the BIS in the septo-hippocampal system (SHS) of the limbic system. In general, lesions in this area typically have similar effects on behavior as do anxiolytic drugs. This literature is quite complex, the findings appear mixed, and interpretations of similar findings are often divergent (for a peer commentary on Gray's discussion of the SHS, see Gray, 1982b). Furthermore, the prominent influence of the cortex in humans - specifically the descending pathways from the frontal cortex - contrasts the less influential role of the cortex in rats. This circumstance may render Gray's neuroanatomical conclusions less applicable to humans.

For the present discussion, we are primarily concerned with the BIS in the "conceptual" as opposed to the central nervous system. An

understanding of the neuroanatomy and neurochemistry of the BIS is obviously important. The present discussion is concerned with the functioning of the BIS in terms of behavior, hence less attention will be given to the neuroanatomical aspects of the BIS.

The Behavioral Inhibition System

Summarizing the relevant findings from the literature on animal learning and motivation as well as the effects of anxiolytic drugs, a clearer picture of the BIS emerges. This inhibitory system is activated by signals of punishment and non-reward. According to two-process theory, such aversive stimuli can acquire their signaling properties through classical conditioning. Through instrumental processes, these same stimuli become discriminative stimuli - specifically S-deltas which signal that the response not be performed. Once activated, the BIS inhibits ongoing behavior in general, and the S-delta mediates passive avoidance and the extinction of responding (see Table 1).

The functioning of the BIS is impaired by the anxiolytic agents discussed above. Since anxiolytic drugs consistently affect only responses to signals of aversive stimuli (punishment and non-reward) and not responses to direct aversive stimuli (primary punishment and non-reward), then the behavioral systems which mediate these responses should be functionally and biochemically distinct. Based on these findings, Gray argues that activity in this BIS results in anxiety or fear. Anxiety then, is "that emotional state which is elicited by stimuli associated with either punishment or non-reward" (Gray, 1987, p. 204). In terms of the fear = frustration hypothesis, this definition

also applies to frustration. The emotional state of frustration, however, is less intense than fear or anxiety.

In addition to being activated by aversive signals the BIS is also believed to be activated by **novel stimuli** and **innate fear stimuli**. Gray (1987) includes novel stimuli based on Sokolov's descriptions of orienting responses and inhibition to novelty. Innate fear stimuli include stimuli associated with species-specific evolutionary dangers. According to Gray, this type of innate fear stimulus is essentially the same as Seligman's (1971, cited in Gray, 1987) concept of "prepared stimuli". Innate fear stimuli also include socially acquired stimuli signaling aversive events. These two additional classes of stimuli will not be discussed further because their nature and effects are not as relevant to the present discussion as are the other stimuli which activate the BIS.

The responses mediated by the BIS discussed thus far include behavioral inhibition in general, and passive avoidance and extinction of responding in particular. In addition to these responses, the BIS also mediates responses of **increased attention** and **increased arousal**. Increases in attention to and analysis of the environment typically occur when signals of punishment and non-reward are presented. These same stimuli also produce an increase in physiological arousal. Fowles (1980) cites evidence suggesting that high levels of state anxiety are associated with increases in electrodermal arousal. Fowles also suggests, however, that anxiety is associated with decreases in cardiovascular activity. Some studies have supported this hypothesis (e.g., Tranel, 1983), but the findings are mixed (see Naveteur & Baque,

1987). These psychophysiological responses will not be discussed in detail further, given that the focus of the present discussion is on behavioral inhibition.

The Flight/Flight System (FFS)

The concept of the FFS is a direct outgrowth of the conceptualization of the BIS. One basis for the BIS is that different types of responses are produced by signals of aversive stimuli versus direct aversive stimuli. In response to the latter type of stimulation, aggression or escape occurs as opposed to inhibition which results from the former.

Furthermore, the differential effects of anxiolytic drugs on the responses to these different types of aversive stimuli also suggest different behavioral systems. Anxiolytic drugs essentially have no effect on altering responses to direct punishment and non-reward. The system activated by direct punishment and non-reward, and mediating responses of aggression and escape has been aptly termed the Fight/Flight System. Returning to Table 1, the stimuli which activate the FFS (direct punishment and non- reward) are functionally similar and thus appear in the Direct stimuli column.

The Behavioral Activating System (BAS)

Gray (1972) has also hypothesized a third system which mediates approach learning and active avoidance in response to signals of reward and non- punishment. Although this approach system, as Gray has called it, has not been as intensively researched as the BIS, it is receiving increased attention by other researchers. Fowles (1980) has termed this

appetitive system the Behavioral Activating System. Table 2 is provided as a guide to our discussion of the BAS and appetitive conditioning.

The organization of Table 2 is similar to Table 1. Under the first column, are the signals of reward and non-punishment in classical then instrumental conditioning terms. Under the second column are direct reward and non-punishment. Again, in keeping with the two-process theory, a stimulus can acquire reinforcing or punishing properties through classical conditioning. A Rew-CS or NonPun-CS can become an S-d when the response meets with reward or non-punishment (active avoidance of punishment). Instrumental processes then guide behavior so that reward and non-punishment are maximized through approach behavior and active avoidance, respectively.

The distinction between signals of reward and non-punishment versus direct reward and non-punishment is not as clear as the distinction between signals versus direct stimulation in the aversive case. It is fairly clear, however, that the BAS is a separate system from the BIS, since responses to these signals are not affected by anxiolytic drugs (Gray, 1987).

In an investigation of the effects of changes in the amount of reinforcement, Tranel (1983) provided support for the distinction between an appetitive and an aversive system at a psychophysiological level. Tranel (1983) showed that changes in the amount of reinforcement affected heart rate but not electrodermal activity. In response to frustrative non-reward, however, electrodermal activity changed but heart rate did not. As noted earlier, in terms of psychophysiological reactivity to different stimuli, the findings are mixed.

Table 2.

Signals of Reward and Non-Punishment Versus Direct Reward and Non-Punishment

Presentation of Stimuli	
Signal	Direct
Rew-CS ----->	Rew-UCS
S-d -----> Response -->	Reward
Signal of -->	APPROACH Reward
NonPun-CS ----->	NonPun-UCS
S-d -----> Response -->	Non- Punishment
Signal of -->	ACTIVE AVOIDANCE Non-Punishment

A fundamental distinction is drawn between systems which mediate responses to appetitive stimuli versus responses to aversive stimuli. The BIS is a system which inhibits behavior when stimuli warn of aversive stimulation, namely punishment and non-reward. The BAS, on the other hand activates behavior when stimuli signal appetitive stimulation, reward or non-punishment.

In Table 2, the non-punishment S-d serves as a signal to respond in order to avoid the receipt of punishment; this is termed **active avoidance**. Non-punishment must be viewed in the context of an expectation of punishment, just as non-reward must be viewed in the context of an expectation of reward. Since signals of non-punishment signal that expected punishment will not occur (contingent upon active avoidance), these signals are conceptualized as appetitive.

Given that these avoidance behaviors are believed to be mediated by two different behavioral systems, their distinction is crucial in the present discussion. Active avoidance is distinguished from passive avoidance in that the former involves performing a response to avoid punishment, while the latter entails inhibiting a response to avoid punishment (Mowrer, 1960). Active avoidance is occasioned by an S-d or signal of non-punishment, whereas passive avoidance follows an S-delta or signal of punishment. In the typical approach-avoidance conflict, the avoidance aspect involves passive as opposed to active avoidance. The conflict is between approaching a desired goal and stopping in order to avoid punishment which will occur as the goal is approached. These avoidance responses also differ in the emotional states with which they are associated. As stated earlier, passive avoidance is associated with

fear or anxiety; active avoidance on the other hand is associated with relief. The contrast between the emotional states associated with these two types of avoidance, further highlights their differences. Given these distinctions, let us now turn our attention to a consideration of individual differences.

Introversion-Extraversion

Gray's (1970) qualification of Eysenck's introversion-extroversion theory has already been mentioned briefly. Essentially, Gray argued that introverts were more conditionable to signals of punishment and non-reward as opposed to being more conditionable in general - as Eysenck had proposed. Through this qualification, Gray (1970, 1987) proposed important modifications in Eysenck's theory.

Before discussing these modifications, a brief overview of Eysenck's theory will be provided. For detailed discussion of Eysenck's theory the reader is referred elsewhere (Eysenck & Eysenck, 1985). Two broad personality dimensions, introversion-extraversion and neuroticism-stability, are at the core of Eysenck's theory. In general, introversion is characterized by passivity and carefulness, while extraversion involves a more active, outgoing style. Neuroticism is characterized by easily arousable labile emotions, while stability refers to a more even-tempered style. Increased neuroticism (or decreased stability) represents an increase in sensitivity to reinforcing events in general (reward or punishment), whereas increased introversion (or decreased extraversion) represents an increase in sensitivity to punishment in particular. From these dimensions, a theory of individual differences and psychopathology was proposed.

In addition to the qualification already mentioned, Gray (1982, 1987) argued for the inclusion of two additional factors: anxiety and impulsivity. In terms of anxiety, neurotic introverts would be more likely to be more anxious than stable introverts, followed by stable extraverts, and finally neurotic extraverts. Since Gray (1987) considers anxiety to be the state associated with activity of the BIS, the neurotic introvert would have a more over-sensitive BIS than the stable introvert. The stable extrovert may have a normally functioning BIS, while the unstable extravert may have an under-sensitive BIS.

Impulsivity, on the other hand, would be more likely associated with neurotic extraverts than stable extraverts, followed by neurotic introverts, and lastly stable introverts. Impulsivity is viewed by Gray (1987) as susceptibility to reward, and thus is associated with activity of the BAS. Neurotic extroverts, then, would have a more over-sensitive BAS than stable extroverts. Although Eysenck (1987) recognizes the validity of some of Gray's arguments, he argues strongly against the inclusion of the anxiety and impulsivity factors. For a more detailed discussion of Eysenck's criticisms of the modifications proposed by Gray, see Eysenck and Eysenck (1985). Despite their differences, the work of Eysenck and Gray are highly convergent.

Now that the relationship between Eysenck's dimensions of introversion-extraversion and neuroticism-stability to Gray's theory of anxiety and CNS systems (BIS and BAS) have been identified, some of the relevant literature will be examined. Subsequent to this, the research conducted with clinical populations will be discussed. Using Eysenck's terminology, non-clinical samples in studies investigating

introversion-extraversion differ from clinical samples primarily on the basis of neuroticism (or stability). Gray, on the other hand, would likely highlight the differences in **anxiety** and impulsivity.

Nagpal and Gupta (1979) investigated Gray's predictions about the greater conditionability of neurotic extraverts under rewarding conditions and of neurotic introverts under punishing conditions. Females aged 16 to 21 years (N = 120) were defined along the neurotic and extravert dimensions on the Eysenck Personality Inventory (EPI); thus, four groups of 30 subjects were formed. Subjects were instructed to construct a sentence using a verb and one of 5 pronouns presented on an index card. Subjects in the reinforcement condition were given verbal praise when they used the pronouns "I" and "we". In another condition, a buzzer was sounded when subjects used pronouns **other than** "I" and "we". Subjects in the punishment condition received a mild electric shock when they used pronouns other than "I" and "we".

In general, the findings were supportive of Gray's predictions about individual differences in sensitivity to punishment and reward. The neurotic extravert group conditioned better under the reward contingencies than under punishment. In fact, this group conditioned better under reinforcement than the other three groups. The neurotic introvert group, on the other hand, conditioned better under punishment (shock) than under reward contingencies. This group conditioned better under punishment than did all the groups. The findings regarding the effects of the buzzer contingency were mixed. Others have obtained similar findings using various tasks (e.g., Boddy, Carver, & Rowley, 1986; Seunath, 1975).

Given that the stable introverts and extraverts performed similarly to the neurotic introverts under conditions of reward, and similar to neurotic extraverts under conditions of punishment, specific conclusions about the functioning of the BAS and BIS can be tentatively offered. The neurotic extraverts' greater conditionability to reward and similar conditionability to punishment is consistent with the conceptualization of an over-sensitive BAS and a "normal" BIS, respectively. Similarly, the neurotic introverts' greater conditionability to punishment and similar conditionability to reward supports the notion of an over-sensitive BIS and a "normal" BAS, respectively.

Sensitivity to punishment in introverts was also shown using a pattern-matching task designed to investigate the differential effects of noncontingent feedback on reaction time (Nichols & Newman, 1986). Subjects were briefly presented a complex figure, which was followed by a similar figure. Subjects pressed one of two buttons, indicating whether the two figures were similar or different. Punishing or rewarding feedback was randomly provided irrespective of the accuracy of the response. The hypotheses that punishment would slow the rate of responding of introverts and not alter response time of extraverts were partially supported. Introverts responded more slowly following punishment, while extraverts actually responded more quickly following punishment than reward.

Application to Psychopathology

The application of the behavioral systems (BIS, BAS, FFS) to understanding psychopathology has received increased attention in recent years. As already discussed, Gray has conceptualized the anxiety

proneness as associated with an overly-sensitive BIS. Others have attempted to understand psychopathy (Newman, 1987), impulsivity (Fowles, 1987), and various childhood problems (Quay, 1988) in terms of the functioning of the BIS and BAS, and the interaction between these two systems. Although the most extensive theoretical, and experimental research on these behavioral systems has been conducted by Gray - emphasizing anxiety, the majority of the applied research has focused on psychopathy and impulsivity.

Syndromes of Disinhibition. Newman and his colleagues (Gorenstein & Newman, 1980; Newman, 1987; Patterson, Kosson, & Newman, 1987) have applied a behavioral system conceptualization, which is essentially the same as that of Gray, to the study of **syndromes of disinhibition**. These disinhibitory syndromes include adult psychopathy, hyperactivity, and conduct disorders, as well as nonpathological disinhibited behavior patterns such as extraversion. These syndromes are characterized by varying degrees of impulsivity and lack of inhibition. Behavior is typically governed by immediate gratification, despite acknowledgement of the merits of more constrained and reflective behavior (typically following punishment or loss of reward as a consequence of disinhibited behavior).

Before a discussion of some of this research, a brief description of the successive **go/no go discrimination** tasks used frequently by this group of researchers will be provided. When a response is made following the presentation of a positive stimulus (S+), the response is rewarded (with chips or points). When the response is not made following a negative stimulus (S-), reward or non-reward will follow,

depending on the study. Passive avoidance errors or errors of commission occur when the response is made following an S-. Errors of omission occur when the response is not made following the presentation of an S+. The contingencies vary from study to study. In general, the purpose of the go/no go task is to investigate differences in response tendencies to obtain reward by responding or to passively avoid punishment by inhibiting approach behavior. An over-sensitive BIS would be expected to result in more errors of omission due to behavioral inhibition, whereas an under-sensitive BIS (or over-sensitive BAS) would be more likely be associated with errors of commission due to a lack of inhibition.

Newman, Widom, and Nathan (1985) utilized two go/no go discrimination tasks with teenagers to examine differences between the dimensions of psychopathy and extraversion in passive avoidance. As hypothesized, disinhibited subjects (as defined by the MMPI Psychopathic Deviance Scale) made more errors of commission than inhibited subjects. This deficiency in passive avoidance was evident as these subjects tended to not inhibit the response (which often led to reward in the case of an S+) after the presentation of an S-. A subsequent go/no go discrimination study using incarcerated psychopaths essentially replicated these findings (Newman & Kosson, 1986).

These and other empirical findings (see Gorenstein and Newman, 1980) suggest that psychopaths, as well as other highly disinhibited individuals, are deficient in the inhibition of goal-oriented behavior in the context of cues for reward (Newman et al., 1985). Furthermore, signals for punishment, which typically produce passive avoidance, have

minimal inhibitory effects on the behavior of these individuals, who appear generally deficient in inhibiting their behavior to avoid aversive consequences. Over-responsivity to reward has been supported using a variety of tasks (e.g., Newman, 1987). According to Newman, these findings suggest a deficient, under-sensitive BIS, and an over-sensitive BAS in psychopaths.

Findings obtained from studies using Conduct Disordered (CD) and Hypersensitive children are generally consistent with many of the findings and conclusions discussed above. On the basis of Gray's work on the behavioral systems of the CNS, Quay (1988; 1988b) conceptualized various childhood problems in terms of BIS and BAS functioning. Attention Deficit Disorder with Hyperactivity (ADDH) was viewed as being associated with an under-sensitive BIS, while Conduct Disorder was hypothesized to be associated with an over-sensitive BAS and an under-sensitive BIS. Anxiety Disorders, on the other hand, were viewed as being associated with an over-sensitive BIS, as Gray suggests.

Although Quay's conceptualizations may be an over-extension of Gray's theory, Quay provides highly specific predictions for differential performance for the various groups on numerous tasks. ADDH children would, according to Quay, show a greater resistance to extinction, higher rates of responding on DRL tasks, and more of a partial reinforcement extinction effect than "normal" children. Conduct Disorder children would be predicted to show a high resistance to extinction, and would show higher rates of responding on DRL tasks than ADDH children due to their over-sensitivity to reward. Anxious children should show a low resistance to extinction, lower rates of responding

during DRL tasks, and less of a partial reinforcement extinction effect than "normal" children. The majority of Quay's predictions await empirical investigation. After some relevant empirical findings on the disinhibitory childhood syndromes of ADDH and CD are presented, anxiety will be discussed.

Shapiro, Quay, Hogan, and Schwartz (1988) administered two tasks to a CD and an emotionally disturbed non-CD comparison group. Subjects ranged in age from 7 to 18 years. A card-playing task was used in which the probability of reward decreased by 10%, while the probability of punishment increased by 10% every 10 trials. The other task was a differential reinforcement for low rate responding (DRL) task. Subjects were told that they could earn nickels by pressing a button, waiting a little while, and pressing it again. A 6-second delay was programmed so that responses made too early would restart the timer. Only responses made after 6 seconds were reinforced.

On the card-playing task, CD subjects played more cards ($M = 78$) than the comparison group ($M = 48$). As a result of their continuing, the CD group received fewer rewards than did the comparison group. The CD group also performed more poorly on the DRL task than did the comparison group. The ratios of correct responses to total responses were .76 and .89 for the CD and comparison groups, respectively. Shapiro et al. (1988) interpreted these two tasks as suggestive of reward dominance among the CD subjects, but noted that a deficit in passive avoidance was possible as well. Similar findings and conclusions have been reported with ADDH boys using DRL tasks (Gordon, 1979), and various schedules of reinforcement (Douglas & Parry, 1983).

Anxiety

Gray views anxiety as activity of the BIS, which is activated by threats of aversive stimulation. This conceptualization of the nature of anxiety deals with the question, "why is he afraid?". This question addresses the issues of the antecedents to and responses of anxiety. The question, "why is he afraid?", deals with the issue of individual differences in anxiety and in the functioning of the BIS (Gray, 1987, p. 2). Individuals with high trait anxiety are viewed as having an over-sensitive BIS. These individuals would be expected to exhibit behaviorally inhibited, risk-avoidant behavior patterns. In addition, an over-sensitive BIS would be expected to be associated with shyness, social withdrawal, sensitivity to failure, and poor active coping skills (Fowles, 1987). Passive avoidance would be a likely coping method. These individuals would also be expected to become more anxious than others in stressful situations.

Fowles (1987) points out a distinction between trait and state anxiety that is implicit in Gray's model. Situations which suggest a possible threat of punishment or non-reward will probably be **passively avoided** by individuals with an overly-sensitive BIS. Impulsive, disinhibited, high-BAS individuals, on the other hand, are more likely to put themselves in risky situations. Because high-BAS individuals may place themselves in situations which high-BIS individuals would not dare to be in, they may experience anxiety more frequently than high-BIS individuals. The high trait-anxious individual, in this view, is more **vulnerable** to threats of punishment and non-reward than high-BAS

individuals; but does not necessarily experience anxiety more frequently than high-BAS individuals (Fowles, 1987).

Conceptualizing this behavior-affect distinction in terms of approach-avoidance conflicts, Fowles (1987) has pointed out that high-BAS individuals' approach gradients are higher than their avoidance gradients. Such a state of affairs will result in the individual coming closer to punishment before conflict occurs, and thus anxiety will be experienced more frequently. High-BIS individuals, on the other hand, have higher gradients of avoidance than approach. As a result, the point of conflict will occur sooner, terminating approach behavior.

Relative to the extensive theoretical and animal-experimental work on the nature of the BIS in anxiety, direct empirical tests of the role of the BIS in human anxiety are limited in number. Nonetheless, several experiments using various populations and procedures have tested aspects of Gray's hypotheses. The studies comparing neurotic introverts to stable introverts, and neurotic and stable extraverts, as well as those examining anxiety will be discussed.

Using a go/no go discrimination task which measured response latency following consequences of reward and punishment, Patterson et al. (1987) showed that introverts responded slower following punishment, while extraverts responded faster following punishment. Neurotic introverts also made more errors of omission than did the stable introverts. Other studies have shown that introverts made fewer errors of commission than extraverts (e.g., Newman et al., 1985). That is, introverts tended to demonstrate excessive inhibition and deficits in

responding to obtain reward. These response patterns are clearly reflective of BIS activity as described by Gray (1987).

O'Boyle et al. (1986) examined the differential effects of benzodiazepine sedation in high- versus low-state anxious individuals before and during dental surgery. Only the high-state anxiety group showed decreases in state anxiety and heart rate prior to surgery, suggesting that benzodiazepines reduced the activity of the BIS. Benzodiazepines, however, did not reduce heart rate during surgery. Since surgery can be considered direct punishment, which does not activate the BIS, reductions in heart rate due to benzodiazepines should not have been expected. The changes prior to surgery were viewed as reflecting the disinhibiting effects of the benzodiazepines on the BIS, which was activated by signals of punishment (pre-surgery cues).

In another study using benzodiazepines, performance on operant tasks were examined (Carlton, Seigel, Murphree, & Cook, 1981). Reinforcement consisted of a gain of \$ 0.25 and punishment involved the loss of \$ 0.25 per trial. Relative to a placebo control group, the diazepam group showed poorer performance on tasks requiring inhibition of responding to avoid punishment. The authors concluded that diazepam attenuated the effects of punishment. Unfortunately, this study did not examine the whether diazepam also affected responses to reward.

Gray's model has recently been applied to the conceptualization of test anxiety (Geen, 1987). Since the study of test anxiety began, descriptions of the responses comprising test anxiety have typically included feelings of inadequacy, helplessness, the anticipation of punishment and loss of self-esteem, increased somatic activity, and

implicit attempts to leave the testing situation. Geen (1986, unpublished manuscript, cited in Geen, 1987) showed that when constraints against escaping from an aversive test situation (unsolvable line tracing task) were low, high-test-anxious (TA) individuals escaped more quickly than low-TA individuals. Under high constraints against escaping, however, high-TA individuals worked more slowly and more cautiously than low-TA individuals.

These findings were discussed by Geen (1987) within the framework of Gray's model. First, an aversive test situation is likely to activate the BIS, especially in high-TA individuals to whom the testing situation is a "complex stimulus **signaling** potential punishment" (emphasis added; Geen, 1987, p. 482). Second, once activated, the BIS inhibits behavior, and increases arousal and attention. Performing more slowly, and more cautiously then, is a form of passive avoidance of error of commission. Verbal reports of effort and attention were consistent with these findings. In another study, Geen (1985) examined differences in performance between high- and low-TA subjects on a signal detection task. One experimental condition emphasized that the task was a "test" reflective of intellectual functioning, while the other condition described the task as exploratory and experimental. The high-TA subjects made significantly more errors of omission in the "test" condition than in the no-test condition. The low-TA group was not affected by test condition. Although not statistically significant, the high-TA group made fewer errors of commission in the test condition than the low-TA group.

Geen (1985b) obtained similar results in a study which found that high-TA subjects attempted fewer anagrams than did low-TA subjects and reported higher state anxiety. When subjects were told they would not be penalized points (punished) for incorrect responses, group differences in the number of anagrams attempted were not found. Thus, the BIS was activated only when the testing situation was viewed as a signal for punishment. Activity of the BIS is associated with the internal state known as anxiety and results in passive avoidance of errors and increased arousal and attention.

Geen (1987) concluded that these findings suggest that under test taking situations, high test anxiety is associated with inhibited responding. Gray (1987b) concluded that Geen's findings are consistent with data which suggest that individual differences in reactions to certain types of reinforcers (or punishers) are strongly associated with characteristics such as introversion and test anxiety.

Conclusions

A conceptual nervous system, which includes distinct systems governing specific types of responses to certain types of stimuli, has been described. The Behavioral Inhibition System (BIS) is responsive to signals of punishment and non-reward, novel stimuli, and innate fear stimuli. Once activated by these aversive signals, the BIS inhibits ongoing behavior and increases in physiological arousal and attention. Appetitive signals of reward and non-punishment activate what is termed the Behavioral Activating System. These signals activate behavior to receive the direct appetitive stimulation. The Fight/Flight System is activated by direct punishment or non-reward, and mediates responses of

aggression or escape. Through the systems of the conceptual nervous system, a model for understanding individual differences in behavior patterns is derived.

High "trait" anxiety was described as a function of an overly sensitive BIS. Psychopathy was viewed as a mirror image of anxiety, both in terms of the behavior and behavioral systems with which they are associated. The conceptualization of test anxiety in terms of Gray's theory of anxiety was discussed, and serves as a foundation for the present study.

The present study examined the effects of test anxiety on performance of various behavioral tasks, each of which involved a conflict between responding for reward or not responding to avoid punishment or non-reward. Highly test anxious individuals were expected to experience higher levels of state anxiety and respond with greater behavioral inhibition than low-anxious individuals. This behavioral inhibition was expected to be evident according to frequency as well as latency measures of responding. More specific hypotheses will be presented following a discussion of the methods and procedures.

Method

Subjects

A sample of 686 subjects (298 males, 388 females) recruited from the introductory psychology and communication subject pools at Virginia Tech participated in the screening phase of the study. The mean age was 19.4 years for males, and 19.0 for females. Subjects scoring either approximately 1 SD above or below the mean of a normative sample on the Test Anxiety Inventory (Spielberger, 1980) were asked to participate in the second phase.

A total of 152 High and Low TAI subjects were tested using the computerized behavioral tasks. Of these, 28 subjects were omitted for one of three reasons. Failure to understand the basic concept and purpose of at least one of the tasks resulted in the omission of 7 High TAI subjects and 4 Low TAI subjects. Five High TAI and 5 Low TAI subjects were omitted because of repeated statements of boredom, and the appearance of disinterest and apathy while completing at least one of the tasks. Computer or experimenter errors resulted in the exclusion of 4 High TAI subjects and 3 Low TAI subjects. The remaining 124 subjects (54 males, 70 females) participated in the present study. Mean age was 19.0 years for males and 19.2 years for females.

The Low TAI group included 67 subjects, 33 in the Non-Reward condition (15 males, 18 females) and 34 in the Punishment condition (16 males, 18 females). The High TAI group consisted of 57 subjects, 28 in the Non-Reward condition (10 males, 18 females) and 29 in the Punishment condition (13 males, 16 females).

Materials

Test Anxiety Inventory (TAI; Speilberger, 1980). The TAI is a self-report instrument designed to measure test anxiety as a situation-specific trait. The TAI was constructed using correlational and factor analytic procedures with large samples of college and high school students. Extensive normative data are available. In addition to obtaining a total score of test anxiety (TAI-T), the TAI provides measures of worry (W) and emotionality (E).

The TAI consists of 20 items, which are rated on a four-point scale of frequency ranging from "almost never" to "almost always". The W subscale consists of 8 items such as "Thoughts of doing poorly interfere with my concentration on tests". The E subscale consists of 8 items such as "During tests I feel very tense". The remaining 4 items are combined with the E and W items to provide the TAI-T score. Raw scores are converted to percentile ranks or T scores. Administration time is between 5 to 8 minutes.

Reports of test-retest reliability range from .80 to .81 over two to four week time periods. Internal consistency for the TAI-T ranges from .92 to .96; and for the E and W subscales, internal consistency ranges from .85 to .91. Convergent validity with other test anxiety scales, and with the STAI State form administered during examination stress ranges from .82 to .83. Evidence supporting the discriminant validity of the E and W scores is mixed (DeVito, 1984).

Speilberger State-Trait Anxiety Inventory (STAI; Speilberger, 1983). The STAI is the most widely used self-report inventory for anxiety. It consists of separate scales for State and Trait anxiety.

The most recent revision of the STAI was based on factor and item analyses using over 5,000 college students. The STAI has been designed for high school and college students, and for adults. Administration time is approximately 10 minutes.

The State form consists of 20 items rated on a four-point **intensity** scale ranging from "Not at all" to "Very much so." Subjects are instructed to indicate how they feel "right now" for each item. Reports of the internal consistency range from .86 to .95. The stability, however, is lower ranging from .16 to .63, reflecting the transient and situationally determined aspects of state anxiety. The construct validity of the State scale has received strong support. The State form has been used to assess intensity of anxiety experienced during testing situations (DeVito, 1984).

The Trait form also consists of 20 items. These items are rated on a four-point **frequency** scale ranging from "Almost never" to "Almost always." The instructions are that the subjects indicate how they "generally feel." Reports of the internal consistency range from .89 to .91; and test-retest reliability over time periods from one hour to 14 weeks ranges from .65 to .86. The construct validity of the Trait form is less clear than that of the State form. Scores do not discriminate well between anxiety-based disorders and other forms of psychopathology. Some have suggested that the Trait scale may reflect feelings of dissatisfaction with oneself, and concern about one's adequacy (Chaplin, 1984).

Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986). The ASI was designed to provide a measure of anxiety

sensitivity, which is considered to be an individual difference in the belief that the state of anxiety will have negative consequences. It has been conceptualized as the cognitive component of the fear of fear construct. The ASI consists of 16-items, which are rated on a five-point intensity scale ranging from "Very little" to "Very much." Representative items include: "It scares me when I feel faint", and "Other people notice when I feel shaky."

Two-week test-retest reliability coefficients range from .71 to .75. Internal consistency of .82 has been reported (Telch, Shermis, & Lucas, 1989). The construct and discriminant validity of the ASI have received good support (Peterson, & Heilbronner, 1987; Reiss et al., 1986; Telch et al., 1989).

Fear Questionnaire (FQ; Marks & Mathews, 1978). The FQ was originally designed to assess treatment outcome with phobic patients. The full 24-item questionnaire includes two parts. The first 15 items consist of stimuli and situations which the respondent is asked to rate in terms of how much they are avoided. A nine-point scale ranging from "Would not avoid it" to "always avoid it" is used. The remaining items consist of anxiety-related reactions, and the respondent is asked to describe how disturbing each one is. This second part was not used in the present study.

Normative data are available on college students (Mizes & Crawford, 1986). Two-week test-retest reliability of .82 has been reported. There is good support for the discriminant validity of the FQ.

Checklist of Positive and Negative Thoughts (CPNT; Glassi, Frierson, & Sharer, 1981). The CPNT was developed to obtain information

about cognitions during test situations. The 37-item questionnaire consists of 18 positive and 19 negative thoughts. The CPNT has been shown to correlate well with the TAI. Internal consistency has been shown to be in the .70s. Items related to knowledge and studying were not used in the present study.

The 12-item modified version of the CPNT used in the present study included 6 positive and 6 negative thoughts. Positive thoughts included: will do all right; mind is clear, can concentrate; feel in control of my reactions; probably doing as well or better than other students; so involved that I have little idea of what's going on around me; and think how good I will feel if I do well. Negative thoughts consisted of: going to do poorly; mind is blank, can't think straight; don't feel able to control my reactions; other students are doing better than I am; wonder why I keep looking around the room or thinking about unrelated things; think how awful it will be if I fail or do poorly. Subjects were instructed to rate the frequency of which each thought occurred on a three-point scale ranging from "Did not experience" to "Experienced several times." The higher the score, the more negative and less positive thoughts were reported.

Eysenck Personality Questionnaire (EPQ; Eysenck & Eysenck, 1975). The EPQ consists of scales designed to measure three primary factors of personality: Psychoticism, Extraversion, and Neuroticism (a Lie scale is also included). These orthogonal factors were derived from extensive factor-analytic and experimental studies. Reported test-retest reliabilities over a one-month period range from .78 to .84 across the four scales. Internal consistencies range from the .70s to the .80s.

The EPQ can be administered to persons over 16 years of age, consists of 90 items, and takes approximately 25 minutes to complete. The items are statements to which the participant must respond "yes" or "no" (Friedman, 1987).

Behavioral Tasks

The behavioral tasks were presented on an IBM Personal Computer using a standard IBM green monitor. The psychological experiment program, Micro Electronics Laboratory, was used to design the computerized tasks. The computer program recorded all responses and provided feedback to the subjects. Two versions of each task were used, one for each experimental condition. For both conditions, correct responses resulted in a .5-second high-pitch tone and visual feedback (lasting 1.5 seconds) indicating that the subject's score had increased by 10 points. For the Non-Reward condition, incorrect responses resulted in visual feedback (lasting 1.5 seconds) indicating that no points had been earned; while no auditory feedback was provided. For the Punishment condition, incorrect response resulted in a .5-second low-pitch tone and 1.5 seconds of visual feedback indicating that the subject's score decreased by 10 points. For each task, the visual feedback included the subject's "total score." The auditory feedback occurred in the middle of the 1.5-second visual feedback.

Frequency and latency measures were taken for each behavioral task. The frequency measures included measures such as the total number of responses (bar presses), number of certain types of responses (e.g., correct, incorrect), and number of points earned. Latency measures included measures of mean Reaction Time (RT), RT after correct and

incorrect responses, and for one task, RT during the final 10 trials. These measures were selected because it was assumed behavioral inhibition would be evidenced by lower rates and longer latencies in responding.

Card Task. A modified version of the card-playing task used by Shapiro et al. (1988) was used. This computerized task presented the subject with a "deck" of 100 "cards" which were sequentially presented in random order. Face cards were designated as winning cards, while number cards were be designated as losing cards. The first block of 10 cards consisted of 9 winning cards and 1 losing card. The probability of getting a losing card increased by 10% after each block of 10 cards. Conversely, the probability of getting a winning card decreased by 10% with each subsequent block. Thus, by the fifth block, the probability of getting a winning card was equal to the probability of getting a losing card. Within each block, the sequence of winning and losing cards was randomized.

The primary dependent variable was frequency of bar presses, which was the number of responses made before terminating the task. If the task was not terminated by the subject, the number of bar presses reached a maximum of 100. Total points earned was another frequency dependent measure. Latency measures were mean RT, which was the average RT between the "?" prompt to respond and the response itself; and mean RT of the last 10 trials, which was the mean RT for the 10 trials before the task ended - either terminated by the subject or automatically following the 100 trials.

Go/No Go Discrimination Task. A modified version of the go/no go discrimination task used by Patterson et al. (1987) was used. Stimuli consisted of 12 two-digit numbers, six of which were designated as positive stimuli (S+) and six as negative stimuli (S-). On the basis of pilot testing, numbers were selected so that no pattern would distinguish the S+ from S- numbers. Each stimulus was presented for a maximum of 3 seconds or until the subjects responded. The inter-trial interval was 1.5 seconds.

Subjects were instructed to learn by trial-and-error when to respond by pressing the space bar and when not to respond. Correct responses (responding to an S+) were rewarded. Incorrect responses (responding to an S-) were followed either by the loss of points or no gain of points, depending on the experimental condition. The failure to respond within 3 seconds, whether correctly to an S- or incorrectly to an S+, did not result in any feedback.

The task provided a total of 114 trials, the first 18 of which were considered pre-treatment trials. The latter 96 trials consisted of 8 blocks of 12 stimuli. Within each block, all 12 stimuli were presented randomly, although no more than three consecutive S+ or S- stimuli were presented.

The frequency dependent measures were number of bar presses, errors of omission (E00), and errors of commission (EOC). Bar presses were the number of responses made by the subject, the maximum being 96. E00 refers to the number of times subjects failed to respond to an S+; whereas EOC refers to the number of times subjects responded incorrectly to an S-. Total points earned was also a frequency measure. Latency

measures included an overall mean RT, which was the mean amount of time between the presentation of the S+ or S- and the response. RT after incorrect responses and RT after correct responses refer to the mean RTs on the trials following EOCs and on the trials following correct responses to an S+, respectively.

Variable Interval Differential Reinforcement of Low rates of Responding Task (VI-DRL). A VI-DRL task similar to that used by Gordon (1979) and Shapiro et al. (1988) was used. Trials with pilot subjects suggested that the 6-second fixed interval schedule, used by these authors with children, was too simple for the subjects in the present study. A VI-6 schedule was used whereby the amount of time to delay for correct responding varied from 3 to 9 seconds. Responses made before the randomly chosen time interval were considered an incorrect response, and restarted the timer. The task was programmed to last for 6 minutes.

The primary frequency dependent measures were the number of bar presses, which was the number of responses made during the 6-minute task; efficiency ratio (ER), the number of correct responses to the number of total responses; and total points earned during the task. Latency measures included mean RT, which was the mean amount of time between responses, RT after incorrect responses, and RT after correct responses (the mean RTs on the trials following incorrect and correct responses, respectively).

Procedure

Pre-Screening. Several mass testing sessions were conducted to administer the pre-screening questionnaires. Groups varied in size from less than 10 to more than 60 subjects. After completing Consent Form A

(Appendix A), subjects were instructed to complete a series of questionnaires. The following questionnaires were included: STAI Trait, TAI, EPQ, FQ, and ASI. In addition, subjects completed a demographic questionnaire. Approximately 40 to 60 minutes were taken by most subjects to complete the pre-screening questionnaires. Subjects scoring near or beyond 1 SD from the normative sample's mean on the TAI were contacted and asked to participate in the second part of the study.

Behavioral Tasks. Once high and low TAI subjects were contacted, individual testing sessions were scheduled. Consent Form B (Appendix B) was administered to each subject at the outset of the session. Subjects were seated at a desk in front of a computer. The experimenter was seated on the right of the subject and was blind to the subject's TAI score (until the end of the experiment) and to his/her assignment to experimental condition (until the first STAI State was completed). An outline of the procedures is presented in Appendix C. The following instructions were read to each subject:

"You will be taking three computerized tests. Each one is different. These tests will measure your learning ability and motivation. They require intelligence and concentration. Generally, students at Virginia Tech do very well on these tests. Your performance will be measured by the number of points you earn. Your goal is to get as many points as you can on each test. This is the most important objective. Each test will last for only a limited amount of time, so you must try to earn as many points as you can in the time available. For each test, you will be provided with instructions about what you need to do. Read them carefully because you cannot ask questions once you begin the test. At the end, I will tell you how you have performed. Do you have any questions so far?"

After completing the STAI State, subjects were then instructed to type a few keys coded to indicate their subject number and condition.

The experimenter determined which experimental condition the subject would be tested under by checking a list. An attempt was made to counterbalance the order in which the tasks were presented and the experimental condition under which the subject would be tested. Although this was not entirely successful, the TAI groups were adequately balanced with respect to experimental condition, sex, and task order. The instructions for each task were presented to subjects on the computer screen.

Card Task. The instructions used by Shapiro et al. (1988) were modified to be more appropriate for the subjects in the present study (see Appendix D). The experimenter clarified the instructions when the subjects had questions, and emphasized the following: that the deck of cards was not "regular" in that there was not a specific number of each type of card; that the subject try to get as high a score as he/she could; and that he/she could stop any time by pressing the "Q" key.

Go/No Go Discrimination Task. The instructions used for the Go/No Go Task were based on those used by Patterson et al. (1987) (see Appendix E). The experimenter clarified the instructions when the subjects had questions. The experimenter emphasized that there was no pattern distinguishing good from bad numbers, that once a number is good or bad it is always that way, and that the subject try to get as high a score as he/she could.

VI-DRL Task. The instructions for the VI-DRL Task were based on those used by Shapiro et al. (1988) (see Appendix F). The experimenter clarified the instructions when the subjects had questions and emphasized that the subject try to get as high a score as he/she could.

STAI State Anxiety. The STAI State was administered immediately after the initial instructions were read to the subject, and was readministered following the completion of each of the three computerized behavior tasks. The instructions were modified so that rather than asking the subject how he/she feels "at this moment", the instructions asked how the subjects felt "during the past few minutes." The experimenter indicated that the instructions were "different" from the STAI State administered initially.

Checklist of Positive and Negative Thoughts (CPNT). A modified version of the CPNT was administered at the end of the experiment, following the completion of the fourth and final STAI State questionnaire.

Debriefing. Following completion of the CPNT, subjects were provided with positive feedback about their performance. The experimenter accessed the subject's questionnaire scores from the pre-screening. The experimenter provided High TAI subjects with information on test anxiety and offered interested subjects a booklet on test anxiety. For subjects who complained of severe difficulties relating to their test anxiety (approximately one-third of the High TAI subjects), the experimenter provided additional information on treatment and referred students to the University Counseling Services.

Hypotheses

Classification Measures.

1a. Assignment of subjects to groups on the basis of TAI-T scores was expected to result in significant group differences in all TAI factor

scores. The High TAI group was expected to have higher TAI-T, TAI-W, and TAI-E scores.

1b. A main effect of condition or interactions involving condition were not expected, since an attempt was made to match subjects on TAI-T scores in their assignment to condition.

1c. Group or condition interactions with sex were not expected.

No predictions were made in terms of the main effect of sex.

Other Anxiety Measures.

2a. A main effect of group was hypothesized for the various anxiety measures (STAI Trait, ASI, and FQ), with the High TAI group obtaining higher scores than the Low TAI group.

2b. A main effect of condition or interaction effects involving condition were not expected.

2c. Group or condition interactions with sex were not expected.

No predictions were made in terms of the main effect of sex.

Eysenck Personality Questionnaire.

3a. A main effect of group was hypothesized for the Neuroticism (N) scale, with the High TAI group obtaining higher N scale scores than the Low TAI group.

3b. A main effect of group was predicted for the Extraversion (E) scale, with the High TAI group obtaining lower E scale scores than the Low TAI group.

3c. A main effect of condition was not expected for any of the EPQ scales, nor were interaction effects involving condition.

3d. Group or condition interactions with sex were not expected for any of the EPQ scales.

No predictions were made with respect to the main effect of sex. No predictions of main effects were made for the Psychoticism and Lie scales.

State Anxiety.

4a. It was hypothesized that there would be a main effect of group on STAI state anxiety scores following the instructions and following all three behavioral tasks as the High TAI group was expected to obtain higher scores than the Low TAI group.

4b. A main effect of condition was hypothesized for State scores following each task (although not after the instructions), wherein State scores were expected to be higher in the Punishment condition than in the Non-Reward condition.

4c. A group by condition interaction effect was predicted for State scores following each task, in that the group differences were expected to be greater in the Punishment condition than in the Non-Reward condition.

No predictions were made in terms of the main effect of sex, or interactions effects involving sex.

Checklist of Positive and Negative Thoughts (CPNT).

5a. A main effect of group was hypothesized for CPNT scores, with the High TAI group obtaining higher scores than the Low TAI group.

5b. A main effect of condition was expected as CPNT scores were hypothesized to be higher in the Punishment condition than in the Non-Reward condition.

5c. A group by condition interaction was also predicted, wherein the group differences were expected to be greater in the Punishment condition than in the Non-Reward condition.

No predictions were made with respect to main or interaction effects of sex.

Behavioral Tasks.

For all of the behavioral tasks, it was predicted that the High TAI group would show greater evidence of behavioral inhibition than the Low TAI group. Thus, for all tasks a main effect of group was expected for the frequency and latency measures wherein the High TAI group was expected to show lower rates and longer latencies in responding than the Low TAI group. For all tasks, a main effect of condition was predicted in that the Punishment condition was expected to result in lower rates and longer latencies in responding than the Non-Reward condition. Finally, a group by condition interaction was hypothesized wherein the group differences in rates and latencies of responding were expected to be greater in the Punishment condition than in the Non-Reward condition for all tasks. Main effects of sex or interaction effects involving sex were not predicted.

Card Task.

6a. A main effect of group was predicted for the frequency measures with the High TAI group making fewer bar presses and obtaining fewer points than the Low TAI group.

6b. A main effect of group was expected for the latency measures wherein the High TAI group was predicted to have longer mean RTs and longer RTs during the last 10 trials than the Low TAI group.

6c. A main effect of condition was expected for the frequency measures as subjects in the Punishment condition were expected to make fewer bar presses and obtain fewer points than subjects in the Non-Reward condition.

6d. A main effect of condition was expected for the latency measures as subjects in the Punishment condition were expected to respond with and longer RTs than subjects in the Non-Reward condition.

6e. A group by condition interaction was predicted for all measures in that group differences were expected to be greater in the Punishment condition than in the Non-Reward condition.

Go/No Go Discrimination Task.

7a. A main effect of group was hypothesized for the frequency measures with the High TAI group making fewer bar presses, fewer errors of commission (EOCs), and more errors of omission (E00s) than the Low TAI group.

7b. A main effect of group was predicted for the latency measures as the High TAI group was expected to have longer RTs than the Low TAI group.

7c. A main effect of condition was predicted for the frequency measures wherein subjects in the Punishment condition were hypothesized to make fewer bar presses, fewer EOCs, and more E00s than in the Non-Reward condition.

7d. A main effect of condition was predicted for the latency measures as subjects in the Punishment condition were expected to have longer RTs than subjects in the Non-Reward condition.

7e. A group by condition interaction was expected with group differences predicted to be greater in the Punishment condition than in the Non-Reward condition.

VI-DRL Task.

8a. A main effect of group was hypothesized for the frequency measures as the High TAI group was expected to make fewer bar presses and have higher efficiency ratios (ER; ratio between total bar presses and correct responses) than the Low TAI group.

8b. A main effect of group was predicted for the latency measures with the High TAI group expected to respond with longer RT than the Low TAI group.

8c. A main effect of condition was expected for the frequency measures as fewer bar presses and higher ERs were expected for the subjects in the Punishment condition than for subjects in the Non-Reward condition.

8d. A main effect of condition was expected for the latency measures in that subjects in the Punishment condition were expected to have longer RTs than subjects in the Non-Reward condition.

8e. A group by condition interaction was predicted as group differences were expected to be greater in the Punishment condition than in the Non-Reward condition.

In sum, for all the behavioral tasks, the main effects of group and condition were expected as were group by condition interactions, wherein the group differences were expected to be greater in the Punishment condition than in the Non-Reward condition. No sex effects (main or interaction) were anticipated.

Results

Experimental Design

A 2 x 2 x 2 (Group x Condition x Sex) between-subjects design was used in present study. Test Anxiety Inventory (TAI) scores were the basis for group assignment. Subjects were assigned to one of two experimental conditions, based on matching of TAI scores. The experimental conditions, Non-Reward and Punishment, were distinguished on the basis of the consequence for incorrect responses. Sex was selected as a factor because sex differences in anxiety are often reported. The order in which the tasks were presented was not included as a factor because the number of subjects per cell was too small.

Classification Data

Test Anxiety Inventory-Total (TAI-T). A three-way (Group x Condition x Sex) ANOVA was performed on TAI-T scores. As expected, this analysis showed a highly significant main effect of group, $F(1, 116) = 1194.868$, $p < .001$, with the High TAI group showing higher TAI-T scores than the Low TAI group. No other main effects or interaction effects were found to be significant, indicating that the TAI-T scores were not different across condition and sex (see Table 3).

Table 3.

Test Anxiety Inventory Means and Standard Deviations

Condition	TAI Group			
	Low TAI		High TAI	
	Males	Females	Males	Females
Non-Reward				
<u>M</u>	25.8	26.6	66.4	63.8
<u>SD</u>	2.6	3.1	5.4	8.0
Punishment				
<u>M</u>	26.3	26.2	64.3	63.4
<u>SD</u>	3.6	3.6	9.7	8.5

TAI Emotionality and Worry Factors (TAI-E and TAI-W). A three-way (Group x Condition x Sex) MANOVA was conducted on TAI-E and TAI-W factors of the TAI. Similar to the findings of the ANOVA conducted on TAI-T scores, the MANOVA revealed a significant effect for group, $F(2, 115) = 630.802, p < .001$. Univariate ANOVAs showed highly significant main effects for group on both the TAI-E, $F(1, 116) = 1126.463, p < .001$ and the TAI-W scales, $F(1, 116) = 675.990, p < .001$. Again, no other main effects or interaction effects were significant for the TAI-E or TAI-W scales. These findings, which were consistent with the original hypotheses, demonstrate that the High TAI group had higher TAI-E and TAI-W scores than the Low TAI group. Like the TAI-T scores, these factor scores did not differ across condition and sex (see Table 4).

Questionnaire Data

Other Anxiety Measures. Scores on the STAI Trait, Anxiety Sensitivity Index (ASI), and Fear Questionnaire (FQ) were examined with a three-way (Group x Condition x Sex) MANOVA. As expected, multivariate analyses showed only a significant effect of group, $F(2, 115) = 48.231, p < .001$. The univariate analyses revealed significant main effects of group for the STAI Trait, $F(1, 116) = 118.491, p < .001$; ASI, $F(1, 116) = 118.491, p < .001$; and FQ, $F(1, 116) = 22.295, p < .001$. As hypothesized, the High TAI group had significantly higher scores on these measures than the Low TAI group. Again, scores on these anxiety measures did not differ across condition and sex (see Table 5).

Table 4.

Test Anxiety Inventory Emotionality and Worry Factors Means
and Standard Deviations

Condition	TAI Group			
	Low TAI		High TAI	
	Males	Females	Males	Females
Emotionality				
Non-Reward				
<u>M</u>	10.8	11.4	28.0	26.9
<u>SD</u>	2.0	1.4	2.3	3.1
Punishment				
<u>M</u>	10.8	11.1	27.1	27.1
<u>SD</u>	2.0	1.7	4.0	3.6
Worry				
Non-Reward				
<u>M</u>	9.5	9.7	25.3	23.6
<u>SD</u>	1.7	1.9	2.1	4.2
Punishment				
<u>M</u>	9.6	9.7	24.4	23.9
<u>SD</u>	1.5	1.9	5.2	4.1

Table 5.

STAI Trait, Anxiety Sensitivity Index, and Fear Questionnaire

Means and Standard Deviations

Measure	TAI Group			
	Low TAI		High TAI	
	Males	Females	Males	Females
STAI Trait				
<u>M</u>	30.8	30.7	48.8	48.6
<u>SD</u>	5.6	6.1	10.9	11.7
Anxiety Sensitivity Index				
<u>M</u>	11.2	11.9	24.1	25.1
<u>SD</u>	5.0	6.3	11.7	10.6
Fear Questionnaire				
<u>M</u>	17.1	23.1	31.8	32.4
<u>SD</u>	8.9	11.7	16.5	15.9

Eysenck Personality Questionnaire (EPQ). Scores on the Psychoticism (P), Extraversion (E), Neuroticism (N), and Lie (L) scales of the EPQ were examined using a three-way (Group x Condition x Sex) MANOVA. EPQ scores were not available for one subject. Multivariate analyses revealed significant main effects of group, $F(4, 112) = 48.842$, $p < .001$.

Univariate analyses showed that the main effect of group was significant for the Psychoticism, $F(1, 115) = 30.570$, $p < .001$; Neuroticism, $F(1, 115) = 153.418$, $p < .001$; and Lie scales, $F(1, 115) = 4.040$, $p < .05$. These findings indicate that the High TAI group obtained higher Psychoticism and Neuroticism scores and lower Lie scores than the Low TAI group (see Table 6). Such group differences were hypothesized for the Neuroticism scale but not the Psychoticism or Lie scales. Contrary to expectations, the main effect of group on the Extraversion scale did not indicate significant differences ($p = .111$), although the High TAI group scored numerically lower than the Low TAI group.

Table 6.

Eysenck Personality Questionnaire Means and Standard Deviations

Scale	TAI Group			
	Low TAI		High TAI	
	Males	Females	Males	Females
Psychoticism				
<u>M</u>	3.3	2.0	6.5	3.3
<u>SD</u>	1.8	1.8	3.4	2.1
Extraversion				
<u>M</u>	15.0	15.9	13.8	14.0
<u>SD</u>	4.6	4.5	6.2	5.6
Neuroticism				
<u>M</u>	6.1	8.4	15.0	16.8
<u>SD</u>	3.7	3.4	4.0	4.0
Lie				
<u>M</u>	5.4	6.8	4.3	5.5
<u>SD</u>	3.2	3.4	3.0	3.2

Self-Report During the Behavioral Tasks

STAI State by Task. STAI State scores obtained following the completion of each task, regardless of the task's order of presentation, were analyzed using a three-way (Group x Condition x Sex) MANOVA. A significant main effect of group was found, $F(4, 113) = 19.918, p < .001$. Separate ANOVAs revealed that this main effect was significant for STAI State scores following the instructions and following the completion of each behavioral task: Instructions, $F(1, 116) = 50.057, p < .001$; Card Task, $F(1, 116) = 43.203, p < .001$; VI-DRL Task, $F(1, 116) = 48.158, p < .001$; and the Go/No Go Task, $F(1, 116) = 54.150, p < .001$. As expected, the High TAI group obtained significantly higher STAI State scores than the Low TAI group following the presentation of the instructions and the completion of each of the behavioral tasks (see Table 7).

The main effect of condition was also found to be significant in the multivariate analysis, $F(4, 113) = 19.918, p < .001$. Univariate analyses found this main effect to be significant for STAI State scores following the Card Task, $F(1, 116) = 9.042, p < .01$ and the Go/No Go Task, $F(1, 116) = 8.668, p < .01$, only. As hypothesized, subjects in the Punishment condition obtained higher STAI State scores following the Card Task and the Go/No Go Task than those in the Non-Reward condition. As expected, there was no condition effect for STAI State scores following the instructions. Contrary to expectations, there was no condition effect on STAI State scores following the VI-DRL task, and no group by condition interaction for STAI scores following any of the tasks.

Table 7.

STAI State Means and Standard Deviations by Task

Task	TAI Group			
	Low TAI		High TAI	
	Males	Females	Males	Females
Non-Reward				
Instructions	26.9	32.4	38.4	38.4
<u>SD</u>	(4.0)	(15.2)	(11.7)	(6.8)
Cards Task	28.7	26.7	35.7	40.8
<u>SD</u>	(6.3)	(6.3)	(11.0)	(12.2)
Go/No Go Task	31.2	31.9	44.1	43.4
<u>SD</u>	(10.0)	(11.0)	(9.1)	(10.0)
VI-DRL Task	26.3	28.9	41.4	40.8
<u>SD</u>	(6.3)	(8.0)	(14.0)	(13.0)
Punishment				
Instructions	27.4	29.1	42.3	43.7
<u>SD</u>	(6.3)	(5.1)	(10.6)	(8.3)
Cards Task	31.0	32.2	51.4	40.1
<u>SD</u>	(9.1)	(16.1)	(9.9)	(10.0)
Go/No Go Task	32.9	37.5	53.2	50.1
<u>SD</u>	(10.7)	(8.1)	(14.7)	(10.9)
VI-DRL Task	27.4	28.9	43.9	37.9
<u>SD</u>	(8.2)	(7.5)	(12.4)	(12.3)

Checklist of Positive and Negative Thoughts (CPNT). A three-way (Group x Condition x Sex) ANOVA was conducted on the scores obtained on the modified CPNT. Consistent with the original hypotheses, a highly significant main effect of group was found, $F(1, 116) = 65.308, p < .001$, indicating that the High TAI group obtained higher CPNT scores than the Low TAI group. The main effect of condition was also found to be significant, $F(1, 116) = 5.297, p < .05$. As expected, subjects in the Punishment condition obtained higher scores than those in the Non-Reward condition (see Table 8). The group by condition interaction, which was hypothesized, was not significant.

Behavioral Tasks

Card Task. For the Card Task, the subjects were required to press the space bar in order to obtain points and positive audio-visual feedback. In the Non-Reward condition, a losing card resulted in the failure to obtain reward; whereas in the Punishment condition, a losing card resulted in the loss of points and negative audio-visual feedback. The probability of a winning card was 90% initially, but decreased by 10% every 10 trials. Subjects were encouraged to obtain high scores, and were given the opportunity to terminate the task.

The primary frequency dependent variables were the number of bar presses made before the task was terminated (either by the subject or automatically after 100 trials), and total points earned. Latency measures were mean RT, which was the average RT between the "?" prompt to respond and the response itself; and mean RT of the last 10 trials, which was the mean RT for the 10 trials before the task was ended.

Table 8.

Checklist of Positive and Negative Thoughts Means and

Standard Deviations

Condition	TAI Group			
	Low TAI		High TAI	
	Males	Females	Males	Females
Non-Reward				
<u>M</u>	17.9	18.2	22.3	22.0
<u>SD</u>	2.3	2.1	2.7	4.1
Punishment				
<u>M</u>	18.1	19.4	24.6	23.7
<u>SD</u>	1.1	3.3	4.3	4.2

Separate three-way (Group x Condition x Sex) MANOVAs were conducted for the frequency (bar presses and total points) and the latency (grand mean RT and mean RT for the last 10 trials) dependent measures (see Table 9). Analyses performed on the frequency measures revealed some effects consistent with the original hypotheses. Analyses of latency measures, contrary to expectations, did not indicate any significant main or interactions effects.

The MANOVA conducted on the frequency measures did not reveal a main effect of group ($p = .101$). However, univariate analyses showed a significant main effect of group for bar presses, $F(1, 116) = 4.709$, $p < .05$. As expected, the High TAI group terminated the session earlier ($M = 65.1$ bar presses) than did the Low TAI group ($M = 74.3$) across conditions.

Multivariate analyses did reveal a significant effect of condition, $F(2, 115) = 249.410$, $p < .001$. Separate ANOVAs showed that the main effect of condition was significant for bar presses, $F(1, 116) = 46.279$, $p < .001$ and total points, $F(1, 116) = 482.795$, $p < .001$. Fewer bar presses were made in the Punishment condition ($M = 55.4$) than in the Non-Reward condition ($M = 85.2$); and fewer points were earned in the Punishment condition ($M = 179.7$) than in the Non-Reward condition ($M = 468.4$). As hypothesized, subjects in the Punishment condition made fewer bar presses and obtained fewer total points than the subjects in the Non-Reward condition.

Table 9.

Card Task Dependent Variables Means and Standard Deviations

Measure	TAI Group			
	Low TAI		High TAI	
	Non-Reward	Punishment	Non-Reward	Punishment
Bar Presses				
<u>M</u>	90.1	58.9	79.4	51.3
<u>SD</u>	17.7	23.8	27.9	23.1
Total Points				
<u>M</u>	483.6	165.9	453.2	193.5
<u>SD</u>	33.7	88.6	81.8	72.7
Mean RT				
<u>M</u>	77.1	130.5	124.9	110.0
<u>SD</u>	73.4	119.9	154.9	77.9
Last 10 RT				
<u>M</u>	79.6	146.9	131.2	121.9
<u>SD</u>	87.8	132.3	212.4	108.4

Note: RT data are in milliseconds.

The group by condition interaction was not significant according to the MANOVA ($p = .086$). However, the group by condition interaction was found to be significant for total points according to exploratory univariate analyses, $F(1, 116) = 4.915$, $p < .05$. This interaction was further explored with simple effects ANOVAs conducted across groups. One-way (Group) ANOVAs conducted for each condition revealed a marginally significant group effect for the Non-Reward Condition, $F(1, 59) = 3.805$, $p = .056$, but not for the Punishment condition. The TAI groups, therefore, differed (although not significantly according to one-way ANOVAs) in their total points only in the Non-Reward condition (See Figure 1). This finding that the High TAI group obtained fewer total points is contradictory to the original hypotheses and will be discussed later.

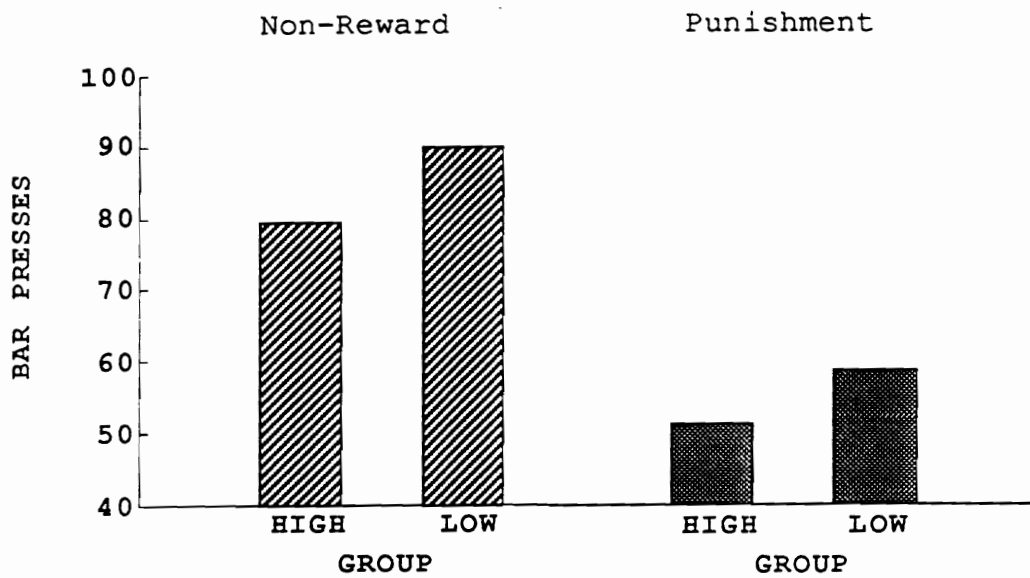


Figure 1. Group by Condition Interaction for Total Points,
Card Task

Go/No Go Discrimination Task. The Go/No Go Task required the subjects to learn for which stimuli (S+) responses would result in reward and for which stimuli (S-) responses would result in punishment (or non-reward). Errors of commission (EOCs) occurred when responses were incorrectly made in response to an S-. Errors of Omission (EOOs) occurred when responses were not made in response to an S+. The number of bar presses made and total points earned were also frequency measures. Latency measures were overall mean RT, which was the mean amount of time between the presentation of the S+ or S- and the response. RT after incorrect responses, and RT after correct responses refer to the mean RTs on the trials following EOCs and responses to an S+, respectively. Separate MANOVAs were conducted for the frequency dependent measures (EOO, EOC, bar presses, and total points) and the latency measures (RT after errors, RT after accurate responses, and mean RT; see Tables 10 and 11).

The MANOVA on the frequency measures showed a significant main effect of group, $F(4, 113) = 2.552, p < .05$. Separate ANOVAs found the main effect of group to be significant for EOOs, $F(1, 116) = 5.874, p < .05$; EOCs, $F(1, 116) = 6.860, p < .05$; and bar presses, $F(1, 116) = 9.200, p < .01$. These findings are consistent with the original predictions that the High TAI group would make more EOOs, fewer EOCs, and made fewer bar presses than the Low TAI group.

Table 10.

Go/No Go Discrimination Task Frequency Dependent Variables Means
and Standard Deviations

Measure	TAI Group			
	Low TAI		High TAI	
	Non-Reward	Punishment	Non-Reward	Punishment
Bar Presses				
<u>M</u>	76.3	54.4	62.8	51.7
<u>SD</u>	17.7	12.4	15.4	13.6
Total Points				
<u>M</u>	493.0	235.0	498.2	253.8
<u>SD</u>	84.4	106.7	128.7	152.5
EOO				
<u>M</u>	4.5	12.1	9.3	13.7
<u>SD</u>	7.4	5.9	7.4	6.2
EOC				
<u>M</u>	32.8	18.5	24.1	17.3
<u>SD</u>	13.1	9.0	11.4	10.7

Table 11.

Go/No Go Discrimination Task Latency Dependent Variables Means and Standard Deviations

Measure	TAI Group			
	Low TAI		High TAI	
	Non-Reward	Punishment	Non-Reward	Punishment
Mean RT				
<u>M</u>	889.8	1099.4	986.8	1126.1
<u>SD</u>	412.5	262.6	225.2	248.2
RT after Errors				
<u>M</u>	925.6	1258.1	895.1	1020.3
<u>SD</u>	443.8	284.5	157.8	271.2
RT after Correct				
<u>M</u>	919.5	1140.9	1049.9	1210.9
<u>SD</u>	463.9	285.7	278.9	333.9

Note: RT data are in milliseconds.

A significant main effect of condition, $F(4, 113) = 61.013$, $p < .001$, was also revealed by the MANOVA. Separate ANOVAs showed that this main effect was significant for each of the frequency measures: EOs, $F(1, 116) = 23.589$, $p < .001$; EOCs, $F(1, 116) = 24.511$, $p < .001$; bar presses, $F(1, 116) = 34.472$, $p < .001$; and total points, $F(1, 116) = 131.912$, $p < .001$. As expected, subjects in the Punishment condition made more EOs, fewer EOCs, fewer bar presses, and obtained fewer total points than subjects in the Non-Reward condition.

Although a group by condition interaction was not significant according to multivariate analyses, separate, exploratory ANOVAs revealed significant effects for two of the four measures. A significant group by condition interaction was evident for EOCs, $F(1, 116) = 4.392$, $p < .05$ and for bar presses, $F(1, 116) = 4.308$, $p < .05$ (see Figures 2 and 3). This group by condition interaction was examined further with simple effects ANOVAs conducted across groups for EOCs and bar presses.

Separate one-way (Group) ANOVAs were conducted for each condition using EOC and bar presses as the dependent measures. The main effects of group on EOC, $F(1, 59) = 7.605$, $p < .01$, and bar presses, $F(1, 59) = 10.001$, $p < .01$ were significant for the Non-Reward condition only. Contrary to the original hypotheses, the High TAI group made fewer EOCs and fewer bar presses than the Low TAI group in the Non-Reward condition than in the Punishment condition. Thus, group differences were greater in the Non-Reward condition than in the Punishment condition.

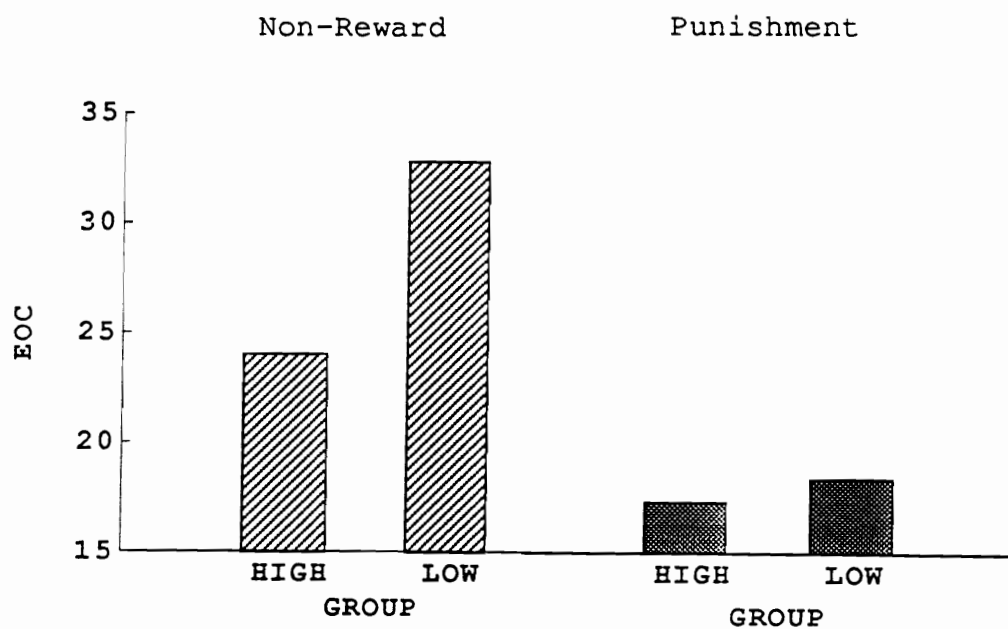


Figure 2. Group by Condition Interaction for Errors of Commission,
Go/No Go Discrimination Task

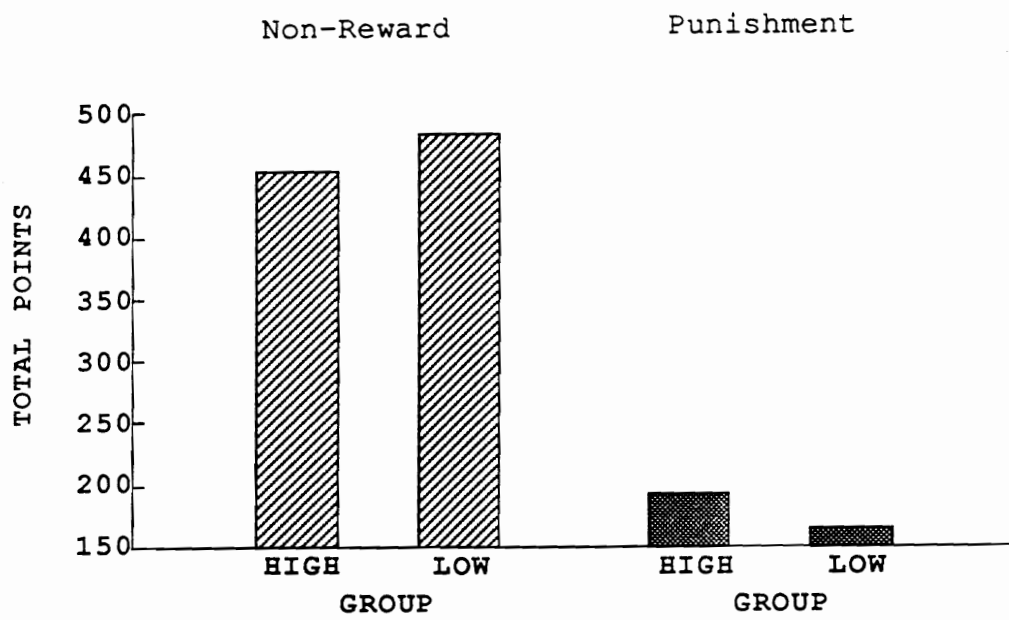


Figure 3. Group by Condition Interaction for Total Points,
Go/No Go Discrimination Task

The latency measures were analyzed using a three-way (Group x Condition x Sex) MANOVA (4 subjects were deleted in these analyses because they had no EOC, and thus had no data for RT after incorrect responses). A significant main effect of condition was found, $F(3, 110) = 4.515$, $p < .01$. Separate ANOVAs found this main effect of condition to be significant for: mean RT, $F(1, 112) = 12.388$, $p < .001$; RT after accurate responses, $F(1, 112) = 10.860$, $p < .001$; and RT after incorrect responses, $F(1, 112) = 13.094$, $p < .001$ (see Table 11). As predicted, the subjects in the Punishment condition had longer RTs in general than the subjects in the Non-Reward condition. Contrary to expectations, however, a main effect of group was not found, nor was a group by condition interaction for any of the latency measures.

VI-DRL Task. The VI-DRL Task required subjects to respond with low rates of bar pressing in order to obtain reward and avoid punishment (or non-reward). A VI-6 schedule was used whereby the amount of time necessary to wait before making a response which was reinforced varied from 3 to 9 seconds. Bar presses were the number of responses made during the 6-minute task; while the efficiency ratio (ER) was the ratio of the number of correct responses to the number of total responses; and total points earned during the task were the frequency measures. Latency measures included mean RT, which was the mean amount of time between responses; and RT after incorrect responses and correct responses, which were the mean RTs on the trials following incorrect and correct responses, respectively.

The three-way (Group x Condition x Sex) MANOVA conducted for the frequency measures (bar presses, total points, and Efficiency Ratio -

ER) revealed only a main effect of condition, $F(3, 114) = 53.469, p < .001$. Separate ANOVAs found this main effect to be significant for total points, $F(1, 116) = 38.894, p < .001$. Not surprisingly, subjects in the Non-Reward condition obtained more points than those in the Punishment condition (see Table 12).

Another three-way (Group x Condition x Sex) MANOVA was conducted for the latency measures (mean RT, RT after errors, and RT after correct responses). This analysis did not reveal any significant main effects. Separate ANOVAs found the main effect of condition to be significant for RT after errors, $F(1, 116) = 4.915, p < .05$, indicating that responses after errors were slower in the Punishment condition than in the Non-Reward condition. Although these condition effects supported the hypotheses, the predicted main effect of group was not found nor was the group by condition interaction effect obtained.

Table 12.

VI-DRL Task Dependent Variables Means and Standard Deviations

Measure	TAI Group			
	Low TAI		High TAI	
	Non-Reward	Punishment	Non-Reward	Punishment
Bar Presses				
<u>M</u>	45.7	42.4	47.0	40.9
<u>SD</u>	12.3	9.9	16.0	9.6
Total Points				
<u>M</u>	338.8	219.1	326.8	220.3
<u>SD</u>	46.8	146.1	54.0	137.3
Efficiency Ratio				
<u>M</u>	0.68	0.74	0.66	0.75
<u>SD</u>	0.19	0.17	0.22	0.17
Mean RT				
<u>M</u>	767.4	819.8	774.4	851.4
<u>SD</u>	167.4	166.0	230.7	180.4
RT after Errors				
<u>M</u>	732.9	781.5	695.0	826.8
<u>SD</u>	220.9	154.7	180.7	219.6
RT after Correct				
<u>M</u>	819.5	848.3	810.0	874.8
<u>SD</u>	162.2	183.2	258.3	190.0

Discussion

Overall, the findings of the present study lend support to Gray's theory that individual differences in anxiety are associated with individual differences in functioning of the Behavioral Inhibition System (BIS). For the behavioral tasks used in the present study, behavioral inhibition was defined in terms of rates of responding and latencies in responding. Moreover, behavioral inhibition was shown to occur more in response to signals of punishment than to signals of non-reward. Relative to subjects scoring low on the Test Anxiety Inventory (TAI), High TAI subjects were expected to make fewer responses and have longer latencies. In addition, relative to subjects in the Non-Reward condition, those in the Punishment condition were expected to make fewer responses and have longer response latencies. Finally, in keeping with Gray's theory, activity of the BIS was expected to be associated with higher levels of state anxiety. The findings of the present study lend support to Gray's theory of the BIS only at a behavioral level of analysis.

Group differences were evident on two (Cards and Go/No Go) of the three behavioral tasks, with the High TAI group showing more behavioral inhibition on frequency measures. Group differences were not consistently found on latency measures. On all of the behavioral tasks, group differences in state anxiety, according to self-report on the STAI State, were evident. As expected, the High TAI group reported higher levels of state anxiety than the Low TAI group. Thus, Gray's view that anxiety is related to increased sensitivity of the Behavioral Inhibition

System (BIS), evident by increased behavioral inhibition and subjective state anxiety, was supported.

Differences in behavioral inhibition as a function of the condition were present in all of the behavioral tasks, according to frequency measures. With respect to the latency measures, condition effects were also evident in two of the three behavioral tasks (VI-DRL and Go/No Go). As expected, subjects in the Punishment condition made fewer responses and took longer to respond than subjects in the Non-Reward condition. Differences in self-reported anxiety across conditions were evident for two of the three behavioral tasks (Cards and Go/No Go), with subjects in the Punishment condition reporting higher levels of anxiety. Consistent with Gray's theory, signals of punishment resulted in greater activity in the BIS than did signals of non-reward, evident by increased behavioral inhibition and subjective anxiety.

In addition to the main effects of TAI group and experimental condition, group by condition interaction effects were hypothesized. It was expected that the TAI group differences would be greatest in the Punishment condition. Contrary to this prediction, the group by condition interactions which were evident for two of the three behavioral tasks (Cards and Go/No Go), indicated that group differences were greater in the Non-Reward condition with the High TAI group showing more behavioral inhibition. These findings will be discussed in more detail following a review of differences associated with classification of subjects.

Classification

The classification of subjects into High and Low TAI groups was successful in terms of obtaining groups with extreme TAI scores. The High TAI group mean TAI score was over 1.5 SD above the mean; while the Low TAI group mean TAI score approached 1.5 SD below the normative sample's mean score. Scores on the Emotionality and Worry factors of the TAI were similarly extreme.

As hypothesized, the High TAI group scored higher than the Low TAI group on the STAI Trait, Anxiety Sensitivity Index (ASI), and Fear Questionnaire (FQ). Although the High TAI group's scores on the STAI Trait and ASI were not extremely high, they suggest that the High TAI subjects, as a group, evinced marginally high levels of "trait" anxiety and reported increased concerns about the negative consequences of experiencing anxiety (Reiss et al., 1986). The Low TAI group's moderately low STAI Trait scores, and average ASI and FQ scores suggest low levels of "trait" anxiety, normal concerns about the negative consequences of anxiety, and normal avoidance of potentially threatening "everyday" stimuli (Mizes, & Crawford, 1986). Chaplin's (1984) view of the STAI Trait, would suggest that the subjects in the High TAI group may be more generally dissatisfied with themselves than the Low TAI subjects.

Although the High TAI group was expected to have higher Neuroticism (N) scale scores than the Low TAI group, they were not expected to have higher Psychoticism (P) scale scores. The High TAI group's marginally elevated scores on the N scale suggest that the High TAI subjects were somewhat prone to worry, tended to become preoccupied with concerns

about what "might go wrong," and reacted to such concerns with a strong anxious response. In contrast, Low TAI subjects' average scores on the P, Extraversion (E), and Lie (L) scales; and marginally low scores on the N scale indicated high "stability", a characteristic purportedly associated with a calm, even-tempered, controlled pattern of behavior (Eysenck & Eysenck, 1975). Contrary to expectations, the groups did not differ with respect to Extraversion. The implications of these findings for the present study are discussed below.

Based on the self-report measures discussed, the Low TAI subjects, as a group, can be viewed as generally "psychologically healthy." In addition to being highly test anxious, subjects in the High TAI group can be characterized as somewhat anxious, neurotic, and perhaps more dissatisfied with themselves. It is critical that the Low TAI group not be viewed as the "opposite" of the High TAI group. Subjects in the Low TAI group, according to the measures obtained, did not exhibit abnormally low levels of fear and were not highly extraverted or disinhibited. This distinction is important given the findings with "psychopaths" and "neurotic extraverts" which suggest that these groups are generally less sensitive to aversive signals (e.g., Newman, 1987). Using Eysenck's terminology (Eysenck & Eysenck, 1975), the Low TAI group could be classified as "stable," whereas the High TAI group could be classified as "neurotic."

According to the anxiety measures and the EPQ, the TAI groups were not as extreme (in terms of measures other than test anxiety) as originally expected. Although the High TAI group was somewhat pathological (as described above), the Low TAI group was relatively

"normal." This is offered as a post-hoc explanation for the group by condition interaction effects which were contrary to the original hypotheses. Group differences were expected to be greater in the Punishment condition, yet they were actually greater in the Non-Reward condition. Had the Low TAI group been more extreme in terms of being disinhibited, and thus less sensitive to signals of punishment, like the "neurotic extraverts" described by Nagpal and Gupta (1979), the group differences may have been greater in the Punishment condition. This will be discussed further later.

In terms of Gray's theory, the High TAI group, based on their scores on the anxiety measures, were expected to have an overly-sensitive BIS. The Low TAI group, on the other hand, was viewed as having a "normal" BIS. Again, had the Low TAI group obtained more extreme scores on the measures described above - and as originally expected, they would have been viewed as having an under-sensitive BIS.

State Anxiety

Consistent with the literature on test anxiety (e.g., Depreeuw, 1984), the High TAI group reported significantly higher levels of state anxiety than the Low TAI group after simply listening to instructions which indicated they would be taking a test and would be evaluated. Furthermore both groups' reports of state anxiety on the STAI State following each of the behavioral tasks lends support to the validity of the TAI, at least in terms of self-reported state anxiety. Although the High TAI group's mean STAI State scores for each task were not extremely high (range: 38.4 to 51.4), they were reliably higher than Low TAI group mean scores (range: 27.6 to 35.9) for each task. These group

differences suggest that the instructions and behavioral tasks were appropriately anxiety-eliciting so that High TAI subjects reported moderate levels of anxiety while Low TAI subjects did not.

The finding that both TAI groups reported higher levels of state anxiety in the Punishment condition than in the Non-Reward condition was not surprising. It was not expected, however, that the High and Low TAI groups would show increases to a similar degree. That is, the hypothesized group by condition interaction predicted that state anxiety in the Low TAI would not be affected as much by the Punishment condition as the High TAI group. The finding that Low TAI subjects were affected to a similar degree, lends additional support to the notion that the Low TAI group is not "fearless" or extremely low-anxious.

According to Gray's theory, higher levels of state anxiety should be associated with greater behavioral inhibition. Group differences in behavioral inhibition on two of the three behavioral tasks support this basic notion. The condition effects on STAI State scores are also consistent with Gray's view of the association between anxiety and activity of the BIS. Associated with this higher level of state anxiety, were higher levels of behavioral inhibition in the Punishment condition across TAI groups. In fact, the main effect of condition was highly significant for all three tasks according to a number of measures. Consistent with Gray's theory then, signals of punishment (Punishment condition) were more highly associated with increased levels of state anxiety and increased behavioral inhibition than were signals of non-reward.

As already discussed, group differences in behavioral inhibition on the behavioral tasks were evident according to several measures. Assignment to groups was based on TAI-T score, purportedly a situation-specific trait measure. Self-reported anxiety during the tasks, according to STAI State scores, also differentiated the groups. Given that the groups differed according to measures of test anxiety and state anxiety, the source of the group differences in performance is not entirely clear. Differences may be a function of "trait" anxiety, test anxiety, state anxiety, or some combination thereof.

The experimental design used in the present study does not allow for clarification of this issue. An experimental manipulation of state anxiety, while controlling for test anxiety and trait anxiety, could better determine the degree to which group differences, such as the ones observed in the present study, were a function of trait, test, or state anxiety.

Behavioral Tasks

The group differences found in the present study can be understood in terms of Gray's theory which proposes that differences in anxiety are related to sensitivity of the BIS, the system which mediates responses to signals of punishment and non-reward. To further advance this notion of differences in sensitivity of the BIS, the following framework is offered.

The parameters of **stimulus reliability** and **consequence intensity** form the basis of this conceptual framework. When a stimulus reliably and consistently signals that a response will lead to a particular event, individual differences in response to that stimulus would be

expected to be minimal. A reliable stimulus would be either an S-d which signals a response will always be followed by an appetitive event; or an S-delta, which signals a response will always be followed by an aversive event. For example, if a vending machine had an "out of order" sign on it, most individuals would not attempt to make a purchase.

In the case of ambiguous signals (i.e., those which are not clearly S-ds or S-deltas) individual differences in responding would be expected, at least in part, to be a function of BIS (or BAS) sensitivity. A BIS which is more sensitive to signals of punishment and non-reward would be more likely to mediate responses of greater behavioral inhibition to ambiguous signals. That is, increased BIS sensitivity can be thought of as a bias to inhibit behavior in response to potentially threatening or ambiguous stimuli.

In terms of the intensity of the consequence for responding to a particular stimulus, individual differences would be expected to be small when the consequence is very intense. Conversely, when the consequence is not intense, individual differences would be expected to be greater. In the case of aversive stimuli, such differences might be a function of Flight/Fight System sensitivity.

In a situation where a reliable and clear S-delta signals that a response not occur to avoid an intense aversive consequence such as serious injury or death, individual differences would not be expected to be great. Taking an extreme example, most people would not get in their car if the engine were on fire. In a situation where the signals are less clear and the consequences not as intense, individual differences would likely be greater. Returning to the car example, if smoke could

be smelled in the vicinity of the car, some individuals might ignore it while others would inspect the engine, call the police, etc. The functioning of the BIS could be one factor which accounts for such individual differences.

Differences in behavioral inhibition between experimental conditions of the present study can be viewed as more of a function of differences in the intensity of the consequences of responding incorrectly. Gray (1987) describes the difference between punishment and non-reward (the failure to obtain reward in the context of reward) in terms of intensity of aversiveness. Although both signals of punishment and non-reward activate the BIS, the BIS is thought to be more responsive to signals of punishment.

Card Task. The signal for this task was a "?", which was presented during the inter-trial interval. In the Non-Reward condition, the card task involved a gradual "thinning" in the density of reinforcement for bar presses (with points and positive audio-visual feedback). A partial reinforcement schedule (PRF) quickly became evident. Sometime during block-9 (after the last reinforced trial), the bar pressing was no longer reinforced. Early termination of the task was provided as an option (extinction).

In the Punishment condition, the density of reinforcement decreased while the density of punishment increased. During block-9 (after the last reinforced trial), bar pressing became a totally punished response. Early termination of the task resulted in both the loss of opportunity for additional reinforcement as well as the avoidance of additional punishment (passive avoidance). This is essentially a case of an

approach-avoidance conflict. The point of "conflict" is viewed as being the point at which the task was terminated. It is unclear why behavioral inhibition in the form of slowed responding was not evident for the Card Task, especially during the last 10 trials - presumably near the point of conflict.

Thus, the "?" was initially an S-d. As it became more associated with non-reward or punishment over the course of continued responding, it became a less reliable signal. The High TAI group's termination of the session earlier (\bar{M} = 65.1 bar presses) than the Low TAI group (\bar{M} = 74.3) suggests that the High TAI group was more sensitive to responding to the "?" as an S-delta after experiencing fewer non-rewarded and punished trials than the Low TAI group.

The task was terminated sooner in the Punishment condition than in the Non-Reward condition. This finding was expected, and supported the assumption that loss of points and negative audio-visual feedback were punishing in a functional sense. Both groups terminated the task at an appropriate point (during block-5) when the probability of punishment was approximately equal to the probability of reward. This lends further support to the notion that the Low TAI group was not unresponsive to punishment or disinhibited.

Contrary to initial expectations, it was in the Non-Reward condition that group differences were the greatest. Low TAI subjects, as a group, terminated the task later (\bar{M} = 90.1) than the High TAI group (\bar{M} = 79.4). This can be viewed as a function of High TAI group being more sensitive to the signals of non-reward. The High TAI group responded to the "?" as an S-delta after experiencing fewer non-

rewarded trials. As discussed earlier, this finding is viewed as a function of the TAI groups not being as extreme as originally expected and that the group differences were overshadowed by the relatively high intensity of consequences for incorrect responses in the Punishment condition. The highly significant condition effects support this possibility.

Comparisons between the present study and the Shapiro et al. (1988) study, which involved the use of a similar task, should be made cautiously. In addition to the obvious subject differences, the Shapiro et al. (1988) version of the card task was slightly different in that dimes were given for reinforcement and taken away for punishment (there was no non-reward condition). Conduct Disordered (CD) children were found to make more responses before terminating the task ($M = 78$) than the comparison group ($M = 48$). This resulted in their obtaining far fewer rewards.

The CD group's apparent insensitivity to the signals of punishment is contrasted to the sensitivity of the Low TAI group in the present study (in the Punishment condition). Although the Low TAI group earned fewer points than the High TAI group in the Punishment condition, this difference was not statistically significant. That is, the Low TAI group did not continue to respond in the face of increasing punishment - as did the CD group in the Shapiro et al. (1988) study. The Low TAI group terminated the session in both conditions at appropriate points in the task. Although the High TAI group terminated the session at an appropriate point in the Punishment condition, termination of the task in the Non-Reward condition at the end of block-7 seems less adaptive

since there was "nothing to lose" (in terms of points) for continued responding.

Go/No Go Discrimination Task. The most powerful effects were evident for the Go/No Go Task. The 12 stimuli presented were, especially initially, ambiguous in terms of whether responding would yield reward or non-reward. As long as it was not entirely clear which stimuli were "good" and which were "bad" numbers, the numbers can be conceptualized as similar to the "?" in the Card Task. With repeated trials, the S+ and S- numbers can be viewed as more reliable S-ds and S-deltas, respectively. An overly-sensitive BIS, would be more likely to mediate responses of behavioral inhibition to these stimuli while they remained ambiguous. Once it was clear, however, that a particular number was an S+ or S-, then individual differences would not be expected. Behavioral inhibition on this task was evident by Errors of Omission (EOO), which occur when the subject fails to respond to an S+. Errors of Commission (EOC), on the other hand, occur when the subject responds to an S-.

The finding that the High TAI group made more EOOs, and fewer EOCs and total bar presses than the Low TAI group was consistent with studies using the Go/No Go Task with neurotic introverts (e.g., Newman et al., 1985; Patterson et al., 1987). The High TAI group could be characterized as responding in a passive avoidant manner. This pattern can be viewed as a bias in inhibiting behavior in response to ambiguous, potentially threatening stimuli. A consequence of behavioral inhibition in this task is that the stimuli **remain** ambiguous because the failure to respond results in insufficient feedback.

Differences in experimental condition were found for the frequency- and latency measures of this task. Greater EOOs with fewer EOCs in the Punishment condition can be viewed as reflective of increased caution in responding to passively avoid punishment. This finding is consistent with Geen's (1985) findings of greater cautiousness in responding among highly test anxious subjects.

The increase in group differences in behavioral inhibition, evident by fewer EOCs and total bar presses, in the Non-Reward condition was contrary to the original hypothesis. As was discussed earlier this finding is viewed as a function of the aversive consequences in the Punishment condition overshadowing differences between the less than extreme groups.

VI-DRL Task. Although some effects were obtained with the VI-DRL Task, meaningful group and condition differences were not demonstrated. Theoretically, the task should involve a sense of urgency. That is, the subject should be in a state where there is a need to respond as soon as possible to obtain the reinforcer and because the reinforcer will not be available later. At the same time, responding too quickly will result in loss of reward and missed opportunities to gain access to the reinforcer. It is doubtful that this urgency was present in the VI-DRL Task used in the present study. Mean RTs of approximately 8 seconds, during a VI-6 schedule supports this notion. Anecdotally, many subjects commented that the VI-DRL task was less challenging than the other tasks.

In sum, for two of the three tasks, group differences in behavioral inhibition were evident. The Punishment condition resulted in increased

behavioral inhibition for all tasks. The finding that group differences were greater in the Non-Reward condition, which were contrary to original expectations, were viewed primarily as a function of not having highly extreme groups (in terms of measures other than test anxiety). The High TAI group showed high levels of behavioral inhibition, whereas the Low TAI group showed appropriate responding and was not at all disinhibited. Furthermore, the Punishment condition may be viewed as involving too much of a contrast in the consequences between correct and incorrect responding. As discussed earlier, the intensity of the consequences would logically have an effect on individual differences. The intensity of the negative consequences (in the Punishment condition) might have been too strong to allow individual differences to be revealed.

Anxiety

With respect to test anxiety, the findings of the present study are generally consistent with those obtained by Geen (1986, 1987). Geen (1987) found that when constraints against leaving the test situation were low, highly test anxious (TA) students stopped earlier than low TA students. For the Card Task, it was made clear at the outset that the subject could stop at any time. High TAI subjects, as a group, stopped earlier (made fewer bar presses before terminating the task) than Low TAI subjects.

In another study, Geen (1986) found that high TA subjects made more E00s on a signal detection task, similar to the Go/No Go Discrimination Task used in the present study. Again, this passive avoidance of errors was greater for the High TAI group than the Low TAI group. One point of

contradiction with Geen's (1985) findings is that he showed TA group differences were greater under a condition where incorrect responses were punished than when incorrect responses did not result in any negative consequence (non-reward). This inconsistent finding may be a function of differences in the relative aversiveness of the consequences within and between studies.

Consistent with findings frequently obtained in studies investigating reactions of high TA subjects in test situations, the High TAI group endorsed more negative and less positive thoughts on the modified version of the Checklist of Positive and Negative Thoughts. Several studies have found that high TA subjects report more negative and interfering thoughts, fewer positive thoughts, and believe that they perform more poorly compared to subjects lower in TA (e.g., Arnkoff & Smith, 1988; Glassi et al., 1981).

Gray's theory attempts to explain and understand differences in the state of anxiety as well as in the characteristic of anxiety proneness. The selective effects of anxiolytic medications on learning and behavior and the animal lesion research, viewed from the perspective of two-factor learning theory form the basis of the BIS. Gray suggests that individual differences in anxiety are a function of BIS sensitivity and activation. To test this, the behavior of high and low TA subjects was observed. The findings of greater behavioral inhibition, which is mediated by the BIS, suggests that high TA is associated with a BIS that is overly-sensitive. This sensitivity was conceptualized as a bias to respond to unreliable or ambiguous stimuli as though they are more likely to result in aversive rather than appetitive consequences.

Having supported the hypothesis that BIS over-sensitivity is associated with anxiety, an issue common to the area of individual differences arises. How stable and cross-situational is this BIS over-sensitivity? With test anxiety, the BIS over-sensitivity may be somewhat situation-specific. As noted earlier, the design of the present study does not allow for firm conclusions on this issue. If these differences are relatively stable, however, a broader question arises. What are the origins of individual differences in BIS functioning?

Although the present study does not address this issue, other areas of research may bring us toward a better understanding of these questions. In a line of research independent of Gray's work, behavioral inhibition in infants and young children has received much attention. A review of this extensive literature base will not be provided, but some relevant findings will be discussed.

The tendency for infants to respond to unfamiliar events with either approach or withdrawal has been viewed as a significant temperamental factor for several decades. Inhibition to the unfamiliar has been shown to be a relatively stable temperamental characteristic that has genetic, biological, and physiological correlates (see Garcia-Coll, Kagan, & Reznick, 1984).

In a study (Garcia-Coll et al., 1984) examining behavioral inhibition of 21-month olds, approximately 10% of the children evaluated were classified as inhibited in their responses (another 10% were classified as uninhibited). For these infants, indices of behavioral inhibition include withdrawal from a stimulus, long latencies of

approach, clinging to the mother, crying, and inhibition of play. When the children were re-examined 10 months later, it was found that inhibition to the unfamiliar was relatively stable. The association between behavioral inhibition and high and stable heart rates was also demonstrated to be relatively stable over time.

A follow-up study (Kagan, Reznick, Clarke, Snidman, & Garcia-Coll, 1984) was conducted when the subjects were 4 years-old. Indices of behavioral inhibition for these young children included frequency of looking at the mother, looking at or away from the examiner, interruptions, failure to respond to questions, as well as a host of latency measures. Children were observed with a peer and with an examiner in a testing situation. The findings further supported those obtained earlier, namely that behavioral inhibition is relatively stable.

Subsequent follow-up studies were conducted when the children were 5 1/2 years-old (Reznick, Kagan, Snidman, Gersten, Baak, & Rosenberg, 1986) and 7 1/2 years-old (Kagan, Reznick, Snidman, Gibbons, & Johnson, 1988). Indices of behavioral inhibition included frequency of approach toward unfamiliar objects and children, and latency of spontaneous speech. Continued stability was demonstrated in measures of behavioral inhibition and disinhibition, as well as in a number of physiological measures. Approximately three-fourths of the children identified as inhibited at 21 months were classified as inhibited at 7 1/2 years of age. The same degree of stability was found for uninhibited children. Although physiological indices such as heart rate remained correlated with behavioral measures, the association was not large enough to

distinguish the groups. The authors speculated that learning and socialization experiences may account for some of the instability in behavioral inhibition over time.

Other longitudinal studies have obtained similar findings with respect to the relative stability of behavioral inhibition in infants (e.g., Broberg, Lamb, & Hwang, 1990; Rothbart, 1988). Some authors have suggested that these temperamental characteristics may be related to adult characteristics of introversion described by Eysenck. A transactional model of development is offered by Garcia-Coll et al. (1984) in conceptualizing the stability of behavioral inhibition. That is, inhibited infants elicit parental responses and environmental experiences which further maintain their inhibited temperamental style. Constitutional factors, which are a function of the interactions between genetic, prenatal, perinatal, and environmental factors, are believed to be important in predisposing infants to displaying an inhibited temperament.

The longitudinal studies discussed above recognize the descriptive discontinuity of behavioral inhibition. The indices of behavioral inhibition were different for children at different developmental levels. Although the behaviors being measured were topographically different, they were viewed as providing a measure of behavioral inhibition. In the longitudinal studies described above, this seems plausible. Is "behavioral inhibition," as defined in the temperamental literature, the same (or at least similar) construct as the behavioral inhibition mediated by the BIS as described by Gray? One way to approach this question of the explanatory continuity of the BIS is to

examine whether behavioral inhibition in infants and young children is associated with anxiety - just as Gray's theory and the findings of the present study suggest it is in adults.

Two studies investigating the association of behavioral inhibition in children with the presence of anxiety disorders in their parents, or the children themselves, lend support to this notion. Differences in behavioral inhibition between children of parents with Panic Disorder and Agoraphobia and a matched sample of children of parents with other psychiatric disorders (e.g., Major Depressive Disorder; MDD) were examined by Rosenbaum et al. (1988). The 56 children ranged in age from 2 to 7 years. The procedures and measures used by Garcia-Coll et al. (1984) were used by these authors in their measurement of behavioral inhibition. This study found that nearly 85% of the children of adults with Panic Disorder and Agoraphobia (PDAG) were classified as inhibited. Rates of inhibition were lowest (15%) for the psychiatric control group without PDAG or MDD. Approximately 50% of children of MDD parents and 70% of children of parents with MDD and PDAG were also classified as inhibited.

Given the high degree of familial concordance of anxiety-based disorders, which has been demonstrated in a number of studies (e.g., Torgersen, 1983; Turner, Beidel, & Costello, 1987), Rosenbaum et al. (1988) concluded that their findings suggest that highly inhibited children may be at increased risk for the development of such problems. A high degree of behavioral inhibition in the early years of life may be a marker or precursor of later anxiety (or other psychiatric disorders).

To further examine this hypothesis, the same group of researchers (Biederman et al., 1990) compared the two groups of children from the Rosenbaum et al. (1988) study (inhibited and uninhibited children of psychiatric parents, and control children of non-psychiatric parents) with the inhibited and uninhibited children from the Kagan et al. (1988) longitudinal study. Direct measures of behavioral inhibition were already obtained, and groups were compared with respect to DSM-III psychiatric diagnoses obtained using diagnostic interviews.

The findings of the Biederman et al. (1990) study indicate that inhibited children, regardless of parental psychopathology, had higher rates of multiple anxiety disorders than uninhibited children. Approximately 20% of the inhibited children were diagnosed with multiple anxiety disorders; whereas none of the uninhibited children evidenced multiple anxiety disorders. Furthermore, the rates of disorders of conduct were low in the inhibited groups and high in the uninhibited groups.

The Biederman et al. (1990) study shows a clear, although not perfect, association between increased behavioral inhibition and anxiety-based disorders in children. That is, not all inhibited children evidenced an anxiety disorder, and perhaps more importantly, some uninhibited children did evidence anxiety. The authors conclude that behavioral inhibition to the unfamiliar may be a risk factor in the development of childhood anxiety disorders.

Future Directions

These studies demonstrating the stability of behavioral inhibition over the course of development in the early years and the association

between behavioral inhibition and anxiety are highly consistent with Gray's theory. Additional longitudinal research, using the studies described above as models, is necessary to further substantiate these findings. Since Gray's theory is largely based on the selective effects of anxiolytic medications, it would be important to examine the effects of these agents on the behavior of inhibited and uninhibited children and infants (if obvious ethical issues could be addressed).

In terms of Gray's theory, continued investigation of group differences in basic learning processes, such as those examined in the present study are needed. Examination of such differences between groups of individuals evidencing different types of anxiety and other psychiatric disorders would be meaningful. In particular, the relationship between anxiety and depression might be better understood through this line of research. Given that there is support for the association between anxiety and BIS functioning, inquiry into the short- and long-term effects of treatments of anxiety on BIS functioning might prove interesting. Finally, the development of additional procedures to assess BIS functioning are needed to foster research efforts such as those noted above.

Behavioral inhibition, according to Gray's work, can be related to the functioning of the BIS. The present study supported the hypothesis that anxiety is associated with an overly-sensitive BIS. Specifically, this sensitivity may be conceptualized as a bias to respond to unreliable or "unfamiliar" stimuli as though they are more likely to result in aversive rather than appetitive consequences. If behavioral inhibition in the temperament research is reflective of BIS functioning

then the findings discussed above suggest that BIS over-sensitivity is relatively stable over the course of development and may be a risk factor in the development of anxiety-based psychopathology.

Transmission of a predisposition to develop anxiety disorders, according to this line of thought, would occur in some cases at the level of the BIS. If such is the case, the behavioral expression of anxiety would likely develop in the context of transactional interactions between genetic, constitutional, and environmental factors.

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Appendix A

Consent Form A

This is to certify that you agree to participate as a volunteer in a study being conducted by Louis P. Hagopian, M.S. and Thomas H. Ollendick, Ph.D. of Virginia Polytechnic Institute and State University. The first phase of the study will involve the completion of some questionnaires. You may be invited to participate in the second phase of the study to gain additional credit. The procedures used for the first phase are described below.

1. Completion of three standard psychological questionnaires.
2. Completion of a questionnaire about mental health history.
3. Approximately 55 minutes will be needed to complete all the questionnaires. Thus 1 hour of experimental credit will be earned for participation in the first phase of the study.
4. Information about your responses will remain confidential. You will be assigned a subject identification number, and your name will not appear on any research documents. You have the right to access any of your questionnaire results.
5. You may withdraw from participation at any time without penalty or prejudice. No risks from participation are anticipated.
6. You will be provided an information form at the end of the study informing you how to contact the experimenter if you have any questions.
7. You may be contacted within a few days, and asked to participate in the second phase of the study to obtain an additional 1 hour of experimental credit.

I have read and I understand the procedures outlined above, and agree to volunteer to participate.

Signature

Date

Print Name Clearly

Student ID

Note: This project has been approved by the Human Subjects Research Committee of the Psychology Department of Virginia Polytechnic Institute and State University. Any questions should be directed to:

Louis P. Hagopian, M.S.
Graduate Researcher
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Thomas H. Ollendick, Ph.D.
Professor
Office Phone: 231-6451

Helen Crawford, Ph.D.
Chairperson,
Human Subjects Committee
Office Phone: 231-6520

E. Stout, Ph.D.
Institutional Review Board
Phone: 231-9359

Appendix B

Consent Form B

This is to certify that you agree to participate as a volunteer in a study being conducted by Louis P. Hagopian, M.S. and Thomas H. Ollendick, Ph.D. of Virginia Polytechnic Institute and State University. This study will involve you performing some computerized tasks and completing a few very brief psychological questionnaires. The procedures are described below.

1. Completion of brief psychological questionnaires on a few different occasions during the session.
 2. Participation in some computerized learning tasks. The tasks vary and may involve pressing a key to make a bet, respond to stimuli to get points, or to get points after waiting a certain amount of time. You will be given some points initially, and may earn or lose points depending on you performance.
 3. For some individuals, some mild discomfort may occur as a result of these tasks. However, no risks from participation are anticipated.
 4. Approximately 55 minutes will be needed to complete all the tasks and questionnaires. Thus, 1 hour of experimental credit will be earned for participation in this phase of the study.
 5. Information about your performance will be confidential. You will be assigned a subject identification number, and your name will not appear on any research documents. You have the right to access any of your performance results.
 6. You may withdraw from participation at any time without penalty or prejudice.
 7. You will be provided with additional information about the nature of the study at the end of the session.
- I have read and I understand the procedures outlined above, and agree to volunteer to participate.

Signature

Date

Print Name Clearly

Student ID

Note: This project has been approved by the Human Subjects Research Committee of the Psychology Department of Virginia Polytechnic Institute and State University. Any questions should be directed to:

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Appendix C

Procedures Outline

Pre-Screening

Consent (Form A)

Questionnaires

Individual Testing

Consent (Form B)

Instructions

STAI State

Behavioral Tasks

Task 1

STAI State

Task 2

STAI State

Task 3

STAI State

Checklist of Positive and Negative Thoughts

Debriefing

Appendix D

Directions for Cards Task

For this test, you will see some playing cards on the screen,
one at a time. This is not a regular deck of cards.
Some cards are FACE cards and will be shown as JACK QUEEN KING ACE.

Some cards are NUMBER cards and go from 2 to 10.

To see whether a card is a face card or a number card,
press the SPACE BAR when you see a "?"

You will start off with 50 points.

If you get a FACE card, you will EARN 10 POINTS.

(1) If you get a NUMBER card, you will LOSE 10 POINTS.
or

(2) If you get a NUMBER card, you will NOT GET ANY POINTS.

You have to play the cards as the computer gives them to you.

YOU CANNOT SKIP CARDS.

You can play until the computer stops
or press the "Q" key to stop early.

Once you stop, the test is finished.

TRY TO GET AS HIGH OF A SCORE AS YOU CAN.

PRESS THE SPACE BAR TO BEGIN.

(1) Reward/Punishment Condition

(2) Reward/Non-Reward Condition

Appendix E

Directions for Go/No Go Discrimination Task

You are going to see some numbers in the center of the screen.

Your task will be to learn, by trial and error,
when to press the space bar

in order to earn as many points as possible.

If you press the space bar when you see a "GOOD" number,
you will EARN 10 POINTS.

If you press the space bar when you see a "BAD" number,
you will LOSE 10 POINTS

(1)

or

(2)

you will NOT GET ANY POINTS.

If you do not press the space bar within a few seconds,
nothing will happen and the next number will appear.

Remember, it is up to you to learn

which numbers are "GOOD" and which are "BAD"

(there is no pattern distinguishing good and bad numbers).

TRY TO GET AS HIGH OF A SCORE AS YOU CAN.

PRESS THE SPACE BAR TO BEGIN PRACTICE.

At the end of the practice trials, additional instructions were
presented on the screen:

That is all of your practice.

Your points will start over now.

The same numbers are good and bad as during the practice.

PRESS THE SPACE BAR TO BEGIN.

(1) Punishment Condition

(2) Non-Reward Condition

Appendix F

Directions for VI-DRL Task

You are going to take a test.

An empty square will appear in the center of the screen.
When you make the square light up, you will EARN 10 POINTS.

To light up the square, push the SPACE BAR
and wait a little while before pressing it again.
Just press the SPACE BAR, wait a while, and press it again.

- (1) If you press it too soon, you will LOSE 10 POINTS,
or
- (2) If you press it too soon, you will NOT GET ANY POINTS,
the square won't light up, and you'll have to wait a while
before you can press the space bar to get more points.
Keep doing the test until the computer stops.
TRY TO GET AS HIGH OF A SCORE AS YOU CAN.
PRESS THE SPACE BAR TO BEGIN.

- (1) Punishment Condition
- (2) Non-Reward Condition

CURRICULUM VITA

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PERSONAL INFORMATION

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EDUCATION

Ph.D. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Completing Doctor of Philosophy degree in Psychology. Area of specialization: Clinical Child (APA Approved). Dissertation title: Behavioral inhibition and test anxiety: An empirical investigation of Gray's theory. Chairperson: Thomas H. Ollendick, Ph.D.

Pre-Doctoral Internship The Kennedy Institute of the Johns Hopkins University University School of Medicine, Department of Pediatrics, Baltimore, Maryland. Completing Pre-Doctoral Internship in Applied Behavior Analysis, Developmental Disabilities, and Behavioral Pediatrics (APA Approved).

M.S. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Master of Science in Psychology, December, 1988. Area of specialization: Clinical Psychology (APA Approved). Thesis title: Asymmetry in hemi-inattention and auditory-linguistic processing as measured by focused-attention dichotic listening: A comparison of reading disabled and non-reading disabled children. Chairperson: David W. Harrison, Ph.D.

B.S. Virginia Commonwealth University, Richmond, Virginia. Bachelor of Science in Psychology, Cum Laude, May, 1985. Undergraduate Thesis title: Effects of concurrent shadowing on right hemisphere linguistic phonetic encoding of normal right-handed males. Chairperson: Thomas H. Leahey, Ph.D.

ACADEMIC HONORS AND AWARDS

National Institute of Mental Health,
Clinical Child Psychology Fellow, 1990
National Dean's List 1984, 1985
Graduated Cum Laude

CLINICAL EXPERIENCE

- July 1990 Pre-Doctoral Intern, Kennedy Institute of the Johns
- present Hopkins University School of Medicine.
 Severe Behavior Unit. Utilized applied behavior analysis
 principles in the assessment and treatment of
 developmentally-disabled children hospitalized for severe
 behavior problems including self-injury, aggression, and
 disruptive behaviors. Supervisors: Wayne Fisher, Ph.D.
 and Cathleen Piazza, Ph.D.
 Behavior Management Clinic and Family Therapy Clinic.
 Conducted behavioral assessment and treatment, and family
 therapy with children exhibiting a wide range of problems
 including aggression, noncompliance, fire-setting,
 attentional deficits, separation anxiety, school phobia,
 and social skills deficits. Supervisors: Gina Richman,
 Ph.D. and Keith J. Slifer, Ph.D.
 Consultation Service. Behavioral assessment of children
 on a neuro-rehabilitation unit evidencing problems such as
 noncompliance to medical regimens, aggression, and food
 selectivity. Provided medical staff with recommendations
 and training in behavior management procedures.
 Supervisor: Keith J. Slifer, Ph.D.
- Aug 1989 Graduate Clinician, Child Study Center, Child
- May 1990 Assessment Team, Virginia Polytechnic Institute and State
 University. Conducted behavioral assessment and treatment
 of children, adolescents, and parents exhibiting a variety
 of clinical problems including noncompliance, anxiety,
 attentional deficits, sexual abuse, and depression.
 Performed comprehensive psycho-educational assessments.
 (Approximately 240 practicum hours). Supervisors: Jack
 W. Finney, Ph.D., Ross W. Greene, Ph.D., and Thomas H.
 Ollendick, Ph. D.
- June 1989 Clinician, Psychological Services Center, Virginia
- Aug 1989 Polytechnic Institute and State University. Engaged in
 the assessment and treatment of adults and children
 exhibiting problems such as depression, anxiety, obesity,
 social skills deficits, and marital problems. Co-
 conducted neuropsychological assessments. Supervisors:
 Richard M. Eisler, Ph.D. and David W. Harrison, Ph.D.

- Aug 1988
- May 1989 Psychology Extern, Child and Adolescent Unit, Saint Albans Psychiatric Hospital, Radford, Virginia. Individual therapist, family co-therapist, and group co-therapist for inpatient adolescents and pre-adolescents. Clinical problems encountered included depression, disorders of conduct, social skills deficits, sexual and physical abuse, schizophrenia, eating disorders, mental retardation, substance abuse, and coercive family processes. Conducted psychological and psycho-educational assessments. Designed and led anger control, assertiveness, and problem solving groups. (Approximately 500 practicum hours). Supervisor: David Hamilton, Ph.D.
- Sept 1987
- June 1987 Graduate Clinician, Psychological Services Center, Virginia Polytechnic Institute and State University. Conducted behavioral assessment and treatment of children exhibiting problems such as generalized anxiety disorder, overanxious disorder, simple phobia, depression, and disorders of conduct. Co-conducted neuropsychological assessments and psychophysiological assessments of children and adults. (Approximately 500 practicum hours). Supervisors: Caryn L. Carlson, Ph.D., and Thomas H. Ollendick, Ph.D.
- Sept 1986
- June 1987 Graduate Clinician, Psychological Services Center, Virginia Polytechnic Institute and State University. Conducted behavioral assessment and treatment of children exhibiting problems such as attentional deficits and overanxious disorder. Approximately 240 practicum hours). Supervisors: Caryn L. Carlson, Ph.D. and Thomas H. Ollendick, Ph.D.
- Nov 1985
- Aug 1986 Mental Health Case Manager/Clinician, Long Term Clinical Care Unit, Henrico Area Mental Health and Retardation Services, Glen Allen, Virginia. Case management and primary clinician for approximately 45 chronically mentally ill clients. Conducted assessment of clients' needs in areas such as housing, vocational training, and psychological/psychiatric treatment; formulated service plans; and linked clients with service providers. Provided individual and family therapy. Supervisor: Paul Murphy, M.Ed.

RESEARCH EXPERIENCE

- Oct 1989
- Mar 1989 Graduate Researcher. Developed and administered a battery of questionnaires assessing anxiety and related clinical problems to over 700 college students. Designed and administered computerized learning tasks to assess individual differences in behavioral inhibition and

operant-classical conditioning interactions. Virginia Polytechnic Institute and State University.

- Sept 1986 Research Therapist, Children's Anxiety Disorders
- May 1990 Clinic. Conducted comprehensive assessments and provided individual treatment and parent training for anxious children and pre-adolescents. Applied and investigated cognitive-behavioral and behavioral treatment protocols. Virginia Polytechnic Institute and State University.
- Sept 1987 Graduate Researcher. Conducted abbreviated psycho-
- Dec 1988 educational evaluations on approximately 60 learning disabled and 30 non-disabled school-aged children. Used a dichotic listening procedure to assess neuropsychological functioning. Virginia Polytechnic Institute and State University.
- Jan 1987 Graduate Researcher, Social skills training of
- May 1987 learning disabled children. Provided social skills training to a self-contained class of learning disabled children; and evaluated outcome following training. Virginia Polytechnic Institute and State University.
- Aug 1984 Research Assistant, Mother-child interactions and
- Dec 1984 children's stress responses in a pediatric setting. Assisted in the design of behavioral observation rating scales for mother-child and pediatrician-child interactions, and administered self-report scales to children and parents. Virginia Commonwealth University/Medical College of Virginia.

PUBLICATIONS AND PRE-PUBLICATIONS

- Hagopian, L. P., & Ollendick, T. H. Simple phobias in children. In M. Hersen & R. T. Ammerman (Eds), Handbook of Behavior Therapy with Children and Adults: A Developmental and Longitudinal Perspective. In press.
- Ollendick, T. H., Hagopian, L. P., & Huntzinger, R. M. Cognitive-behavior therapy with nighttime fearful children. Journal of Behavioral and Experimental Psychiatry. In press.
- Hagopian, L. P., Weist, M. D., & Ollendick, T. H. (1990). Cognitive-behavior therapy with an 11-year old girl fearful of AIDS and illness: A case study. Journal of Anxiety Disorders, 4, 257-265.
- Hagopian, L. P., Harrison, D. W., & Alden, J. D. (1989). Dichotic listening in reading disabled children: Hemi-inattention and linguistic dysfunction, [Abstract], The Clinical Neuropsychologist.

Hagopian, L. P. (1988). Effects on concurrent verbal shadowing on linguistic phonetic encoding, [Abstract], The Clinical Neuropsychologist.

PROFESSIONAL PRESENTATIONS

Hagopian, L. P., Ollendick, T. H., & Weist, M. D. (November, 1989). Cognitive-behavior therapy with and 11-year old girl fearful of AIDS and illness: A case study. Paper presented at the Annual Convention of the American Psychological Association for Advancement of Behavior Therapy, Washington, D.C.

Hagopian, L. P., Harrison, D. W., & Alden, J. D. (August, 1989). Dichotic listening in reading disabled children: Hemi-inattention and linguistic dysfunction. Paper presented at the Annual Convention of the American Psychological Association, New Orleans, LA.

Ollendick, T. H., Hagopian, L. P., Huntzinger, R. M., & Weist, M. D. (November, 1988). Cognitive-behavior therapy with children: An initial analysis of the cognitive and behavioral components. Paper presented at the Annual Convention of The Association for Advancement of Behavior Therapy, New York, NY.

Hagopian, L. P. (August, 1988). Effects of concurrent verbal shadowing on linguistic phonetic encoding. Paper presented at the Annual Convention of the American Psychological Association, Atlanta, GA.

TEACHING EXPERIENCE

Aug 1989 Graduate Instructor, Social Psychology. Designed and
- May 1990 instructed an undergraduate Social Psychology course for
 two semesters (enrollment of 60 students per semester).
 Virginia Polytechnic Institute and State University.
 Supervisor: Danny K. Axsom, Ph.D.

Jan 1988 Graduate Teaching Assistant, Graduate Statistics for
- May 1988 Psychologists. Statistical Analysis System (SAS) and VM
 X-Edit instructor and consultant for psychology graduate
 students. Virginia Polytechnic Institute and State
 University. Supervisor: Robert S. Schulman, Ph.D.

Sept 1987 Graduate Teaching Assistant, Environmental
- Dec 1987 Psychology. Assistant lecturer and grader for
 approximately 80 students. Virginia Polytechnic
 Institute and State University. Supervisor: Jack W.
 Finney, Ph.D.

Dec 1986 Graduate Teaching Assistant, Introductory Psychology.

- June 1987 Discussion leader of three sections. Virginia Polytechnic Institute and State University. Supervisor: J. Neal Bohannon, Ph.D.
- Jan 1985 Undergraduate Teaching Assistant, Introductory Psychology.
- May 1985 Assistant lecturer and grader for approximately 200 students. Virginia Commonwealth University. Supervisor: Donelson R. Forsyth, Ph.D.

PROFESSIONAL AFFILIATIONS

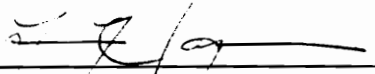
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