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

Kok, R.

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Introduction

Introduction

The development of self-regulation is one of the major challenges of a child's healthy and adaptive development (Colman, Hardy, Myesha, Raffaelli, & Crockett, 2006; McClelland & Cameron, 2011a). Unlike many other species, humans are not at the mercy of automatic, stimulus-response associations, but with the help of others develop the ability to inhibit dominant responses and actively select alternative behaviors (Conway & Stifter, 2012). Self-regulation develops over an extended period starting already in infancy (Bernier, Carlson, & Whipple, 2010), with a rapid developmental spurt in early childhood (Anderson, 2002), and further maturation in adolescence (Crone, 2009). Though children are innately inclined to strive for self-regulation (Bronson, 2000) and many intrinsic factors such as child temperament and neurological development are key to early self-regulation, extrinsic factors such as high quality interactions with caregivers are essential to nourish and channel self-regulatory development (Bronson, 2000; Fox & Calkins, 2003). In the current thesis, the contribution and interplay of parental and biological factors in the development of self-regulation in the preschool period are studied.

Self-regulation of behavior and emotions

It was long assumed that young children had little capacity to regulate their behavior and emotions. In the last decades, however, evidence accumulated that early indicators of self-regulation are already developing in the preschool years (Bernier et al., 2010; Eisenberg & Sulik, 2012). The foundation for self-regulation is laid in infancy. First, the regulation of autonomic arousal and sleep-wake cycles and primitive emotion and behavior regulation are developed (Calkins, Smith, Gill, & Johnson, 1998; Kopp, 1982). In this early period regulation is primarily reactive and externally

regulated. During the toddler and preschool years, regulation becomes more proactive, planful, and conscious, and the locus of control of regulation moves from external to internal (Bronson, 2000; Kopp, 1982). At the end of the toddler period demands and expectations about self-regulation increase and it is expected that children are capable of basic self-regulation in behavioral, physiological, and emotional domains (Kopp, 1982). However, individual differences exist in the extent to which children demonstrate competent self-regulation, even in non-clinical populations (Calkins et al., 1998).

Research on the development of self-regulation has been conducted from different theoretical frameworks (Bridgett, Oddi, Laake, Murdock, & Bachmann, 2012) and therefore a variety of concepts and definitions have been formulated. In general, self-regulation refers to the capacity to control and direct one's attention, thoughts, emotions, and behavior (McClelland & Cameron, 2011b) and to utilize and adapt this capacity to different contextual and personal demands (Colman et al., 2006). Developmental researchers have studied self-regulation from a framework of *effortful control,* which is defined as the ability to inhibit a dominant response in order to activate a subdominant response (Kochanska, Murray, & Harlan, 2000; Rothbart, 1989a, 1989b; Rothbart & Ahadi, 1994; Rothbart & Bates, 1998). Other developmental studies have focused specifically on emotion-related self-regulation which includes the temperamental processes to monitor, manage, and change the experience and expression of emotions (Eisenberg & Sulik, 2012; Silk, Steinberg, & Morris, 2003). Neuroscientists and cognitive psychologists investigating self-regulation often use the term *executive function* to indicate the set of higher-level cognitive processes needed to regulate behavior and emotions (Bridgett et al., 2012). Socialization research has focused on self-regulated, *committed compliance* as a marker of development of behavioral regulation in early childhood (e.g., Denham, Warren-Khot, Bassett, Wyatt, & Perna, 2011; Kochanska, Coy, & Murray, 2001). The parsing of the construct into unique processes has led to greater understanding of how specific self-regulatory processes relate to specific consequences (Conway & Stifter, 2012) but the variation in definitions and frameworks applied in these studies has also hindered research in this field (McClelland & Cameron, 2011b). Recently, scholars have attempted to integrate the various frameworks and have found that there is substantial overlap between the constructs used in the different research traditions (Bridgett et al., 2012; McClelland & Cameron, 2011b; Zhou, Chen, & Main, 2012). For this reason, in the current thesis we approach self-regulation as a broad construct, including aspects of behavioral regulation such as child compliance behaviors and executive function, and an aspect of emotion regulation in the form of internalizing problems.

Determinants of self-regulation

Studies on the origins of self-regulation in children have focused on a broad array of possible determinants, including biological factors such as brain development, genetic heritability, and child temperament, but also environmental factors such as the quality of the early attachment relationship, parenting, and contextual factors.

The upsurge of methods to image brain structures and activity and to study the contribution of molecular genetic determinants of development has resulted in an increase in studies on the biological nature of the higher-order cognitive skills involved in self-regulation. For example, children born very preterm or with very low birth weight with abnormalities in white matter maturation in the brain show higher levels of cognitive and executive function problems in childhood and adolescence (Skranes et al., 2009; Woodward, Clark, Pritchard, Anderson, & Inder, 2011). Neuroscientists have long thought that mainly the prefrontal cortex is involved in self-regulatory capacities, but recent evidence indicates that integrity of the entire brain is necessary for optimal executive function skills (Alvarez & Emory, 2006; Jacobs, Harvey, & Anderson, 2011; Skranes et al., 2009). Individual differences in self-regulatory capacity may also be due to genetic variation. Studies on the heritability and familiarity of executive function have found evidence for a heritable, genetic basis varying in size depending on the specific measure of executive function and on the nature of the sample (Friedman et al., 2008; Jester et al., 2009; Polderman et al., 2007; Yamagata et al., 2005).

From a socialization perspective, the quality of parenting may be an important predictor of self-regulation. Because of the protracted development of self-regulation and the fact that children rely on their parents to help them regulate behavior and emotions in infancy, parents may play a crucial role in self-regulation development (Bernier, Carlson, Deschênes, & Matte-Gagné, 2012; Conway & Stifter, 2012; Kopp, 1982). Positive parenting in toddlerhood, characterized by maternal warmth, praise, and guidance, has been found to be concurrently associated with higher levels of compliance (Calkins et al., 1998) and to predict better self-regulation in preschool and school-aged children (Colman et al., 2006; Jennings et al., 2008). However, a meta-analysis on the concurrent association between maternal responsiveness and self-regulation in preschool indicated that they were not related (Karreman, Van Tuijl, Van Aken, & Dekovic, 2006). Also, more global measures of positive parenting, such as calm maternal responses to transgressions, were not found to be longitudinally related to executive function development in preschool (Hughes & Ensor, 2009). In contrast, maternal positive discipline and control strategies, such as distraction and appropriate limit setting, were concurrently and longitudinally related to higher levels of compliance (Karreman et al., 2006), better ability to delay gratification (LeCuyer & Houck, 2006), and more advanced executive function abilities (Schroeder & Kelley, 2010). Negative discipline which is characterized by negative control strategies and

physically punitive behavior was concurrently and longitudinally related to less advanced levels of self-regulatory functions such as compliance and emotion regulation (Calkins et al., 1998; Colman et al., 2006; Karreman et al., 2006).

Recently, researchers have attempted to combine the biological and socialization perspectives to better explain differences in child development. Studies focusing on genetics and studies focusing on brain development showed that not all children might be equally affected by environmental factors due to biological or genetic differences. The buffering potential of positive parenting has been demonstrated in a study on the association between low birth weight and the risk of externalizing and internalizing problems in childhood (Laucht, Esser, & Schmidt, 2001). Similarly, the development of self-regulation was more hampered by early negative parenting for preterm or low birth weight infants with a difficult temperament than in those without biological and temperamental risk (Poehlmann et al., 2011). In addition, an intervention study aimed to enhance maternal sensitive discipline found that in children with a 7-repeat allele of the DRD4 gene whose mothers showed the largest increase in sensitive discipline, externalizing problems declined the most (Bakermans-Kranenburg, Van IJzendoorn, Pijlman, Mesman, & Juffer, 2008). These findings are congruent with the theories of *differential susceptibility* and *biological sensitivity to context* which state that variation in susceptibility to environmental influences such as parenting has an evolutionary advantage (Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2007; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2011). It is therefore important to investigate the interplay of both biological and parental determinants in the study of the development of self-regulation.

Consequences of self-regulation

Self-regulatory capacity has been implied in various aspects of child and adult well-being. Self-regulation deficits are related to psychopathologies, such as autism and ADHD (Pennington & Ozonoff, 1996). On the other hand, higher levels of self-regulation lead to more social competence (Eisenberg & Sulik, 2012), more advanced moral development and empathy in childhood and adolescence (Feldman, 2007; Kochanska, Murray, & Coy, 1997), and higher levels of academic achievement and school success (McClelland et al., 2007; Obradovic, 2010). Because early self-regulation is involved in a variety of developmental consequences from childhood up to adolescence and adulthood, it is important to study the origins of individual differences in self-regulation across children.

The current study

The role of parental and biological factors in the development of self-regulation was studied in the Generation R Study. The Generation R Study was designed to identify early environmental and genetic determinants of growth, development, and health

from fetal life onwards, in Rotterdam, the Netherlands (Jaddoe et al., 2012). Detailed measurements were obtained in a subgroup of children of Dutch national origin, meaning that the children, their parents, and their grandparents were all born in the Netherlands to reduce confounding and effect modification by ethnicity. The participating children were born between February 2003 and August 2005. Children and their parents visited the research centre regularly for various behavioral and somatic measurements. The measurements used in the current thesis are summarized in Figure 1.

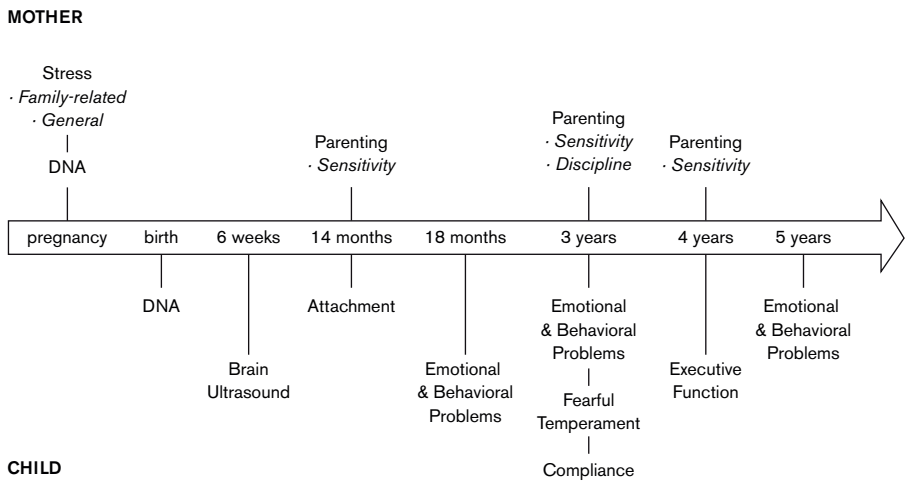

Figure 1. Measurements in Generation R used in current thesis.

Aim of this thesis

The general aim of the studies presented in this thesis is to provide more insight into the influence of biological and parental factors in the development of self-regulation in the preschool years. Observational measures, parental reports, and biological measures were used to assess these associations.

The main focus of Chapter 2 is the association between infant-mother attachment quality and toddlers' compliance and active resistance during a clean-up task. In Chapter 3 we examine the role of maternal stress during pregnancy, maternal discipline, and child dopamine-related gene polymorphisms in the development of compliance. A mediation model is tested with maternal discipline as the mediator in the association between maternal stress during pregnancy and child compliance. In addition, the moderating effect of child COMT rs4680 genotype and DRD4

polymorphism in the association between maternal discipline and compliance is explored. In Chapter 4 we study whether parenting influences executive function at preschool age independently or in interplay with corpus callosum length in infancy. Chapter 5 concerns the association between maternal sensitivity and child internalizing problems in the preschool period. We examine longitudinal and bidirectional associations between maternal sensitivity and child internalizing problems in two large population-based studies. In Chapter 6 the effect of maternal 5-HTTLPR on sensitive parenting is studied. Moreover, the moderating effect of child fearful temperament in the association between 5-HTTLPR and maternal sensitivity is examined. Against the background of our results, parental and biological determinants in the development of child self-regulation are discussed in Chapter 7.

References

A

Alvarez, J. A., & Emory, E. (2006). Executive function and the frontal lobes: A meta-analytic review. *Neuropsychology Review, 16,* 17-42. DOI: 10.1007/s11065-006-9002-x

Anderson, P. (2002). Assessment and development of executive function (EF) during childhood. *Child Neuropsychology, 8,* 71-82. DOI: 10.1076/chin.8.2.71.8724

B

Bakermans-Kranenburg, M. J., Van IJzendoorn, M. H., Pijlman, F. T. A., Mesman, J., & Juffer, F. (2008). Experimental evidence for differential susceptibility: Dopamine D4 receptor polymorphism (DRD4 VNTR) moderates intervention effects on toddlers' externalizing behavior in a randomized controlled trial. *Developmental Psychology, 44,* 293-300. DOI: 10.1037/0012-1649.44.1.293

Belsky, J., Bakermans-Kranenburg, M. J., & Van IJzendoorn, M. H. (2007). For better and for worse: Differential susceptibility to environmental influences. *Current Directions in Psychological Science, 16,* 300–304. DOI: 10.1111/j.1467-8721.2007.00525.x

Bernier, A., Carlson, S. M., Deschênes, M., & Matte-Gagné, C. (2012). Social factors in the development of early executive functioning: a closer look at the caregiving environment. *Developmental Science, 15,* 12-24. DOI: 10.1111/j.1467-7687.2011.01093.x

Bernier, A., Carlson, S. M., & Whipple, N. (2010). From external regulation to self-regulation: Early parenting precursors of young children's executive functioning. *Child Development, 81,* 326-339. DOI: 10.1111/j.1467-8624.2009.01397.x

Bridgett, D. J., Oddi, K. B., Laake, L. M., Murdock, K. W., & Bachmann, M. N. (2012). Integrating and differentiating aspects of self-regulation: Effortful control, executive functioning, and links to negative affectivity. *Emotion.* Advance online publication. DOI: 10.1037/a0029536

Bronson, M. B. (2000). *Self-regulation in early childhood: Nature and Nurture.* New York: Guilford Press.

C

Calkins, S. D., Smith, C. L., Gill, K. L., & Johnson, M. C. (1998). Maternal interactive style across contexts: Relations to emotional, behavioral and physiological regulation during toddlerhood. *Social Development, 7,* 350-369. DOI: 10.1111/1467-9507.00072

Colman, R. A., Hardy, S. A., Myesha, A., Raffaelli, M., & Crockett, L. (2006). Early predictors of self-regulation in middle childhood. *Infant and Child Development, 15,* 421-437. DOI: 10.1002/icd.469

Conway, A., & Stifter, C. A. (2012). Longitudinal antecedents of executive function in preschoolers. *Child Development, 83,* 1022-1036. DOI: 10.1111/j.1467-8624.2012.01756.x

Crone, E. (2009). Executive functions in adolescence: inferences from brain and behavior. *Developmental Science, 12,* 825-830. DOI: 10.1111/j.1467-7687.2009.00918.x

D

Denham, S. A., Warren-Khot, H. K., Bassett, H. H., Wyatt, T., & Perna, A. (2011). Factor structure of self-regulation in preschoolers: Testing models of a field-based assessment for predicting early school readiness. *Journal of Experimental Child Psychology, 111,* 386-404. DOI: 10.1016/j.jecp.2011.10.002

E

Eisenberg, N., & Sulik, M. J. (2012). Emotion-related self-regulation in children. *Teaching of Psychology, 39,* 77-83. DOI: 10.1177/0098628311430172

Ellis, B. J., Boyce, T., Belsky, J., Bakermans-Kranenburg, M. J., & Van IJzendoorn, M. H. (2011). Differential susceptibility to the environment: An evolutionary-neurodevelopmental theory. *Development and Psychopathology*, *23*, 7–27. DOI: 10.1017/S0954579410000611

F

Feldman, R. (2007). Mother-infant synchrony and the development of moral orientation in childhood and adolescence: Direct and indirect mechanisms of developmental continuity. *American Journal of Orthopsychiatry, 77,* 582-597. DOI: 10.1037/0002-9432.77.4.582

Fox, N. A., & Calkins, S. D. (2003). The development of self-control of emotion: Intrinsic and extrinsic influences. *Motivation and Emotion, 27,* 7-26. DOI: 10.1023/A:1023622324898

Friedman, N. P., Miyake, A., Young, S. E., DeFries, J. C., Corley, R. P., & Hewitt, J. K. (2008). Individual differences in executive functions are almost entirely genetic in origin. *Journal of Experimental Psychology: General, 137,* 201-225. DOI: 10.1037/0096-3445.137.2.201

H

Hughes, C. H., & Ensor, R. A. (2009). How do families help or hinder the emergence of early executive function? *New Directions in Child and Adolescent Development, 123,* 35-50. DOI: 10.1002/cd.234

J

Jacobs, R., Harvey, A. S., & Anderson, V. (2011). Are executive skills primarily mediated by the prefrontal cortex in childhood? Examination of focal brain lesions in childhood. *Cortex, 47,* 808-824. DOI: 10.1016/j.cortex.2010.06.002

Jaddoe, V. W. V., Van Duijn, C. M., Franco, O. H., Van der Heijden, A. J., Van IJzendoorn, M. H., De Jongste, J. C., . . . Hofman, A. (2012). The Generation R Study: design and cohort update 2012. *European Journal of Epidemiology, 27,* 739-756. DOI: 10.1007/s10654-012-9735-1

Jennings, K. D., Sandberg, I., Kelley, S. A., Valdes, L., Yaggi, K., Abrew, A., & Macey-Kalcevic, M. (2008). Understanding of self and maternal warmth predict later self-regulation in toddlers. *International Journal of Behavioral Development, 32,* 108-118. DOI: 10.1177/0165025407087209

Jester, J. M., Nigg, J. T., Puttler, L. I., Long, J. C., Fitzgerald, H. E., & Zucker, R. A. (2009). Intergenerational transmission of neuropsychological executive functioning. *Brain and Cognition, 70,* 145-153. DOI: 10.1016/j.bandc.2009.01.005

K

Karreman, A., Van Tuijl, C., Van Aken, M. A. G., & Dekovic, M. (2006). Parenting and self-regulation in preschoolers: A meta-analysis. *Infant and Child Development, 15,* 561-579. DOI: 10.1002/icd.478

Kochanska, G., Coy, K. C., & Murray, K. T. (2001). The development of self-regulation in the first four years of life. *Child Development, 72,* 1091-1111. DOI: 10.1111/1467-8624.00336

Kochanska, G., Murray, K., & Coy, K. C. (1997). Inhibitory control as a contributor to conscience in childhood: From toddler to early school age. *Child Development, 68,* 263-277. DOI: 10.1111/j.1467-8624.1997.tb01939.x

Kochanska, G., Murray, K. T., & Harlan, E. T. (2000). Effortful control in early childhood: Continuity and change, antecedents, and implications for social development. *Developmental Psychology, 36,* 220-232. DOI: 10.1037//0012-1649.36.2.220

Kopp, C. B. (1982). Antecedents of self-regulation: A developmental perspective. *Developmental Psychology, 18,* 199-214. DOI: 10.1037/0012-1649.18.2.199

L

Laucht, M., Esser, G., & Schmidt, M. H. (2001). Differential development of infants at risk for psychopathology: the moderating role of early maternal responsivity. *Developmental Medicine & Child Neurology, 43,* 292-300. DOI: 10.1111/j.1469-8749.2001.tb00208.x

LeCuyer, E., & Houck, G. M. (2006). Maternal limit-setting in toddlerhood: Socialization strategies for the development of self-regulation. *Infant Mental Health Journal, 27,* 344-370. DOI: 10.1002/imhj.20096

M

McClelland, M. M., & Cameron, C. E. (2011a). Self-regulation and academic achievement in elementary school children. *New Directions for Child and Adolescent Development, 133,* 29-44. DOI: 10.1002/cd.302

McClelland, M. M., & Cameron, C. E. (2011b). Self-regulation in early childhood: Improving conceptual clarity and developing ecologically valid measures. *Child Development Perspectives, 6,* 136-142. DOI: 10.1111/j.1750-8606.2011.00191.x

McClelland, M. M., Cameron, C. E., Connor, C. M., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology, 43,* 947-959. DOI: 10.1037/0012-1649.43.4.947

O

Obradovic, J. (2010). Effortful control and adaptive functioning of homeless children: Variable- and person-focused analyses. *Journal of Applied Developmental Psychology, 31,* 109-117. DOI: 10.1016/j.appdev.2009.09.004

P

Pennington, B. F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry, 37,* 51-87. DOI: 0021-9630(95)00128-x

Poehlmann, J., Schwichtenberg, A. J. M., Shlafer, R. J., Hahn, E., Bianchi, J., & Warner, R. (2011). Emerging self-regulation in toddlers born preterm or low birth weight: Differential susceptibility to parenting? *Development and Psychopathology, 23,* 177-193. DOI: 10.1017/S0954579410000726

Polderman, T. J. C., Posthuma, D., De Sonneville, L. M. J., Stins, J. F., Verhulst, F. C., & Boomsma, D. I. (2007). Genetic analyses of the stability of executive functioning during childhood. *Biological Psychology, 76,* 11-20. DOI: 10.1016/j.biopsycho.2007.05.002

R

Rothbart, M. K. (1989a). Temperament and development. In G. A. Kohnstamm, J. A. Bates, & M. K. Rothbart (Eds.), *Temperament in childhood* (pp. 187-247). New York: Wiley.

Rothbart, M. K. (1989b). Temperament in childhood: A framework. In G. A. Kohnstamm, J. A. Bates, & M. K. Rothbart (Eds.), *Temperament in childhood* (pp. 59-73). New York: Wiley.

Rothbart, M. K., & Ahadi, S. A. (1994). Temperament and the development of personality. *Journal of Abnormal Psychology, 103,* 55-66. DOI: 10.1037/0021-843X.103.1.55

Rothbart, M. K., & Bates, J. K. (1998). Temperament. In W. Damon, & N. Eisenberg (Eds.), *Handbook of child psychology* (pp. 105-167). New York: Wiley.

S

Schroeder, V. M., & Kelley, M. L. (2010). Family environment and parent-child relationships as related to executive functioning in children. *Early Child Development and Care, 180,* 1285-1298. DOI: 10.1080/03004430902981512

Silk, J. S., Steinberg, L., & Morris, A. S. (2003). Adolescents' emotion regulation in daily life: Links to depressive symptoms and problem behavior. *Child Development, 74,* 1869-1880. DOI: 10.1046/j.1467-8624.2003.00643.x

Skranes, J., Lohaugen, G. C., Martinussen, M., Indredavik, M. S., Dale, A. M., Haraldseth, O., . . . Brubakk, A. (2009). White matter abnormalities and executive function in children with very low birth weight. *Developmental Neuroscience, 20,* 263-266. DOI: 10.1097/WNR.0b013e32832027fe

W

Woodward, L. J., Clark, C. A. C., Pritchard, V. E., Anderson, P. J., & Inder, T. E. (2011). Neonatal white matter abnormalities predict global executive function impairment in children born very preterm. *Developmental Neuropsychology, 36,* 22-41. DOI: 10.1080/87565641.2011.540530

Y

Yamagata, S., Takahashi, Y., Kijima, N., Maekawa, H., Ono, Y., & Ando, J. (2005). Genetic and environmental etiology of effortful control. *Twin Research and Human Genetics, 8,* 300-306. DOI: 10.1375/1832427054936790

Z

Zhou, Q., Chen, S. H., & Main, A. (2012). Commonalities and differences in the research on children's effortful control and executive function: A call for an integrated model of self-regulation. *Child Development Perspectives, 6,* 112-121. DOI: 10.1111/j.1750-8606.2011.01176.x