Available online at www.sciencedirect.com
SCIENCE DIRECT®
Personality and Individual Differences 40 (2006) 1269–1279
PERSONALITY AND INDIVIDUAL DIFFERENCES
www.elsevier.com/locate/paid

A psychometric evaluation of the Highly Sensitive Person Scale: The components of sensory-processing sensitivity and their relation to the BIS/BAS and "Big Five"

Kathy A. Smolewska *, Scott B. McCabe, Erik Z. Woody

Department of Psychology, University of Waterloo, Waterloo, Ont., Canada N2L 3G1

Received 14 April 2004; received in revised form 21 August 2005; accepted 20 September 2005
Available online 4 January 2006

Abstract

Aron and Aron (1997) developed the Highly Sensitive Person Scale (HSPS) to measure individual differences in sensory-processing sensitivity (SPS). The purpose of the present study was to examine further the psychometric properties of the HSPS, and its association with the behavioural inhibition system (BIS) and behavioural activation system (BAS) (Carver & White, 1994), and the "Big Five" (Costa & McCrae, 1992). Results demonstrate that the HSPS is a valid and reliable measure of the construct of SPS. However, in contrast to Aron and Aron's finding that the scale is unidimensional, the current results support a three-component structure consisting of Aesthetic Sensitivity (AES), Low Sensory Threshold (LST), and Ease of Excitation (EOE). BIS activity was especially associated with the component of EOE. In addition, the components had different patterns of association with the "Big Five". More specifically, AES showed the strongest relation with Openness to Experience, while LST and EOE were found to be most closely associated with Neuroticism.

Keywords: Sensory-processing sensitivity; Highly Sensitive Person Scale; Big Five; BIS/BAS

* Corresponding author. Tel.: +1 519 885 6751.
E-mail address: ksmolews@uwaterloo.ca (K.A. Smolewska).

0191-8869/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.paid.2005.09.022

1. Introduction

Research on responses to environmental changes has shown that, when faced with a new stimulus, individuals adopt one of two strategies: approach and exploration, or cautious attentiveness that may lead to avoidance. Aron and Aron (1997) suggest that one's choice of strategy is related to the manner in which sensory information is transmitted to, and processed in the brain, which they refer to as sensory-processing sensitivity (SPS).

According to Aron and Aron (1997), individual differences in SPS are determined, in part, by the reactivity of the operating parameters of the behavioural inhibition system (BIS). The BIS, along with the fight/flight system and the behavioural activation system (BAS), is one of three brain systems hypothesized to control emotional behaviour and to constitute the neurological basis for temperament (Gray, 1991).

Several researchers suggest that variation in the sensitivity of the BIS and BAS underlies motivational processes (e.g., Carver & White, 1994; Gray, 1991). The BAS, which is associated with ascending dopaminergic pathways and the cortico-striato-pallido-thalamic loops (De Pascalis, Fiore, & Sparita, 1996), is the source of goal-directed behaviour, positive feelings and responses to conditioned and unconditioned signals of reward (Corr, 2002). The BIS, which consists of the septohippocampal system, its monoaminergic afferents from the brainstem and its neocortical projection in the frontal lobe, is believed to be sensitive to punishment, non-reward and novelty (Gray, 1991).

Activity in the BIS is believed to be accompanied by a subjective state in which "one responds to threat (stimuli associated with punishment or non-reward) or uncertainty (novelty) with the reaction, 'stop, look, and listen, and get ready for action'" (Gray, 1991, p. 110). At high levels of physiological arousal, the efficiency of this reaction decreases and the individual may become hypervigilant, allocating attention to both relevant and irrelevant stimuli. Thus, an individual who has a characteristically more active BIS may be more easily distracted, less focused, and more easily overwhelmed with even small levels of stimulation, as well as overly sensitive to negative stimuli and thus prone to anticipate danger unnecessarily. Aron and Aron (1997) argue that the primary role of the BIS system is the processing of novel stimuli and that those who are high on SPS are also high in BIS functioning. In other words, they suggest that the BIS is the neuropsychological substrate of the personality trait, SPS.

In a series of studies, Aron and Aron (1997) found that SPS is a unidimensional construct composed of consistently intercorrelated, seemingly heterogenous sensitivities, such as those to strong sensory input, caffeine, hunger, pain and others' moods. Aron and Aron (1997) devised a 27-item questionnaire, The Highly Sensitive Person Scale (HSPS), to measure this proposed construct, and provided some evidence supporting its reliability and validity. According to their analyses, the HSPS represents a unidimensional construct that is characterized by an increased sensitivity to the processing of external (e.g., light, noise) and internal (e.g., pain, hunger) sensory information.

Aron and Aron's (1997) findings also show that SPS, as measured by the HSPS, is a construct that is reasonably separable from introversion and neuroticism. This finding is important because sensitivity has often been confused with introversion and neuroticism within personality research. In addition to SPS being a unique and important part of personality, Aron and Aron argue that it could potentially be a diathesis for psychopathology, particularly neurotic forms.

However, the construct of SPS is in need of further study. First, because Aron and Aron's (1997) psychometric assessment of the HSPS was based on relatively small samples, it would be useful to conduct a psychometric analysis using a large sample to allow for more stable parameter estimates and cross-validation. In their factor analysis of the HSPS, Aron and Aron report that a single factor solution fit best. However, a closer examination of the results of their analysis shows that factor loadings on the first factor ranged from .24 to .64. This suggests that some items were better represented by this one factor than others. An overview of the item content reveals a wide range of sensitivities, from sensitivity to environmental subtleties and substances (e.g., caffeine) to distractibility and overarousal. The scatter within the factor loadings and the diversity in item content suggest that the scale may be represented by more than one factor. Thus, it would be advantageous to reevaluate the factor structure in a new, larger sample.

Second, although Aron and Aron hypothesize that the BIS is the neuropsychological substrate of the personality trait of SPS, they never actually tested this in their series of studies. Thus, the association of SPS to Gray's constructs of BIS and BAS still needs to be examined.

Finally, Aron and Aron (1997) examined the association of the HSPS with personality measures assessing Introversion and Neuroticism to affirm the uniqueness of the SPS construct. While their findings suggest that SPS, as measured by the HSPS, is a construct that is partially independent from Introversion and Neuroticism, it is yet to be determined whether or not SPS is distinct from other widely recognized, broad personality dimensions. Specifically, Neuroticism and Introversion/Extraversion are only two of five personality traits commonly referred as "the Big Five" (Costa & McCrae, 1992). Thus, in addition to replicating previous findings between SPS, Neuroticism and Introversion, it would be important to examine the placement of the SPS construct within the broader constellation of personality factors encompassed by "the Big Five" (i.e., Neuroticism, Extraversion, Conscientiousness, Openness, and Agreeableness).

Accordingly, one goal of this study is to reexamine the psychometric properties of Aron and Aron's (1997) 27-item HSPS with a larger sample, offering more accurate parameter estimates and a reevaluation of its factor structure. A second goal is to test Aron and Aron's prediction that SPS is associated with a number of personality and neurophysiological constructs. Thus, this study will examine the relationship of SPS to Gray's (1991) constructs of BIS and BAS and to the "Big Five." Predictions of particular importance for construct validity are that SPS should be associated chiefly with BIS, rather than BAS; in addition, it is important to show that the associations of SPS with Neuroticism and Extraversion are no more than moderate, indicating that it is reasonably distinct from them.

2. Method

2.1. Participants and procedure

Measures for this study were completed as part of a larger questionnaire packet administered to 851 University of Waterloo students (257 men and 594 women) attending an undergraduate introductory psychology course. The mean age of the participants was 19.7 years and the standard deviation was 2.9 years. The questionnaires were completed voluntarily by the students outside of the classroom and students were requested to return completed packets within a week.

2.2. The Highly Sensitive Person Scale (HSPS) (Aron & Aron, 1997)

The HSPS, consisting of 27 items each rated from 0 to 7 (“0” = “strongly disagree”; “7” = “strongly agree”), measures SPS, which represents physiological reactivity to stimuli in the environment (e.g., “Are you easily overwhelmed by strong sensory input?”), as well as more subtle reactivity (e.g., “Do you become unpleasantly aroused when a lot is going on around you?”). In the present study, total scores on the HSPS had a Cronbach’s alpha of .89.

2.3. NEO-five factor inventory (NEO-FFI; Costa & McCrae, 1992)

The NEO-FFI is a brief 60-item version of the NEO PI-R and yields indices of Neuroticism, Extraversion, Openness, Agreeableness and Conscientiousness. Scores on the NEO-FFI are highly correlated with those on the NEO PI-R (Costa & McCrae, 1992). Consistent with previous work, in the present study the five indices showed good reliability, with alphas ranging from .73 to .81.

2.4. The BIS/BAS scale (Carver & White, 1994)

The BIS/BAS scales were designed to assess individual differences in the sensitivity of the two motivational systems proposed by Gray (1991). The BIS Scale (7 items) measures BIS sensitivity, or the degree to which respondents expect to feel anxiety when confronted with cues for punishment. The BAS Scale (13 items) measures BAS sensitivity, with subscales for reward responsiveness (5 items), drive (4 items) and fun seeking (4 items). Reward responsiveness measures the degree to which rewards lead to positive emotions, while drive measures a person’s tendency to actively pursue appetitive goals. Fun seeking measures the tendency to seek out and impulsively engage in potentially rewarding activities. Concerning validity, the BIS scale predicts negative mood in a situation where people anticipate punishment, and the drive and reward responsiveness scales predict positive mood in a situation where people anticipate rewards (Carver & White, 1994; Gomez & Gomez, 2002). Consistent with previous results, in the present study the scales showed good reliability, with an alpha of .78 for BIS and alphas of .70–.75 for the BAS subscales.

3. Results

3.1. Exploratory principal components analysis of the HSPS

Given the large sample size, an exploratory analysis on half of the sample was conducted and a confirmatory factor analysis was conducted on the second half based on the results of the exploratory analysis. The sample selected randomly for the exploratory analysis consisted of 380 cases and had an alpha coefficient of .89 for the HSPS. A principal components analysis with oblimin oblique rotation was applied to the set of 27 items. The screen test indicated that a three-component solution was optimal (eigenvalues: 7.02, 2.28, 1.64, 1.35, 1.27, 1.18, 1.08); the first three components accounted for 40.5% of the variance. Individual items were retained as indicators of a

Table 1
Principal components analysis with oblimin rotation (pattern matrix): Component loadings, alphas, and mean inter-item correlations for the HSPS (exploratory split-half sample)

Item		Components		
		1 (EOE)	2 (AES)	3 (LST)
3.	Do other people's moods affect you?	.36		
4.	Do you tend to be more sensitive to pain?	.36		
13.	Do you startle easily?	.42		
14.	Do you get rattled when you have a lot to do in a short amount of time?	.68		
16.	Are you annoyed when people try to get you to do too many things at once?	.62		
17.	Do you try hard to avoid making mistakes or forgetting things?	.36		
20.	Does being very hungry create a strong reaction in you, disrupting your concentration or mood?	.56		
21.	Do changes in your life shake you up?	.65		
23.	Do you find it unpleasant to have a lot going on at once?	.68		
24.	Do you make it a high priority to arrange your life to avoid upsetting or overwhelming situations?	.36		
26.	When you must compete or be observed while performing a task, do you become so nervous or shaky that you do much worse than you would otherwise?	.58		
27.	When you were a child, did your parents or teachers seem to see you as sensitive or shy?	.47		
2.	Do you seem to be aware of subtleties in your environment?		.65	
8.	Do you have a rich, complex inner life?		.76	
10.	Are you deeply moved by the arts or music?		.69	
12.	Are you conscientious?		.53	
15.	When people are uncomfortable in a physical environment do you tend to know what needs to be done to make it more comfortable (like changing the lighting or the seating)?		.53	
22.	Do you notice and enjoy delicate or fine scents, tastes, sounds, works of art?		.68	
5.	Do you find yourself needing to withdraw during busy days, into bed or into a darkened room or any place where you can have some privacy and relief from stimulation?		.39	
6.	Are you particularly sensitive to the effects of caffeine?			.70
7.	Are you easily overwhelmed by things like bright lights, strong smells, coarse fabrics, or sirens close by?			.70
9.	Are you made uncomfortable by loud noises?			.70
18.	Do you make a point to avoid violent movies and TV shows?			.57
19.	Do you become unpleasantly aroused when a lot is going on around you?			.53
25.	Are you bothered by intense stimuli, like loud noises or chaotic scenes?			.74
Coefficient alpha		.81	.72	.78
Mean inter-item correlation		.26	.30	.34

Note: EOE = Ease of Excitation; AES = Aesthetic Sensitivity; LST = Low Sensory Threshold; $N = 380$.

component if their loading on that component was greater than .35. When an item loaded on two components, it was eliminated from further analysis. This criterion resulted in the elimination of

two items: ''Are you easily overwhelmed by strong sensory input?'' and ''Does your nervous system sometimes feel so frazzled that you have to get off by yourself?''.

Table 1 shows the rotated components and their respective items. Component 1, labeled Ease of Excitation (EOE), included 12 items related to becoming mentally overwhelmed by external (e.g., ''Do you find it unpleasant to have a lot going on at once?'') and internal (e.g., ''Does being hungry create a strong reaction in you, disrupting your concentration or mood?'') demands. Component 2, labeled Aesthetic Sensitivity (AES), included 7 items related to aesthetic awareness (e.g., ''Are you deeply moved by arts and music?''). Component 3, labeled Low Sensory Threshold (LST), consisted of 6 items related to unpleasant sensory arousal to external stimuli (e.g., ''Are you easily overwhelmed by things like bright lights, strong smells, coarse fabrics, or sirens close by?''). Table 1 also provides mean inter-item correlations and alphas for each of the three components, showing that they have good internal consistency. The components themselves were modestly intercorrelated: EOE correlated .32 with both AES and LST, and the latter two correlated .23.

3.2. Confirmatory factor analysis of the HSPS

Amos 4.0 (Arbuckle, 1999) was used to perform a MLE confirmatory factor analysis (CFA) on the half of the sample unselected for the exploratory analysis. The sample consisted of 442 cases, and the reliability of the 27-item HSPS within this sample was again .89. A three-factor model, based on the foregoing exploratory analysis, was evaluated and compared statistically to a one-factor model. The fit of the three-component model was good, $\chi^2(275,\ N = 442) = 902.26$, $p < .001$, CFI = .973, RMSEA = .072. (CFI > .95 and RMSEA < .08 indicate reasonably good fit; Hu & Bentler, 1999.) The fit of the unidimensional model was also fairly good, $\chi^2(278,\ N = 442) = 1309.42,\ p < .001,$ CFI = .956, RMSEA = .092; however, the three-factor model clearly fit significantly better than the one-factor model, $\chi^2_{\text{diff}}(3,\ N = 442) = 407.16,\ p < .001$. Intercorrelations among the factors of the HSPS were .40 for EOE and AES, .45 for LST and AES, and .73 for EOE and LST. In summary, this analysis cross-validated the three-component model, but indicated somewhat stronger relations among the subscales than the exploratory analysis had suggested.

3.3. Relation of the HSPS factor scores with the NEO-FFI and BIS/BAS

Given the support of the CFA for a three-factor solution, factor scores were calculated for each participant in the full data set ($N = 844$) using unit (equal) weighting. Table 2 shows the correlations of the three-HSPS factor scores with scores on the NEO-FFI and the BIS/BAS. The factor subscales, especially EOE, were significantly associated with Neuroticism, as was the full 27-item scale. There was also a moderate association between AES and Openness. In fact, Openness was the only variable that was found to show an association of this strength with AES. Surprisingly, the only significant correlation with Extraversion was a weak association with LST. Agreeableness and Conscientiousness were not found to be associated with any of the HSPS dimensions.

Consistent with the hypothesis that the BIS but not BAS scales would be associated with the HSPS, BIS was related significantly to the HSPS and all its factor scores (especially EOE),

Table 2
Correlations of the HSPS factor subscales and full-scale with the NEO-FFI and BIS/BAS

	HSPS factor subscales			HSPS (27 items)
	EOE	AES	LST	
Neuroticism	.48*	.19*	.31*	.45*
Extraversion	−.09	.00	−.12*	−.09
Openness	.07	.37*	.09	.19*
Agreeableness	.07	−.04	−.03	.02
Conscientiousness	.06	.03	.01	.05
BIS	.36*	.15*	.19*	.32*
BAS Reward Resp.	.19*	.18*	.01	.16*
BAS drive	−.03	.09	.01	.03
BAS fun seeking	−.09	.08	−.09	−.07

Note: EOE = Ease of Excitation; AES = Aesthetic Sensitivity; LST = Low Sensory Threshold; HSPS = Highly Sensitive Person Scale; NEO-FFI = NEO-Five Factor Inventory; BAS = Behavioural Activation System; BIS = Behavioural Inhibition System; $N = 823$.
* $p < .01$.

whereas two out of the three-BAS scales were not associated with any of them. However, the BAS Reward Responsiveness did show a small correlation with the AES and EOE subscales.

In view of the moderate association of both Neuroticism and BIS with HSPS total and subscale scores, regression analyses were conducted to examine the relative contribution of these two variables, which are both conceptually related to anxiety. Neuroticism and BIS were entered as simultaneous predictors in four analyses, one for each of the following dependent variables: EOE, AES, LST, and HSPS total score (27 items). The results, presented in Table 3, suggest that Neuroticism makes a somewhat stronger unique contribution to each subscale of the HSPS, as well as to the total HSPS score. However, BIS also makes a unique contribution to two of the three-HSPS subscales (EOE and LST) and to the total score.

Table 3
Beta coefficient results and model summary from regression analyses: HSPS factor subscales and full-scale with Neuroticism and BIS as simultaneous predictors

Dependent variables	Predictors		Model summary	
	Neuroticism	BIS	*R*-Square	*F*(2, 821)
EOE	.40*	.22*	.27	150.85*
AES	.16*	.09	.05	18.86*
LST	.28*	.10*	.10	47.48*
HSPS (27 items)	.38*	.19*	.23	113.27*

Note: EOE = Ease of Excitation; AES = Aesthetic Sensitivity; LST = Low Sensory Threshold; HSPS = Highly Sensitive Person Scale; NEO-FFI = NEO-Five Factor Inventory; BAS = Behavioural Activation System; BIS = Behavioural Inhibition System; $N = 823$.
* $p < .01$.

4. Discussion

In contrast to Aron and Aron's contention that the HSPS measures a unidimensional construct, the present results support a three-factor structure that distinguishes Ease of Excitation (EOE), Aesthetic Sensitivity (AES), and Low Sensory Threshold (LST). The positive intercorrelations among these factors, however, are consistent with a general, higher-order construct of SPS.

4.1. Sensory-processing sensitivity and BIS/BAS

According to Aron and Aron (1997), high SPS reflects high BIS functioning. The results of the correlational analyses suggest that high BIS activity is most strongly associated with the component of EOE, as well as the 27-item HSPS total score. In contrast, BIS was found to have a weaker association with the AES and LST components. Thus, motivation to behave in a cautious manner aimed at preventing negative consequences and unpleasant states appears to have the clearest link with EOE, or the tendency to become overwhelmed by stimulation and experience disruptions in concentration.

The BAS Reward Responsiveness scale was also found to have an association with EOE, AES and the HSPS total score, albeit a relatively small one. This suggests that those scoring high on EOE and AES may indeed be sensitive to cues signaling incentive, in addition to those signaling threat or punishment. However, the finding that the other BAS subscales were not related to either the HSPS factor or total scores implies that it is a particular aspect of the appetitive motivational system, one specifically tied to Reward Responsiveness, that is associated with SPS.

In general, when BAS sensitivity is high, individuals are thought to demonstrate a range of responses to cues of incentive, including positive affect (i.e., elation and hope), increased energy, and increased psychomotor activity (Depue & Collins, 1999). While the construct of Reward Responsiveness encapsulates a tendency to respond to desired events (both anticipated and experienced) with heightened energy and positive affect, the Drive and Fun-Seeking factors reflect approach motivation or behaviour elicited in the context of incentive. This suggests that those scoring high on EOE or AES may have a tendency to experience higher levels of positive affect in response to rewarding stimuli. However, the affinity to engage in active pursuit of incentive reward does not seem to be associated with either EOE or AES.

4.2. Sensory-processing sensitivity and the "Big Five"

4.2.1. Neuroticism

Aron and Aron (1997) argue that sensitivity has often been confused with Neuroticism (e.g., Howarth, 1986), fearfulness (e.g., Gray, 1991), and reactivity (Strelau, 1983). One reason for this confusion lies in the notion that both sensitive and fearful individuals react to stimuli in a cautious manner that may lead to avoidance. Since those who are highly sensitive are more aware of their surroundings and more easily aroused, it may seem reasonable that they would be more emotional and more prone to worry.

The present results, however, suggest that the HSPS factors are not associated equally with Neuroticism. Negative emotionality was most strongly related to EOE, or the tendency to become overwhelmed by stimulation and experience disruptions in concentration. In contrast, its correlation

with the AES factor was rather small. This pattern of findings is quite sensible because Neuroticism is generally linked with proneness to high-strung, tense and worrying behaviour (Friedman & Schustack, 1999), rather than depth of aesthetic experience.

4.2.2. Extraversion

Aron and Aron (1997) found that SPS is related to, but distinguishable from introversion. Based on Aron and Aron's findings, we expected a negative association between the HSPS and Extraversion; however, the only significant correlation was a weak association with LST. Thus, SPS appears to be virtually unrelated to one's level of Extraversion. This finding provides further support for the need to distinguish between sensitivity, shyness and introversion.

4.2.3. Openness to experience

The only personality factor, aside from Neuroticism, that was moderately associated with the HSPS was Openness. Specifically, the AES factor of the HSPS was the one SPS dimension that correlated with this personality dimension. Generally, individuals who score high on openness are imaginative, witty and have a strong aesthetic sense (Friedman & Schustack, 1999).

The present finding that AES is associated with Openness but not with Neuroticism is consistent with DeYoung, Peterson, and Higgins' (2002) suggestion that Openness may be associated with the function of the central dopaminergic (DA) system, which mediates approach behaviour, positive affect and incentive reward sensitivity (Ashby, Isen, & Turken, 1999; Panksepp, 1999). Since Aron and Aron (1997) conceptualized SPS as a function of the BIS, this argument may initially sound counterintuitive. However, it is consistent with a recent revision of Gray's Reinforcement Sensitivity Theory (RST) (Corr, 2001). According to the new joint-subsystems hypothesis (Gray & McNaughton, 2000), the BIS and the BAS have the potential to influence both reward-mediated and punishment-mediated behaviour. Specifically, they propose that the BIS is only activated when there is simultaneous activation of the BAS. They argue that "... the presence of stimuli or contingencies per se is not sufficient to activate this system" (p. 86; authors' own italics), but that an approach–avoidance conflict elicits the state of anxiety. Thus, it seems plausible that a person with a lower BIS threshold (i.e., Aron and Aron's conception of a highly sensitive person) could score above average on AES. However, since Openness is related to approach, a person with a heightened BIS may experience increased anxiety because the inhibition system would be frequently activated as a result of approach–avoidance conflicts.

4.3. Future research directions

Since the HSPS is a relatively new measure, there are several aspects of it that are in need of further study. First, because this study was conducted using a rather homogenous sample (i.e., first-year undergraduate students from a limited range of ethnic backgrounds), future research should examine the relationships among these constructs in a more heterogenous group. Specifically, comparisons should be made on the basis of age, gender and cultural background. Second, the cross-sectional, correlational design employed in this study prevents us from making any conclusions regarding the causal relationship between the constructs measured. Hence, a longitudinal study examining the relationship between BIS, Neuroticism and SPS more closely would be particularly valuable. Also, the present research did not employ any behavioural, perceptual or

physiological measures as correlates of the HSPS. Thus, it will be important to explore various correlates of this measure in an experimental situation. Studies examining individual differences in attention (e.g., measures of latent inhibition, sensory gating), responsivity to stimuli (e.g., ERPs), and perceptual awareness would be particularly beneficial in the differentiation of individuals scoring high on each of the three factors.

Finally, a more in-depth investigation of the relationship between SPS and various aspects of personality should be conducted. Research focusing on the association between Neuroticism, Openness and SPS seems to be most promising. Recent research suggests that Openness is linked to a reduction in latent inhibition (Peterson & Carson, 2000), an alteration in attention associated with increased dopamine neurotransmission (Gray et al., 1997). Since at least one factor of the HSPS-R was found to be associated with Openness, it would be interesting to see whether reductions in latent inhibition are also related to SPS.

References

Arbuckle, J. L. (1999). *Amos 4.0* [computer software]. Chicago: SmallWaters Corp.

Aron, E. N., & Aron, A. (1997). Sensory-processing sensitivity and its relation to introversion and emotionality. *Journal of Personality and Social Psychology, 73*, 345–368.

Ashby, F. G., Isen, A. M., & Turken, A. U. (1999). A neuropsychological theory of positive affect and its influence on cognition. *Psychological Review, 106*, 529–550.

Carver, C. S., & White, T. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology, 67*, 319–333.

Corr, P. J. (2001). Testing problems in J.A. Gray's personality theory: A commentary on Matthews and Gilliland (1999). *Personality and Individual Differences, 30*, 333–352.

Corr, P. J. (2002). J.A. Gray's reinforcement sensitivity theory: Tests of the joint subsystems hypothesis of anxiety and impulsivity. *Personality and Individual Differences, 33*, 511–532.

Costa, P. T., & McCrae, R. R. (1992). *Revised NEO Personality Inventory and NEO Five Factor Inventory professional manual*. Odessa, FL: Psychological Assessment Resources.

De Pascalis, V., Fiore, A. D., & Sparita, A. (1996). Personality, event-related potential (ERP) and heart rate (HR): An investigation of Gray's theory. *Personality and Individual Differences, 20*, 733–746.

Depue, R. A., & Collins, P. F. (1999). Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. *Behavioral and Brain Sciences, 22*, 491–569.

DeYoung, C. G., Peterson, J. B., & Higgins', D. M. (2002). Higher-order factors of the Big Five predict conformity: Are there neuroses of health? *Personality and Individual Differences, 33*, 533–552.

Friedman, H. S., & Schustack, M. W. (1999). *Personality: Classic theories and modern research*. Boston: Allyn and Bacon.

Gomez, A., & Gomez, R. (2002). Personality traits of the behavioural approach and inhibition systems: Associations with processing emotional stimuli. *Personality and Individual Differences, 32*, 1299–1316.

Gray, J. A. (1991). The neuropsychology of temperament. In J. Strelau & A. Angleitner (Eds.), *Explorations in temperament: International perspectives on theory and measurement* (pp. 105–128). New York: Plenum Press.

Gray, J. A., & McNaughton, N. (2000). *The neuropsychology of anxiety: An enquiry into the functions of the septo-hippocampal system* (2nd ed.). Oxford: Oxford University Press.

Gray, J. A., Moran, P. M., Grigoryan, G., Peters, S. L., Young, A. M. J., & Joseph, M. H. (1997). Latent inhibition: The nucleus accumbens connection revisited. *Behavioural Brain Research, 88*, 27–34.

Howarth, E. (1986). Introversion and neuroticism: A persistent relationship. *Psychological Reports, 58*, 389–390.

Hu, L.-T., & Bentler, P. M. (1999). Cut-off criteria for fit indices in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1–55.

Panksepp, J. (1999). *Affective neuroscience*. New York: Oxford University Press.
Peterson, J. B., & Carson, S. (2000). Latent inhibition and openness to experience in a high-achieving student population. *Personality and Individual Differences, 28*, 323–332.
Strelau, J. (1983). *Temperament, personality, activity*. San Diego, CA: Academic Press.