



## Negative reactivity in toddlers born prematurely: Indirect and moderated pathways considering self-regulation, neonatal distress and parenting stress

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### ABSTRACT

High negative reactivity in early childhood interferes with later academic and behavioral adjustment. Thus, investigating the origins of high negative affectivity in early childhood is of high relevance for understanding emotional morbidity after preterm birth. The present work explored (1) direct prematurity-related consequences for negative reactivity, (2) self-regulatory deficits as a mechanism indirectly relating prematurity to negative affectivity and (3) the implications of the interplay between procedural distress in the neonatal period and parenting stress for preterm children's negative reactivity. The sample was comprised of 146 preterm children (very vs. moderately to late preterm) and 86 healthy full-term children, both free of major neurological impairment. Assessment involved negative affect and parenting stress (parent-report; 12, 24 months corrected age, CA), effortful control (behavioral battery, parent report; 24 months CA) and the number of potentially distressing neonatal intensive care procedures as well as severity of illness during the neonatal period (retrospective chart review). There was no direct link from prematurity to a disposition for high negative reactivity in early childhood nor was prematurity indirectly associated with higher negative reactivity through lower levels of effortful control. The relation between neonatal pain and distress and negative affectivity depended on the level of parenting stress with low parenting stress at the end of the first year of children's life buffering the negative influence of neonatal distress. The present findings underscore the importance of complex interactions among environmental factors in processes of emotional plasticity after preterm birth thereby providing critical suggestions for follow-up care.

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### 1. Introduction

Despite considerable progress in neonatal intensive care within the last three decades, there is a growing concern about the long-term emotional development of preterm children (Bhutta, Cleves, Casey, Craddock, & Anand, 2002; Hayes & Sharif, 2009). Outcome studies have described increased rates of sad mood, as well as anxious and aggressive behavior in very preterm born school-children compared to their full-term peers. A higher incidence of affective behavior problems even

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appears in the absence of neurological deficits (Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosterlaan, 2009; Hayes & Sharif, 2009; Loe, Lee, Luna, & Feldman, 2011) and has been shown to persist into adolescence (Conrad, Richman, Lindgren, & Nopoulos, 2010; Saigal, Pinelli, Hoult, Kim, & Boyle, 2003). The emotional development of moderately to late preterm school-children remains relatively unexplored, however. The few existing studies on this topic provide preliminary evidence in favor for an increased prevalence of emotional problems within this population (Ketharanathan, Lee, & de Mol, 2011; Talge et al., 2010).

The described emotional morbidity is generally believed to interfere with adaptation in educational and social contexts thereby increasing the risk for academic underachievement (e.g. Gumora & Arsenio, 2002; McClelland et al., 2007). Thus, examining potential antecedents and respective developmental pathways in early childhood is of high importance in order to facilitate the early identification of children at risk and to provide them with appropriate interventions. According to temperament research and developmental psychopathology (Nigg, 2006), emotion-related behavior problems often result from a disposition for high negative reactivity in early childhood, i.e. a short latency, a high frequency, a long duration of, and a lowered threshold for negative affective responses when faced with unfamiliar stimuli or anticipated punishment (Rothbart & Bates, 1998). Following this rationale, the present work studied the development of negative affectivity in preterm children during their first two years of life.

In contrast to school-age, findings in early childhood are inconclusive with respect to a general association between prematurity and dispositions for high negative reactivity or emotion-related behavior problems, with considerable methodological variations between studies (Clark, Woodward, Horwood, & Moor, 2008; Delobel-Ayoub et al., 2006; Hughes, Shults, McGrath, & Medoff-Cooper, 2002; Larroque, N'Guyen, Guédeney, Marchand, & Burguet, 2005; Oberklaid, Sewell, Sanson, & Prior, 1991; Reijneveld et al., 2006; Spittle et al., 2009; Spungen & Farran, 1986). Overall, literature in early childhood contradicts a general, direct and simple relationship between prematurity and negative affectivity. Several reasons may account for this: First, the relation between prematurity and emotional reactivity may become particularly obvious at high degrees of prematurity, but earlier studies have rarely addressed possible differential effects for higher vs. lower degrees of prematurity within one sample. For instance, it has been demonstrated that the association between prematurity and cognitive development varies with the degree of prematurity (Ekeus, Lindström, Lindblad, Rasmussen, & Hjern, 2010; Goldenberg, Culhane, Iams, & Romero, 2008; MacKay, Smith, Dobbie, & Pell, 2010), being more accentuated for children born before the 32nd week of gestation, i.e. very preterm children. Second, inconsistent evidence regarding a direct prematurity–affectivity relation may originate from the existence of indirect pathways, but previous research on emotional outcome has mainly focused on prematurity as a direct predictor (e.g. Larroque et al., 2005; Spungen & Farran, 1986) without systematically considering mediations. Third, it has been suggested that compared to prematurity per se, resulting contextual conditions (e.g. exposure to neonatal distress in neonatal intensive care) may be more closely associated to processes underlying an altered emotional development (Anand & Scalzo, 2000). Hence, these risk factors may be more consistent predictors of affective morbidity of preterm children. Fourth, the modulating influence of protective environmental factors after hospital discharge may reduce the likelihood of finding a simple relation between prematurity-related factors and emotional outcome. However, the majority of previous studies examined unique contributions of single (mainly biological) predictors (particularly gestational age, birth weight) without considering possible interactions with context conditions. Concerning these open questions, the present study pursued two major aims. First, it explored early differences in negative affectivity comparing full-term children to preterm children born at varying degrees of prematurity. The second aim was to clarify the mechanisms underlying the emotional development in preterm children in infancy and toddlerhood. In detail, combining current models of temperament research and developmental neuroscience the current work tested (1) an indirect pathway between prematurity and negative affectivity through self-regulation as well as (2) the influence of neonatal distress and its modulation by caregiver environment on negative reactivity.

The first hypothesized mechanism addressed an indirect pathway linking premature birth to poor emotional development through self-regulatory deficits. It was explored following up on (a) the well established role of self-regulation as a key factor for positive emotional development in general (Eisenberg, Spinrad, & Eggum, 2011; Nigg, 2006) and (b) the evidence for self-regulatory deficits in preterm children (Aarnoudse-Moens et al., 2009; Mulder, Pitchford, Hagger, & Marlow, 2009). According to the theoretical framework proposed by Rothbart and colleagues (Rothbart & Bates, 1998), differences in negative affectivity are assumed to be tightly interwoven with capacities of voluntary self-regulatory competencies specified in the temperament dimension of effortful control (Derryberry & Rothbart, 1997). The emergence of effortful control in toddlerhood allows children to modulate reactive response tendencies independent of external support by enabling them to inhibit a prepotent response and activate a subdominant response instead, to plan as well as to detect errors (Rothbart & Bates, 1998). Models of temperament and psychopathology research indicate a critical role of effortful control in keeping emotion-related arousal within a comfortable range thereby promoting optimal information processing and behavioral adaptation (Nigg, 2006; Rueda, Checa, & Rothbart, 2010). With the development of effortful control children are assumed to get more skilled in shifting attention away from threatening toward pacifying stimuli as well as in suppressing inappropriate emotional reactions independent of immediate punishment or reward, such as the expression of frustration in the face of blocked goals (Calkins & Fox, 2002; Derryberry & Rothbart, 1997). Indeed, there is an extensive body of research that is in line with the proposed role of effortful control for emotional expressivity, the regulation of frustration and anger (e.g. Kochanska & Knaack, 2003; Rhoades, Greenberg, & Domitrovich, 2009) as well as the incidence of emotion-related behavior problems (e.g. Eisenberg et al., 2009; Feldman, 2009). At a neural level, the emergence of effortful control is based on the maturation of the executive attention system involving the prefrontal cortex as well as the anterior gyrus cinguli (Posner, Rothbart, Sheese,

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