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Brief report

Exploratory factor analysis of human infant temperament in the rhesus monkey

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ABSTRACT

The triadic model of human infant temperament, involving Negative Affectivity, Orienting/Regulation, and Surgency/Extraversion factors, was applied to the rhesus neonate using exploratory factor analysis (EFA). Replicating and expanding earlier work in rhesus monkeys, the three-factor solution produced latent constructs comparable to human neonatal temperament.

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The goal of this brief report is to evaluate the underlying or latent structure of human infant temperament in the rhesus monkey. Temperament, defined as the constitutional traits that drive individual differences in reactivity and self-regulation, is an important predictor of social, intellectual, and behavioral development (Gartstein & Rothbart, 2003). Understanding of the latent structure of human temperament has grown in recent years. However, research reflecting the latent structure of human infant temperament has yet to be assessed in the rhesus infant.

Three major domains of human infant temperament, emotion, attention, and motoric/activity, have been proposed (Posner & Rothbart, 2007; Rothbart & Bates, 2006) which appear to relate to several theoretical and scientific triadic models of human infant temperament (Clark & Watson, 1999). Numerous assessment methodologies and test batteries have been developed to uncover the latent structure of temperament (Gartstein & Rothbart, 2003). However, many instruments have had limited utility in this pursuit due to their inclusion of items irrelevant to temperament that obscure the latent structure of temperament with more global constructs captured by the test (Derryberry & Rothbart, 1988; Gartstein & Rothbart, 2003). For example, in addition to temperament measures (e.g., irritability, activity, and orienting) the Neonatal Behavioral Assessment Scale (NBAS), one of the most widely used infant behavioral measures, includes items related to neurological development and maturation (Brazelton, 1973). As a result the NBAS has been effective at characterizing the more global construct of infant development but not the latent structure of temperament. Based on the classic research and theoretical work on temperament questionnaires performed by Thomas and Chess, Escalona, Shirly, and others, the Infant Behavioral Questionnaire (IBQ) was designed specifically to capture human infant temperament by only including items rationally derived from hypothesized temperament constructs (Gartstein & Rothbart, 2003). There is evidence for the traidic structure of human infant temperament across early development and among different cultures when using the Revised-IBQ

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Table 1
Factor correlation matrix.

Factor	Negative Affectivity	Orienting/Regulation	Sugency/Extraversion
Negative Affectivity	1		
Orienting/Regulation	0.23	1	
Sugency/Extraversion	−0.28	0.10	1

(Gartstein, Knyazev, & Slobodskaya, 2005; Gartstein & Rothbart, 2003). The terms Negative Affectivity (reflecting an infant's constitutional tendency towards negative emotion and distress), Regulatory Capacity/Orienting (related to an infant style of affective regulation including greater impulsivity, fearfulness, and orienting), and Surgency/Extraversion (indicating an infant's tendency for energetic activity, positive affect, and high intensity pleasure) adequately represent the major structure of infant temperament contained in several models (Gartstein & Rothbart, 2003). This triadic structure is related to dimensions of reactivity in basic emotions and attention/regulation and is sensitive to developmental abnormalities and outcomes (Posner & Rothbart, 2007; Rothbart & Bates, 2006). Although competing models and definitions of temperament are extant, Rothbart and colleagues' definition of temperament and their proposed three-factor structure is the only model with both strong theoretical underpinnings, proposed physiological mechanisms, and scientific validation in large cross-cultural infant samples (Gartstein et al., 2005) making it a particularly desirable model to test in the rhesus monkey.

In the late 1980s, items from various tests of human infant temperament were adapted into the Infant Behavioral Assessment Scale (IBAS) for monkeys, specifically to assess the behavioral development of neonatal rhesus macaques. Similar to its counterpart in the human literature (i.e., the NBAS), the IBAS contains items designed to not only measure temperament but maturation, neuromotor functioning, and reflex behaviors as well (Schneider, Colleen, Suomi, & Champoux, 1991). Previous research on this measure has produced between 1 and 5 components but has yet to be used to study the latent structure of temperament. Interestingly, three of the components (i.e., State Control, Orienting, and Activity), that have constantly emerged in both nursery-reared and mother-reared (M.L. Schneider, personal communication, 1987) infants resemble the three temperament factors found in the human literature (Schneider et al., 1991; Schneider & Suomi, 1992). Rather than developing a specific test designed to measure temperament, as was done in the human research, it may be possible to eliminate items unrelated to temperament in the IBAS to investigate the structure of temperament in the rhesus monkey. We hypothesized that by selecting only those items in the IBAS designed to measure temperament, the underlying latent constructs that emerge from a three-factor solution in an exploratory factor analysis (EFA) would resemble the three factors in the human literature.

Neonatal rhesus monkeys (*Macaca mulatta*; $N = 542$; 302 males, 240 females) at the Laboratory of Comparative Ethology, National Institute of Child Health and Human Development composed the subject pool for this study. Mother-reared ($n = 223$) and nursery-reared infants ($n = 319$) were included in his study, because previous research suggests that groupings of state control, orienting, and activity are present in both conditions. The details of the mother- and nursery-rearing conditions have been described previously (see Schneider et al., 1991; Schneider & Suomi, 1992). The IBAS was administered to each infant on several occasions during early development. The earliest administration (i.e., day 7 post-partum) was selected for use in the present study to minimize potential environmental impacts on the structure of temperament (Posner & Rothbart, 2007). Details of IBAS administration and the detailed definition of each item have been previously described (Schneider & Suomi, 1992). Inter-rater reliability >.90 was achieved between technicians. With exception of one item (i.e., number of vocalizations including coos, chirps, or screeches during a non-stressful 1-min interval), items were rated on a 3-point Likert-type scale (range 0–2). Previous research on these items suggest moderate to strong longitudinal interindividual agreement during the first month of life (Schneider et al., 1991).

This study's aim was to identify those measures contained in the IBAS relevant to temperament and to apply the three-factor solution to the remaining items. Items originally included in the IBAS to measure behaviors unrelated to temperament (i.e., behaviors designed to measure reflexes, muscle tone, and motor maturation) were excluded from the present study (Schneider et al., 1991). Items excluded based on this criteria were Galant's response, palmer grasp, planter grasp, head-posture prone, head-posture supine, body righting, traction, Labyrinthian righting, fine motor, balance, place response, parachute reflex, rotation reflex, fine motor movement, balance, and rooting reflex. The distributional properties of the remaining items were investigated to eliminate items with unacceptable levels of skewness or kurtosis. Six items had skewness and kurtosis values greater than 2. Using a square root transformation, one of these items, vocalization was successfully normalized. The other five items (fearfulness, consolability, cuddliness, orienting to audio, and reach and grasp) were excluded because typical normalizing techniques were ineffective due to the limited Likert-type scaled range used to measure them. There were 26 items remaining which had relatively normal distributions, although 7 items had skewness and kurtosis values ranging from 1.0 to 1.6. This study tested the three-factor solution on 26 remaining items using EFA limited to a three-factor solution. Principal axis factoring (PAF) analysis using a promax rotation with Kaiser normalization was employed. Loadings greater than 0.41 were considered meaningful. The three-factor solution explained 41.65 percent of the variance and the square root mean residual (SRMR) was 0.07. Between factor correlations were <0.30 (Table 1). Items that loaded from each factor are presented in Table 2.

The results from this study replicate and expand research performed on smaller samples of infant rhesus monkey. As anticipated, the factors obtained in this study resemble three of the IBAS components identified in previous studies using

Table 2
Pattern matrix: standardized regression coefficients (factor loadings).

Item	Factor		
	Negative Affectivity	Orienting/Regulation	Sugency/ Extraversion
Irritability: lower scores = irritability	−0.88		
Predominate state: high scores = agitation	0.86		
Soothability: high scores = upset	0.81		
Response intensity (i.e., vocalization shrillness): higher scores = hostility or fear	0.78		
Tremulousness: higher scores = nervousness	0.63		
Vocalizations: low scores = shyness	−0.46		
Calm self: high scores = distress	0.42		
Duration looking		0.89	
Attention: higher scores = attentiveness		0.84	
Visual orienting		0.82	
Visual following		0.68	
Motor activity			0.78
Passivity			−0.75
Spontaneous crawl			0.56
Coordination			0.44

principal components analysis (i.e., State Control, Orientation, and Activity; Schneider et al., 1991). These findings validate previous work that used these IBAS groupings to investigate the relationship of early behavior to heredity, neonatal health, and development (e.g., Champoux et al., 2002). More importantly, this study produced factors, called Negative Affectivity, Orienting/Regulation, and Sugency/Extraversion, which resemble those in the three-factor model of human infant temperament.

Adjectives descriptive of human Negative Affectivity such as tense, scared, nervous, irritability, upset, and distress (Clark & Watson, 1999) resemble the items in the comparative factor found in this study. Moreover, in both human and rhesus infants, Regulatory Capacity/Orienting is a factor containing orienting and reactivity variables (Gartstein & Rothbart, 2003). Finally, similar to the factor identified in human research which contains items of activity level, approach, sociability, stimulation seeking, and perceptual sensitivity (Gartstein & Rothbart, 2003), Surgency/Extraversion consisted of measures related to energetic activity and environmental exploration/stimulation seeking.

The current study suggests that the human and rhesus structures of infant temperament fits well into the three broad conceptual domains of emotion, attention, and motoric/activity. An item-by-item evaluation in comparative models is problematic because some human infant behaviors have no counterpart in rhesus infant behavior (e.g., smiling). Moreover, even when behaviors are apparently similar in monkey and human infants, the behaviors may not have the same comparative meaning nor load on the same factors. Regardless, the overlap between the items in this study and the items used in the human test are compelling. However, because the square root mean residual (SRMR) was 0.07, slightly higher than the statistically desired 0.05, future research using confirmatory factor analysis (CFA) may be need to modify the model to produce and even better fitting model. Moreover, longitudinal CFA may help to determine if this structure holds consistently by sex and rearing condition over the first 4 weeks post-partum. This EFA provides the first step required to begin this line of research in rhesus monkeys and contributes to the establishment of a comparative structural model of temperament in rhesus monkeys that may allow animal research to not only replicate human work but to provide greater translational power to guide human infant temperament research. We conclude that the three-factor structure of infant temperament is appropriately measured by selected items of the IBAS and the items contained in each may be adequately representative of the factors seen in the human literature.

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