The Relation of Personality Types to Physiological, Behavioural, and Cognitive Processes

DANIEL HART[1]*, DEBRA BUROCK[2], BONITA LONDON[3], ROBERT ATKINS[1] and GLORIA BONILLA-SANTIAGO[1]

[1]*Rutgers University, Camden, NJ, USA*
[2]*Bryn Mawr College, Bryn Mawr, PA, USA*
[3]*Columbia University, New York, NY, USA*

Abstract

Three personality types, labeled resilient, over-controlled, and under-controlled, were identified through cluster analysis of classroom observations of 63 children, and used to understand biological, cognitive, and behavioural processes that influence academic achievement and aggression. Resilient children were found to be high in trait cortisol and high in academic achievement. Under-controlled and over-controlled children showed the greatest change in cortisol levels under stress, low levels of academic achievement, and attributed hostility to others in ambiguous situations. Under-controlled children also exhibited high levels of externalizing behaviour in the classroom. The findings suggest that the single processes or traits assessed in this study do not mediate the associations of personality types to academic achievement and behaviour. The implications of the findings for the personality type construct and for personality processes are discussed. Copyright © 2005 John Wiley & Sons, Ltd.

INTRODUCTION

Personality type refers to the configuration of personality traits that characterizes an individual. In recent years, research has consistently demonstrated that three personality types can be identified in childhood and adolescence (for a review, see Caspi, 1998). Following Robins, John, Caspi, Moffitt, and Stouthamer-Loeber (1996), these three types are often labelled resilient, over-controlled, and under-controlled. Asendorpf and van Aken (1999) proposed that the three personality types can be understood in terms of the broad personality dimensions of *ego-resiliency* and *ego-control*. Ego-control refers to the 'degree of impulse control and modulation' (Block & Block, 1980b, p. 41) characterizing

the individual. Ego-resiliency is indicated by the 'ability to modify one's behaviour in accordance with contextual demands' (Block & Block, 1980b, p. 48). An individual who is high in ego-resiliency is flexible in impulse control, expressing emotions and impulses when appropriate but containing them when necessary to do so. Persons low in ego-resiliency lack this flexibility; those who tend towards impulse expression may become consistent under-controllers, while those whose characteristic style is to bind impulse expression may develop into over-controllers. The combination of ego-control and ego-resiliency therefore leads theoretically to three groups: *resilient*, constituted of those high in ego-resiliency (and who are flexible in ego-control); those low in ego-resiliency and low in ego-control, or *under-controlled*; and those low in ego-resiliency and high in ego-control, or *over-controlled*. Asendorpf and van Aken (1999) have demonstrated that these combinations of ego-control and ego-resiliency correspond empirically to the three personality types.

Recent research on personality types (Asendorpf & van Aken, 1999; Asendorpf, Borkenau, Ostendorf, & Van Aken, 2001; Hart, Atkins, & Fegley, 2003; Hart, Hofman, Edelstein, & Keller, 1997; Robins et al., 1996; Weir & Gjerde, 2002) has provided a nomological network for each of the three personality types. Based on the recent research, children of the resilient type are characterized by self-confidence, academic achievement, and success in relationships; those assigned to the over-controlled type evidence shyness and social withdrawal; and delinquency, aggression, and physical activity characterize those children assigned to the under-controlled type (for a review, see Hart et al., 2003). Together, these various studies demonstrate that personality types are reliably associated with developmental outcomes such as academic achievement, aggression, and internalization.

In this article, we begin the search for biological, cognitive, and behavioural processes that *connect* personality types to developmental outcomes. Theorists (Hair & Graziano, 2003; McAdams, 1995; Revelle, 1995) have pointed out that studies identifying correlations between broad features of personality and outcomes must be supplemented by research which illuminates the processes which connect broad features of personality to these outcomes. For example, *resilience*—an idea to which the label 'resilient personality type' refers—connotes an ability to withstand stress and to thrive in the presence of adversity (Masten et al., 1999). Yet there has been no research to date that has investigated whether those characterized as belonging to the resilient personality type respond to stress differently than those individuals assigned to the over-controlled and under-controlled personality types. Similarly, there is abundant evidence that children assigned to the resilient personality type do better in school than those of the other two types (e.g. Hart et al., 2003; Hart et al., 1997). However, no study has observed the classroom behaviour of children of the different types to determine whether the relation of personality type to academic achievement can be explained by what children of different types *do* in school. Finally, though several studies have demonstrated that under-controlled children are more aggressive than are resilient children (e.g. Hart et al., 1997; Robins et al., 1996), there are no findings concerning the processes which culminate in the conflict so characteristic of under-controlled children. Robins and Tracy (2003) have argued that there is a critical need for research on processes which may connect developmental outcomes to personality types, and it is this need that we seek to address.

In this study, we investigated the association of personality types to biological, behavioural, and cognitive processes. Personality type research is moved towards biological processes through the examination of the association of personality type to cortisol, which is an indicator of physiological stress. Second, we assessed the link of

personality types to classroom behaviours that may interfere with learning. Third, the tendency to make hostile attributions to others, a social information processing bias that produces aggression in children, is examined for associations with personality type.

Personality type and cortisol

Cortisol is a glucocorticoid produced by the adrenal glands, which are components of the hypothalamic–pituitary–adrenal (HPA) axis. The level of cortisol in the blood is affected by stress. Stress results in a cascade of processes, one of which results in increased secretion of cortisol into the bloodstream (Nemeroff, 1998). Short-term increases in the level of cortisol result in increased mental alertness and readiness whereas chronically high levels of cortisol are associated with a number of adverse neuro-cognitive outcomes (Flinn & England, 1995).

Three general hypotheses have been advanced concerning the relation of cortisol to personality. First, some have suggested that individuals who have experienced enduring stress and/or have stress-prone personalities—those with depressogenic personality styles, for example—are characterized by *high* levels of *trait cortisol* (i.e. cortisol levels that are typical for the individual in daily life in the absence of significant stressors), due to hyper-secretion of cortisol resulting from chronic stimulation of the HPA axis (e.g. Belanoff et al., 2002; Gold, Drevets, & Charney, 2002). A second hypothesis, emerging from research on post-traumatic stress disorder, is that severe stress—one cause of which is maladaptive personality patterns—eventually results in adaptation and suppressed activation of the HPA axis, which in turn is reflected in *low* levels of trait cortisol (hypo-secretion; Golier & Yehuda, 1998; Heim, Ehlert, & Hellhammer, 2000).

Both hypotheses have support. Among adults, cortisol measured in the morning is positively associated with self-esteem, hardiness (Zorrilla, DeRubeis, & Redei, 1995), and life satisfaction (Brandtstädter, Baltes-Götz, Kirschbaum, & Hellhammer, 1991), and negatively correlated with anxiety, depression, and emotional lability (Brandtstädter et al., 1991). In children, morning cortisol levels are positively associated with cognitive measures of neurological functioning (Davis, Bruce, & Gunnar, 2002). Several studies have found that the level of cortisol is negatively correlated with externalizing problems (Granger et al., 1998; McBurnett, Lahey, Rathouz, & Loeber, 2000; Smider et al., 2002). On the other hand, there are a number of studies which have found that trait cortisol levels are positively associated with both internalizing (e.g. Smider et al., 2002) and externalizing (e.g. Gunnar, Tout, de Haan, Pierce, & Stansbury, 1997) problems.

The third hypothesis concerning cortisol and personality focuses on the reactivity of the HPA axis to stress. Many researchers have proposed that individuals with maladaptive personalities respond physiologically to environmental challenges with exaggerated activation of the HPA axis (e.g. Nemeroff, 1998), one reflection of which would be a sharp increase in cortisol. This exaggerated activation of the HPA axis may interfere with effective information processing and the selection of appropriate responses (for a review, see Bremner, 1999). In contrast, resilient individuals may be able to modulate activation of the HPA axis in stressful situations, and consequently are spared the intense physiological reactions that prevent effective adaptation in difficult situations. There is abundant evidence supportive of this hypothesis. Social phobics show greater increases in cortisol following stress than do comparison adults (Condren, O'Neill, Ryan, Barrett, & Thakore, 2002), and adults with high self-esteem show smaller increases in cortisol following experimentally induced failure than do adults with low self-esteem (Pruessner,

Hellhammer, & Kirschbaum, 1999). Securely attached toddlers show smaller increases in cortisol upon entry into day care than do insecurely attached toddlers (Ahnert, Gunnar, Lamb, & Barthel, 2004). Children in whom cortisol increases from morning to afternoon in daycare are more likely to be emotionally negative than are children in whom cortisol declines over the course of a day in daycare (Dettling, Gunnar, & Donzella, 1999), and children whose cortisol levels show sharp increases are prone to delinquent and antisocial behaviour (Flinn & England, 1995). Consequently, we predicted that resilient children would show less cortisol elevation over baseline levels while experiencing stress than would under-controlled or over-controlled children.

Classroom behaviour and personality type

Three studies have found that children of the resilient type are higher in academic achievement than are children of the other two types (Hart et al., 2003; Hart et al., 1997; Robins et al., 1996). Two of the studies found that children of the under-controlled type were especially low in academic achievement (Hart et al., 2003; Robins et al., 1996). Using growth curve analysis, Hart et al. (2003) found in two studies that children of the under-controlled type acquired academic knowledge at a slower rate than did resilient children. While the relation of academic achievement to personality type is convincingly documented by these studies, none of the studies provides an explanation for the link. In the research presented here, classroom behaviours theoretically relevant both to learning and to the personality types are directly observed. Broadly, both externalizing behaviours (e.g. disruptive, aggressive, excessive restlessness, interfering with others) and internalizing behaviours (social withdrawal, inattentiveness, daydreaming) are associated with low academic achievement (Finn, Pannozzo, & Voelkl, 1995). Our prediction was that externalizing behaviour in the classroom would be highest in under-controlled children and that over-controlled children would have the highest levels of classroom internalizing behaviour. Establishing associations between personality type and classroom behaviour contributes to the explanation of the association of personality type to academic achievement.

Personality type and hostile attributions

Research has consistently found that personality type is related to aggression. Hart et al. (2003) reported that, in comparison to mothers of resilient and over-controlled children, mothers of under-controlled children report higher levels of aggression in their children. Hart et al. (1997) found that teachers rated under-controlled children to be higher in aggression than resilient or over-controlled children. One possible explanation for differences in aggression is that children of the three personality types may interpret social cues differently. Specifically, there is a large body of research that demonstrates that children who are biased towards interpreting others' actions as hostile in intent are prone to be aggressive (for a meta-analysis of the evidence, see de Castro, Veerman, Koops, Bosch, & Monshouwer, 2002). In terms of the personality types, our expectation was that under-controlled children, who are very aggressive, ought to be more likely to interpret others' behaviour as hostile in intent than resilient children, who are low in aggression. While over-controlled children are not typically aggressive, they too were expected to be higher in the tendency to make hostile attributions than resilient children. This prediction derives from research demonstrating that children with symptoms of depression—a pattern which is characteristic of over-controlled children—are more likely to make

hostile attributions than are children without such symptoms (Quiggle, Garber, Panak, & Dodge, 1992).

Independence of personality types from their associated processes

Personality types are hypothesized to correspond to organizations of traits within individuals (Hart et al., 2003). One implication of this assumption is that neither a single trait nor a single process should displace personality types in accounts of developmental outcomes. For instance, if the personality trait of aggression predicted the course of development as well as personality types, then the former should be preferred because it offers a more parsimonious explanation. In this study, we tested whether processes and behaviours displace personality types in the prediction of classroom behaviour. It might be argued that a correlation between personality and academic trajectory is wholly a consequence of internalizing and externalizing problems that both cause academic difficulties and result in assignment to the under-controlled type. For example, a child whose behaviour is characterized by problems resulting from distractibility might have trouble learning in school and may be perceived as belonging to the under-controlled type. In such a case, explanatory primacy for theory and for intervention might be accorded to behaviour problems rather than to personality type. We have claimed that personality type is probably related to academic achievement through many paths: the breadth of social relations, the focusing of attention in cognitively challenging situations, emotion regulation, and so on. Consequently, our prediction is that the relation of personality type to academic development is not accounted for by measures of behaviour. By including measures of internalizing and externalizing behaviours in the analyses, the unique contribution of personality type, independent of classroom behaviour, to academic achievement can be assessed.

METHOD

Participants

Sixty-three children (34 females) in grades 5–7 were recruited from a public charter school in a low-income city in the Eastern United States. There were 22 students in fifth grade (*M* age = 10.6 years), 24 students in sixth grade (*M* age = 11.5 years), and 17 students in seventh grade (*M* age = 12.8). During a regularly scheduled parent meeting held in the evening, parents were briefed on the purpose of the study, cortisol measurement, observation of students, and attribution interviews (these measures are described below). Sixty-three parents granted permission for their children to participate, a participation rate of approximately 90%. Children whose parents granted permission for participation were contacted individually in school, the purpose and methods of the study were explained, and consent to participate was solicited. All children whose parents granted permission to participate chose to do so.

Procedures/measurements

Assignment to personality types
Each participant was observed for 45–60 minutes in the classroom by one of three observers. Following the observation period, the observer made personality ratings of the participant using the California Child Q-set (CCQ; Block & Block, 1980a). The CCQ

consists of 100 personality characteristics (e.g. 'Is warm and responsive') that are sorted according to their descriptiveness of the participant, following a fixed, nine-point distribution that ranges from 1 ('extremely uncharacteristic') to 9 ('extremely characteristic').

t-scores for ego-resiliency and ego-control were computed from the CCQ items following procedures described elsewhere (Block & Block, 1980b).

Twenty participants were observed on different occasions by two observers. The average correlation among pairs of raters for ego-resiliency was 0.71 and the average correlation for ego-control was 0.57; these levels of agreement are comparable to those reported in other studies (e.g. Gjerde, Block, & Block, 1986).

Participants were assigned to personality types using nearest centroid clustering on the *t*-scores for ego-resiliency and ego-control. Initial cluster centers were specified using the average of the *t*-scores (the metric in which these results are reported) for ego-resiliency and ego-control reported in previous studies (Asendorpf & van Aken, 1999; Hart et al., 1997; Robins et al., 1996), which ensures that the clusters derived in this study correspond to those in previous research. The *t*-scores used for initial cluster centers for ego-resiliency and ego-undercontrol were, respectively, 0.58 and 0.52 (resilient), 0.42 and 0.40 (over-controlled), and 0.44 and 0.62 (under-controlled). Twenty-eight participants were assigned to the resilient type, 21 to the over-controlled type, and 14 to the under-controlled type. Personality type was not associated with gender ($\chi^2 = 1.3$, $p > 0.5$). An analysis of variance ($F = 1.13$, $p > 0.3$) suggested no significant difference in age among children of the three personality types.

Cortisol assessment

Salivary cortisol samples were collected on two dates approximately 1 month apart. Each sample was collected at school, in the middle of the school week, before lunch, and between 11:00 a.m. and 12:30 p.m. Students sucked on a cotton swab for approximately 30 seconds (Kirschbaum, Bartussek, & Strasburger, 1992).

The first testing time (T1) occurred during a routine week, and consequently we consider this cortisol measurement to be of the trait level. Trait level samples were collected from the 61 participants in school at T1.

The second testing time (T2) occurred during a week of standardized testing. Standardized tests are generally considered stressful. Moreover, the results of standardized tests are extraordinarily important for charter schools such as the one from which the participants in this study are drawn, because charter schools' effectiveness is judged by the results of such tests and the implications are well known to the students. For these reasons, the T2 cortisol was considered to be a measure of cortisol under stress. Samples were collected from the 59 participants in school at T2.

All of the saliva samples were stored at -20°C, and packed in dry ice, and then transported to the Behavioural Endocrinology Laboratories at Pennsylvania State University for radioimmunoassay. Each sample was assayed twice. The average intra-assay coefficient of variation was 3.8%. The two assay scores for each sample were averaged. Following previous research, we calculated a *cortisol reactivity* score by subtracting trait cortisol from the cortisol measured on the testing day. High scores reflect high reactivity to stress.

Classroom behaviour

Students' academic behaviour was assessed using the *Child Behaviour Checklist—Direct Observation Form* (CBC-DOF-revised form, Achenbach, 1986). A judge watched each participant in class for ten consecutive minutes (as specified in the manual), and then

estimated the salience of each of 97 problem behaviours on a 0–4 scale, with 0 indicating that the problem behaviour was not observed and 4 meaning that the behaviour was intense or observed for longer than 3 minutes.

Two broadband behaviour scores are derived from the CBC-DOF. Internalization and externalization scores were derived by summing scores for problem behaviours identified on the form as internalizing or externalizing. Items constituting the internalization scale include 'confused or seems to be in a fog', 'too fearful or anxious', and 'self-conscious or easily embarrassed'. Externalization items include 'defiant or talks back to staff', 'disturbs other children', and 'physically attacks people'.

Each participant was observed twice, at two different time points over the course of a month, by different observers. The correlation of externalization measured on the first occasion by the first judge with externalization measured at the second time by the second judge was 0.23, and the parallel correlation for internalization was 0.29. The scores of the two raters were averaged to form aggregate internalization and externalization scales. Scores for externalizing behaviour ranged from 0 to 10 ($M = 2.16$); internalizing behaviour scores ranged from 0 to 26 ($M = 3.01$). Because scores for internalization and externalization had positive skews, log transformations of these scores were used in the statistical tests that follow (however, means of the raw scores are presented in Table 1).

Attribution of hostile intent
Participants were presented with eight scenarios illustrating psychological or physical harm to a target child. In all eight scenarios, peers were the source of harm to the imaginary target child. The actions of the peers were ambiguously described so as to permit both attributions of hostile intent and harm caused by accident. Each participant was interviewed, and for each scenario asked to (1) identify the motivations of the peers for the harm illustrated in the scenario, and (2) suggest an appropriate response to the harmful action. A researcher transcribed participants' answers.

For each scenario, a participant's judgment of the motivation and suggestion of appropriate response were coded for the presence of hostility/aggression. This means that 16 answers were coded: eight scenarios, each with an identification of motivation and a suggestion of an appropriate response. Two raters coded the interviews for ten participants (160 answers), and agreed on the presence or absence of hostility/aggression for 95% of the motivations and responses. The number of answers with hostility/aggression was used

Table 1. Ego-resiliency, ego-control, cortisol, behaviour, attribution, and GPA scores by personality type

	Personality type			*M*	SD
	Resilient	Over-controlled	Under-controlled		
Ego-resiliency (*t*-score)	58.64	42.48	43.99	50.00	10.00
Ego-control (*t*-score)	51.61	60.43	37.68	50.00	10.00
Trait cortisol	0.12	0.10	0.09	0.11	0.05
Reactive cortisol	−0.01	0.02	0.03	0.01	0.08
Externalization	2.30	2.00	3.18	2.40	2.45
Internalization	3.09	4.36	3.36	3.57	3.43
Hostile attributions	0.30	0.40	0.40	0.35	0.18
GPA (Z-score)	0.13	0.00	−0.30	−0.01	0.62

as the summary index. To assess the internal homogeneity of this scale, the correlation of each item to the summary index was calculated. One item had a negative correlation with the total, and consequently was excluded from the summary index. The alpha for this reduced scale was 0.71; scores ranged from 0 to 15 (a participant's answers suggested hostility/aggression for the motivation and appropriate response for all items).

Grade point average

Grade point average (GPA) was calculated by transforming grades for each subject area (e.g. English, Mathematics) into Z-scores, and then averaging Z-scores for each participant.

RESULTS

Plan of analysis

We proceed in three steps. First, we examine the assignment of participants to types to ensure that the types are consonant with theoretical expectations. Next, the hypothesized relations of personality type to trait cortisol, cortisol reactivity, internalization, externalization, hostile/aggressive attributions, and GPA are examined. Finally, we test the extent to which externalization and internalization *mediate* the relation of personality type to GPA.

To test our hypotheses, we used the *Amos* program (version 4, Arbuckle & Wothke, 1999) to estimate correlation and regression coefficients with a maximum-likelihood (ML) procedure, because a few subjects were lacking cortisol measurements at T1 or T2. ML and the more familiar ordinary-least squares (OLS) procedure yield essentially identical estimates of coefficients. However, ML as implemented in the *Amos* program accommodates missing data. Standard implementations of OLS do not, as they require either that participants with missing data be excluded from the analyses, or that missing data be replaced with mean values. Arbuckle (1996) among others has demonstrated that the exclusion of data and the substitution of mean values for missing data can yield very inaccurate estimates of coefficients. Consequently, statisticians recommend the ML procedure implemented in *Amos* for the estimation of coefficients when data are missing (e.g., Duncan, Duncan, Strycker, Li, and Alpert, 1999).

In all our regression analyses, we represent personality types using dummy and contrast codes tailored to the hypotheses that are being tested. For example, for some analyses, children of the resilient type are compared with children of the other two types; in other analyses, under-controlled children are compared with the resilient and over-controlled types. The advantage of using dummy and contrast codes for testing specific hypotheses is described by Cohen, Cohen, West, & Aiken (2003).

Differences between types

As described in the Methods section, the clustering procedure was initialized with values intended to ensure an assignment of participants to the threefold typology described in the Introduction. Comparisons of the three groups demonstrate that the three groups differ in the expected ways. Table 1 presents the means for the *t*-scores for ego-resiliency and ego-control. As the means indicate, the clustering resulted in the appropriate assignment. Consonant with previous research, participants assigned to the resilient type were higher in

ego-resiliency than the other two types. To confirm the reliability of this finding, scores for ego-resiliency and ego-control were regressed on personality type, age, and gender. In the analysis of ego-resiliency, personality type was represented by contrast codes, with the first of these corresponding to the comparison of the resilient type to the other two types, and the second contrast corresponding to a comparison of the over-controlled to the under-controlled types. As expected, the first contrast was significant (beta $= 80$, $p < 0.0001$), confirming that the resilient type was higher in ego-resiliency than the other two types. In the analysis of ego-control, personality type was represented by two dummy variables; the first of these compared the under-controlled type with the resilient type, and the second compared the over-controlled type with the resilient type. Both were significant (beta $= -0.57$, and 0.45, $p < 0.001$, respectively), and indicate first that the over-controlled type was higher than the resilient type in ego-control, and second that the under-controlled type was lower in ego control than the resilient type. Because the types were constructed to produce these differences, the significant findings do not constitute a test of hypotheses (the full set of analyses can be obtained upon request from the first author) but instead confirm only that the clustering analysis was successful in producing the desired groups.

Correlations among continuous variables

Table 2 presents the correlations among the continuous measures. The personality dimensions (ego-resiliency and ego-control) are correlated with scores for internalization, externalization, and GPA, but not with the scores for cortisol and hostile attributions. In addition, there is a negative correlation between scores for trait and reactive cortisol, as has been observed in other studies (Quas, Bauer, & Boyce, 2004). There is little evidence for associations among the other variables.

Relation of personality types to variables of theoretical interest

Trait cortisol
Trait cortisol scores were regressed on personality type, age, and gender. Personality type was represented in the analysis by two contrasts, the first comparing resilient children to children of the other two types, and the second contrast comparing children of the over-controlled type to those of the under-controlled type. The first of these contrasts tests whether resilient children are higher in trait cortisol than children of the other two types. As the results in Table 3 indicate, this contrast was significant.

Table 2. Correlations among continuous measures

	1	2	3	4	5	6	7
Ego-resiliency (1)							
Ego-control (2)	0.16						
GPA (3)	0.30*	−0.04					
Trait cortisol (4)	0.23	0.09	0.20				
Reactive cortisol (5)	−0.10	−0.01	−0.15	−0.55*			
Externalization (6)	−0.09	0.33*	−0.33*	0.07	0.18		
Internalization (7)	0.00	−0.26*	−0.26*	−0.10	−0.05	−0.02	
Hostile attributions (8)	−0.23	−0.01	−0.03	−0.01	0.11	−0.05	−0.06

$*p < 0.05$.

Table 3.   Regression analyses predicting cortisol, behaviour problems, hostile attribution, and GPA scores with personality type, age, and gender

	Predictor	*B*	SE*B*	Beta
Trait cortisol	Contrast, resilient (2/3) vs. over-controlled (−1/3), under-controlled (−1/3)	0.02	0.01	0.25*
	Contrast, over-controlled (−1/2) vs. under-controlled (1/2)	0.00	0.02	−0.00
	Gender (females = 1, males = 0)	0.00	0.01	0.00
	Age	−0.01	0.01	−0.20
Reactive cortisol	Contrast, resilient (2/3) vs. over-controlled (−1/3), under-controlled (1/3)	−0.02	0.01	−0.26*
	Contrast, over-controlled (−1/2) vs. under-controlled (1/2)	0.00	0.01	−0.00
	Gender (females = 1, males = 0)	0.01	0.01	0.17
	Age	0.01	0.00	0.30*
Internalization (log of raw score)	Contrast, over-controlled (2/3) vs. resilient (−1/3), under-controlled (−1/3)	0.02	0.09	0.04
	Contrast, resilient (1/2) vs. under-controlled (−1/2)	0.09	0.07	0.15
	Gender (females = 1, males = 0)	−0.10	0.07	−0.17
	Age	−0.04	0.03	−0.19
Externalization (log of raw score)	Contrast, under-controlled (2/3) vs. resilient (−1/3), over-controlled (−1/3)	0.19	0.09	0.26*
	Contrast, resilient (1/2) vs. over-controlled (−1/2)	0.04	0.09	0.06
	Gender (females = 1, males = 0)	−0.10	0.08	−0.16
	Age	−0.02	0.03	−0.02
Hostile attributions	Contrast, resilient (2/3) vs. over-controlled (−1/3), under-controlled (1/3)	−0.10	0.05	−0.28*
	Contrast, over-controlled (−1/2) vs. under-controlled (1/2)	−0.01	0.06	0.01
	Gender (females = 1, males = 0)	0.04	0.05	0.10
	Age	0.01	0.02	0.02
GPA	Contrast, under-controlled (1) vs. resilient (0), over-controlled (0)	−0.41	0.20	−0.28*
	Contrast, over-controlled (1) vs. resilient (0), under-controlled (0)	0.09	0.17	−0.07
	Gender (females = 1, males = 0)	0.21	0.16	0.17
	Age	0.07	0.06	0.14

*$p < 0.05$.

Reactive cortisol

Reactive cortisol was regressed on the same set of variables used in the analysis of trait cortisol. The hypothesis was that resilient children are lower in reactive cortisol than are children of the other two types; this hypothesis was confirmed by the results presented by Table 3.

Internalization

The hypothesis was that children of the over-controlled type would be higher in internalization than would be children of the other two types. The results of the regression analysis, presented in Table 3, do not support this hypothesis.

Table 4. Regression analysis testing mediation effects of externalization and internalization on the relation of personality type to GPA

Predictor	B	SEB	Beta	B	SEB	Beta
Contrast, over-controlled (1) vs. resilient (0), under-controlled (0)	−0.13	0.17	0.10	−0.08	0.15	−0.06
Contrast, under-controlled (1) vs. resilient (0), over-controlled (0)	−0.43	0.19	−0.30*	−0.35	0.19	−0.24
Externalization				−0.55	0.23	−0.28*
Internalization				−0.63	0.26	−0.28*

*$p < 0.05$.

Externalization
Consistent with expectations, children of the under-controlled type were higher in externalization than were children of the other two types, as the results in Table 3 indicate.

Hostile attributions
The hypothesis that resilient children are less likely to perceive hostile intent and to believe that aggressive reaction is warranted in ambiguous scenarios was confirmed, as the findings in Table 3 indicate.

GPA
Finally, the findings in Table 4 are consistent with our hypothesis regarding GPA. The regression of GPA on personality type, gender, and age indicates that under-controlled children are lower in academic achievement than are resilient children.

Internalization and externalization as mediators of the association of personality type with GPA

The final set of analyses tested the possibility that internalizing and externalizing behaviour in the classroom mediate the association of personality type to GPA. Personality types in this set of analyses were represented by dummy variables contrasting over-controlled children to resilient children and under-controlled children to resilient children. The results in Table 4 suggest that internalization and externalization partially mediate the relation of personality type to GPA. Partial mediation is suggested by the slightly (but not significantly) smaller beta weight (−0.24) for the association of the dummy variable contrasting under-controlled and resilient children to GPA in the equation including scores for internalization and externalization than in the equation without scores for these two variables (−0.30).

DISCUSSION

To reiterate, the goal of this study was to identify connections of personality types to biological, behavioural, and cognitive processes that link personality types to developmental outcomes. To ensure continuity with previous research, the cluster analysis used in this study to derive personality types was initialized using information from previous studies. Consequently, the findings from this study contribute to the accumulation of knowledge about the personality types identified in previous research (e.g. Hart et al., 1997; Robins et al., 1996).

As predicted, personality types were associated with cortisol levels. In comparison with under-controlled and over-controlled children, resilient children were *higher* in trait cortisol, but *lower* in reactive cortisol. This pattern suggests that children of the three types differ in the sensitivity of the HPA axis.

One possible interpretation is that these differences in HPA functioning result from chronic *stress*, which occurs at the intersection of environmental challenge with personal resources. High stress can result from (a) adverse environmental circumstances, (b) limited personal resources, or (c) an interaction of (a) and (b). High levels of environmental challenge may produce changes in the HPA axis, as research on post-traumatic stress disorder demonstrates (e.g. Golier & Yehuda, 1998). Similarly, previous research has shown that high levels of environmental risk (large family, poverty, poor home environment, father absence), which presumably produces stress, is associated with change from the resilient personality type to the under-controlled personality type in children (Hart et al., 2003). It is possible that the stress that produces transformation in personality type is also effecting change in the HPA axis.

A complementary hypothesis is that environmental challenge interacts with personality type to produce the stress that results in HPA axis changes. In comparison with resilient children, over-controlled children and under-controlled children have fewer personality resources with which to respond effectively to environmental challenges, and consequently over-controlled and under-controlled children may experience more stress than resilient children. This stress may produce the depression of trait cortisol and exaggerated responsiveness to stress that was found to be characteristic of under-controlled and over-controlled children.

An alternative to the stress hypothesis for the differences among personality types in trait and reactive cortisol is the *temperament* hypothesis, which posits that individual differences in HPA sensitivity and activity are evident at birth. For example, Kagan (in press) has hypothesized that patterns of behaviour in infancy that resemble the resilient and over-controlled personality types ('uninhibited' and 'inhibited', respectively) have their roots in the sensitivity of biological structures to environmental challenge.

The data collected in this study do not shed light on whether the differences in HPA functioning among the personality types are a result of stress or of temperament. However, understanding the relations among personality type, stress, temperament, and HPA functioning is an important area for future investigations. These future investigations should include cortisol samples from (1) larger samples, (2) different times of day, and (3) multiple occasions. The advantage of larger samples is the increase in statistical power, which would allow more sensitive testing of models of the relation of cortisol to other factors than was possible with the small sample available in this study (for example, only 14 children were assigned to the over-controlled type, severely limiting power). Moreover, a large sample would permit testing hypotheses in one sub-sample and replicating findings in the other, a process fundamental to scientific progress (Hart et al., 2003). Sampling cortisol at different times of day would allow testing for disruptions in the diurnal cycle of cortisol as a function of personality type, a particularly interesting hypothesis in light of growing evidence for the importance of such disruptions in understanding the influence of stress on the HPA axis (e.g. Gunnar & Donzella, 2002). Finally, sampling cortisol on multiple occasions can increase the reliability of the cortisol indices, which in turn increases the likelihood that relations of cortisol to other variables will be identified.

We also demonstrated that personality type is related to externalizing behaviour in the classroom, and found evidence suggesting that the relation of personality type to academic

achievement is partially mediated by classroom behaviour. It appears therefore that the relation of personality type to academic achievement flows through other processes besides the forms of classroom behaviour measured in this study. It is possible that the relation of personality type to academic achievement is a result of motivational or attributional[1] processes, a hypothesis that gains strength from our demonstration of differences among types in the attribution of hostility. For example, perhaps resilient children are more likely than under-controlled children to attribute academic success and failure to effort, which is subject to volitional control, rather than understanding academic performance to be a direct reflection of a fixed quality of self that cannot be changed. As Dweck and her colleagues (e.g. Mueller & Dweck, 1998) have demonstrated, the former pattern is associated with persistence and success in academic settings, while the latter often leads to low engagement in the classroom.

Finally, we were able to demonstrate that resilient children are less likely than under-controlled and over-controlled children to attribute hostile intentions to others. This finding is consistent with previous research suggesting that the bias towards attributing hostility to others is characteristic of both children high in aggressiveness, as under-controlled children often are, and children high in depressive symptoms, which is typical of over-controlled children.

Figure 1 provides a graphic summary of the findings concerning personality types. Particularly evident are the similarities between the over-controlled and under-controlled types: they share low levels of ego-resiliency (necessarily true by the rules used to assign participants to types) and similar patterns of trait and reactive cortisol, and are characterized by the same tendency to make hostile attributions to others in ambiguous contexts. In other words, the over-controlled and under-controlled types are remarkably similar in terms of physiological and interpretational processes, but radically different at the behavioural level as reflected in mean scores for ego-control and externalization.

One important goal for future research is to understand how two personality types—over-controlled and under-controlled—that share physiological and cognitive qualities can have such different behavioural profiles. One possibility is that these two types share a common, biological diathesis (for example, as exhibited in the physiological response to stress) for poor adaptation, but with the evolution of this diathesis into the over-controlled or the under-controlled personality type depending upon the child's experiences within the family and other contexts (Steinberg & Avenevoli, 2000). If this hypothesis were true, the research task would be to identify the interactions of a broad disposition to poor adaptation with specific kinds of transactions with the environment which result in personality types. Alternatively, future research may demonstrate that over-controlled and under-controlled children differ in physiological and cognitive processes (see e.g. Kagan, in press). Researchers pursuing supportive research would seek to identify characteristics that contribute to the explanation of how two types that are similar can produce substantially different patterns of behaviour.

One goal for this research was to identify the psychological processes that link personality types to development outcomes. Our findings increase rather than diminish the need for future research addressing this issue. The associations observed in this study of personality type with trait and reactive cortisol, academic achievement, hostile attributions, and classroom behaviour were predictable from previous research. Yet the patterns of associations among these constructs do not permit the construction of models in

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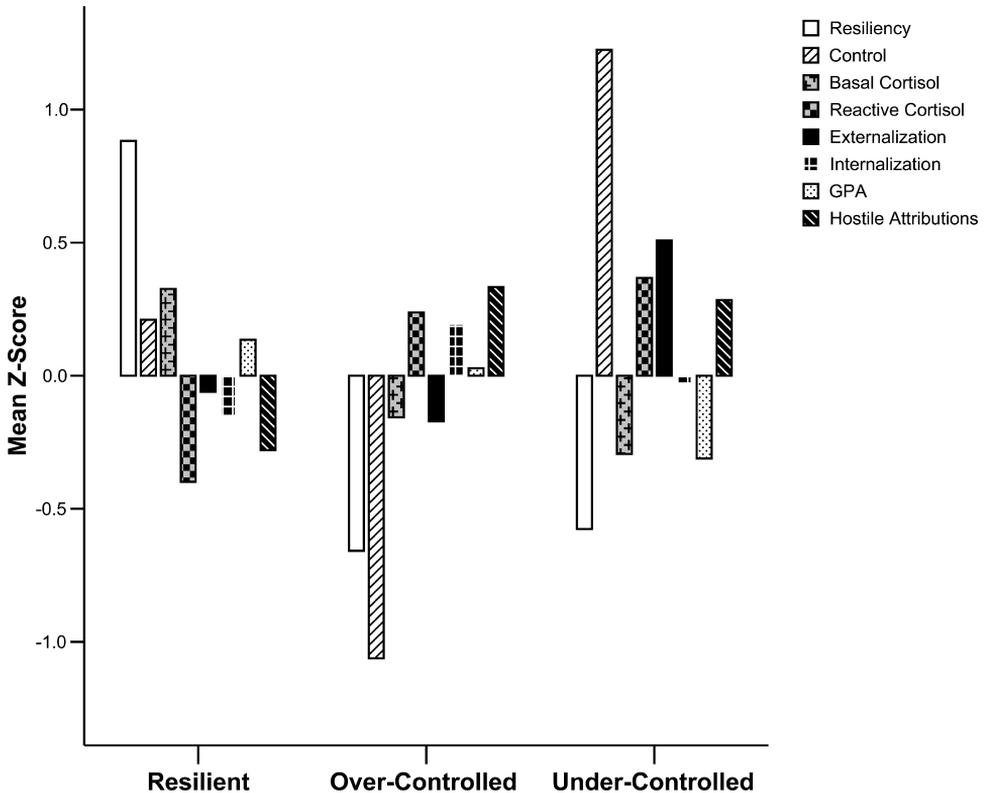[1]We are grateful to one of the anonymous reviewers for this idea.

Figure 1.   Average Z-scores for the measures in the study by personality type.

which it can be inferred that personality types are connected to developmental outcomes through the operation of one or more of these constructs: the relation of personality type to academic achievement, for example, was seemingly not explained by differences in classroom behaviour. While our findings do not identify the mediating processes that connect personality types to outcomes, the network of correlates of types that we do find are sufficiently interesting to warrant theoretical and empirical work towards this goal.

In the last several years, there has been an extensive, ranging debate about the value of the typological approach to personality. One criticism of the typological approach is that stronger predictions about an outcome might be made from using continuous scores for personality traits, rather than using these scores to assign individuals to categorical personality types and then using these category scores to predict the outcome (e.g. Asendorpf, 2003; Costa, Herbst, McCrae, Samuels, & Ozer, 2002). For example, in the context of this study it might be argued that using scores for ego-resiliency and ego-control as predictors, rather than the type scores, would result in more powerful predictions of scores for cortisol, classroom behaviour, GPA, and hostile attribution. In this study, we find that personality types are effective predictors of other variables. For instance, we found in this study that types are related as hypothesized to trait and reactive cortisol, but, as the correlations in Table 2 indicate, neither ego-resiliency nor ego-control is linearly related to these physiological markers.

The findings in this study do not demonstrate a decisive advantage for personality types over personality traits in the prediction of developmental outcomes. However, we believe that the findings do suggest that personality typologies can be helpful in advancing theory and research in personality. As just noted, the personality types can contribute to the understanding of how personality is linked to physiology. However, the fundamental value of personality typologies may lie in their value in providing a different perspective on personality. Pickles and Angold (2003, p. 529) have suggested that, in the study of psychopathology, diagnostic categories and dimensional, continuous variables may be the psychological analogue to the 'duality of light, a phenomenon with both wave- and particle-like properties'. We believe that refracting personality through the typological lens may be helpful in understanding how traits and processes are organized within individuals, and we hope that this paper and others that adopt a typological approach spawn research focusing on this fundamental goal of personality research.

ACKNOWLEDGEMENT

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