



NEUROTICISM AND THE FACILITATION OF THE AUTOMATIC ORIENTING OF ATTENTION

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Summary—The personality dimension of neuroticism (N) is of particular interest because high N (neurotic) individuals are predisposed to experience negative affect and psychopathology. This study provides a test of the hypothesis that N is associated with individual differences in attentional processes, and, more specifically, that the automatic orienting of attention occurs more readily in neurotic individuals. Subjects performed a visual search task, during which a distractor stimulus on occasion appeared in the stimulus display. Female neurotic subjects were significantly more impaired than were stable subjects in their visual search task performance by the presence of a distractor, indicating that their attention was more strongly attracted by the distractors. We suggest that the predisposition of neurotic individuals to negative affect and psychopathology may be mediated by the disruption of controlled self-regulatory processes, and a mechanism is proposed by which this impairment may be attributed in part to the facilitation of the automatic orienting of attention. © 1998 Elsevier Science Ltd. All rights reserved

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The personality dimension of neuroticism (N) emerges consistently in factor-analytic studies of personality and temperament (e.g. Eysenck, 1967; Eysenck & Eysenck, 1985; McCrae & Costa, 1987; Tellegen, 1985; Zuckerman *et al.*, 1993). N is of particular interest because high N (neuroticism) constitutes a predisposition to negative affect (e.g. Costa & McCrae, 1980; Eaves, Eysenck & Martin, 1989; Larsen & Ketelaar, 1989; Tellegen, 1985; Watson & Clark, 1984) and diverse forms of psychopathology (e.g. anxiety and mood disorders, Clark, Watson & Mineka, 1994; alcoholism, Sher & Trull, 1994; personality disorders, Widiger & Costa, 1994).

However, explanations as to why this should be the case have varied considerably. H. J. Eysenck originally equated neuroticism with emotionality or general reactivity, stating that the neurotic individual “is emotional, reacting too strongly to all sorts of stimuli” (Eysenck & Eysenck, 1975, p. 5). In turn, these “strong emotional reactions interfere with his proper adjustment, making him react in irrational, sometimes rigid ways” (Eysenck & Eysenck, 1975, p. 5).

More recently, it has been suggested that the underlying physiological substrates of N directly cause negative affect states. For example, Larsen and Ketelaar (1989) (see also Tellegen, 1985) proposed that the central nervous system structures that constitute an ‘anxiety system’ are more active in high N (neurotic) than in low N (stable) individuals, and that the former experience more negative affect as a direct result of heightened anxiety system activity.

A rather different approach is implied by the view that information processing and cognition profoundly influence an individual’s affect state. In particular, this cognitive mediation perspective implies that negative emotions are often caused by negative cognitions, such as excessively negative interpretations of situations and events (e.g. Beck, 1976; Beck *et al.*, 1979; Ellis, 1962). Hence, an alternative explanation for the association of neuroticism with negative affect is that neuroticism reflects, at least in part, individual differences in processes that directly affect cognitive activity. These alterations in cognition, in turn, mediate the individual’s affect state. That is, the association of neuroticism with negative affect may reflect primarily its effects on information processing.

We (Wallace & Newman, 1997) recently have proposed just such a mechanism, by which attentional processes affect cognition, thereby indirectly influencing an individual’s affect and behavior. Briefly, we suggest that controlled information processing often is necessary for the evaluation and

correction (i.e. regulation) of excessively negative thoughts about situations and events (Gilbert, 1989; see also Bargh, 1984; Hollon & Garber, 1988, 1990; Posner & Snyder, 1975). Controlled processing "is characterized as a slow, generally serial, effortful, capacity-limited, subject-regulated processing mode that must be used to deal with novel or inconsistent information" (Schneider, Dumais & Shiffrin, 1984, p. 2).

Furthermore, controlled processes are "limited-capacity processes requiring attention" (Shiffrin & Schneider, 1977, p. 160). That is, controlled information processing requires that sufficient attentional resources be available. Hence, to the extent that attention is allocated elsewhere, controlled processing (and thus the ability to engage in the controlled regulation of one's cognitive activity) will be curtailed.

To foreshadow the conclusion of the next section (see also Wallace & Newman, 1997), we propose that neuroticism is associated with a facilitation of the automatic orienting of attention. That is, if all other factors are equal, the automatic orienting of attention occurs more readily for neurotic individuals than for their stable counterparts. Finally, if the automatic orienting of attention is facilitated, then the controlled use of attention to support self-regulatory processes will be compromised. Therefore, neurotic individuals will experience more difficulty in performing the controlled evaluation and correction of maladaptive cognitions, and hence will be prone to experience negative affect and psychopathology.

Gray's model: Extraversion and neuroticism

Our conceptualization of N is based on a model of personality that we developed in conjunction with our investigations of impulsive motor behavior (e.g. Bachorowski & Newman, 1985, 1990; Nichols & Newman, 1986). This model is essentially a synthesis of H. J. Eysenck's (1967) dimensional personality theory of extraversion (E) and neuroticism (N), and Gray's (Gray, 1975, 1987; Gray & Smith, 1969) neuropsychological model (for a more detailed description, see Wallace, Bachorowski & Newman, 1991).

Although Gray continues to revise his model, we have found the 'three arousal' version (see Fowles, 1980, 1988) most useful for conceptualizing E and N. Briefly, this variant of Gray's model consists of three interacting components (see Fig. 1). The behavioral activation system (BAS) is sensitive to conditioned appetitive stimuli, such as stimuli associated with reward. When such stimuli are detected, BAS activity increases. The function of the BAS is to initiate goal-directed behavior, and as BAS activity increases, approach behavior becomes more likely.

Similarly, the behavioral inhibition system (BIS) is sensitive to conditioned aversive stimuli, such as cues for punishment, as well as to novel stimuli. BIS activity increases when such stimuli are present. As BIS activity increases, ongoing behavior is inhibited, and attention is directed to the potentially threatening or discrepant stimulus.

Increases in the activity levels of either the BAS or the BIS produce proportionate increases in the activity of the third component of Gray's model—the non-specific arousal system (NAS). Therefore, when stimuli are present to which either the BAS or the BIS is sensitive, NAS activity increases.

Our personality model maps the three components of Gray's model onto Eysenck's personality dimensions of E and N. The relative strengths of the BAS and the BIS are reflected in E (see also Gray, 1981; Gray *et al.*, 1983). We consider high E individuals (extraverts)—who are outgoing, sociable, active and optimistic—to be BAS dominant; the BAS is stronger than the BIS. Hence, extraverts are more responsive to BAS stimulus inputs (e.g. opportunities for reward), and readily engage in BAS-mediated goal-directed behavior.

Conversely, low E individuals (introverts)—who are quiet, unsociable, passive and careful—are BIS dominant. Because the BIS is stronger than the BAS, these individuals are more sensitive to stimuli such as potential threats, and are prone to engage in behavioral inhibition (but see Wallace *et al.*, 1991).

We view N as reflecting individual differences in the activity of the NAS to its inputs from the BAS and BIS. The high N individual, who "is emotional, reacting too strongly to all sorts of stimuli" (Eysenck & Eysenck, 1975, p. 5), manifests high NAS reactivity. That is, a given level of BAS or BIS activity produces a greater increase in NAS activity for neurotic individuals. As a

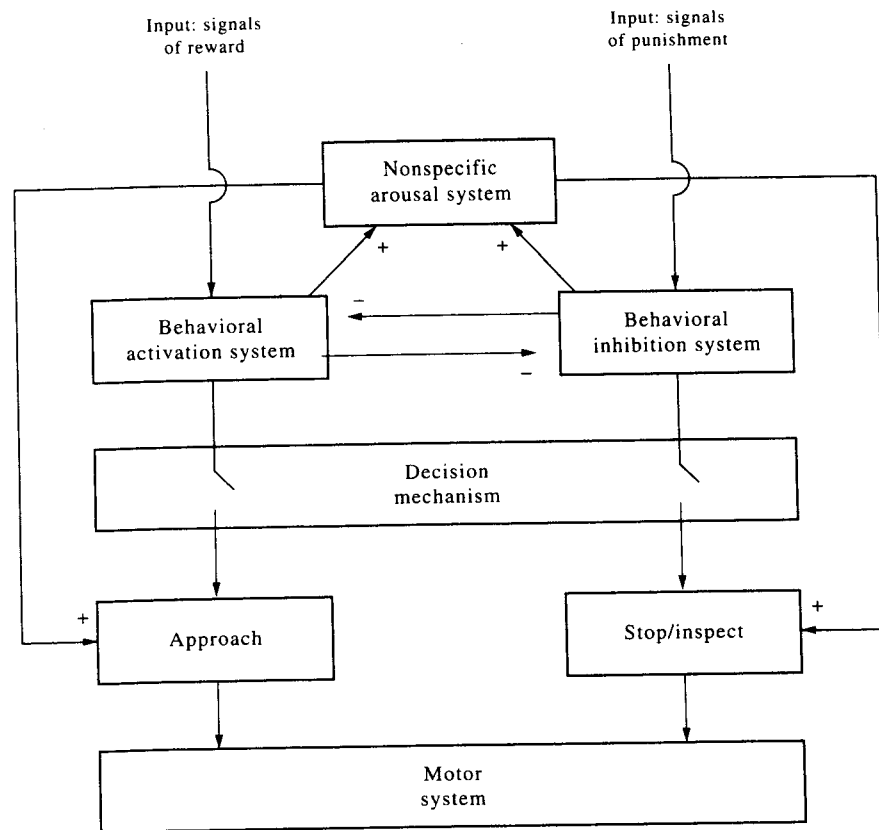


Fig. 1. Gray's neuropsychological model. Adapted from Gray (1987).

consequence, neuroticism is conducive to heightened NAS activity: If all other factors are equal, neurotic individuals experience higher levels of NAS activity than do their stable counterparts.

According to Gray, as NAS activity increases, the consequences of BAS and BIS activity also are facilitated (see Fig. 1). First, heightened NAS activity increases the intensity of BAS-mediated overt motor responses. For instance, in our laboratory, *Ss* who were expected (on the basis of our personality model) to experience the highest levels of NAS activity during the experiment have repeatedly been observed to manifest the fastest response speeds (Bachorowski & Newman, 1990; Nichols & Newman, 1986; Wallace & Newman, 1990; for a review see Wallace *et al.*, 1991). Such results not only support the postulate that increases in NAS activity produce proportionate increases in the intensity of motor responses, but also provide corroboration for the personality model described above.

Neuroticism and attention

More recently, we have begun considering the effects of NAS activity on processes associated with the BIS (Wallace & Newman, 1997). Because one consequence of BIS activity is the direction of attention to discrepant or potentially threatening stimuli, it seemed plausible to us that increases in NAS activity might have an effect on attention. If this is the case, it follows from our identification of *N* with the NAS construct that *N* is associated with individual differences in attentional processes.

In fact, other researchers have observed neurotic and stable *Ss* to manifest such differences. For example, Derryberry and Reed (1994) used a reaction time task to investigate the influences of *E* and *N* on the covert shifting of attention (i.e. movements of the attentional focus that occur in the absence of overt movements of the eye itself). In their paradigm, the *Ss*' task was to detect target stimuli that were preceded by cueing stimuli. Benefits, or reductions in the time required for target detection, resulted when the target appeared in the cued location. This is because attention had

already been shifted to the location in which the target subsequently appeared. Costs, or increases in target detection time, occurred when the target appeared in the uncued location, and resulted from the necessity of shifting attention from the cued location to the location of the target before target detection could occur.

In their study, Derryberry and Reed (1994) found effects of individual differences primarily in terms of costs, rather than benefits. Of particular relevance to the present thesis, these researchers discovered that "effects on costs were greater for neurotic introverts and neurotic extraverts" (Derryberry & Reed, 1994, p. 1137). That is, the observed attentional effects were stronger in neurotic Ss.

Avila (1995) used a task similar to that employed by Derryberry and Reed (1994) to examine individual differences in processes involved in the visual orienting of attention. In brief, his neurotic Ss manifested greater inhibition of return (i.e. an increased latency to return attention to a previously-cued location) than did their stable counterparts. Avila concluded from this result that neurotic individuals tend "to engage attention more vigorously" (p. 508) on probable locations of targets or significant stimuli than do stable persons.

In addition to those behavioral data, electroencephalographic (EEG) data, specifically studies of the latency of the P300 component of event-related brain potentials, have proved relevant to the suggestion that neuroticism reflects, in part, individual differences in attentional processes. P300 is associated with the orienting or allocation of attention (e.g. Näätänen, 1988; Pritchard, 1981), and P300 latency reflects, at least in part, the strength with which a stimulus automatically attracts attention (Kramer *et al.*, 1986).

In one study involving measurements of P300 latency, Pritchard (1989) presented 1000 and 2000 Hz tones to his subjects, while recording EEG data. The 1000 Hz tones were presented four times more frequently than were the 2000 Hz tones. Pritchard (1989) found that his male neurotic Ss evidenced shorter P300 latencies to the 2000 Hz tones than did stable Ss. This observation is consistent with the interpretation that the infrequent or discrepant tone stimuli more strongly attracted the attention of the neurotic Ss than that of their stable counterparts. However, this effect was not evident in his female Ss.

Stelmack *et al.* (1993) also examined P300 latencies in neurotic and stable individuals, but included only female Ss in their study. Their Ss performed a series of six information processing tasks, which involved searching for, and detecting, various sorts of target stimuli. EEG was recorded during performance of the experimental tasks. In contrast to the null results of Pritchard (1989), aggregate analysis showed decreased P300 latency in female neurotic Ss relative to stable Ss, suggesting that the orienting of attention was facilitated in neurotic Ss.

In sum, there is some recent empirical support for the thesis that N reflects individual differences in attentional processes. On primarily theoretical grounds, we (Wallace *et al.*, 1991) proposed that the trait of neuroticism is associated with an increased focusing of attention. Our more specific current proposal, derived primarily from (i) the association in Gray's model of the BIS and NAS with the orienting of attention, and (ii) the EEG data cited above, is that as NAS activity increases, the automatic orienting of attention is facilitated, just as is the speed of BAS-mediated overt motor responses. Hence, because neuroticism constitutes a predisposition to experience heightened levels of NAS activity, we presume that neuroticism is associated with a facilitation of the automatic orienting of attention. In other words, our hypothesis is that N reflects, at least in part, individual differences in this attentional process.

To digress briefly, the correspondence between the proposed anatomical substrates of the NAS (and hence of N) and central nervous system structures subserving the orienting of attention also support the plausibility of our hypothesis. First, Gray (1987) proposed that the NAS may be identified with the noradrenergic locus coeruleus (LC). Second, Posner and his colleagues have identified a posterior attention system (Posner, 1988; Posner & Peterson, 1990), which subserves the orienting of attention to visual stimuli. This system is extensively innervated by the LC, and hence the LC plays a substantial role in the orienting of attention.

This line of reasoning, in conjunction with our identification of N with Gray's NAS construct, supports the present hypothesis that N is associated with individual differences in the automatic orienting of attention. Parenthetically, it also suggests that N is associated with individual differences in noradrenergic activity mediated by the LC (Wallace & Newman, 1997).

EXPERIMENT 1

In the previous section, we proposed that in neurotic individuals, the automatic orienting of attention is facilitated. That is, if all other factors are equal, the automatic orienting of attention occurs more readily in neurotic than in stable individuals.

The task that we developed to test this hypothesis was conceptually similar to that employed by Schneider and Shiffrin (1977) and Shiffrin and Schneider (1977). In this classic series of experiments, their *Ss* searched a series of alpha-numeric character displays for designated target letters or numbers. Such visual search tasks can involve either varied mapping (VM) or consistent mapping (CM) of stimuli and responses. In the former case, target and non-target stimuli "change roles in random fashion across trials; that is, a target on one trial can be a [non-target] on another, and vice versa" (Shiffrin & Dumais, 1981). On the other hand, under CM conditions target and non-target stimuli never interchange roles. These investigators demonstrated that CM training is conducive to the development of automatic attention responses, which "direct attention... automatically to the target, regardless of concurrent inputs or memory load" (Schneider & Shiffrin, 1977, p. 2).

In one experiment (Shiffrin & Schneider, 1977, experiment 4d), *Ss* on each trial viewed a series of rapidly-presented alpha-numeric character displays (called frames). They were instructed to search these frames for the designated VM targets, after being directed to ignore two of the four display positions. On occasion, however, a character that had been a target in a CM task that *Ss* had performed previously (and which thus elicited an automatic attention response) appeared in one of the to-be-ignored positions. When this character appeared in the same frame as did a designated VM target, the *Ss*' ability to detect the target declined substantially.

This result indicates that, as the tendency to direct attention automatically to an irrelevant stimulus increases, the ability to detect a concurrently-presented target suffers a commensurate impairment. Hence, a paradigm such as this should provide an index of the extent to which attention is automatically diverted from the primary visual search task: As attention is automatically directed to an irrelevant or distractor stimulus, the ability to perform a VM visual search task is curtailed.

We believed that a paradigm such as this would be suitable for testing our attentional hypothesis of neuroticism. However, Shiffrin and Schneider's task involved "months of (CM) training" (Shiffrin & Dumais, 1981). Given that our personality research typically entails the use of dozens of *Ss* per experiment, this clearly was not a feasible option. Consequently, our first challenge was to develop a paradigm in which *Ss*' attention would be drawn to task-irrelevant stimuli with sufficient strength to produce a reliable performance decrement, but that could be administered in a reasonable length of time.

As a first approximation, we elected not to utilize stimuli that automatically attracted attention by virtue of previous CM training. Instead, we selected task-irrelevant distractor stimuli that were quite dissimilar to the letter stimuli that were relevant to the VM search task. Thus, these distractors were expected to attract attention by virtue of being discrepant.

In addition, because the distractors were irrelevant to the *Ss*' manifest task of searching for target stimuli, *Ss* would have no reason to attend to those stimuli in a voluntary or controlled manner. Indeed, because attending to the distractor stimuli would result in impaired performance on the manifest task, the opposite should be the case. That is, *Ss* would be motivated not to attend to the distractor stimuli. Therefore, it seemed plausible to us that any direction of attention to the distractor stimuli would be primarily involuntary and automatic.

Predictions for this experiment involved the comparison of *Ss*' visual search task accuracy when a distractor stimulus was present to their task accuracy, when a distractor did not appear. Our first prediction was that *Ss* would manifest poorer task performance when a distractor was present than when no distractor was present. In effect, this prediction reflected our expectation that the experimental manipulation (i.e. using discrepant stimuli to disrupt visual search task performance) would, indeed, be effective.

Second, we predicted that the attention of neurotic *Ss* would be more strongly drawn to the distractor stimuli than would that of stable *Ss*. Thus, neurotic *Ss* would suffer a greater decrement in visual search task performance due to the presence of a distractor. This prediction constituted the test of our attentional hypothesis of neuroticism.

METHOD

Subjects

Ss were college undergraduates who were enrolled in introductory psychology courses at the University of Wisconsin-Madison, and who received extra credit points for their participation. Totals of 73 females and 70 males participated. Two female Ss and one male S had previously participated in a similar experiment, and one female and two males failed to complete the Eysenck Personality Questionnaire (EPQ; Eysenck & Eysenck, 1975). The data for these Ss were neither analyzed nor used in computing median E and N scores (see below).

Experimental task

Practice trials. The task began with 25 practice trials. At the beginning of each trial, a single lowercase letter—which was designated the target—was displayed on the computer monitor for 2000 msec. The target was randomly selected from among the letters b, f, h, j, l, m, t, v and z. Immediately following the offset of the target letter, five frames were successively presented, each for 175 msec. These frames consisted of three uppercase letters selected from the same set as was the target, which were spaced equidistantly in a horizontal line 20 mm long, with the letters 4 mm apart. Following the fifth frame, dot masks appeared for 175 msec in the two outer positions. Finally, the prompt 'TARGET?' was displayed on the screen for 1000 msec.

Whether a trial was a target-present trial—that is, whether the uppercase form of the target letter appeared in one of the frames—was randomly determined, with a probability of 0.5. The target never appeared in the middle position of the stimulus display, and was restricted to the second, third or fourth frames.

Ss were instructed to press a response button when the 'TARGET?' prompt appeared if either of the outer letters of the stimulus display was the same letter as the target. If the target letter did not appear in one of those two positions, Ss were instructed not to press the button.

Ss were awarded five points for correct responses (hits) and non-responses (correct rejections), lost five points for incorrect responses (false alarms) and non-responses (misses), and were informed that their task was to win as many points as possible. Following the 'TARGET?' prompt, one of two feedback displays appeared for 2000 msec: 'Correct! You win 5 points' following hits and correct rejections, and 'Wrong! You lose 5 points' following false alarms and misses.

Test trials. A total of 128 test trials followed the practice trials with no demarcation. These trials were identical to those described, with one notable exception. On occasion, a non-letter character appeared in one of the two outer positions of either frame 3, 4 or 5. These distractors were of comparable size to the alphabetic characters, and were an arrow, a dollar sign, the numeral 9, and a 'smiley face'. The probability of these distractor-present trials was 0.5.

During target-present distractor-present trials, the discrepant stimulus always appeared in the same frame as did the target. That is, the target appeared in one outer position and the discrepant stimulus in the other. On average, 32 of these trials occurred during the test phase of the experiment.

PROCEDURE

Ss participated individually in the experiment. One of three female experimenters met the S at a waiting room, at which time the S completed the EPQ. After completing the EPQ, each S was conducted to the testing room, and was seated at a table on which were positioned a PC-type computer and monitor, and a response box.

The instructions for the experimental task were displayed on the computer monitor. After reading these instructions, Ss performed the experimental task. Micro-Experimental Laboratory software (Schneider, 1988) was used to present stimuli and collect response data. Experimenters informed each S immediately prior to the start of the task that the stimulus displays would be quite brief and at first might seem difficult to perceive.

During the experiment, the experimenter sat quietly at the S's right. To decrease Ss' sense that they were being closely observed, they were told by the experimenter that she was present in case

there should be a problem with the computer. Moreover, the experimenter conspicuously read coursework material while the *S* performed the task.

RESULTS

Ss scoring below the sample median on the EPQ E scale were designated introverts; those scoring above this value were designated extraverts. This procedure also was used to classify *Ss* with respect to N. However, because the average scores on the E and N scales may differ for males and females (Eysenck & Eysenck, 1975), medians were computed separately for these groups. For females, the cutting score for E was 16.5 ($M = 15.60$, $SD = 3.99$) and for N was 13.5 ($M = 12.86$, $SD = 5.29$); the E and N cutting scores for males were 15.5 ($M = 15.18$, $SD = 4.18$) and 10.5 ($M = 10.19$, $SD = 5.30$), respectively.

Because our task may be conceptualized using a signal detection model, analyses were performed using the non-parametric measure of signal detection task accuracy or sensitivity A' (Craig, 1979). This statistic "is more appropriate than d' when false alarm rates are very low" (Strayer & Kramer, 1990), as was the case in the present data set. However, to preclude those *Ss* who made relatively large numbers of errors from disproportionately affecting the sample means, a ratio measure was employed. This ratio was the *S*'s accuracy (A') on distractor-present trials divided by that on distractor-absent trials. This statistic (henceforth called the A' ratio) was then referenced to zero by subtracting 1 from the above quotient. Thus, the A' ratio was zero if there was no difference in accuracy between distractor-present and distractor-absent trials, whereas a score less than zero indicated that a higher proportion of errors were made when distractor stimuli were present.

This statistic was computed separately for the first and second blocks of 64 test trials, and the resulting data were analyzed using a repeated-measures analysis of variance (with trial block as a within-*Ss* factor, and personality group as a between-*Ss* factor). Only the data for *Ss* whose accuracy on distractor-absent (neutral) trials was at a greater-than-chance level (i.e. accuracy of greater than 50% correct) for target-present and target-absent trials in both trial blocks were utilized in this analysis. Because past results for male and female neurotic *Ss* on occasion have not been consistent (e.g. Pritchard, 1989), separate ANOVAs were performed for each *S* gender.

Mean A' ratios for the four *S* groups (stable introverts, neurotic introverts, stable extraverts and neurotic extraverts) appear in Table 1. The data for nine males (two stable introverts, two neurotic introverts, three stable extraverts and two neurotic extraverts) and 14 females (four stable introverts, three neurotic introverts, five stable extraverts and two neurotic extraverts) were not analyzed, because they did not meet the previously-described accuracy criterion.

Male subjects

Contrary to our prediction, the mean A' ratio ($M = -0.002$) was not significantly less than zero, $F(1,54) < 1$; there was no evidence based on this statistic that male *Ss* were adversely affected by the presence of a distractor stimulus. Moreover, neurotic and stable *Ss* did not differ significantly in their reactions to the detractors, $F(1,54) = 1.68$. On the other hand, two effects that we had not predicted were evident: Task performance of introverts was enhanced relative to that of extraverts when a distractor was present $F(1,54) = 5.14$, $P < 0.03$, and this effect was more pronounced in stable *Ss* $F(1,54) = 4.05$, $P < 0.05$.

Table 1. Mean A' ratios of Stable Introverts (SI), Neurotic Introverts (NI), Stable Extraverts (SE), and Neurotic Extraverts (NE) in Experiment 1

Group	SI	NI	SE	NE
Males	0.019	0.010	-0.031	0.007
Females	-0.009	-0.008	0.009	-0.050

Female subjects

Unlike male Ss, for females the mean of -0.012 was significantly less than zero, $F(1,52)=6.65$, $P<0.02$, indicating that their visual search task performance was impaired by the distractor stimuli. Furthermore, neurotic Ss were significantly more impaired by the presence of the distractors than were stable Ss, $F(1,52)=6.47$, $P<0.02$. However, the interaction between E and N also was statistically significant, $F(1,52)=7.01$, $P<0.02$. Examination of the cell means indicates that the predicted difference between neurotic and stable Ss was evident only in extraverts.

DISCUSSION

For female Ss, the main effects for the overall mean and for N were, as predicted, significant in both cases. That is, female Ss were impaired in their visual search task performance by the presence of a distractor stimulus, and neurotic Ss, and in particular neurotic extraverts, evidenced more impairment than did their stable counterparts. For male Ss, on the other hand, no support was found for either of these predictions: Neither were male Ss adversely affected by the distractors, nor were neurotic Ss more impaired than stable Ss.

To determine whether male and female Ss did, in fact, differ in their reactions to the distractor stimuli, a *post hoc* analysis was performed. This analysis was identical to those just reported, with the exception that S gender was added as a between-Ss factor. Indeed, male Ss were significantly less affected than female Ss by the presence of a distractor stimulus, $F(1,106)=3.93$, $P<0.05$.

To summarize, the attention of female Ss was attracted strongly enough by the distractor stimuli to impair their visual search task performance, whereas this was not the case for male Ss. Likewise, the results for female Ss provided some support for our proposal that the automatic orienting of attention occurs more readily in neurotic individuals. However, this effect was evident in extraverts only. No support for this hypothesis was found in the results of male Ss.

EXPERIMENT 2

As just described, the results of Experiment 1 provided only partial support for our hypotheses. Female Ss manifested the expected distractor effect, whereas male Ss did not. Likewise, our proposal that the automatic orienting of attention is facilitated in neurotic individuals received support only from our female Ss. However, even within females, this difference was seen only in extraverts.

One factor that we believed might contribute to these discrepancies, and in particular the lack of effectiveness of the distractor manipulation in male Ss, was the level of difficulty of the visual search task itself. In other words, we entertained the possibility that the level of baseline task difficulty had not been optimal for the observation of stable differences in error rates based on the presence or absence of distractor stimuli. In fact, error rates on distractor-absent test trials were somewhat low in experiment 1: Females who attained the criterion level of task accuracy averaged 10.9% errors, and their male counterparts averaged 11.6%. Consequently, for experiment 2 we modified the visual search task to attain an increase in task difficulty.

We attempted to obtain a higher level of baseline visual search task difficulty in two ways. First, the number of targets for which Ss were required to search was increased from one to two. Thus, two letters, instead of one, had to be retained in the S's short-term memory while the frames were searched.

Second, the number of display positions that Ss were required to search was increased from two to three. In experiment 1, targets appeared only in the outer two positions of the linear three-character displays. The displays in the present experiment also consisted of three characters. However, these characters were located at the vertices of an imaginary triangle, and any one of them might be a target. On distractor-present target-present trials, the distractor stimulus could appear in either of the two display positions not occupied by the target. Due to triangular shape of the display, when a distractor appeared it was equidistant from either display position that might be occupied by a target.

In addition, the orientation of the display varied randomly between trials: On approximately one half of the trials the triangular display was oriented like a pyramid, with one vertex at the top of

the display. On the other half, the display was rotated 180 degrees, so that the triangle was oriented 'point down'.

Predictions for this experiment were identical to those in Experiment 1: We expected that (i) *Ss* would have more difficulty performing the visual search task on distractor-present than on distractor-absent trials, and (ii) neurotic *Ss* would be more adversely affected by the detractors than would stable *Ss*.

METHOD

Subjects

Ss were 65 female and 52 male undergraduates at the University of Wisconsin-Madison, who, as in Experiment 1, were enrolled in introductory psychology courses, and who received extra credit points for their participation. The data for three of these *Ss* were not utilized in the analyses or in computation of E and N medians; two female *Ss* had previously participated in a similar experiment, and one male *S* failed to complete the EPQ.

Experimental task

As just described, the present task differed from that in Experiment 1 in that *Ss* searched for either of two target letters in displays consisting of three characters arranged in a triangular configuration. The distance between the three characters was approximately 18 mm. In addition to these changes, two additional task modifications were introduced. First, the two targets, as well as the non-target letters, were selected from among all 26 letters of the alphabet. Second, during the 25 practice trials each of the five frames and the dot mask were presented for 300 msec (rather than 175 msec), whereas during the 128 test trials, the exposure was decreased to 250 msec. In all other respects, the experimental task was identical to that used in Experiment 1.

Procedure

The only procedural changes from Experiment 1 were that (i) one female and one male served as experimenters, and (ii) the instructions reflected the modifications of the experimental task.

RESULTS

Ss were classified with respect to E and N as described above. For females, the cutting score for E was 16.5 ($M=16.08$, $SD=3.56$), and that for N was 11.5 ($M=12.11$, $SD=4.89$). The corresponding values for males were 16.5 ($M=15.33$, $SD=3.87$) and 10.5 ($M=11.08$, $SD=6.53$). Analyses were identical to those performed in experiment 1, and, again, were computed separately for female and male *Ss*.

Mean A' ratios for the four *S* groups (stable introverts, neurotic introverts, stable extraverts and neurotic extraverts) appear in Table 2. Fifteen male *Ss* (three stable introverts, five neurotic introverts, three stable extraverts and four neurotic extraverts) failed to attain the requisite 50% level of task accuracy (compared with nine in Experiment 1). Twenty-two female *Ss* (three stable introverts, seven neurotic introverts, five stable extraverts, and seven neurotic extraverts) also did not perform the task at greater-than-chance accuracy levels (compared with 14 in the previous experiment).

Table 2. Mean A' ratios of Stable Introverts (SI), Neurotic Introverts (NI), Stable Extraverts (SE), and Neurotic Extraverts (NE) in Experiment 2

Group	SI	NI	SE	NE
Males	0.024	0.005	-0.006	-0.020
Females	0.013	-0.046	0.001	-0.076

Male subjects

As was the case in Experiment 1, the mean A' ratio ($M=0.001$) did not differ from zero, $F(1,32) < 1$, and the main effect for N was not statistically significant, $F(1,32) < 1$. Thus, there was no indication that male Ss were adversely affected by the distractor stimuli, or that neurotic and stable Ss differed in the degree of impairment engendered by the presence of the detractors. In addition, neither the main effect for E nor the $E \times N$ interaction—which were present in experiment 1—approached statistical significance, both F 's were < 1 .

Female subjects

For female Ss the overall mean ($M=-0.026$) was significantly less than zero, $F(1,36)=8.80$, $P<0.006$, indicating that these Ss were substantially impaired by the distractor stimuli in their ability to perform the visual search task. Furthermore, the task performance of neurotic Ss was significantly more impaired by the distractor manipulation than that of stable Ss , $F(1,36)=13.62$, $P<0.0008$. There was no evidence of the $E \times N$ interaction that was present in Experiment 1, $F(1,36) < 1$.

DISCUSSION

The modifications of the visual search task achieved our objective of increasing the baseline task difficulty. This is evident both in an increase in the numbers of Ss failing to meet the 50% accuracy criterion (see above), and in the error rates for the remaining Ss on distractor-absent trials. Female Ss averaged 20.7% errors, compared with 10.9% in Experiment 1. Males averaged 22.4% errors, compared with 11.6% in the previous experiment. In addition, no Ss were able to achieve error-free performance on distractor-absent trials in either trial block, whereas 17 Ss in Experiment 1 were able to do so.

Nevertheless, these differences were not reflected in increased support for our predictions from our male Ss . Again, there was no support for our prediction that the task performance of neurotic Ss would be more adversely affected by the distractor stimuli than would that of stable Ss . Likewise, support for the prediction that the distractor manipulation would lead to a general performance decrement was absent. Moreover, the results of a *post hoc* analysis, identical to that performed in Experiment 1, indicated that, in Experiment 2, males tended to be less affected by the distractor manipulation than were females, $F(1,68)=2.89$, $P<0.10$.

Therefore, it is apparent that, in both experimental paradigms used in this study, males simply were less impaired by the distractor stimuli than were female Ss . This disparity suggests that, in the paradigm used in this series of experiments, the automatic orienting of attention was less likely to occur in males. It is not clear whether this disparity is a function of the paradigms used in this study, or if it reflects a real gender-based individual difference in attentional processes. At this time, the only statement that we can make with certainty is that the observation of gender differences in the efficacy of the distractor manipulation was an unexpected one. Further research will be necessary to permit conclusions to be drawn about the implications of this result.

Nevertheless, this differential efficacy may be relevant to the lack of support in males for our neuroticism hypothesis. Specifically, one factor that may have contributed to the lack of support for our prediction regarding the nature of neuroticism is that the distractor manipulation simply was not strong enough to create substantial impairment in males. In other words, the likelihood of obtaining reliable group differences in the magnitude of the distractor effect may have been rather small because the effect itself was non-existent. So, because the experimental manipulation was not effective, it would, in fact, be rather surprising if predicted group differences in the efficacy of that manipulation were obtained.

On the other hand, although the increase in task difficulty in Experiment 2 did not alter the pattern of results for male Ss , it resulted in a strengthening of both predicted effects in females. As in Experiment 1, the distractor manipulation did cause an overall impairment in task performance, and, compared with their stable counterparts, this impairment was substantially more pronounced in both neurotic introverts and neurotic extraverts. Hence, for female Ss , the paradigm used in this

experiment yielded results that strongly supported our primary prediction, that the automatic orienting of attention is facilitated in neurotic individuals.

GENERAL DISCUSSION

The primary purpose of this study was to test the hypothesis that the trait of neuroticism is associated with facilitation of the automatic orienting of attention. That is, if all other factors are equal, the automatic orienting of attention occurs more readily in neurotic individuals than in their stable counterparts.

We further contended that this hypothesis is relevant to understanding the association of neuroticism with negative affect (e.g. Costa & McCrae, 1980; Eaves *et al.*, 1989; Larsen & Ketelaar, 1989; Tellegen, 1985; Watson & Clark, 1984) and psychopathology (e.g. Clark, Watson & Mineka, 1994; Eysenck, 1967; Eysenck & Eysenck, 1985; Sher & Trull, 1994; Widiger & Costa, 1994). Operating from a cognitive mediation perspective, we began with the premises that (i) maladaptive cognitions—such as excessively negative interpretations of situations and events—contribute to negative affective reactions, and (ii) the evaluation and correction (regulation) of maladaptive thoughts often is accomplished via controlled information processing (Gilbert, 1989; Wallace & Newman, 1997; see also Bargh, 1984; Hollon & Garber, 1988, 1990; Posner & Snyder, 1975). Therefore, the controlled self-regulation of maladaptive cognitions may act to mitigate or preclude negative feelings and inappropriate actions.

However, controlled (or attentive (Shiffrin, 1988)) information processing requires that sufficient attentional resources be available (Shiffrin & Schneider, 1977). Accordingly, if attention is diverted elsewhere, controlled processing—and the ability to evaluate and correct maladaptive thoughts—will be curtailed. Thus, negative feelings and inappropriate actions become more likely.

Again, our hypothesis is that the automatic orienting of attention is facilitated in neurotic individuals. As a consequence, because their attention is more likely to be diverted automatically, these individuals are especially prone to the disruption of controlled regulation of maladaptive cognitions, and hence to negative affect and inappropriate behavior.

Although, as described previously, no support for our prediction was provided by our male Ss, the results for female Ss—particularly in Experiment 2—did, indeed, provide substantial support for our hypothesis that N reflects in part individual differences in the automatic orienting of attention. We recognize that the conclusions that might be drawn from this experiment are somewhat limited due to the fact that the experimental manipulation was reliably effective for female Ss only. One of our current goals is to develop a paradigm that will allow testing our predictions in male Ss, who have not to this point manifested the expected distractor-mediated performance decrement to the extent of our female Ss.

Nonetheless, we believe that, on the basis of the results of the present study, as well as of past experiments (e.g. Bachorowski & Newman, 1990; Nichols & Newman, 1986; Wallace & Newman, 1990; see also Wallace *et al.*, 1991) we are in a position to make several statements about the primary question driving this program of research: What are the psychological processes that underlie the observed characteristics associated with E-, N-, and P—primary dimensions of human personality identified by H. J. Eysenck (see also Zuckerman *et al.*, 1993).

First, it is our contention that, in terms of psychological processes, N is best understood as reflecting individual differences in the effectiveness of controlled self-regulation (e.g. the evaluation and correction of maladaptive thoughts). That is, controlled self-regulatory processes are more likely to be compromised in neurotic, than in stable, individuals. As has been discussed, as the automatic orienting of attention becomes more likely, so too does the disruption of controlled self-regulatory processes.

Also, as noted above, neuroticism is conducive to increases in response speed. When a response is being executed rapidly, it is less likely that the individual will be able to engage in the controlled regulation of that response (i.e. determine whether the response is having the desired results, and alter it appropriately if it is not) (Newman & Wallace, 1993, 1997; Wallace *et al.*, 1991).

In sum, we have asserted here and elsewhere (Wallace & Newman, 1997) that (i) attentional and motor processes associated with neuroticism promote the disruption of controlled self-regulation,

and (ii) this propensity accounts for the association of neuroticism with negative affect and psychopathology.

Second, as discussed above, previous results indicate that E reflects individual differences in the relative balance of reward and punishment sensitivities (i.e. the tendencies to focus on opportunities for reward or on potential threats that are present in a given situation). Extraverts are more attuned to opportunities for reward, whereas introverts are more attuned to potential threats. This hypothesis is a direct derivation from the identification of E with the BAS and BIS components of Gray's model (Wallace *et al.*, 1991; see also Gray, 1981; Gray *et al.*, 1983).

We are left, then, with the question of how P—the third personality dimension identified by H. J. Eysenck—might be understood, especially in terms that are consistent with our use of Gray's model to elucidate the psychological underpinnings of E and N. High P individuals have been described as cold, egocentric, antisocial, aggressive and unempathic (Eysenck & Eysenck, 1985).

At this point, we freely admit that we are departing from the realm of data, and are entering territory that is substantially more speculative. That being said, the possibility that we are exploring currently relates to Gray's BIS construct. In addition to the properties described previously, one of its functions is to predict negative events or outcomes based on past experience, and to activate behavior that will avoid those negative events when similar situations are encountered in the future (Gray, 1987).

Our present conjecture is that P reflects individual differences in the sequelae of BIS activity in response to unexpected aversive events, and in particular the steps that are taken to understand those events so that they may be predicted, and hence avoided. That is, P may reflect individual differences in the preferential focus adopted to understand negative events or outcomes.

In brief, low P is associated with a tendency to focus on one's own actions or characteristics, rather than external circumstances, to understand and avoid negative events. High P individuals, on the other hand, focus on external circumstances rather than the contributions of their own actions. Stated another way, an individual's position on P reflects the relative balance between the tendencies to focus on self or on external factors, such as other persons, to understand and predict negative events or outcomes. For instance, high P individuals tend to focus on, or blame, others for negative events that they experience, whereas low P individuals tend to focus on, or blame, themselves. So, just as E reflects the relative balance between tendencies to focus on opportunities for reward or on potential threats, P reflects the relative balance between the tendencies to focus on self or on external factors following aversive events.

Although the current status of this hypothesis certainly would be deemed preliminary or exploratory, it is, nonetheless, not totally lacking in empirical support. In particular, results of research conducted by Gudjonsson and colleagues (Gudjonsson *et al.*, 1991; Gudjonsson & Singh, 1989; see also Gudjonsson, 1984) lends credence to this proposal. In the course of their investigations of criminal behavior, these researchers constructed a self-report measure of offenders' attributions or explanations for the crimes for which they are incarcerated. That is, this measure—the Blame Attribution Inventory—assesses how criminals understand why it was that they committed their crimes. Three factors comprise this scale, with the internal vs external factor being of most relevance to the present thesis. Briefly, an internal attribution for an action involves explaining the act as being primarily the result of one's own personal characteristics. An external attribution, on the other hand, entails placing the responsibility or blame for one's actions on social or environmental factors. These researchers have consistently observed that high P criminals blame their maladaptive actions (and hence the aversive consequences of those criminal acts) on external factors, such as other persons or situational forces, rather than viewing the acts and their consequences as resulting from their own personal characteristics.

In closing, we note that, in addition to being at least consistent with the results just described, our suggestion regarding the nature of P fits well into our existing theoretical framework. Within this conceptual scheme, E confers specific biases that are accentuated by high N (Wallace & Newman, 1997). The biases associated with E result from individual differences in the relative balance of reward and punishment sensitivities, or the tendencies to focus on opportunities for reward or on potential threats. Similarly, we suggest that P is associated with biases that are augmented by neuroticism, and reflects the relative balance between the tendencies to focus on self or on external factors (e.g. others) following negative events.

N, on the other hand, confers no specific biases, such as those associated with E and P. Instead, it reflects individual differences in the likelihood of experiencing a disruption of controlled information processing, due to the facilitation of motor responses and of the automatic orienting of attention. Therefore, neuroticism may be considered the general severity or psychopathology factor, because of its association with impaired controlled processing and hence with decreased efficacy of controlled self-regulatory processes. That is, in general, psychopathology of any type is expected to be more severe in its manifestations in neurotic individuals, because maladaptive aspects of biases associated with E and P (as well as other maladaptive cognitive, behavioral or affective response tendencies) are less likely to be evaluated and corrected, and thus more likely to be manifested as negative affect and inappropriate behavior.

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