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Personality Change at the Intersection of Autonomic Arousal and Stress

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Abstract

We hypothesized that personality change in children would be predicted by the interaction of family risk with susceptibility to autonomic arousal, with children characterized by both families at high risk and highly reactive autonomic nervous systems showing maladaptive change. This hypothesis was tested in a six-year longitudinal study in which personality prototype, problem behavior, and negative emotional intensity were measured at two-year intervals. The results indicated that children with exaggerated skin conductance responses, a measure of autonomic reactivity, and living in families with multiple risk factors, were most likely to develop towards an under-controlled personality type and exhibit increases in problem behavior and negative emotional intensity. The implications of the results for understanding the relation of stress to biological vulnerability are discussed.

Childhood depression, delinquency, and behavioral inhibition have all been linked to the interaction of stress with genes associated with the regulation of affect. Researchers have found that children with low levels of social support and a variant of a gene that results in lowered availability of serotonin in the brain are at heightened risk for depression (Kauffman et al. 2004) and behavioral inhibition (Fox, et al, 2005). Similarly, Foley et al. (2004) and Caspi et al. (2002) reported that conduct disorder was predicted by an interaction of childhood adversity with a gene variant regulating MAO-A activity, which is also linked to emotional regulation. Barr et al. (2004) found that macaques with both the genetic susceptibility and adverse family history (motherless) that were exposed to a stressor responded with exaggerated arousal of the hypothalamus-pituitary-adrenal (HPA) axis. In humans, chronic hyper-arousal of the HPA axis is hypothesized to produce neurobiological changes associated with depression and related psychiatric syndromes (Heim, Plotsky, & Nemeroff, 2004). These lines of research suggest that maladaptive personality *change* is most likely in children who are both living in adverse environments and prone to heightened physiological arousal—either as a result of genes and/or as a consequence of chronic stress (see Moffitt, Caspi, & Rutter, 2006, for a discussion).

We test this hypothesis in this study. We measured personality change in the prototypicality of personality types and personality traits in a six-year study with four measurement points. None of the studies cited above had longitudinal designs with repeated measurement of the same personality traits; some used cross-sectional designs (e.g., Kaufman, et al. 2004) while others used longitudinal designs but without repeated measures (e.g., Fox et al. 2005).

Consequently, none of these studies had the multiple waves of measurement necessary to demonstrate change

We assessed resemblance to, or the prototypicality of, three *personality types* (see Hart, Atkins, & Fegley, 2003, for a discussion of personality types and traits). Three childhood personality types regularly emerge in research (Caspi, 1998): the resilient type, characterized by high ego-resilience ("ability to modify one's behavior in accordance with contextual demands," Block & Block, 1980, p. 48) academic achievement, and success in relationships; the over-controlled type, defined by high ego-control ("degree of impulse control and modulation," Block & Block, 1980, p. 41), low ego-resilience, shyness, and negative emotion; and the under-controlled type, characterized by low levels of ego-resilience, ego-control, high levels of delinquency, and negative emotion. Family risk has been shown to be associated with change from the resilient type to the under-controlled type (Hart, Atkins, & Fegley, 2003). Our prediction was that this association would be moderated by heightened physiological arousal.

We also measured change in problem behavior and negative emotional intensity. These two traits bear conceptual relationships to delinquency and depression, constructs studied in research reviewed above.

We measured change in the prototypicality of personality types and in personality traits by using *growth curves*. The linear trajectories for each participant for prototypicality of the three personality types and for each of the two characteristics were estimated and then related to the interaction of family risk and SCR.

Skin conductance response (SCR) is a frequently used measure of autonomic arousal linked with activation of multiple components of emotion regulation in humans including the amygdala and HPA axis (Ehlert & Straub, 1997; Fowles, Kochanska, & Murray, 2000; Gläscher & Adolphs, 2003; Williams, et al., 2004). Barr et al. (2004) found that animals genetically susceptible to stress exhibited heightened levels of physiological arousal only under stressful, not baseline conditions. Here, we control for baseline SCR to isolate the distinctive contribution of heightened arousal under stress to the prediction of personality change.

Methods

Participants

Participants were those with complete data (70 males, 68 females) on the measures for personality type prototypicality drawn from a longitudinal investigation (see Eisenberg et al., 1996, 2005). Participants were largely White (85%; the remainder of the sample was 7% Hispanic, 3% African American, 5% others) and from lower- to upper-middle class families ($M = \$48,500$).

Procedure

At entry into the study (Time 1), participants were in grades K-3. Participants were reassessed 24 (Time 2), 48 (Time 3) and 72 (Time 4) months following the initial session.

Time 1—Skin conductance response was measured in the laboratory (see Holmgren, Eisenberg, & Fabes, 1998, for details). Two 8mm silver–silver chloride electrodes were attached to the child's left-hand palmar surface using a 0.050 molar sodium chloride Unibase cream mixture. The left arm was then loosely strapped to the chair to reduce mobility. The electrodes were linked to a Colbourne S71-23 Skin Conductance Coupler and a computer. Children viewed two films displayed on a 48 cm monitor and located 3 meters

away. The first film (165 s) featured a dolphin swimming in the ocean and was used to collect baseline data. The second 25-second film began when a fire started in a girl's room due to flames from the girl's lamp and showed her parents responding to her screams. Skin conductance response (SCR) included all responses that rose .05 micromhos or more. Artifacts due to movement or skin response deltas that were larger than 3.5 micromhos and more than 2.5 *SDs* above a given child's mean were deleted. We computed summary indices for the baseline (SCR-b) condition and for the distress condition (SCR-d). The summary measure was the average of the means of the standardized values for both response amplitudes and the number of responses. One participant had an SCR-d score more than 5 *SD* higher than the mean, and was excluded.

Personality type prototypicality was determined by assessing the proximity of ego-resiliency and ego-control scores for each participant to the prototype for each personality. A teacher sorted the 100 personality items in the California Child Q-Sort (CCQ; Block & Block, 1980) according to their descriptiveness of the participant, following a fixed distribution that ranges from 1 ("extremely uncharacteristic") to 9 ("extremely characteristic"). Each child's vector of scores was then correlated with the vector of scores corresponding to the prototype for ego-resiliency, with the resulting *r* serving as the index of ego-resiliency. Similarly, a measure of ego-undercontrol was derived by correlating the vector of scores for each participant with the vector of scores for the prototype for ego-control (see Block & Block, 1980, for details on this procedure).

Prototypes for the three personality types were derived from previous studies (e.g., Asendorpf & van Aken, 1999, Hart, Burock, Atkins, London, & Bonilla-Santiago, 2005) which have reported mean ego-resiliency and ego-control scores for the three personality types. The resilient prototype is defined by a *t*-score of 60 for ego-resiliency and 50 for ego-control, 40 for ego-resiliency and 60 for ego-control for the over-controlled type, and 40 for ego-resiliency and 40 for ego-control for the under-controlled type. Typicality for each personality type was calculated by summing the absolute values of the differences between a participant's *t*-scores for ego-resiliency and ego-control and the corresponding *t*-scores for each prototype, and then reversing the sign so that larger numbers correspond to greater prototypicality.

Negative emotional intensity was measured with teachers' ratings on a 7-point scale (from "never" to "always") of 5 items (e.g., "When this child experiences anxiety, it normally is very strong").

Using a scale developed by Lochman (1995), teachers judged the frequency of 23 *problem behaviors* (e.g., "physically harms other children") on a 4-point scale (1 = never, 4 = often). Details about the origins, construction, and reliability of both scales are provided by Eisenberg et al. (1996).

Mothers reported household income and educational attainment. Consistent with previous research (Hart, Atkins, & Fegley, 2003), we considered an income in the bottom 20% (\$25,000 or less) of the sample and educational attainment of 12 or fewer years (16% of the sample) to be family risk factors, and summed risk factors to form a family risk score. Missing data for income (4 families) and educational attainment (1 family) were replaced using regression estimates derived from Time 2 measures of the same variables.

Times 2–4—Teachers rated children on 53 of the 100 personality items in the CCQ (Block & Block, 1980) using a 1 (very uncharacteristic) to 9 (very characteristic) scale. Ego-resiliency and ego-control scores were derived following the procedures outlined earlier, and were then used to calculate prototypicality scores as described for Time 1. Problem

behaviors and negative emotional intensity were assessed following the Time 1 procedures (alphas for both measures at all 4 times exceed .80). Different teachers provided the ratings at Times 1–4, ensuring the independence of the observations at the different assessments.

Results

Relation of Types to Other Variables

Table 1 presents the means for the Time 1 continuous measures and correlations among them.

Longitudinal Patterns of Stability and Change

Personality type prototypicality—We calculated correlations among prototypicality scores for each of the three personality types. For the resilient prototypicality score measured at Time 1, r s for prototypicality measured at Times 2, 3, and 4, respectively, were .49, .44, and .41. For prototypicality measured at Time 2, r s with prototypicality measured at Time 3 and T4 were .61 and .68. Finally, for prototypicality measured at Times 3 and 4, r was .60.

Similar levels of stability were observed for the prototypicality scores for the under-controlled type: r s for Time 1 with Times 2, 3, and 4, respectively, were .60, .42, and .32; for Time 2 with Times 3 and 4, respectively, .59 and .59; and for Times 3 and 4, .52. Prototypicality scores for the under-controlled type were of the same magnitude: r for Time 1 with Times 2–4, respectively, was .46, .45, and .33; for Time 2 with Time 3 and 4 scores, .51 and .59; and for Time 3 and Time 4, .54.

We used growth curves to measure change in prototypicality for each of the three personality types. For each participant, we regressed the resilient type prototypicality score on age in months at assessment (four scores per participant) and used the resulting slope as the index of change (the same method was used to measure change in prototypicality for the under-controlled and over-controlled types, problem behavior, and negative emotional intensity). The mean slope for the resilient prototypicality score was $-.0001$ ($SD = .18$), indicating that there is very little developmental change. The mean slope for the over-controlled type was positive ($.006$, $SD = .13$), but also very small in magnitude. The mean slope for scores for the under-controlled prototype was -0.008 ($SD = .13$).

The slopes for prototypicality scores were uncorrelated with Time 1 maternal educational attainment, family income, SCR-b, and SCR-d. We then regressed growth curve slopes on the Time 1 measure of the construct (prototypicality score), SCR-b, SCR-d, family risk score, and the interaction of SCR-d and family risk score. The results are presented in Table 2, and indicate that the interaction of family risk score and SCR-d was associated with increases in the prototypicality of the under-controlled type, as hypothesized, (but not with the slopes for the other two prototypicality scores). The equation in Table 2 can be used to predict change in prototypicality for the under-controlled type for children with low and high levels of stress (0 and 2, respectively) and with low (-1 SD below the mean) and high ($+1$ SD above the mean) SCD-d. Figure 1a indicates that it is only participants with high SCD-d and moderate to high levels of stress who become more similar to the under-controlled type over the course of the study.

Problem behavior and negative emotional regulation—The correlations of problem behavior measured at Time 1 with problem behavior at Times 2–4 were, respectively, .59, .50, and .40; from Time 2 to Times 3 and 4, .61 and .48; from Time 3 to Time 4, .46. The correlations of Time 1 negative emotional intensity with negative emotional intensity at

Times 2, 3, and 4 were .30, .30, and .11 ($p > .05$); Time 2 with Times 3 and 4, .39 and .30; and Times 3 and 4, .42.

Growth curves were also calculated for problem behaviors (M slope = $-.001$, $SD = .001$) and negative emotional intensity, (M slope = $-.001$, $SD = .002$). The slopes were uncorrelated with Time 1 maternal educational attainment, family income, SCR-b, and SCR-d. We regressed the slopes for negative emotional intensity and problem behavior growth curves on the Time 1 measure of the construct (problem behaviors or negative emotional intensity), SCR-b, SCR-d, family risk score, and the interaction of SCR-d and family risk score. The results are presented in Table 2, and indicate that the interaction of family risk score and SCR-d was associated with increases in problem behavior and negative emotionality. We can estimate from Table 2 that a child with high SCR-d (+1 SD) and family risk scores at Time 1, compared to a child with equal Time 1 scores for family risk, problem behavior, and negative emotionality, but with low SCR-d, would have Time 4 behavior problem and negative emotional intensity scores more than 1 SD standard deviation higher. Change in negative emotional intensity and problem behavior scores over the course of the study are illustrated in Figure 1b and c.

Discussion

We found an interaction between SCR-d and family risk score in the prediction of change in personality. To our knowledge, this is the first research to demonstrate that the interaction of family adversity with a biological characteristic is associated with longitudinally-measured change in childhood personality. The association of risk score and SCR-d to personality change was robust, as it emerged with both personality type prototypicality scores and was evident in the specific traits of problem behavior and negative emotional intensity. The combination of high SCR and high family risk predicted substantial (~ 1 SD over six years) increases in the under-controlled prototypicality score, negative emotional intensity, and behavior problems. Escalating levels of problem behavior is a well-known risk factor for children (Brame, Nagin, & Tremblay, 2002). Resemblance to the under-controlled personality type is associated with a range of undesirable developmental outcomes (Hart, Atkins, & Fegley, 2003).

An issue for future research concerns the specificity of the relation of family adversity and biological vulnerability to personality change. Our research suggests that the relation is very general; the measure of family adversity was very simple and broad, SCR reflects (imperfectly so, and future research ought to use multiple measures) the activation of a multi-organ system in the body rather than the operation of a single process, and personality change was observed in internalizing (negative emotional intensity) and externalizing (problem behaviors) traits, and in global personality types. The interaction of stress and genotype in the prediction of personality change described in the introduction also seems relatively insensitive to the measurement of both stress and personality. Effective prevention of maladaptive childhood personality change requires a clearer understanding of the relations among stress, physiological functioning, and psychological processes than is currently available. Because our research demonstrates that the personality trajectories exhibited by children at different levels of stress and autonomic reactivity vary dramatically, future research on basic processes and interventions is warranted.

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Figure 1.
Estimated personality change in S.D. units from Time 1 to Time 4, for children low and high in skin conductance reactivity living in low- and high-stress homes.

Table 1

Means and Correlations Among Time 1 Measures

Time 1 Measures	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Age (1)											
Family Income (2)	.01										
Maternal Educational Attainment (3)	-.08	.22*									
Family Stress (4)	-.02	-.49*	-.45*								
Resilient Type Prototypicality (5)	-.13	.26*	.09	-.13							
Over-Controlled Prototypicality (6)	.02	-.01	-.22*	.07	-.30*						
Under-Controlled Prototypicality (7)	.15	.00	.08	-.09	-.21*	-.27*					
Problem Behavior (8)	-.14	.05	-.06	.12	-.31*	.61*	-.25*				
Affect Intensity (9)	.06	-.18*	.00	.06	-.49*	.49*	.02	.59*			
Skin Conductance, Control (SCR-b) (10)	-.22*	.06	.02	-.07	-.05	-.04	.01	.10	.07		
Skin Conductance, Distress (SCR-d) (11)	-.13	-.01	-.14	.06	-.20*	.13	-.05	.13	.11	.52*	
Mean	89.36	49.18	14.88	0.29	-17.72	-25.04	-23.93	1.60	3.48	0	0
SD	13.71	24.61	1.86	0.52	12.40	9.91	9.04	0.61	1.23	0.20	0.30

* $p \leq .05$

Table 2

Regression of Growth Rates for Personality Type Prototypicality, Problem Behavior, and Negative Emotional Intensity on Time 1 Personality Type, Skin Conductance, and Family Risk

	Resilient Prototypicality			Over-Controlled Prototypicality			Under-Controlled Prototypicality			Problem Behavior			Negative Emotional Intensity		
	<i>B</i>	<i>SE</i>		<i>B</i>	<i>SE</i>		<i>B</i>	<i>SE</i>		<i>B</i>	<i>SE</i>		<i>B</i>	<i>SE</i>	
Intercept	.004	.015		-.006	.010		-.008	.011		.039	.004		.039	.004	
Skin Conductance Response, Control (SCR-b)	.091	.076		.058	.050		.036	.057		-.008	.007		-.008	.007	
Skin Conductance Response, Distress (SCR-d)	-.104	.061		-.017	.039		-.031	.045		-.001	.006		-.001	.006	
Family Risk	.008	.026		.020	.017		.003	.019		-.001	.003		-.001	.003	
Family Risk X SCR-d	.004	.069		.011	.045		.107	.052 ^a		.018	.008 ^b		.018	.008 ^b	
Time 1 Resilient Prototypicality	-.008	.001 [*]													
Time 1 Over-Controlled Prototypicality				-.009	.001 [*]										
Time 1 Under-Controlled Prototypicality							-.007	.001 [*]							
Time 1 Problem Behavior										-.008	.001 [*]				
Time 1 Negative Emotional Intensity													-.012	.001 [*]	
	<i>n</i> = 138, <i>R</i> ² = 0.28			<i>n</i> = 138, <i>R</i> ² = 0.47			<i>n</i> = 138, <i>R</i> ² = 0.29			<i>n</i> = 112, <i>R</i> ² = 0.37			<i>n</i> = 102, <i>R</i> ² = 0.13		

* $p \leq .05$, p -rep > .875.

^a f^2 for the inclusion of the interaction term = .03;

^b f^2 for the inclusion of the interaction term = .04;

^c f^2 for the inclusion of the interaction term = .04.