Associations Between Temperament and Social Responsiveness in Young Children

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Abstract

Recent research has demonstrated that social responsiveness (comprised of social awareness, social information processing, reciprocal social communication, social motivation, and repetitive/restricted interests) is continuously distributed within the general population. In the present study, we consider temperament as a co-occurring source of individual differences in social responsiveness in young children. The sample consisted of 62 infants assessed at 2-, 3-, and 4-years-old. Measures of temperament were obtained at each age (Early Childhood Behavior Questionnaire, Children's Behavior Questionnaire) and social responsiveness was measured at 4-years-old (Social Responsiveness Scale; SRS). Multivariate patterns of association between components of temperament and social responsiveness were observed at each age, with overall findings in line with the broader literature examining temperament and socio-development associations. Importantly, these results provide support for the usefulness of temperament as a relevant source of variability in social responsiveness, as measured by the SRS, in typically developing young children.

In everyday interactions, children differ in the behaviors, feelings and attitudes they exhibit in their social exchanges with others. Although these differences are traceable to a variety of domains, temperament represents an especially relevant source of variability, as it reflects individual differences in reactivity and regulation that involve emotion, motivation and attention-related processes (Rothbart & Bates, 2006). Individual differences in temperament have been associated with broad ranging socio-developmental outcomes, including social competence (i.e., socially appropriate behaviors and social success, or peer likeability), parent-child relations and school adjustment, as well as internalizing and externalizing behaviors (Sanson, Hemphill, & Smart, 2004). Recently, clinical and epidemiological studies using the Social Responsiveness Scale (Constantino, 2002) have demonstrated that social behaviors typically associated with autism (i.e., social awareness, social information processing, capacity for reciprocal social communication, social motivation, and repetitive/restricted interests) are continuously distributed among the general population (Constantino,

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2011). This dimensional approach offers a promising means of enhancing our understanding of temperamental co-relations with socio-developmental outcomes. The current study sought to identify patterns of association between components of temperament and social responsiveness within a typically developing sample of young children.

Temperament and Socio-Developmental Outcomes

Temperament has been defined as "constitutionally based individual differences in reactivity and self-regulation, in the domains of affect, activity, and attention" (Rothbart & Bates, 2006, p. 100). Though temperament is considered by definition to be relatively stable and biologically based, it is also modifiable as a function of development and environmental influences such as heredity, maturation and experience (Rothbart & Bates, 1998; 2006; Rothbart & Derryberry, 1981). Importantly, this underscores the significance of considering developmental shifts in the manifestation of temperament relative to other domains of interest, including as socio-developmental outcomes. Following the framework of Rothbart and colleagues (Rothbart & Bates, 2006), temperament involves individual variability in reactivity (i.e., latency, intensity and duration of emotional, attentional and motor responsiveness to changes in both internal and external environment) and regulation (i.e., processes of effortful control and orienting that modulates reactivity). Though the terminology used varies across studies, three overarching temperament dimensions are widely accepted and are briefly described below (for a review see Sanson, et al., 2004).

Negative affect is generally conceptualized as fear, shyness, anxiety, sadness, anger, discomfort, or general distress proneness (Rothbart, Ahadi, & Evans, 2000; Rothbart & Bates, 2006). Negative affect, expressed as general distress proneness, is the earliest emerging form of environmental reactivity, while reactivity to novelty and limitations (fear and frustration) are later emerging forms. Also called negative reactivity, this dimension has been related to internalizing and externalizing problems and deficits in social skills (Eisenberg et al., 1993; Eisenberg et al., 2000; Murphy, Shepard, Eisenberg, & Fabes, 2004; Sallquist et al., 2009). *Surgency/extroversion* refers to positive emotionality, sociability, reward sensitivity and activity level (Gartstein & Rothbart, 2003; Rothbart, et al., 2000). This dimension, also referred to as approach-withdrawal or inhibition, characterizes responses to novel situations and people. Researchers have identified relations between temperamental inhibition and internalizing behaviors including anxiety in social situations (Kagan & Snidman, 1999; Perez-Edgar & Fox, 2005; Sanson et al., 2009). *Effortful control* is the ability to regulate attention (e.g., nondistractibility, persistence), emotions and behavior (Rothbart, Ellis, Rueda, & Posner, 2003). Early emerging effortful control behaviors during the first year of life include orienting and soothability, while volitional attentional control develops in early childhood concurrent with significant changes in neurobiology (Putnam, Gartstein, & Rothbart, 2006; Rothbart, et al., 2003). Effortful control has been associated with lower levels of externalizing problems and with better social skills and social competence (Sanson, et al., 2009; Sanson & Prior, 1999). Although these associations are complex, broadly speaking, negative affect, surgency/extroversion and effortful control have each been associated with socio-developmental outcomes.

Although various models have been posed to account for these effects (i.e., direct linear effects; indirect linear effects; temperament × environment interactions; temperament × temperament interactions), a transactional approach emphasizes the ongoing interaction among intrinsic child characteristics (e.g., temperament, cognitive capability, health, etc.) and environmental aspects (parent and family characteristics, sociocultural context, etc.; Cicchetti & Cohen, 1995). From this perspective, temperament is often viewed as a risk or protective factor for developmental outcomes. That is, although temperament alone is not considered causative for particular outcomes (i.e., poor socio-development,

psychopathology, etc.) it is nonetheless considered an important contributor to developmental pathways. Research supports this view, as negative affect is associated with increased vulnerability to environmental stressors, while positive emotionality and regulation skills may serve as protective factors (Eisenberg, et al., 2000; Rothbart & Bates, 2006; Sanson, et al., 2004). In a closely related viewpoint, temperament has been positioned as an organizer of developmental change (Fox, Henderson, Perez-Edgar, & White, 2008), wherein certain temperament styles influence and maintain developmental outcomes. In this way, individual differences in temperament reactivity and regulation (including maturational and experiential changes) have meaningful import for understanding socio-emotional development.

From this perspective, children who are temperamentally more positive (e.g., adaptability, positive affect, soothability) and/or high in effortful control (e.g., self-regulation of distress and inhibition, attention regulation) may have increased opportunities for participating in social exchange, as their positive emotionality and capacity for self-regulation support their interaction with others; in contrast, temperamental negativity (e.g., fear, frustration, sadness, discomfort) and/or low effortful control may compromise social exchange by impacting infants' opportunities for interaction. Support for this is found in research examining joint attention in infants and toddlers. Although results are somewhat inconsistent, aspects of temperamental positive affect have been related to more frequent episodes of social attention sharing (i.e., joint attention) and negative affect has been associated with less frequent joint attention (Salley & Dixon, 2007; Todd & Dixon, 2010; Vaughan et al., 2003; Vaughan Van Hecke et al., 2007). Overall, evidence supports the view that temperament may operate as either a risk or protective factor for socio-developmental outcomes; however, associations with social responsiveness, as a specific index of socio-development have not been examined.

Social Responsiveness

Social responsiveness can be considered in terms of a general association with social developmental outcome, and more specifically, as a reflection of the particular social communication deficits associated with autism spectrum disorders (ASDs). For our purposes, we use the term to reference the domains measured using the Social Responsiveness Scale (SRS; Constantino, 2002), including social awareness, social information processing (social cognition), capacity for reciprocal social communication, social motivation (anxiety/avoidance), and repetitive/restricted interests.

Within the general population, a continuous distribution of deficits in social responsiveness has been observed using methods such as symptom counts and/or quantitative ratings of autistic social impairment (Constantino, 2011; Constantino & Todd, 2003; Ronald, Happe, Price, Baron-Cohen, & Plomin, 2006; Skuse et al., 2009). For example, within a population based sample (788 twin pairs) elevations were observed across core areas of autism (i.e., reciprocal social behavior, social communication, and abnormal restricted/repetitive behaviors) for 1.4% of males and 0.3% of females that fell at or above the mean elevation for children with PDD-NOS (Constantino, Przybeck, Friesen, & Todd, 2000; Constantino & Todd, 2003). This variability in social responsiveness was maintained even after accounting for other domains of psychopathology (Constantino, Hudziak, & Todd, 2003). A handful of studies have examined differences in social responsiveness in other clinical populations, by way of comparisons to both non-clinical and ASD populations. For example, youth with mood and anxiety disorders, disruptive behavior disorders and attention-deficit/hyperactivity disorder (ADHD) exhibit higher scores on ASD symptom scales relative to typically developing youth (Geurts et al., 2004; Gilmour, Hill, Place, & Skuse, 2004; Pine, Guyer, Goldwin, Towbin, & Leibenluft, 2008).

In other words, although the deficits observed among individuals with autism spectrum disorders are by definition markedly atypical in comparison to other populations, the threshold for diagnosis is in fact a categorical one. Therefore, subthreshold autistic traits (i.e., autistic traits that fall below the threshold of severity for an ASD diagnosis) are observable among individuals without an ASD diagnosis. This may include deficits in any number or combination of social responsiveness domains that nonetheless fall short of the level of clinically significant impairment necessary for an ASD diagnosis. For example, a child may display low social motivation but intact social awareness and social cognition; another child may show low levels of social reciprocity in all areas and yet not meet the diagnostic cutoff. The characterization of social responsiveness in this way allows a dimensional representation of an individual's strengths and weaknesses in a variety of domains. This is significant for understanding variation in socio-developmental competencies among the typically developing population.

As discussed above, temperament can be considered as a risk or protective factor for socio-development outcomes, and as such, greater impairment in social responsiveness (i.e., those scoring low on social responsiveness) may correspond with a specific temperament profiles in young children. Furthermore, given the observed variability in the manifestation of social responsiveness, these individual differences are likely to have important implications as a metric of general socio-developmental outcome in typically developing populations. The nature of the associations between temperament and specific components of social responsiveness, particularly variability in these associations across ages, may shed light on the developmental domains that cohere to lead to specific adaptive and less adaptive socio-developmental outcomes. To our knowledge, no other study has examined multivariate co-relations between temperament and this quantification of social responsiveness in typically developing children.

Present Study

In the present study, the primary aim was to examine patterns of association between multidimensional measures of temperament and social responsiveness in young children. The current study had two goals. The first purpose was to examine the multivariate relationship between dimensions of temperament as measured at 2 and 3 years of age with social responsiveness outcome at 4 years of age. The second purpose was to examine the concurrent multivariate relationship between dimensions of temperament and social responsiveness (as measured by the Social Responsiveness Scale) at 4 years of age. Based on previous studies linking temperament and broader socio-developmental outcomes (i.e., social competency, developmental psychopathology), it was hypothesized that at each age, temperament dimensions of surgency/extraversion and effortful control would be positively associated with higher levels of social responsiveness, whereas negative affect would be negatively associated with social responsiveness in young children.

Methods

Participants and Procedure

Participants were drawn from a sample of infants and mothers enrolled in a longitudinal study (5-months to 4-years of age) examining cognition and emotion integration during early development. Data available on temperament at 2-, 3-, and 4-years-old and social engagement outcome at 4-years-old were examined in this study. Criteria for inclusion in this study included complete temperament and social responsiveness data at each time point. The final sample of 60 children (31 boys and 29 girls; 52 Caucasian, 2 African American, 1 Asian and 5 Hispanic) were born full term and had no diagnosed neurological problems or developmental delay. All mothers completed a high school education, with 85% of mothers

also having a college degree. Mothers were paid for participation at each wave of the study. Children were given a small gift for participation at each age.

Prior to each visit, mothers were mailed questionnaires to complete at home. On arrival at the research laboratory, participants and their mothers were greeted, procedures were described, signed consent was obtained from the mothers, questionnaires were collected and laboratory tasks examining cognition and emotion were completed. For the purposes of the present report, only data from questionnaire measures were examined.

Measures

Temperament—Measures of temperament were obtained from parent report using measures designed to tap into developmentally appropriate scales of temperament. When children were 2 years old, mothers completed the 201-item Early Childhood Behavior Questionnaire (ECBQ; Putnam, et al., 2006). The 18 ECBQ scales, derived from 201 items, have demonstrated internal consistency ranging from .57 to .90 (average =.81) and interrater reliability estimates ranging from .09 to .57 (average r=.39) (Putnam et al., 2006). In the current study, ECBQ scales had an internal consistency ranging from .66 to 92 (average =.79). When children were 3 and 4 years of age, mothers completed the Children's Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001). The CBQ scales, derived from 196 items, have demonstrated internal consistency ranging from . 64 to .92 (average =.77) and interrater reliability estimates ranging from .67 to .92 (average =.75) (Rothbart, et al., 2001). In the current study, CBQ scales had an internal consistency ranging .63 to 94 (average =.78).

On the ECBQ and CBQ, mothers rated the frequency of specific day-to-day behaviors using a 7-point scale with responses ranging from 1 ("never") to 7 ("always"). From these ratings, three overarching factors are derived – surgency/extroversion negative affect, and effortful control (see Table 1 for scale loadings on each factor for both measures).

Social Responsiveness—Social responsiveness was quantified at 4 years of age, as measured by parent report on the Social Responsiveness Scale (SRS; Constantino, 2002). The SRS is a 65-item questionnaire designed to examine the various dimensions of interpersonal behavior, communication and restricted/repetitive interests that are characteristic of autism spectrum disorders. Overall, the SRS items form a single factor that is continuously distributed in the general population (Constantino, et al., 2000; Constantino & Todd, 2003). This quantification of social responsiveness is uncorrelated with IQ and represents a domain of social development that is distinct from other psychopathology (Constantino, et al., 2000; Constantino & Todd, 2003).

The SRS yields a total T-score, as well as T-scores on five subdomains that provide a more detailed picture of social impairments. Higher scores are indicative of greater impairment, with children above the SRS total score cutoff (T-score =60) evidencing low social responsiveness. Note however that a high score on the SRS does not necessarily mean that a child will receive an ASD diagnosis. The SRS total score has demonstrated good internal consistency, ranging from .93 to .97 across normative and clinical groups (average =.95), interrater reliability estimates ranging from .75 to .91 (average =.83), and test retest reliability estimates (average 17 months) of .77 for females and .85 for males. In the current study, the SRS total score had an internal consistency of .87.

On the SRS, mothers rate specific and observable elements of social behavior on a scale form one (not true) to four (almost always true) on the basis of their frequency, rather than intensity, of occurrence. Items query a range of mild to severely abnormal attributions and behaviors. The *social awareness* subdomain queries the ability to detect social cues and

represents the sensory aspects of reciprocal social behavior (e.g., "Is aware of what others are thinking or feeling", "Doesn't seem to mind being out of step with others"). The *social cognition* subdomain involves social information processing, or the ability to interpret social cues, representing the cognitive-interpretive aspects of reciprocal social behavior (e.g., "Takes things to literally and doesn't get the real meaning of conversation", "Is able to understand the meaning of other people's tone of voice and facial expressions"). The *social communication* subdomain includes the capacity for reciprocal expressive social communication (e.g., "Has difficulty relating to peers", "Is able to communicate his or her feelings to others"). The *social motivation* subdomain captures the extent to which a child is generally motivated to engage in social-interpersonal behavior and includes anxiety, inhibition, and empathic orientation (e.g., "Would rather be alone than with others", "Seems more fidgety in social situations than when alone"). The *restricted/repetitive interests* subdomain includes stereotypical, repetitive behaviors or highly restricted interests characteristic of autism (e.g., "Has more difficulty than other children with changes in routine", "Has an unusually narrow range of interests").

Analytic Strategy—Multivariate canonical correlation analysis (CCA) was used to test the hypothesized links between temperament and social responsiveness. CCA is a multivariate technique that allows for simultaneous comparisons among multiple dependent variables and reduces experimentwise error (type I) that would result from running multiple statistical tests such as multiple regression for each dependent variable. This approach is in line with the goals of the present study, as CCA provides the ability to simultaneously consider multivariate associations across dimensions of both temperament and social responsiveness. This in turn allows identification of detailed patterns of association including the *unique* and relative contributions of indices of temperament and components of social responsiveness at each age.

In addition, gender and maternal education, as a proxy for socioeconomic status, were included in the analyses. Results from meta-analyses of temperament have suggested the presence of gender differences; girls may show higher levels of effortful control and boys higher levels of surgency/extroversion (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006). Socio-developmental outcome research has also documented gender effects. Among typically developing children, some evidence suggests that temperament may be more predictive of resilience for girls, while other studies report this effect for boys only (see Sanson, et al., 2004); among atypically developing populations, prevalence rates for clinical level deficits in social communication (i.e., ASDs) are higher for males (Fombonne, Simmons, Ford, Meltzer, & Goodman, 2003). Although evidence for socio-metric differences is inconsistent, some researchers have reported that elevated scores on temperamental difficulty are more likely among children from lower SES families (Sanson, et al., 2004). Although these factors were included as potentially relevant covariates, given the inconsistency of these findings, no specific hypotheses were made regarding the roles of gender and SES.

Results

Descriptives

Descriptive data for temperament factor and scale scores (2-year-old ECBQ and 3- and 4-year-old CBQ) are presented in Table 1. Social responsiveness descriptive data at 4-years-old are presented in Table 2. Recall that higher scores on each subdomain indicate greater impairment; however, a high score on the SRS does not necessarily mean that a child will receive an ASD diagnosis. Although there were no children with an identified ASD diagnosis or developmental delay in the present study, a total of 6 children were at or above

the clinical cutoff (total T score ≥ 60), representing deficits in social responsiveness within the subclinical range. It is worth noting that, as a group, means for SRS subscales were as expected for a typically developing sample of children; excluding those above the clinical cutoff, the majority of children who evidenced deficits in social responsiveness were nonetheless within the range of normal limits.

Primary Analyses

A canonical correlation analysis was used to examine the multivariate relationship between temperament at 3 time points (ages 2, 3, and 4) and social responsiveness at age 4. At each time point the relationship between a set of temperament variables was examined in relationship with the set of social responsiveness variables. The five subscale scores representing children's social responsiveness, as measured by the Social Responsiveness Scale, served as the criterion variable (Set 1). The variables in this data set included social awareness, social cognition, social communication, social motivation and restricted/repetitive interests. The predictor variables (Set 2) were the three temperament dimensions, entered in three separate analyses at each age (specific scales for negative affect, surgency/extroversion and effortful control are listed in Table 1 by age). A separate canonical correlation analysis was used for each subset of temperament with the set of social responsiveness allowing full examination of the multivariate relationship between the major components of temperament and the construct of social responsiveness.

In each analysis 0-2 canonical functions were statistically significant using a Wilk's lambda significance criterion. Tables 3 -5 report the results for each of the age points and also include the canonical correlation. The effect size reports the amount of variance shared by the 2 sets of variables. The number of canonical variates interpreted in each analysis was determined by statistical significance as well as the amount of explained variance between the sets of variables. In each set the first variate explained at least 40% of the variance; when a second variate was interpreted it accounted for approximately 30% of the remaining variance. In no case was it deemed necessary to explain a third variate, even if statistical significance existed, based on the low amount of variance explained.

For significant functions, the squared canonical correlations were examined to determine the amount of variance accounted for by the variate(s). The standardized canonical function coefficients and the structure coefficients were examined for each significant function. Standardized canonical function characteristics operate similar to beta weights in multiple regression, reflecting the relative contribution of the variable given the other variables included in the variate. The structure coefficients are correlation coefficients between the variable and its created variable from the set, which describe the direct contribution of the variable without the impact of the other variables in the equation. According to the guidelines of Sherry and Henson (2005), both standardized and structure coefficients have been reported for a more thorough interpretation of the analyses. Variables with the highest contribution to the canonical variate were selected using the convention of a .45 cutoff for the structure coefficient. These structure coefficients appear in bold in the table.

At age 2, negative affect was the only significant temperament factor (Wilks' ʌ = .16 for the canonical variate), accounting for 58% of the variance (Table 3). Correlations from the social responsiveness set indicate that social cognition, social communication, social motivation and restricted/repetitive interests significantly contributed to the variate. This same pattern was also apparent in the standardized coefficients. Although the coefficient for social cognition was smaller than one would expect, this was due to the level of correlation within the variable set. The relevant variables from the negative affect set were discomfort, mother's education and gender. The sign of the correlation is shared for all social responsiveness variables, discomfort and gender (i.e., all correlations were negative), which

indicates the presence of positive associations between these variables; in contrast, mother's education level displayed the opposite sign, indicating an inverse association. This pattern of association indicated that higher levels of discomfort and being male were associated with impairment in social cognition, social communication, social motivation and restricted/repetitive interests; in addition, children whose mother's had higher education levels (i.e., some college or better) had reduced levels of social impairment. (Note that scoring for the Social Responsiveness Scales yields higher values for greater impairment, while lower SRS values indicate better social responsiveness.)

At age 3, significant variates were found for each temperament set and social responsiveness (Table 4). For the surgency/extroversion subset, there were two significant canonical variates (Wilks' = .16); the first accounted for 46% of the variance and the second accounted for 38% of the remaining variance. Again there was some collinearity in both the social responsiveness and extraversion set that presented a slightly different pattern in the standardized coefficients, however, the general pattern was similar. The first variate indicated that a higher level of shyness was associated with impairment in social communication and social motivation (i.e., higher SRS scores), while higher levels of impulsive behavior reduced social impairment in these domains. For the second variate, as was the case at age 2, greater impairment in social cognition, social communication and restricted/repetitive interests was related to being male; children whose mothers had higher education levels (i.e., some college or better) had reduced levels of social impairment.

For the negative affect subset at age 3, one canonical variate was significant (Wilks' = .34) and accounted for 40% of the variance. Higher levels of fear and being male were related to lower social communication, social cognition and more restricted/repetitive interests (i.e., higher SRS scores). Children whose mothers had higher levels of education had reduced levels of impairment in social responsiveness.

Finally, in the effortful control subset at age 3, one canonical variate (Wilks' =.32) significantly accounted for 48% of the variance. This function indicated that greater impairment in social awareness was related to being female and having a mother with a higher education level.

At age 4, analysis of concurrent association between social responsiveness and temperament sets revealed significant canonical variates (Table 5). For the surgency/extroversion subset at age 4, two variates were significant (Wilks' =.17), with the first accounting for 63% of variance and the second accounting for 36% of the remaining variance. For the first variate, higher levels of shyness, but lower levels of activity and impulsivity were associated with greater impairment in social motivation and social communication (i.e., higher SRS scores). For the second variate, the function indicated that being male and children whose mothers had lower education levels displayed greater impairment in social cognition, social communication and more restricted/repetitive interests.

For the negative affect subset at age 4, one variate was significant (Wilks' = .37) and accounted for 43% of the variance. Social motivation appeared to suffer from collinearity in the set, as evidenced by its low standardized coefficient. This function indicated that higher levels of fear and sadness, but lower levels of soothability and lower maternal education were associated with greater impairment in social communication, social motivation social cognition and restricted/repetitive interests.

For the effortful control subset at age 4, there were two significant variates (Wilks' = .27); the first accounted for 47% of the variance and the second 32% of the remaining variance. In the first variate, lower levels of inhibitory control and attention shifting were associated with greater impairment in all SRS domains. For the second variate, the pattern indicated that

being female and having a mother with some college or more education increased deficits in social awareness, while being male and having a mother with lower education levels increased deficits in social communication.

Discussion

The purpose of this study was to examine multivariate relationships between temperament and social responsiveness in typically developing young children. Kagan (2011) has recently emphasized the importance of identifying patterns of development within and across domains of interest, as these relationships may lead to an understanding of the larger causal patterns of influence and conditions which lead to a specific developmental outcome. From this view, the variability in social responsiveness reported within typically (and atypically) developing populations (Constantino, 2011; Constantino & Todd, 2003; Ronald, et al., 2006; Skuse, et al., 2009) provides a means of characterizing patterns of adaptive and less adaptive development in this domain alongside individual variability in temperament that together yields a uniquely rich window on socio-developmental outcomes. We know of no other studies that have examined temperament across infancy and early childhood in relation to social responsiveness outcomes in typically developing children.

We initially hypothesized that at each age (2, 3 and 4 years-old), temperament dimensions of surgency/extraversion and effortful control would be positively associated with higher levels of social responsiveness (as measured by the SRS subdimensions), whereas negative affect would be negatively associated with social responsiveness in young children. The overall pattern of results from the multivariate canonical analyses provided support for this hypothesis; however, the actual findings are somewhat more complex and are summarized below. The multivariate pattern of association between each broad temperament factor and social responsiveness outcome is discussed below.

Surgency/Extroversion

Associations between temperament scales comprising surgency/extroversion were observed beginning at 3 years of age. Higher levels of shyness (i.e., inhibition or approach in situations involving novelty) at 3 and 4 years displayed a consistent and strong association with impairments in both social motivation and social communication; lower levels of impulsivity (i.e., speed of response initiation) and activity level (i.e., level of gross motor activity) were also associated with increased impairment in these SRS subdomains. This link between shyness, social motivation and social communication is consistent with the broader literature documenting relations between temperamental inhibition and internalizing disorders or social anxiety (Kagan & Snidman, 1999; Perez-Edgar & Fox, 2005; Sanson, et al., 2009). The observation that less impulsivity and lower activity level actually decreased social motivation and social communication was less expected, but this may also be considered as avoidance/withdrawal behaviors, as they reflect lower levels of positive reactivity in response to the internal and external environment. It is worth noting that other aspects of positive affect did not contribute to the variate (i.e., positive anticipation, smiling, high intensity pleasure), which suggests that the expression of avoidance behaviors (i.e., shyness, low impulsivity, low activity level), rather than the expression of positive affect alone, is more relevant for the social responsiveness outcomes measured by the SRS.

Negative Affect

Our findings reveal consistent associations between indices of negative affect at each age and later social responsiveness in early childhood. At age 2, discomfort (i.e., amount of negative affect expressed in response to sensory qualities of stimulation) was the only dimension that emerged as significant. However, it was associated with multiple

impairments in later social responsiveness at age 4, as each contributed strongly to the variate (i.e., social cognition, social communication, social motivation and restricted/ repetitive interests). By age 3, the most relevant component of negative affect was higher levels of fear (i.e., unease, worry, nervousness in novel or threatening situations), which was linked to greater impairments in social communication, social cognition and repetitive/ restricted behaviors. Concurrent associations (at age 4), included impairments across multiple domains of social responsiveness (the same observed at age 2) that were increased by higher fear and sadness (i.e., negative affect in response to disappointment, object loss), and less soothability (i.e., slower recovery from distress).

This overall pattern is in line with the broader literature supporting associations between negative affect and socio-development (Eisenberg, et al., 1993; Eisenberg, et al., 2000; Murphy, et al., 2004; Sallquist, et al., 2009), but importantly these results provide evidence for the role of negative affect in the development and/or expression of specific social responsiveness skills. Together, these components of negative affect are closely identified with behavioral inhibition, which in turn has been related to socialization and coping strategies (Rothbart & Bates, 2006). However, the present results suggest that these indices of temperament may be implicated in the development and/or expression of multiple social responsiveness behaviors (i.e., interpreting social cues, reciprocal social communication, motivation to engage with others, flexible social behavior). Interestingly, less adaptive social communication may be particularly problematic for children high in negative affect. While greater impairment in this domain was not only linked to each of these temperament scales, social communication also represented the largest direct contribution to the variate at each age.

Effortful Control

A significant pattern of associations was observed between measures of effortful control and social responsiveness at age 4. Lower levels of inhibitory control (i.e., capacity to plan/ suppress inappropriate approach responses in novel or uncertain situations) and attention shifting (i.e., shifting attention from one activity to another) were associated with impairment across all measured components of social responsiveness. This suggests that effortful control may be particularly relevant for understanding the concurrent expression of social responsiveness at this age. As effortful control undergoes considerable change in early childhood (Putnam, et al., 2006; Rothbart, et al., 2003), it is not surprising that this dimension would not emerge as a significant factor earlier in development. Diminished capacity for inhibitory control and modulation of attention would pose greater compromise to a toddler's optimal social interactions, including the ability to successfully detect, interpret and engage in a reciprocal social exchange.

Gender and Maternal Education

Although the influences of gender and maternal education were not entirely consistent (across age and temperament factors), this is in keeping with the broader literature. Nonetheless, several interesting patterns were evident. Generally speaking, being male was associated with greater deficits in multiple domains of social responsiveness across age (it should be noted that the T-scores on the SRS are normed by gender). This was most consistently observed with social cognition and social communication. Although reports have been mixed in terms of the impact of temperament on socio-developmental outcomes for boys and girls (see Sanson, et al., 2004), results are consistent with evidence of higher rates of social communication deficits in males (Fombonne, et al., 2003).

In terms of maternal education level, a relatively consistent pattern of association was also observed. Greater impairment in social responsiveness was associated with children whose

mothers had lower levels of education (i.e., less than a college education), a finding which is consistent with observations of elevated levels of temperamental difficulty among lower SES families (Sanson, et al., 2004). Deficits in social communication were most consistently linked to lower maternal education level, although deficits in social cognition and restricted/ repetitive interests also emerged as significant. The exception to these patterns occurred for impairment in social awareness, which was associated with being female and having a mother with a higher level of education. Although the nature of these associations are not entirely clear, they raise interesting questions for future research and suggest the importance of gender and SES contributions when considering outcomes in these domains.

Summary

Our findings reveal a number of significant patterns of associations between indices of temperament and later social responsiveness in early childhood. These results should not be interpreted to suggest that temperamental profiles are causative in themselves but rather, represent a distinct, but related domain of development that may operate as a risk or protective factor for social responsiveness outcomes. One primary implication of these results relates to the consistent finding that components of negative affect were associated with greater deficits in social responsiveness; high levels of early discomfort may also serve as a potential warning sign for later, less adaptive, social responsiveness. In contrast, associations with effortful control were not evident until age 4; interestingly, the effortful control scales were linked to all measured aspects of social responsiveness. This shift reflects developmental change in the expression and assessment of temperament (Rothbart & Bates, 2006), but may also offer insight into factors related to the eventual emergence of social responsiveness. Nonetheless, it is important to consider that for this typically developing sample, the degree of impairment in both social responsiveness and temperament domains was moderate.

One important strength of the current paper is the use of canonical analyses to simultaneously consider multivariate associations across all variables of interest, which allowed us to explore in detail patterns of association. While this approach limited our ability to consider interactions, it allowed us to identify the *unique* and relative contributions of indices of temperament and social responsiveness at each age. Although we did not have an independent measure of psychopathology (i.e., anxiety, externalizing disorders, etc.), the SRS identifies deficits in social responsiveness that are independent from other kinds of psychopathology (Constantino, et al., 2003). This supports the interpretability of the current results as distinct from the influence of other psychopathology. Although parent reported measurement of temperament and social responsiveness are accepted means of characterizing individual differences, future research should incorporate multiple measures of development in these domains. In addition, because of the constraints inherent to our sample size, it was not possible to examine the trajectories of temperament across time for individual infants. Furthermore, these data do not allow us to examine the co-emergence of temperament and social responsiveness. These are important next steps towards determining the nature of the relationship between temperament and social responsiveness, as it remains unclear when and how temperamental dispositions influence the emergence and manifestation of social responsiveness.

To our knowledge, this study represents the first attempt to characterize multivariate patterns of association between temperament and social responsiveness outcomes in typically developing children. Characterizing patterns among factors relating to deficits in social responsiveness has important implications for understanding developmental trajectories towards both typical and atypical social-developmental outcomes. Even mild deficits in social responsiveness may have an impact on functioning and outcomes in a variety of domains. As a result, beginning to describe these patterns opens up the possibility of

examining variation in features of temperament that affect not only outcomes in early childhood, but also potentially the emergence of the parameters of social engagement earlier in development.

Acknowledgments

References

Cicchetti, D.; Cohen, DJ. Perspectives on developmental psychopathology. In: Cicchetti, D.; Cohen, DJ., editors. Developmental psychopathology: Vol 1. Theory and methods. John Wiley; New York: 1995. p. 3-20.

Constantino, JN. The social responsiveness scale. Western Psychological Services; Los Angeles, California: 2002.

Constantino JN. The quantitative nature of autistic social impairment. Pediatric Research. 2011; 69(5 Pt 2):55R–62R. doi: 10.1203/PDR.0b013e318212ec6e.

Constantino JN, Hudziak JJ, Todd RD. Deficits in reciprocal social behavior in male twins: Evidence for a genetically independent domain of psychopathology. Journal of the American Academy of Child and Adolescent Psychiatry. 2003; 42(4):458–467. doi: 10.1097/01.CHI. 0000046811.95464.21. [PubMed: 12649633]

Constantino JN, Przybeck T, Friesen D, Todd RD. Reciprocal social behavior in children with and without pervasive developmental disorders. Journal of Developmental and Behavioral Pediatrics. 2000; 21(1):2–11. [PubMed: 10706343]

Constantino JN, Todd RD. Autistic traits in the general population: A twin study. Archives of General Psychiatry. 2003; 60(5):524–530. doi: 10.1001/archpsyc.60.5.524. [PubMed: 12742874]

Eisenberg N, Fabes RA, Bernzweig J, Karbon M, Poulin R, Hanish L. The relations of emotionality and regualtion to preschoolers' social skills and sociometric status. Child Development. 1993; 64(5):1418–1438. [PubMed: 8222881]

Eisenberg N, Guthrie IK, Fabes RA, Shepard S, Losoya S, Murphy BC, Jones S, Poulin R, Reiser M. Prediction of elementary school children's externalizing problem behaviors from attentional and behavioral regulation and negative emotionality. Child Development. 2000; 71(5):1367–1382. [PubMed: 11108101]

Else-Quest NM, Hyde JS, Goldsmith HH, Van Hulle CA. Gender differences in temperament: A meta-analysis. Psychological Bulletin. 2006; 132(1):33–72. doi: 10.1037/0033-2909.132.1.33. [PubMed: 16435957]

Fombonne E, Simmons H, Ford T, Meltzer H, Goodman R. Prevalence of pervasive developmental disorders in the British nationwide survey of child mental health. International Review of Psychiatry. 2003; 15(1-2):158–165. doi: 10.1080/0954026021000046119. [PubMed: 12745327]

Fox, NA.; Henderson, HA.; Perez-Edgar, K.; White, LK. The biology of temperament: An integrative approach. In: Fox, NA.; Henderson, HA.; Perez-Edgar, K.; White, LK., editors. Handbook of developmental cognitive neuroscience. 2nd ed.. MIT Press; Cambridge, MA: 2008. p. 839-853.

Gartstein MA, Rothbart MK. Studying infant temperament via the revised Infant Behavior Questionnaire. Infant Behavior & Development. 2003; 26(1):64–86. doi: 10.1016/ S0163-6383(02)00169-8.

Geurts HM, Verte S, Oosterlaan J, Roeyers H, Hartman CA, Mulder EJ, Berckelaer-Onnes IA, Sergeant JA. Can the Children's Communication Checklist differentiate between children with autism, children with ADHD, and normal controls? Journal of Child Psychology and Psychiatry and Allied Disciplines. 2004; 45(8):1437–1453. doi: 10.1111/j.1469-7610.2004.00850.x.

Gilmour J, Hill B, Place M, Skuse DH. Social communication deficits in conduct disorder: a clinical and community survey. Journal of Child Psychology and Psychiatry and Allied Disciplines. 2004; 45(5):967–978. doi: 10.1111/j.1469-7610.2004.t01-1-00289.x.

Kagan J. Three Lessons Learned. Perspectives on Psychological Science. 2011; 6(2):107–113. doi: 10.1177/1745691611400205.

Kagan J, Snidman N. Early childhood predictors of adult anxiety disorders. Biological Psychiatry. 1999; 46:1536–1541. [PubMed: 10599481]

Murphy BC, Shepard SA, Eisenberg N, Fabes RA. Concurrent and across time prediction of young adolescents' social functioning: The role of emotionality and regulation. Social Development. 2004; 13(1):56–86.

Perez-Edgar K, Fox NA. Temperament and anxiety disorders. Child and adolescent psychiatric clinics of North America. 2005; 14(4):681–706. viii. doi: 10.1016/j.chc.2005.05.008. [PubMed: 16171698]

Pine DS, Guyer AE, Goldwin M, Towbin KA, Leibenluft E. Autism spectrum disorder scale scores in pediatric mood and anxiety disorders. Journal of the American Academy of Child and Adolescent Psychiatry. 2008; 47(6):652–661. doi: 10.1097/CHI.0b013e31816bffa5. [PubMed: 18434923]

Putnam SP, Gartstein MA, Rothbart MK. Measurement of fine-grained aspects of toddler temperament: the early childhood behavior questionnaire. Infant Behavior & Development. 2006; 29(3):386–401. doi: 10.1016/j.infbeh.2006.01.004. [PubMed: 17138293]

Ronald A, Happe F, Price TS, Baron-Cohen S, Plomin R. Phenotypic and genetic overlap between autistic traits at the extremes of the general population. Journal of the American Academy of Child and Adolescent Psychiatry. 2006; 45(10):1206–1214. doi: 10.1097/01.chi.0000230165.54117.41. [PubMed: 17003666]

Rothbart MK, Ahadi SA, Evans DE. Temperament and personality: Origins and outcomes. Journal of Personality and Social Psychology. 2000; 78(1):122–135. doi: 10.1037//0022-3514.78.1.122. [PubMed: 10653510]

Rothbart MK, Ahadi SA, Hershey KL, Fisher P. Investigations of temperament at three to seven years: the Children's Behavior Questionnaire. Child Development. 2001; 72(5):1394–1408. [PubMed: 11699677]

Rothbart, MK.; Bates, JE. Temperament. In: Damon, W.; Eisenberg, N., editors. Handbook of child psychology: Vol. 3. Social, emotional, and personality development. 5th ed.. Wiley; New York: 1998. p. 105-176.

Rothbart, MK.; Bates, JE. Temperament. In: Damon, RLW.; Eisenberg, N., editors. Handbook of child psychology: Social, emotional, and personality development. 6th ed.. Vol. 3. Wiley; New York: 2006. p. 465-501.

Rothbart, MK.; Derryberry, D. Development of individual differences in temperament. In: Lamb, ME.; Brown, AL., editors. Advances in developmental psychology. Vol. 1. Erlbaum; Hillsdale, NJ: 1981. p. 37-86.

Rothbart MK, Ellis LK, Rueda MR, Posner MI. Developing mechanisms of temperamental effortful control. Journal of Personality. 2003; 71(6):1113–1143. [PubMed: 14633060]

Salley B, Dixon WE Jr. Temperamental and joint attentional predictors of language development. Merrill-Palmer Quarterly. 2007; 53(1):131–154. doi: 10.1353/mpg.2007.0004. [PubMed: 18080005]

Sallquist JV, Eisenberg N, Spinrad TL, Reiser M, Hofer C, Zhou Q, Liew J, Eggum N. Positive and negative emotionality: trajectories across six years and relations with social competence. Emotion. 2009; 9(1):15–28. doi: 10.1037/a0013970. [PubMed: 19186913]

Sanson A, Hemphill SA, Smart D. Connections between temperament and social development: A review. Social Development. 2004; 13(1):142–170. doi: 10.1046/j.1467-9507.2004.00261.x.

Sanson A, Letcher P, Smart D, Prior M, Toumbourou JW, Oberlklaid F. Associations between early childhood temperament clusters and later psychosocial adjustment. Merrill-Palmer Quarterly. 2009; 55(1):26–54. doi: 10.1353/mpq.0.0015.

Sanson, A.; Prior, M. Temperamental and behavioral precursors to oppositional defiant disorder and conduct disorder. In: Quay, HC.; Hogan, AE., editors. Handbook of disruptive behavior disorders. Kluwer Academic/Plenum; New York: 1999. p. 397-417.

Sherry A, Henson RK. Conducting and interpreting canonical correlation analysis in personality research: A user-friendly primer. Journal of Personality Assessment. 2005; 84(1):37–48. [PubMed: 15639766]

Skuse DH, Mandy W, Steer C, Miller LL, Goodman R, Lawrence K, Emond A, Golding J. Social communication competence and functional adaptation in a general population of children: Preliminary evidence for sex-by-verbal IQ differential risk. Journal of the American Academy of Child and Adolescent Psychiatry. 2009; 48(2):128–137. doi: 10.1097/CHI.0b013e31819176b8. [PubMed: 19106766]

Todd JT, Dixon WE Jr. Temperament moderates responsiveness to joint attention in 11-month-old infants. Infant behavior & development. 2010; 33(3):297–308. doi: 10.1016/j.infbeh.2010.03.007. [PubMed: 20434778]

Vaughan A, Mundy P, BLock J, Burnette CP, Delgado C, Gomez Y, Meyer J, Neal AR, Pomares Y. Child, caregiver, and temperament contributions to infant joint attention. Infancy. 2003; 4(4):603–616. doi: 10.1207/S15327078IN0404_11.

Vaughan Van Hecke A, Mundy PC, Acra CF, Block JJ, Delgado CE, Parlade MV, Meyer JA, Neal AR, Pomares YB. Infant joint attention, temperament, and social competence in preschool children. Child Development. 2007; 78(1):53–69. doi: 10.1111/j.1467-8624.2007.00985.x. [PubMed: 17328693]

Table 1

Descriptive statistics for temperament measures (ECBQ and CBQ) by age

	2 Years ECBQ n=79		3 Years CBQ n=67	4 Years CBQ n=60
Surgency/Extraversion	5.12 (.51)	**Surgency/Extraversion**	4.94 (.66)	5.00 (.67)
Activity Level	5.01 (.72)	Activity Level	5.18 (.59)	5.22 (.62)
High Intensity Pleasure	4.95 (.79)	High Intensity Pleasure	5.25 (.76)	5.30 (.72)
Impulsivity	5.06 (.65)	Impulsivity	4.82 (.67)	4.82 (.68)
Positive Anticipation	5.06 (.88)	Positive Anticipation	5.24 (.69)	5.33 (.67)
Sociability	5.54 (.94)	Smiling	5.85 (.54)	5.91 (.58)
		Shyness	3.47 (1.28)	3.33 (1.28)
Negative Affect	2.96 (.49)	**Negative Affect**	3.74 (.58)	4.21 (.49)
Discomfort	2.46 (.74)	Anger/Frustration	4.54 (.70)	4.43 (.80)
Fear	2.50 (.81)	Discomfort	4.01 (.90)	4.18 (.78)
Frustration	3.59 (.71)	Fear	3.30 (1.09)	3.69 (1.07)
Motor Activation	2.23 (.85)	Sadness	3.75 (.71)	3.86 (.69)
Perceptual Sensitivity	4.08 (.92)	Soothability	4.92 (.65)	4.86 (.71)
Sadness	2.81 (.85)			
Shyness	3.28 (.96)			
Soothability	5.27 (.72)			
Effortful Control	4.49 (.55)	**Effortful Control**	4.78 (.49)	4.67 (.36)
Attention Focusing	4.25 (.81)	Attention Focusing	4.39 (.85)	4.42 (.85)
Attention Shifting	4.60 (.55)	Attention Shifting	4.03 (.80)	4.07 (.99)
Cuddliness	4.90 (1.00)	Inhibitory Control	4.32 (.68)	4.57 (.59)
Inhibitory Control	4.06 (.87)	Low Intensity Pleasure	5.50 (.53)	5.53 (.48)
Low Intensity Pleasure	4.66 (.82)	Perceptual Sensitivity	4.90 (.83)	5.09 (.76)

Note: Means (Standard Deviation)

Table 2

Descriptive statistics and inter-correlations for social responsiveness (SRS) at 4 years old (n=60)

	Mean (SD)	1	2	3	4	5
SRS Total T Score	50.22 (6.48)					
1. Social Awareness	55.43 (8.22)	-				
2. Social Cognition	52.13 (7.33)	.391 **	-			
3. Social Communication	49.92 (.83)	.442 **	.642 **	-		
4. Social Motivation	50.52 (9.09)	.307 *	.415 **	.622 **	-	
5. Restricted/Repetitive Interests	50.98 (7.60)	.403 **	.541 **	.604 **	.496 **	-

Note: SRS Total T score indicates severity of autistic symptomatology; higher scores indicate increased risk and greater impairment in dimensions of social responsiveness.

*
p<.05

**
p<.01

***
p<.001

Table 3

Canonical correlations between temperament at 2 years old and social responsiveness at 4 years old

	Variate 1	
	Coeff	r_s
Social Responsiveness Set		
Social Awareness	.159	−.008
Social Cognition	−.081	−**.549**
Social Communication	−.798	−**.870**
Social Motivation	−.221	−**.680**
Repetitive/Restrictive Interests	−.181	−**.635**
Temperament Set		
Negative Affect		
Discomfort	−.567	−**.566**
Fear	−.202	−.411
Frustration	.288	−.199
Motor Activity	−.197	−.443
Sadness	−.239	−.429
Perceptual Sensitivity	−.037	−.228
Shyness	.112	−.332
Sociability	−.084	.102
Mother's Education	.500	**.524**
Gender	−.502	−**.472**
% of variance		.58

Note: Coeff, standardized canonical function (canonical loading); r_s, structure coefficients (correlation coefficients); variables with the highest contribution to the canonical variate (in bold) were selected using a .45 cutoff for the structure coefficient.

Table 4

Canonical correlations between temperament at 3 years old and social responsiveness at 4 years old

Social Responsiveness Set

	Variate 1 Coeff	Variate 1 r_s	Variate 2 Coeff	Variate 2 r_s		Variate 1 Coeff	Variate 1 r_s		Variate 1 Coeff	Variate 1 r_s
Awareness	.366	.147	.237	−.201	Awareness	.761	.295	Awareness	−.961	−**.644**
Cognition	.118	−.159	−.484	−**.800**	Cognition	−.151	−**.508**	Cognition	−.342	−.023
Communication	−.392	−**.498**	−.647	−**.753**	Communication	−.948	−**.721**	Communication	.622	.341
Motivation	−.964	−**.857**	.568	−.175	Motivation	.175	−.372	Motivation	.165	.349
Restr. Interests	.418	−.137	−.384	−**.708**	Restr. Interests	−.157	−**.502**	Restr. Interests	.348	.249

Temperament Sets

Surgency/Extroversion	Variate 1 Coeff	Variate 1 r_s	Variate 2 Coeff	Variate 2 r_s	Negative Affect	Variate 1 Coeff	Variate 1 r_s	Effortful Control	Variate 1 Coeff	Variate 1 r_s
Activity Level	−.222	.222	.484	.332	Anger	.090	−.265	Attention Focus	−.401	−.074
High Pleasure	.139	.444	.215	.143	Discomfort	−.075	−.117	Attention Shift	−.082	.185
Impulsivity	.082	**.618**	−.632	−.245	Fear	−.412	−**.496**	Inhib Control	.795	.266
Pos. Anticip.	.115	.188	−.293	.155	Sadness	−.156	−.365	Low Pleasure	−.373	−.164
Smiling	−.049	.357	.434	.425	Soothability	−.017	.179	Percep. Sens.	.472	.248
Shyness	−.907	−**.966**	.246	−.032						
Mother Ed.	.156	.426	.446	**.464**	Mother Ed.	.568	**.648**	Mother Ed.	−.621	−**.529**
Gender	.047	−.225	−.594	−**.525**	Gender	−.569	−**.683**	Gender	.493	**.530**
% Variance	.46		.38		% Variance	.40		% Variance	.48	

Note: Coeff, standardized canonical function (canonical loading); r_s, structure coefficients (correlation coefficients); variables with the highest contribution to the canonical variate (in bold) were selected using a .45 cutoff for the structure coefficient.

Table 5

Canonical correlations between temperament at 4 years old and social responsiveness at 4 years old

Social Responsiveness Set

	Variate 1		Variate 2		Variate 1		Variate 1		Variate 2	
	Coeff	r_s	Coeff	r_s	Coeff	r_s	Coeff	r_s	Coeff	r_s
Awareness	.223	−.046	.601	.164	.244	−.198	.333	**.642**	.951	**.555**
Cognition	−.107	−.321	−.058	−**.473**	.288	−**.464**	−.040	**.558**	−.034	−.267
Communication	.017	−**.469**	−.675	−**.617**	−1.09	−**.944**	−.008	**.648**	−.902	−**.516**
Motivation	−1.19	−**.941**	.516	−.109	−.020	−**.606**	−.082	**.450**	.029	−.262
Restr. Interests	.28	−.246	−.725	−**.707**	−.212	−**.681**	.892	**.954**	−.020	−.247

Temperament Sets

Extraversion/Surgency

	Variate 1		Variate 2	
	Coeff	r_s	Coeff	r_s
Activity	−.004	**.454**	.314	−.008
High Pleasure	.059	.411	.017	−.151
Impulsivity	.186	**.760**	−.068	−.078
Pos. Anticip.	.026	.249	−.691	−.356
Smiling	−.091	.327	.046	−.093
Shyness	−.864	−**.984**	.284	−.028
Mother Ed.	.583	.327	.742	**.625**
Gender	−.194	−.159	−.614	−**.490**
% Variance	.63		.36	

Negative Affect

	Variate 1	
	Coeff	r_s
Anger	.275	−.415
Discomfort	.102	−.374
Fear	−.412	−**.521**
Sadness	−.521	−**.497**
Soothability	.352	**.476**
Mother Ed.	.586	**.621**
Gender	−.343	−.425
% Variance	.43	

Effortful Control

	Variate 1		Variate 2	
	Coeff	r_s	Coeff	r_s
Atten. Focus	.350	.076	.007	.204
Atten. Shift	−.144	−**.547**	−.301	−.336
Inhib. Control	−.913	−**.873**	−.126	−.231
Low Pleasure	−.041	−.239	.397	.364
Percep. Sens.	.208	−.247	−.478	−.197
Mother Ed.	−.359	−.348	.603	**.665**
Gender	.068	.203	−.439	−**.517**
% Variance	.47		.32	

Note: Coeff, standardized canonical function (canonical loading); r_s, structure coefficients (correlation coefficients); variables with the highest contribution to the canonical variate (in bold) were selected using a .45 cutoff for the structure coefficient.