Research Report

Personality Change at the Intersection of Autonomic Arousal and Stress

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ABSTRACT—*We hypothesized that personality change in children can be predicted by the interaction of family risk with susceptibility to autonomic arousal and that children characterized by both high-risk families and highly reactive autonomic nervous systems tend to show maladaptive change. This hypothesis was tested in a 6-year longitudinal study in which personality-type prototypicality, problem behavior, and negative emotional intensity were measured at 2-year intervals. The results indicated that children who both had exaggerated skin conductance responses (a measure of autonomic reactivity) and were living in families with multiple risk factors were most likely to develop an undercontrolled personality type and to exhibit increases in problem behavior and negative emotional intensity. The implications of the results for understanding personality change 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 both 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 (Kaufman et al., 2004) and behavioral inhibition (Fox et al., 2005). Similarly, Foley et al. (2004) and Caspi et al. (2002) reported that conduct disorder is predicted by an interaction of childhood adversity with a gene variant regulating monoamine oxidase A activity, which is also linked to emotional regulation. Barr et al. (2004) found that exposing macaques with both genetic susceptibility and adverse family history (being reared without a mother) to a stressor resulted in exaggerated arousal of the hypothalamus-pituitary-adrenal (HPA) axis. In humans, chronic hyperarousal 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 both live in adverse environments and are prone to heightened physiological arousal—either as a result of genes or as a consequence of chronic stress (see Moffitt, Caspi, & Rutter, 2006, for a discussion).

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We tested this hypothesis in this study. We measured change in children's personality in a 6-year study with four measurement points. None of the previously cited studies used longitudinal designs with repeated measurement of the same personality traits; some used cross-sectional designs (e.g., Kaufman et al., 2004), whereas others used longitudinal designs 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 the resemblance of subjects' personality to three personality types (see Hart, Atkins, & Fegley, 2003, for a discussion of personality types and traits) that regularly emerge in research on children (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 overcontrolled 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 undercontrolled type, characterized by low levels of ego resilience and ego control and high levels of delinquency and negative emotion. Family risk has been shown to be associated with change from the resilient type to the undercontrolled type (Hart et al., 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 constructs are conceptually related to the constructs of delinquency and depression that were foci of the research reviewed in the opening paragraph.

We measured change in the resemblance of subjects' personality to the three personality types (i.e., change in personality-type prototypicality) and change in problem behavior and negative emotional intensity by using *growth curves*. Each subject's linear trajectories for these variables were estimated and then related to the interaction of family risk and skin conductance response (SCR).

SCR is a frequently used measure of autonomic arousal in humans. It is linked with activation of multiple components of emotion regulation, including the amygdala and HPA axis (Ehlert & Straub, 1998; 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 conditions. In this study, we controlled for baseline SCR to isolate the distinctive contribution of heightened arousal under stress to the prediction of personality change.

METHOD

Subjects

Subjects (70 males, 68 females) were those participants in a longitudinal investigation who had complete data on the measures for personality-type prototypicality (see Eisenberg et al., 1996, 2005). They were largely White (85%; 7% were Hispanic, 3% were African American, and 5% were of other ethnicities) and from lower- to upper-middle-class families (mean income = \$48,500/year).

Procedure

At entry into the study (Time 1), subjects were in kindergarten through Grade 3. They were reassessed 24 (Time 2), 48 (Time 3), and 72 (Time 4) months following the initial session.

Time 1

At Time 1, we measured SCR in the laboratory (see Holmgren, Eisenberg, & Fabes, 1998, for details). Two 8-mm silver/silver-chloride electrodes were attached to the child's left-hand palmar surface using a 0.050-M sodium-chloride Unibase cream mixture. The child was seated, and his or her left arm was then loosely strapped to the chair to reduce mobility. The electrodes were linked to a Coulbourn (Allentown, PA) S71-23 Skin Conductance Coupler and a computer. The child then viewed two films displayed on a 48-cm monitor located 3 m away. The first film (165 s) featured a dolphin swimming in the ocean and was used to collect baseline data. The second film (25 s) began with a lamp causing a fire in a girl's room and showed her parents responding to her screams. The SCR data included all responses that rose 0.05 μmhos or more. Artifacts due to movement and skin-response deltas that were larger than 3.5 μmhos and more than 2.5 standard deviations above a given child's mean were deleted. We computed summary indices for the baseline condition (SCR-b) and for the distress condition (SCR-d). The summary measure for SCR-b was the average of the standardized value for response amplitude and the standardized value for number of responses; the summary measure for SCR-d was calculated in the same way. One subject had an SCR-d score more than 5 standard deviations higher than the mean and was excluded from analyses.

Personality-type prototypicality was determined by assessing the proximity of ego-resiliency and ego-control scores for each subject to the prototype for each personality type. A teacher sorted the 100 personality items in the California Child Q-Sort (CCQ; Block & Block, 1980) according to their descriptiveness of the subject, following a fixed distribution that resulted in 11 of the 100 items being assigned to each point in the 9-point scale (ranging from 1, *extremely uncharacteristic*, to 9, *extremely characteristic*), with 12 items assigned to the midpoint. The 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, the measure of ego control was derived by correlating the child's vector of scores 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, Atkins, Burock, London, & Bonilla-Santiago, 2005) that reported mean ego-resiliency and ego-control scores for the three personality types. The resilient prototype is defined by t scores of 60 for ego resiliency and 50 for ego control; the overcontrolled prototype is defined by t scores of 40 for ego resiliency and 60 for ego control; and the undercontrolled prototype is defined by t scores of 40 for ego resiliency and 40 for ego control. Prototypicality for each personality type was calculated by summing the absolute values of the differences between a subject's t scores for ego resiliency and ego control and the corresponding t scores for that prototype and then reversing the sign so that larger numbers corresponded to greater prototypicality.

Negative emotional intensity was measured with a scale drawn from previous research (Eisenberg et al., 1996). Teachers judged the descriptiveness of five items (e.g., "When this child experiences anxiety, it normally is very strong") using a 7-point scale (from 1, *never*, to 7, *always*). Teachers also rated the frequency of 23 problem behaviors (e.g., "physically harms other children"), using a 4-point scale developed by Lochman (1995; 1 = *never*, 4 = *often*).

Mothers reported household income and their own educational attainment. In keeping with previous research (Hart et al., 2003), we considered an income in the bottom 20% (\$25,000/year or less, coded "1" for presence of economic risk) of the sample and an educational attainment of 12 or fewer years (16% of the sample, coded "1") to be family risk factors, and we summed risk factors to form a family-risk score. Missing data for Time 1 income (four families) and educational attainment (one family) were estimated from Time 2 measures of the same constructs.

Times 2–4

At the three follow-ups, teachers rated the children on 53 of the 100 personality items in the CCQ (Block & Block, 1980), using a scale from 1 (*very uncharacteristic*) to 9 (*very characteristic*). Ego-resiliency and ego-control scores were derived by correlating the vectors for each child with the prototypes for ego resilience and ego control 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 four times exceeded .80). Different teachers provided the ratings at Times 1 through 4; thus, the observations at the different assessments were independent.

RESULTS

Table 1 presents the means for the Time 1 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, *r*s between Time 1 and Times 2, 3, and 4 were .49, .44, and .41, respectively; *r*s between Time 2 and Times 3 and 4 were .61 and .68, respectively; and the *r* between Times 3 and 4 was .60.

Similar levels of stability were observed for the undercontrolled and overcontrolled types. For the overcontrolled prototypicality scores, *r*s between Time 1 and Times 2, 3, and 4 were .60, .42, and .32, respectively; *r*s between Time 2 and Times 3 and 4 were .59 and .59, respectively; and the *r* between Times 3 and 4 was .52. For the undercontrolled prototypicality scores, *r*s between Time 1 and Times 2, 3, and 4 were .46, .45, and .33, respectively; *r*s between Time 2 and Times 3 and 4 were .51 and .59, respectively; and the *r* between Time 3 and Time 4 was .54.

We used growth curves to measure change in prototypicality for each of the three personality types, change in problem behavior, and change in negative emotional intensity. For each subject, we regressed these measures on age in months at the time of assessment (four scores per subject) and used the resulting slope as the index of change. The mean slope for the resilient type was −0.0001 (SD = 0.18), indicating that there was very little developmental change in this score. The mean slope for the overcontrolled type was positive (0.006, SD = 0.13), but also very small in magnitude. The mean slope for scores for the undercontrolled prototype was −0.008 (SD = 0.13).

The slopes for prototypicality scores were uncorrelated with maternal educational attainment, family income, SCR-b, and SCR-d at Time 1. We regressed the growth-curve slope for each construct on the Time 1 measure of that construct, SCR-b, SCR-d, family-risk score, and the interaction of SCR-d and family-risk score. The results, which are presented in Table 2, indicated that the interaction of family-risk score and SCR-d was associated with increases in undercontrolled prototypicality, as hypothesized (but not with the slopes for the other two prototypicality scores). We used the parameter estimates in Table 2 to predict change in undercontrolled prototypicality for children with low and high levels of family risk (0 and 2, respectively) and with low (−1 *SD* below the mean) and high (+1 *SD* above the mean) SCD-d scores. Figure 1a indicates that only subjects with high SCD-d scores and moderate to high levels of family risk became more similar to the undercontrolled type over the course of the study.

TABLE 1
Correlations Among the Time 1 Measures

Time 1 measure	*M* (*SD*)	Time 1 measure 1	2	3	4	5	6	7	8	9	10	11
1. Age (months)	89.36 (13.71)	—										
2. Family income (annual)	\$49,180 (\$24,610)	.01	—									
3. Maternal educational attainment	14.88 (1.86)	−.08	.22*	—								
4. Family stress	0.29 (0.52)	−.02	−.49*	−.45*	—							
5. Resilient prototypicality	−17.72 (12.40)	−.13	.26*	.09	−.13	—						
6. Overcontrolled prototypicality	−25.04 (9.91)	.02	−.01	−.22*	.07	−.30*	—					
7. Undercontrolled prototypicality	−23.93 (9.04)	.15	.00	.08	−.09	−.21*	−.27*	—				
8. Problem behavior	1.60 (0.61)	−.14	.05	−.06	.12	−.31*	.61*	−.25*	—			
9. Negative emotional intensity	3.48 (1.23)	.06	−.18*	.00	.06	−.49*	.49*	.02	.59*	—		
10. Skin conductance, baseline	0.00 (0.20)	−.22*	.06	.02	−.07	−.05	−.04	.01	.10	.07	—	
11. Skin conductance, distress	0.00 (0.30)	−.13	−.01	−.14	.06	−.20*	.13	−.05	.13	.11	.52*	—

*$p \leq .05$.

TABLE 2

Regression Results: Growth Rates for Personality-Type Prototypicality, Problem Behavior, and Negative Emotional Intensity Regressed on Time 1 Measures

	Personality-type prototypicality									
	Resilient (n = 138, R^2 = .28)		Overcontrolled (n = 138, R^2 = .47)		Undercontrolled (n = 138, R^2 = .29)		Problem behavior (n = 112, R^2 = .37)		Negative emotional intensity (n = 102, R^2 = .13)	
Predictor	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Intercept	.004	.015	−.006	.010	−.008	.011	.039	.004	.039	.004
Skin conductance response, baseline	.091	.076	.058	.050	.036	.057	−.008	.007	−.008	.007
Skin conductance response, distress	−.104	.061	−.017	.039	−.031	.045	−.001	.006	−.001	.006
Family risk	.008	.026	.020	.017	.003	.019	−.001	.003	−.001	.003
Family Risk × Skin Conductance Response, Distress	.004	.069	.011	.045	.107*[a]	.052	.018*[b]	.008	.018*[c]	.008
Time 1 resilient prototypicality	−.008*	.001								
Time 1 overcontrolled prototypicality			−.009*	.001						
Time 1 undercontrolled prototypicality					−.007*	.001				
Time 1 problem behavior							−.008*	.001		
Time 1 negative emotional intensity									−.012	.001

[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.
*$p \leq .05$, $p_{rep} > .875$.

Longitudinal Patterns of Stability and Change: Problem Behavior and Regulation of Negative Emotion

For problem behavior, the correlations between Time 1 and Times 2 through 4 were .59, .50, and .40, respectively; the correlations between Time 2 and Times 3 and 4 were .61 and .48, respectively; and the correlation between Time 3 and Time 4 was .46. For negative emotional intensity, the correlations between Time 1 and Times 2, 3, and 4 were .30, .30, and .11 (this is the only stability correlation with a p value greater than .05), respectively; the correlations between Time 2 and Times 3 and 4 were .39 and .30, respectively; and the correlation between Time 3 and Time 4 was .42.

The mean slope of the growth curve for problem behavior was −0.001 (SD = 0.001), and the mean slope of the growth curve for negative emotional intensity was −0.001 (SD = 0.002). The slopes were uncorrelated with maternal educational attainment, family income, SCR-b, and SCR-d at Time 1. We regressed the slope for each of these constructs on the Time 1 measure of that construct, SCR-b, SCR-d, family-risk score, and the interaction of SCR-d and family-risk score. The results, which are presented in Table 2, indicated that the interaction of family-risk score and SCR-d was associated with increases in problem behavior and negative emotionality. We can estimate that at Time 4, a child who had a high SCR-d (+1 SD) and a family-risk score of 2 at Time 1 would have behavior-problem and negative-emotional-intensity scores more than 1 standard deviation higher than those of a child who had equal scores for family risk, problem behavior, and negative emotionality at Time 1, but a low SCR-d. Change in negative emotional intensity and problem behavior over the course of the study are illustrated in Figures 1b and 1c.

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 family-risk score and SCR-d with personality change was robust, as it was evident with both personality-type prototypicality and the specific traits of problem behavior and negative emotional intensity. The combination of high SCR and high family risk predicted substantial (~1 SD over 6 years) increases in undercontrolled prototypicality, 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 undercontrolled

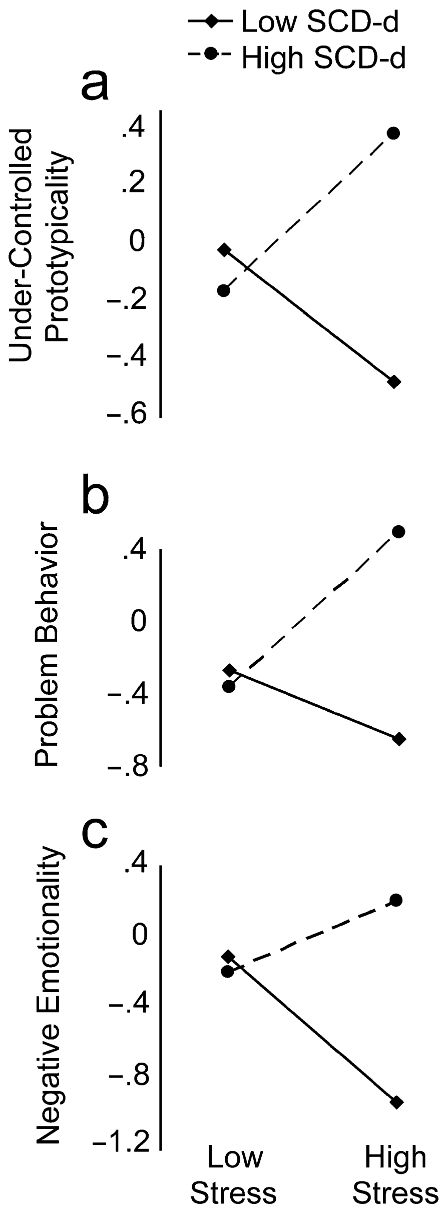

Fig. 1. Children's estimated personality change in standard deviation units from Time 1 to Time 4, as a function of skin conductance reactivity and stress in the home. The graphs show changes in (a) proximity to the undercontrolled personality type, (b) problem behavior, and (c) negative emotionality. SCD-d = skin conductance response in the distress condition.

personality type is associated with a range of undesirable developmental outcomes (Hart et al., 2003).

Further research is needed to determine whether there are family stressors that interact uniquely with specific biological qualities to produce specific types of personality change. Our research suggests that the relation of family adversity and biological vulnerability to personality change is very general; the measure of family adversity that we used was very simple and broad, SCR reflects (imperfectly) the activation of a multiorgan system in the body rather than the operation of a single process (future research should use multiple measures), and personality change was observed in internalizing (negative emotional intensity) and externalizing (problem behavior) traits, as well as in global personality types. The interactions of stress and genotype in predicting other kinds of personality change, as described in the introduction, also seem relatively insensitive to the measurement of both stress and personality. Effective prevention of maladaptive personality change during childhood 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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