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## "Do as I say!" : parenting and the biology of child self-regulation

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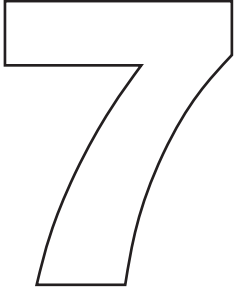


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## Discussion

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## Discussion

In the current series of studies, we investigated the role of parenting and biology in the development of self-regulation in the preschool period.

We found that attachment insecurity in infancy was related to higher levels of toddler active resistance during Clean-Up but not related to the level of noncompliance. No evidence was found for a moderating role of fearful temperament in the association between attachment security and child compliance behaviors. Child self-regulated, committed compliance in a prohibition context was associated with maternal negative discipline. Children of mothers who used more negative disciplines strategies showed less committed compliance. A small main effect of DRD4 genotype on committed compliance was found; children carrying the 7-repeat allele were more compliant than those not carrying the 7-repeat allele. The association between maternal positive discipline and child committed compliance was moderated by the child's COMT rs4680 genotype, indicating that the association was stronger in children with the Met/Met genotype than for children with other COMT genotypes.

Maternal family-related stress during pregnancy predicted lower levels of committed compliance at 3 years of age through lower levels of maternal positive discipline. Moreover, if mothers were more sensitive, children had lower levels of inhibition problems, working memory problems, and planning problems one year later. The influence of sensitive parenting on these domains of executive function development was independent of the length of the corpus callosum in infancy, which is an indicator of early brain maturation and the efficiency of interhemispheric connectivity (Keshavan et al., 2002). In children with a relatively short corpus callosum in infancy, higher levels of maternal positive discipline predicted lower levels of inhibition problems.

The longitudinal relation between sensitive parenting and internalizing problems in preschoolers was studied in two independent and large population-based samples. Maternal sensitivity was found to be modestly but consistently related to internalizing problems across time. Differences in levels of maternal sensitivity appeared partly genetically determined; mothers carrying the *s*-allele of 5-HTTLPR were more sensitive than *l*-allele carriers. Some evidence was found that the level of social fearfulness in children might moderate the effect of 5-HTTLPR on sensitivity; mothers carrying the *s*-allele were more sensitive than mothers without *s*-alleles to children with low levels of social fear.

The findings presented in this thesis provide a comprehensive overview of the role of parenting and the interplay between parenting and biology in the development of self-regulation. In our studies we replicate and extend previous findings in a large population-based cohort study with observations of parenting and child behavior and biological measures.

### *Parental determinants of self-regulation*

Early childhood socialization is an important factor in the development of self-regulation, because infants rely on their parents for regulation of behavior and emotions (Kopp, 1982) and because the extended development of self-regulation in the preschool years makes the development of regulatory abilities particularly sensitive to environmental influences (Conway & Stifter, 2012). Earlier studies have provided mixed findings with regard to the importance of positive parenting for self-regulation (e.g., Calkins, Smith, Gill, & Johnson, 1998; Karreman, Van Tuijl, Van Aken, & Dekovic, 2006). We found evidence that a variety of parental determinants are involved in aspects of self-regulation in the preschool age. First, both difficulties in emotion regulation, associated with internalizing problems (e.g., Bayer, Sanson, & Hemphill, 2006), and difficulties in behavior regulation, such as active resistance and executive function problems (e.g., Bernier, Carlson, & Whipple, 2010; Kochanska et al., 2010), were predicted by less positive parenting or an insecure attachment relationship. Second, the role of parenting was not only restricted to aspects of self-regulation with a relational component, such as compliance and active resistance (Kim & Kochanska, 2012), but also apparent for an aspect of self-regulation that is considered nonsocial, namely executive function. Third, aspects of parenting that are control-focused, such as maternal positive and negative discipline, as well as aspects of parenting or relationship quality with mainly an affective component, such as maternal sensitivity and attachment security (Karreman et al., 2006), were found to contribute to self-regulation.

*Interplay of parental and biological determinants of self-regulation*

In the past years evidence has accumulated confirming the hypothesis that some children are more susceptible than others to both positive and negative environmental influences based on temperamental, physiological, or genetic differences (Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2007; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2011). Our findings partly converge with earlier studies testing this hypothesis. No evidence was found for an interaction effect of attachment security and fearful temperament in determining compliance and active resistance during Clean-Up. This does not support earlier studies demonstrating the moderating role of fearful or difficult temperament in the association between the quality of the parent-child relationship and self-regulation (Kim & Kochanska, 2012; Kochanska, Aksan, & Joy, 2007). Our findings may indicate that the interaction between child temperament and parenting is restricted to a relatively limited developmental window around two years of age (Kochanska et al., 2007).

We did find evidence that child genotype moderates the association between maternal positive discipline and child committed compliance; children with the Met/Met variant of the COMT rs4680 genotype appeared more hampered by lower levels of maternal positive discipline but also appeared to benefit more from high levels of maternal positive discipline. To our knowledge, our study was the first to explore the role of the dopamine-related common polymorphism COMT in the association between parenting and committed compliance. Others have found evidence that variations in 5-HTTLPR moderate the association between insecure attachment and self-regulation (Kochanska, Philibert, & Barry, 2009) and that variations in the DRD4 gene may be involved in the susceptibility of children for positive parenting (Bakermans-Kranenburg, Van IJzendoorn, Pijlman, Mesman, & Juffer, 2008). In our study, variations in the dopamine D4 receptor gene did not moderate the association between maternal discipline and child committed compliance. In general it has been suggested that the basis of differential susceptibility to the environment might be found in allelic variation in the dopamine and serotonin circuitries as these are related to sensitivity to reward and punishment (Ellis et al., 2011). It seems plausible that systems of reward and punishment would also be involved in the development of self-regulation and the ability of parenting strategies to modulate this development. Research in this field has just begun, and future research is needed to clarify the role of dopaminergic and serotonergic system variations in the association between parenting and self-regulation.

The association between a shorter corpus callosum in infancy and child inhibitory problems appeared moderated by the level of maternal positive discipline; children with a relatively short corpus callosum experiencing high levels of maternal positive discipline showed less inhibitory problems than children with a shorter corpus callosum experiencing low levels of maternal discipline. This finding is congruent with earlier studies indicating that positive parenting might act as a buffer in children with biological vulnerability (Laucht, Esser, & Schmidt, 2007; Poehlmann et al., 2011).

In general, our findings suggest that a simple model of parental influence on self-regulation may not be sufficient to explain the relatively large individual differences in self-regulation across children. The modest effect sizes of our studies do not allow for firm conclusions on the exact roles of parenting and biological factors in self-regulation. The discrepancies between our findings and earlier studies may suggest that the susceptibility of individuals to the environment is domain specific instead of domain general (Belsky & Pluess, 2009), which could imply diverging results of studies using different environmental exposures and different outcome measures. Research in this field would profit especially from experimental studies on the differential susceptibility hypothesis (Van IJzendoorn, & Bakermans-Kranenburg, 2011; Van IJzendoorn et al., 2011a). Intervention studies to enhance sensitive parenting or attachment security have found evidence for differences in effectiveness in reducing externalizing problems or enhancing attachment security based on variations in temperamental reactivity or genotype of the child (Bakermans-Kranenburg et al., 2008; Klein Velderman, Bakermans-Kranenburg, Juffer, & Van IJzendoorn, 2006).

Despite the excitement and enthusiasm about gene-environment research in the past decade, critics worry that the combination of multiple testing and publication bias against null results has resulted in an inflation of false positives in gene-environment literature (Duncan & Keller, 2011). Independent and well-powered replications (Duncan & Keller, 2011) and thoroughly conducted meta-analyses (Ioannidis, 2003) might improve the quality of gene-environment research in the future.

### *Mechanisms behind the association between parenting and self-regulation*

Attachment security, maternal sensitivity, and positive discipline were associated with less active resistance during Clean-Up, more committed compliance to prohibitions, and lower levels of internalizing problems, inhibition problems, working memory problems, and planning problems. Several mechanisms may explain the relation between positive parenting and the development of self-regulation. First, because infants have not yet developed the ability to regulate their emotions and behavior, they have to rely on their caregiver as a source of external regulation (Kopp, 1982). It has been postulated that this process of *dyadic regulation* eventually resulting in self-regulation, is established in a secure attachment relationship or with a sensitive and responsive caregiver (Sroufe, 1996). Specific aspects of positive parenting appear



essential in this shift from external regulation to self-regulation. Consistent parenting that provides structure in the child's early life, makes the environment predictable, and allows the child to recognize regular routines, which foster the development of emotion regulation (Bronson, 2000). From a social learning perspective, sensitive and responsive parents can model regulation of emotions and behavior for the child and thus stimulate the growth of self-regulation (Bandura, 1971). Also, positive parenting can provide the child with opportunities to practice self-regulation by challenging the child. This process of providing support and guidance in planning and organizing so that children can perform tasks beyond their current level of ability has been conceptualized as *scaffolding* (Wood, Bruner, & Ross, 1976). The theoretical framework of scaffolding is reminiscent of the work by Lev Vygotsky, emphasizing the importance of competent social partners in the development of cognitive functions (Vygotsky, 1962, 1978). According to Vygotsky, children learn by giving them experiences that are challenging, but within their *zone of proximal development*; the range of developmental achievements they can attain with guidance by social partners. In this series of studies we did not include direct measures of the quality of maternal scaffolding, but this concept appears to be closely related to other aspects of positive parenting that are incorporated in our studies. It has been suggested that a mutually responsive and secure relationship between mother and child is associated with the frequency of scaffolding and the effectiveness of scaffolding (Carlson, 2009). Moreover, for scaffolding to be effective, it should be appropriately timed and contingent to the child's behavior (Bibok, Carpendale, & Müller, 2009), which is characteristic of sensitive parenting (Ainsworth, Blehar, Waters, & Wall, 1978).

A second potential mechanism behind the relation between parenting and self-regulation is that positive parenting might have a direct impact on brain development (Belsky & De Haan, 2011) or gene expression (Van IJzendoorn, Bakermans-Kranenburg, & Ebstein, 2011b). Although research on the influence of parenting on child neurobiology is still in its infancy, more and more evidence is accumulating that early caregiving experiences alter the structure and functioning of the brain (for an overview, see Belsky & De Haan, 2011). Most research on the influence of parenting on brain development has focused on extremely negative parenting such as neglect and abuse, however there is some evidence that variation in parenting in the normal range can also influence brain function or structure (Belsky & De Haan, 2011). For example, a sensitivity training for parents of preterm children was found to result in short-term improvements in children's cerebral white matter (Milgrom et al., 2010).

A similar but different mechanism might be that the influence of early caregiving on the child's development is the result of epigenetic changes in the child (Van IJzendoorn et al., 2011b). Epigenetic changes are alterations in the expression or function of genes due to biochemical modifications such as methylation of DNA. Variations in maternal care in rodents have been found to alter methylation patterns

that impact the function of the stress system in offspring (Szyf, Weaver, Champagne, Diorio, & Meaney, 2005) and next generations (Meaney, 2001). Interestingly, these alterations in methylation patterns were the consequence of variations in maternal care within the normal range (Meaney, 2001). In humans, there is still very little evidence for the impact of parental care on development through epigenetic processes. It is especially unclear whether normal variations in parental care influence methylation patterns. Considering more extreme rearing experiences, epigenetic differences in the stress system have been found in postmortem examinations of adult suicide victims with and without experiences of childhood abuse (McGowan et al., 2009).

A third explanation that needs to be considered is the possibility that the relation between positive parenting and child self-regulation is due to a confounding factor that underlies both parental behavior and child behavior. Although we were able to control for a number of possible confounding factors in our analyses, such as child gender, socio-economic status and maternal psychological symptoms, other factors such as personality characteristics and particular genetic factors were not assessed. An indication that it is possible that genetic factors underlie the association between parenting and self-regulation might be found in our results that the level of maternal sensitivity was predicted by maternal 5-HTTLPR and that child committed compliance was predicted by the child's DRD4 genotype. Because genetic variation appears to predict part of the variation in maternal and child behavior, a shared genetic variant in both mother and child can constitute an alternative explanation for the relation between positive parenting and preschool self-regulation.

### *Bidirectional effects*

In the past decades, the importance of considering the bidirectional nature of parent-child interactions over the course of development has been emphasized in a growing number of studies (for an overview, see Pardini, 2008). At the same time, behavioral genetic research has stimulated the study of evocative gene-environment correlations, defined as genetically influenced child characteristics that might shape the parenting environment of the child (Rutter, Moffitt, & Caspi, 2006). However, empirical studies that examined bidirectional influences between parents and children remain rare. The inherently correlational nature of many studies on parenting and child development makes it difficult to confer the direction of effects and possible causation (Rutter, 2007). In our studies we found associations between attachment security and active resistance two years later, and associations between maternal sensitivity and child executive function abilities one year later. Maternal discipline and child committed compliance were concurrently associated. Although the longitudinal nature of some of these associations makes reverse causation less probable (Rutter, 2007), evocative gene-environmental correlations or person-environment correlations cannot be precluded. Moreover, because no baseline measures of child self-regulation

were included in our studies, we could not assess whether there was within-individual change in self-regulation as a result of parenting.

In our study on the association between maternal sensitivity and child internalizing problems across the preschool years we attempted to overcome these methodological problems by investigating the contribution of bidirectional pathways between maternal behavior and child behavior across time. Modest but consistent associations were found between maternal sensitivity and child internalizing problems at a later age. The mother-to-child pathways were more consistent and replicable than the child-to-mother pathways. These findings converge with the hypothesis that the influence of parenting on child behavior is larger than vice versa (Lansford et al., 2011), although they also support the bidirectional nature of mother-child interaction (Pardini, 2008). More research is needed to further disentangle parental contributions to child behavior and child contributions to parental behavior, and to study possible underlying genetic factors that can influence both. Longitudinal adoption studies are among the interesting designs to answer these questions. For example, a study by O'Connor, Deater-Deckard, Fulker, Rutter, and Plomin (1998) demonstrated that children with a genetic risk for antisocial behavior were more likely to receive negative parenting from their (not biologically related) adoptive parents. Moreover, prenatal cross-fostering designs including children born through in vitro fertilization who are genetically unrelated to their rearing parents have the potential to disentangle genetic and environmental influences on child development (e.g., Harold et al., 2011; Rice et al., 2010).

### *Self-regulation: a social construct?*

Although self-regulation is generally considered an internal motivation of controlling one's behavior and emotions, one could argue that the associations between positive parenting and self-regulation suggest that behavioral and emotional regulation are relational or social constructs. Child compliance, for instance, is inherently linked to the person posing the rules and the quality of the relationship with this person. Indeed, we found that the quality of the attachment relationship between mother and child predicted the level of active resistance to parental requests. A study on the relational nature of self-regulated compliance has found large similarities in the quality of compliance of a child toward requests of mother, father, or another caregiver (Feldman & Klein, 2003). However, the similarities in self-regulated compliance between caregivers might be explained by similarities in the quality of the relationship of the child with these different caregivers (Feldman & Klein, 2003).

The question whether self-regulation should be considered internally controlled or controlled by environmental and social factors has been elaborated from a motivational framework by Ryan, Kuhl, and Deci (1997). In this theoretical framework, a more complex portrayal of regulation is described on a continuum varying in the locus of control, source of motivation, and level of internalization. External regulation and internalized self-regulation are the ends of this continuum but several intermediate types of regulation are described. Ryan and colleagues (1993) suggest that supportive and autonomy-granting parenting behavior fosters the development of internalized self-regulation.

Although most theories on the development of self-regulation sketch a shift from external or co-regulation to a more mature and internalized type of regulation (e.g., Bronson, 2000; Kopp, 1982), it has also been argued that external regulators might remain important long after internalization has been established (Diamond & Aspinwall, 2003). Over the life course, individuals often rely on external regulation of emotion by the provision of comfort and support or distraction by others. Perhaps the boundaries between internal and external regulation of emotions and behavior should be considered more or less fluid (Diamond & Aspinwall, 2003). Although children appear to develop internally motivated regulation over time, this does not preclude the possibility that external agents help regulate behavior and emotions in certain situations. Some aspects of behavior and emotion regulation might be more dyadic in nature, such as compliance, than other types of regulation that are considered to be individual, cognitive attributes, such as executive function (Kim & Kochanska, 2012). Future studies on the regulation of behavior and emotions should consider the possible role of social agents for regulation without discarding the importance of individual characteristics (Diamond & Aspinwall, 2003).

### *Measurements*

In the current series of studies different measurement methods were used, including observational measures, parental reports, and biological measures. In behavioral research a frequent threat to the validity of conclusions is *common method bias*, variance attributable to the measurement method instead of the constructs the measures represent (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). To avoid this bias, predictor and criterion variables in all studies were derived from different sources of information or from independent raters. Observational measures in structured situations were used to assess maternal parenting and attachment security. Advantages of observations over parental reports of parent-child interaction are that observations are not influenced by parental characteristics such as mood (Aspland & Gardner, 2003) or the ability of parents to reflect on their behavior (Hoff, Laursen, & Tardif, 2002). Furthermore, it is thought that self-reported parenting is a reflection of the parent's beliefs and aspirations about parenting but not necessarily a good indication

of the actual parenting behavior (Hoff et al., 2002). Meta-analyses on the association between parenting and child development have demonstrated that the effect sizes for the relation between observed parenting and child outcomes are larger than for the relation between self-reported parenting and child development (e.g., McLeod, Wood, & Weisz, 2007; Rothbaum & Weisz, 1994).

Although observational measures are generally considered the preferred method to measure parenting, for self-regulation in preschoolers there is debate about the value of different measurement methods. Reasons for this debate are the complex nature of the concept self-regulation, which makes it difficult to measure (Gioia & Isquith, 2004), and the fact that preschoolers are limited in their behavioral repertoire compared to older children and adolescents (Espy, Kaufmann, Glisky, & McDiarmid, 2001). The validity of self-regulation tasks has been questioned for several reasons. The traditional measures of self-regulation are dependent on lower-order cognitive skills such as language and attention, which makes it difficult to determine the exact cause of deficits (Anderson, Anderson, Northam, Jacobs, & Mikiewicz, 2002). Furthermore, the structured nature of some neuropsychological tasks might obscure deficits in self-regulation in daily life (Gioia & Isquith, 2004). Studies comparing parental reports of self-regulatory functions and results on neuropsychological tests have found surprisingly low correlations suggesting that these two methods measure different aspects of self-regulation (e.g., Anderson et al., 2002; Mahone & Hoffman, 2007). In our studies both observational measures of committed compliance and active resistance, and parental reports of child executive function and internalizing problems were used.

### *Limitations*

Despite the strengths of our studies, such as the longitudinal nature of the data, the large number of participants, and the variety of sources of information, the results must be interpreted within the context of their limitations. First, the studies were conducted within the Generation R Focus Cohort, a relatively homogeneous sample of Dutch families. A large proportion of these families was of higher socioeconomic status. The homogeneity of this sample makes it difficult to generalize our findings to less advantaged and ethnically diverse populations. The associations we found between positive parenting and self-regulation might not be representative for other populations. For example, earlier studies have demonstrated that the negative associations between maternal physical discipline and child externalizing problems found in European-descent families are not necessarily similar in families with a different ethnic background (e.g., Deater-Deckard, Dodge, Bates, & Pettit, 1996). However, the association between maternal sensitive parenting and positive child outcomes appears to be similar in different ethnic groups (Mesman, Van IJzendoorn, & Bakermans-Kranenburg, 2011). Still, the developmental outcomes of

variations in early self-regulation might not be the same in all cultures. It has for example been found that emotion regulation strategies such as physical comfort seeking and self-soothing behavior predict lower levels of externalizing problems in Caucasian children but higher levels of externalizing problems in African American children (Supplee, Skuban, Shaw, & Prout, 2009). Research in more diverse populations is needed to further test the effects of parental and biological determinants for the development of self-regulation, and the importance of early self-regulation for later development across ethnic and socio-economic groups.

A second limitation is that the observations of parenting and child self-regulation were based on relatively short tasks of two to eight minutes per construct which might have affected the reliability and validity of these measures. Due to the size of the sample used in this series of studies it was logistically not feasible to observe the mothers and children for a longer period of time. To assure that we would be able to measure the target behavior in this short period of time, the tasks were highly structured and designed to elicit mother-child interaction or self-regulatory behavior. To increase the ecological validity of the observations, the measures of parenting and child self-regulation were conducted at the end of a 1.5 hour lab visit, so mother and child had had time to adjust to the unfamiliar setting.

A third limitation is that we focused only on the influence of parenting by mothers on self-regulation, although in the last decades the independent or buffering role of the father in the development of children has been widely confirmed (e.g., Martin, Ryan, & Brooks-Gunn, 2010; Pleck, 2010). Because the level of involvement of fathers has increased over the years, it has become more important to focus on the influence of fathers (Lamb, 2010) and the influence of the whole family system on child development (Cox & Paley, 1997). Mothers and fathers might differ in their parenting behavior and roles; fathers for example spend a larger proportion of time with their child in playful interaction while mothers specialize in caregiving and comforting (Lamb, 2010). As a result of these differences, mothers and fathers might play different roles in the socialization process of their child (Grossmann et al., 2002). Future studies should investigate the specific role of paternal parenting and its interplay with maternal parenting in the development of self-regulation, as done by Lucassen and colleagues.

### *Implications for practice and research*

Self-regulation has been found to be essential for a wide variety of developmental domains. Committed compliance in young children is associated with higher levels of empathy in childhood and adolescence (Feldman, 2007). More advanced self-regulation predicts higher quality of social functioning (Spinrad et al., 2007) and school functioning (e.g., Monette, Bigras, & Guay, 2011), and self-regulation deficits have been implicated in a variety of developmental disorders and psychopathologies, such as autism and ADHD (e.g., Pennington & Ozonoff, 1996).

Our studies demonstrate the role of various aspects of positive parenting and mother-child relationship quality in preschool children's regulation of emotions and behaviors. Our findings underline the importance of the recent shift in research on self-regulation from mainly focusing on the neuropsychological perspective to also considering the role of social interactions and parenting (Lewis & Carpendale, 2009). A combination of both perspectives is more fruitful in our understanding of early self-regulation (Carlson, 2009). Although we found some preliminary evidence that self-regulation depends on the interplay of biological and parental determinants, our studies can only provide a glimpse on the complex mechanisms that might be involved.

Future research should try to shed more light on the mechanisms behind the relation between positive parenting and child self-regulation. Clarification of these mechanisms provides essential knowledge to develop appropriate interventions that can enhance regulatory abilities of children. These interventions can be directly focused on enhancing self-regulatory skills of children in the preschool years or in school (for an overview, see Blair & Diamond, 2003). However, the importance of positive parenting for the development of self-regulation suggests that one of the few evidence-based interventions available to enhance maternal sensitivity and maternal positive discipline, Video-feedback Intervention to promote Positive Parenting and Sensitive Discipline (VIPP-SD), could be used to indirectly improve self-regulation (Juffer, Bakermans-Kranenburg, & Van IJzendoorn, 2007; Van Zeijl et al., 2006). More research is needed to investigate the effectiveness of these different intervention foci and methods for stimulating the development of self-regulation in children. Given the broad range of developmental outcomes of self-regulation, further research on its etiology and the ways we can promote self-regulatory ability is an important task for the future.



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