Relationships Between Temperament Dimensions in Personality and Unconscious Emotional Responses

Aihide Yoshino, Yoshie Kimura, Takeshi Yoshida, Yoshitomo Takahashi, and Soichiro Nomura

Background: *In addition to character dimensions, personality includes temperament dimensions, defined as individual differences in implicit associative learning responses to environmental stimuli processed by unconscious memories. We examined whether temperament dimensions were associated with patterns of unconscious emotional responses of an autonomic nature.*

Methods: *From 70 healthy men, high and low novelty-seeking (NS) groups and high and low harm-avoidance (HA) groups were selected using scores on the Tridimensional Personality Questionnaire measuring temperament dimensions. Emotionally negative, neutral, and positive visual stimuli were presented subliminally using backward masking, and skin conductance responses (SCRs) were measured as an autonomic index of emotional responses. Skin conductance responses to the three emotional stimulus conditions were compared between groups.*

Results: *Skin conductance responses in the high NS group were significantly greater than in the low NS group when positive or negative emotional stimuli were presented but not neutral stimuli. Skin conductance responses in the high HA group were significantly greater than in the low HA group for stimuli of all three valences.*

Conclusions: *Autonomic response patterns to unconscious emotional perception differed between NS and HA, suggesting that different dimensions of temperament may be associated with different patterns of unconscious emotional responses. Novelty seeking and HA may be associated with specificity and susceptibility of preattentive emotional perception, respectively.*

Key Words: Autonomic response, backward masking, emotion, personality, temperament, unconsciousness

Personality has been defined as the dynamic organization within the individual of psychophysical systems that determine a person's unique adjustments to the environment (Allport 1937). Two types of learning involving conscious and unconscious memories contribute differently to the organization of personality; accordingly, Cloninger (1987) and Cloninger et al (1993) suggested that personality could be divided into character and temperament dimensions. Conscious memories are represented as words, images, or symbols about facts that have explicit meanings declared verbally. In contrast, unconscious memories involve preconceptual perceptual processing that encodes procedures of motion, priming, and emotional valence (Graf and Schacter 1985; Squire and Zola-Morgan 1991). Associative learning such as conditioning and emotional responses requires unconscious memories about perceptual experience but does not involve conscious recall or recognition (Gray and MacNaughton 2000; LeDoux 1996). Temperament dimensions have been defined as individual differences in associative learning in response to novelty, danger or punishment, and reward (Cloninger 1987; Cloninger et al 1993); these dimensions involve automatic and preconceptual responses to perceptual stimuli, reflecting heritable biases in the unconscious memory system. Cloninger (1987) developed a self-rating questionnaire, Tridimensional Personality Questionnaire (TPQ), to measure three dimensions of temperament, defined as basic mutually independent stimulus-response characteristics: novelty seeking (NS), harm avoidance (HA), and reward dependence (RD). The TPQ subsequently was revised to include character dimensions and renamed the Temperament and Character Inventory (TCI) (Cloninger et al 1993). Novelty seeking is viewed as a trait involving activation or initiation of behaviors such as exploratory activity in response to novelty, approach to potential rewards, and active avoidance of monotony and punishment. Novelty seeking is thought to reflect variation in the brain's behavioral activation system. High-NS individuals are characterized as impulsive and excitable, while low-NS persons are stoic and rigid. Harm avoidance is viewed as a trait resulting in inhibition or cessation of behaviors, such as pessimistic worry in anticipation of future problems, passive avoidant behaviors such as fear of uncertainty, and rapid fatigability. Harm avoidance is thought to reflect variation in the brain's behavioral inhibition system. High HA is characterized by cautiousness and apprehensiveness, while low-HA persons are confident and energetic. Reward dependence is viewed as a trait promoting maintenance or continuation of ongoing behaviors manifest as sentimentality, social attachment, and dependence on approval of others. The TPQ and TCI have been used in many areas of psychiatry and neuroscience research. In particular, NS and HA have been examined frequently in behavioral genetic studies (Herbst et al 2000). Temperament dimensions as measured by self-rating questionnaires may be associated with the preconceptual perceptual responses such as unconscious emotional responses, but we know of no reported analyses of such relationships.

Skin conductance responses (SCRs), measures of autonomic arousal, can be used to index emotional processing, since SCRs are altered transiently by emotional stimuli (Bauer 1998; Lang et al 1993). The ventromedial and dorsolateral prefrontal cortices, anterior cingulate gyrus, parietal lobe, insula, and amygdala are reported to influence SCRs via the posterior hypothalamus (Critchley 2002). The amygdala is particularly implicated in SCRs related to associative learning between a stimulus and reinforcement.

Backward masking is a procedure used to present visual stimuli unconsciously. Conscious awareness of a visual target shown only briefly (<40 milliseconds) can be prevented by a subsequent masking stimulus; subjects report seeing the mask but not the target (Breitmeyer 1984; Lamme and Roelfsema

From the Department of Psychiatry (AY, YK, TY, SN), National Defense Medical College; and Division of Behavioral Sciences (YT), National Defense Medical Research Center, Saitama, Japan.

Address reprint requests to Aihide Yoshino, M.D., Department of Psychiatry, National Defense Medical College, 3-2 Namiki, Tokorozawa, Saitama, 3598513 Japan; E-mail: aihide@me.ndmc.ac.jp.

Received March 25, 2004; revised July 27, 2004; accepted September 13, 2004.

0006-3223/05/$30.00
doi:10.1016/j.biopsych.2004.09.027

2000). Previous studies have reported that an emotional picture (Glascher and Adolphs 2003) and an aversively conditioned fearful facial stimulus (Esteves et al 1994a, 1994b) can elicit reliable SCRs even if masked. Further, a previous neuroimaging study (Morris et al 1998, 1999) showed that the amygdala, superior colliculus, and pulvinar, which constitute the subcortical emotional pathway, were activated by masked fearful facial stimuli. Moreover, patients with specific phobias showed elevated SCRs in response to masked pictures depicting objects provoking the phobia (Öhman and Soares 1994).

In the present study, to better understand the relationships between temperament dimensions and unconscious emotional responses, we compared SCRs in response to emotional pictures presented subliminally with backward masking between high-scoring and low-scoring subject groups with respect to NS and HA. Since individuals with high NS were likely to approach an emotionally positive object or actively avoid an emotionally negative object, we hypothesized that preattentive emotional responses in high-NS individuals were greater than those in low-NS individuals when negative and positive emotional stimuli were presented but not neutral stimuli. On the other hand, preattentive emotional responses in high-HA individuals were hypothesized to be greater than those in low-HA individuals regardless of arousal level of emotional stimuli, since high-HA individuals were likely to have increased autonomic arousal and attention because of apprehension arising in relation to daily events.

Methods and Materials

Participants

Seventy healthy male volunteers (mean age ± SD, 23.7 ± 1.2 years) whose visual acuity was normal either unaided or with correction participated in the study. Written informed consent was obtained from all participants after a detailed description of the study, which was approved by the Ethics Committee of National Defense Medical College. Subjects first were instructed to complete the Japanese version of the TPQ, which already had been standardized (Takeuchi et al 1993). Distributions of TPQ subscale scores were 9 to 26 (mean, 18.1 ± 4.2; median, 18) for NS, 3 to 32 (mean, 16.5 ± 6.4; median, 16) for HA, and 8 to 29 (mean, 18.2 ± 4.3; median, 19) for RD. Since the correlation coefficient between NS and HA scores was .11 ($p = .35$), these two variables were considered mutually independent.

Subjects were assigned to groups on the basis of high or low NS and HA scores, with "high" and "low" subjects selected from the first and last 10 men in the score distribution. Of the subjects tentatively selected for a group, 26 consented to participate in the SCR-testing protocol: 10 men for the high-NS group, 6 for the low-NS group, 9 for the high-HA group, and 9 for the low-HA group. Four and two subjects in the high-NS group also belonged to the high-HA and low-HA groups, respectively. Each subject in the low-NS group also belonged to the high-HA or low-HA group. Table 1 shows mean age and TPQ subscale scores in the four groups. No statistically significant difference was evident in age or HA and RD scores between high-NS and low-NS groups or in age or NS and RD scores between high-HA and low-HA groups. Cash payment was given to subjects after the experiment. We did not adopt RD as a research object, since it differed from NS and HA in that RD had not been examined frequently in behavioral neuroscience research. Further, RD has not been considered a sole temperament dimension, since it includes another temperament, persistence (Cloninger et al 1993).

Table 1. Mean Age and TPQ Scores in High-Score and Low-Score Groups Concerning NS and HA

		Age		NS		HA		RD	
	n	Mean	SD	Mean	SD	Mean	SD	Mean	SD
NS Group									
High NS	10	23.8	1.3	24.4[a]	1.8	18.7	5.5	17.5	4.2
Low NS	6	23.2	1.0	12.2	1.8	17.2	4.4	21.3	5.8
HA Group									
High HA	9	23.0	1.3	19.0	5.2	23.4[b]	1.5	18.8	5.2
Low HA	9	23.4	1.5	19.1	2.6	8.1	3.3	17.7	4.8

TPQ, Tridimensional Personality Questionnaire; NS, novelty seeking; HA, harm avoidance; RD, reward dependence.

[a]Significant difference between groups (unpaired *t* test, $t = 13.2$, $df = 14$, $p < .0001$).

[b]Significant difference between groups (unpaired *t* test, $t = 15.3$, $df = 16$, $p < .0001$).

Stimuli

We selected 36 pictures from the International Affective Picture System (IAPS) (Lang et al 1999). The IAPS is a standardized, well-characterized collection of visual images designed to evoke a negative (unpleasant), neutral, or positive (pleasant) emotional state. Pictures in the IAPS vary with respect to two primary dimensions: affective valence, ranging from unpleasant to pleasant (1 to 9), and arousal, ranging from calm to excited (1 to 9). Previous studies (Lang et al 1990, 1993) found SCRs measure the arousal dimension, while heart rate and startle reflex are measures of the valence dimension. Moreover, a previous study (Glascher and Adolphs 2003) reported that the IAPS pictures can elicit reliable SCRs even if masked. Three groups of 12 pictures were selected by valence: negative, neutral, and positive. Negative pictures consisted of such images as frightening animals and mutilated human bodies. Neutral pictures depicted ordinary objects such as tableware and plants. Positive pictures included images such as erotically posed couples and female nudes. Mean valence levels for the selected negative, neutral, and positive emotional pictures were 2.6, 4.9, and 7.7, respectively, while mean arousal levels were 6.2, 2.4, and 6.8, respectively (Table 2). Arousal levels for the negative and positive stimulus conditions were significantly higher than for neutral pictures, but differences were not significant between arousal levels for the negative and positive conditions.

Stimuli were displayed on a personal computer-controlled 27-inch cathode ray tube (CRT) color display (refreshment rate, 100 Hz) in a darkened room. The subject sat in front of the

Table 2. IAPS Normative Ratings of Arousal and Valence for the Three Stimulus Conditions Shown to Subjects

	Negative		Neutral		Positive	
Pictures	Mean	SD	Mean	SD	Mean	SD
Arousal[a]	6.2	.6	2.4	.5	6.8	.6
Valence[b]	2.6	.9	4.9	.1	7.7	.5

Three sets of 12 pictures were selected from the IAPS (Lang et al 1999) according to valence (negative, neutral, and positive valence) on the basis of IAPS norms.

IAPS, International Affective Picture System.

[a]$F = 206.2$, $df = 2/33$, $p < .0001$, neutral < negative, positive (Scheffe's test).

[b]$F = 192.8$, $df = 2/33$, $p < .0001$, negative < neutral < positive (Scheffe's test).