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Prenatal and Postnatal Parental Behavior in the Context of Infant Regulation

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List of Publications

This dissertation will present three publications that have been published or are under review in peer-reviewed international journals.

1st Publication

Samdan, G., Kiel, N., Petermann, F., Rothenfußer, S., Zierul, C., & Reinelt, T. (2020). The relationship between parental behavior and infant regulation: A systematic review. *Developmental Review, 57,* 100923. https://doi.org/10.1016/j.dr.2020.100923

2nd Publication

Samdan, G., Reinelt, T., Kiel, N., Mathes, B., & Pauen, S. (2022). Maternal self-efficacy development from pregnancy to 3 months after birth. *Infant Mental Health Journal*, *43,* 864–877. https://doi.org/10.1002/imhj.22018

3rd Publication

Kiel, N., **Samdan, G.,** Wienke, A., Reinelt, T., Pauen, S., Mathes, B., Herzmann, C. (in review). From co-regulation to self-regulation: Maternal soothing behavior and self-efficacy related to infant regulation at 3 and 7 months. *Frontiers in Psychology*.

The following publication is not a core element of this dissertation, but was written during the doctorate and contributes relevant findings:

Reinelt, T., **Samdan, G.,** Kiel, N. & Petermann, F. (2019). Frühkindliche Prädiktoren externalisierender Verhaltensauffälligkeiten [Early childhood predictors of externalizing behavior]. *Kindheit und Entwicklung, 28*, 19-32. https://doi.org/10.1026/0942-5403/a000268

Summary

Following the notion that parenting starts with pregnancy (Glover & Capron, 2017), the current dissertation investigated how early parenting is shaped and how it relates to infant regulation, thereby taking a longitudinal perspective. Based on a systematic review and the data from the longitudinal study, the Bremen Initiative to Foster Early Childhood Development (BRISE) on the development of socially and/or culturally disadvantaged families, this dissertation focuses on two main research questions: (1) How does parenting emerge and develop from pregnancy to early infancy? (2) How are early parenting and infant regulation related?

The first publication provides a systematic literature review of 107 studies in total. It summarizes what is already known about the relation between parenting and infant regulation in the first two years of life. Corresponding analyses suggested that semi-structured measures seem best suitable to measure infant regulation during the first year and that structured measures seem better at probing self-regulation in older children. Parental reports were less likely to capture the positive relation between parental behavior and infant regulation when compared to structured and semi-structured methods. Most studies assessed the predictive role of parental behavior on infant regulation and revealed a stronger association than vice versa. Directions for future research were discussed by means of the shortcomings of the studies included in the systematic review, such as the need to examine the role of negative parenting, considering the role of fathers, and taking into account demographic information.

The second publication focused on the emergence of parenthood longitudinally. More specifically, (a) the development of maternal self-efficacy - a precursor of early parenting - was investigated from pregnancy to the postnatal period, and (b) the role of demographic factors together with formal and informal support during pregnancy were studied in their predictive value for maternal self-efficacy three months after birth. Results revealed that maternal self-

efficacy increased rapidly from the prenatal to the postnatal period. Mothers with previous birth experience, lower levels of education, those who were born outside of Germany, as well as mothers with higher levels of formal and informal social support during pregnancy all showed higher levels of maternal self-efficacy three months after birth. Moreover, first-time mothers and mothers born in Germany benefited more from formal support than mothers with previous experience and mothers born outside of Germany. These findings underline the need for early intervention programs for expectant mothers during the prenatal phase.

Lastly, the third publication focused on the postnatal period, examining the influence of maternal self-efficacy at three months after birth on infant regulation at three and seven months, and the role of maternal soothing behavior in order to explain this relationship. Infant crying and sleeping behavior, as well as parental close and distant soothing strategies were of special interest. Findings indicated that (a) infant regulatory behavior was quite stable across measurement points; (b) mothers with higher self-efficacy regarding parenting used more close soothing strategies, and that (c) soothing strategies directly influenced and maternal self-efficacy indirectly influenced infant crying and sleeping behaviors. These findings point out that sensitive and adequate parental practices promote better infant regulation in terms of crying and sleeping.

Altogether, the studies revealed positive associations between early parental practices and infant regulation during the first two years of life, thus underscoring the need to support mothers as early as possible, especially mothers from socially and/or culturally disadvantaged populations.

Keywords: transition to parenthood, maternal self-efficacy, parenting, infant regulation

Introduction

The transition phase to parenthood (or re-parenthood) is a milestone in each mother and father's life. Major changes in family structure and functioning that involve new parenting abilities and tasks can induce increased stress levels, but always come with pleasant as well as challenging experiences (Feeney et al., 2001). During this period, mothers can be vulnerable to experiencing depressive symptoms (Le Strat et al., 2011). Gloger-Tippelt (1988) characterizes mothers during the early period after delivery as *overwhelmed and exhausted* with severe physical overload and persistent fatigue. This is followed by a phase of *challenge and adaptation* in which mothers begin to adjust their daily routines to meet the needs of the child, learn to recognize these needs, and act accordingly. During the transition to parenthood, mothers (re-)adjust their maternal identity, adapt to the increased infant-related responsibilities, to the fatigue caused by lack of sleep, infant crying or breastfeeding difficulties, and face the danger of social isolation as a result of decreased time for social activities (Lévesque et al., 2020).

Especially mothers with poor social support and low socioeconomic status are vulnerable in this regard. They have an increased risk of experiencing symptoms of stress and depression both during and after pregnancy (Dadi, Miller, & Mwanri, 2020; Dadi, Miller, Bisetegn, et al., 2020). They also have less knowledge on parenting and fewer resources to provide an enriching environment for their offspring from early on (Anders et al., 2015). Such experiences have implications not only for the mother herself but also for her offspring, and the relation between the two (Priel & Besser, 2002). Thus, it is important to investigate the maternal transition period to (re-)parenthood, environmental factors to improve the experience of this phase, and its reflections on the early infant behavior.

Theories that explain parenting and child development focus on dynamic relationships between numerous factors that affect one another. Bronfenbrenner's bioecological systems

theory (Bronfenbrenner & Morris, 2006) investigates the ecological systems that the child is exposed to, ranging from the immediate social environment (i.e., the microsystem) to the general value system of a given society (i.e., the macrosystem). The microsystem is particularly important within the scope of this dissertation. The child engages directly and regularly in a reciprocal way with people in its immediate environment, such as parents and relatives who have a major direct influence on the developing child. On the other hand, the macrosystem, comprising social, cultural and economic factors, influences child development in an indirect way. Likewise, but from a parental perspective, the parenting model of Taraban and Shaw (2018) derived from Belsky's classic process of parenting model (Belsky, 1984) postulates that parenting is a complex process, influenced by three main aspects: (a) parental characteristics (e.g., personality and psychological well-being of mother / father), (b) the family social environment (e.g., social support and partnership quality), and (c) the child's development (e.g., emotion regulation and temperament). These three factors influence each other and the parenting in a reciprocal way. In addition, the socioeconomic status of the family and the advantages or disadvantages associated with it can influence associations between them (Taraban & Shaw, 2018).

Other models focus on specific aspects of child development, such as the development of self-regulation. For example, the biopsychosocial model of self-regulation by Calkins and colleagues (2016) addresses the dynamic relationship between the biology of the child, its behavior, and the environment that is responsible for the development of the self-regulatory processes. From a similar point of view, the EDOS (Early Development of Self-regulation; Pauen & EDOS Group, 2016) model differentiates between the mental level of the child (e.g., emotions and cognitions), the behavioral level of the child (e.g. actions and expressions), and the behavioral level of the caregiver (e.g., support given to the child) when explaining the gradual development of self-regulation from infancy to school age.

All these models highlight that neither parenting nor infant development can be studied alone, but that they engage in a bidirectional and dynamic relationship throughout the developmental process. To start with, this relationship will be elaborated with a focus on parenting.

Parenting

"Through others we become ourselves" (Vygotsky, 1987)

Empirical research shows strong connections between parental factors and child development, although there is no uniform way of defining how parental factors affect child outcomes. As already mentioned, this relation depends on child characteristics such as age, sex, or temperament, and also on parental characteristics such as former experiences in child-rearing, type of interaction with the child, or parental socioeconomic status (Maccoby, 2000). Therefore, it becomes important to investigate these factors to be able to understand how this complex interplay determines child development.

Parenting Characteristics

With respect to parenting, research broadly distinguishes between *positive* and *negative parenting* (Taraban & Shaw, 2018). Along with sensitivity, responsiveness to a given child's physiological and psychological needs, being warm, supportive, emotionally available and involved are conceptualized and considered as characteristics of positive parenting (Lotzin et al., 2015; Power, 2016; Taraban & Shaw, 2018). Negative parenting includes harsh and hostile parental behaviors associated with anger and aggression, and extreme behaviors such as emotional withdrawal, over-reactivity, or intrusiveness (Gallegos et al., 2016; Lotzin et al., 2015; Power, 2016; Taraban & Shaw, 2018).

Parental behaviors and practices are critical for the infant's future self-regulation abilities, as children experiencing responsivity, support and emotional security tend to successfully learn

how to regulate their emotions and how to control their own behavior (Morris et al., 2007; Peris & Miklowitz, 2015). Though self-regulation emerges after birth, an infant's ability to regulate emotions and behaviors is still limited at that time. Parents often play a key role in assisting their infants by co-regulating their needs and emotions. They provide physical and emotional care and conscious regulatory support (Murray et al., 2015; Whitebread & Basilio, 2012). Mothers typically use a range of different *soothing mechanisms* such as breastfeeding, rocking the baby in their arms, and speaking or singing softly to help their infants regulate their inner states. These behaviors are often described as *co-regulation* (Groß et al., 2013). They can be compared to Vygotsky's (1978) scaffolding principle, in which parents support the child so that he/she can accomplish a skill that is not yet fully developed.

Maternal Self-Efficacy

Not only parenting behavior but also thoughts and cognitions about parenting are of interest when it comes to determining child development. According to Bandura's social cognitive theory, which constitutes the origins of the concept of *maternal self-efficacy*, environmental, behavioral, and personal factors (including self-efficacy beliefs) interact with each other to determine human behavior (Bandura, 1999).

Self-efficacy comprises the belief in one's capabilities to successfully accomplish a particular behavior, task or performance (Bandura, 1977, 1994). It evolves from four primary sources: (a) direct experiences of being successful, (b) indirect experiences of observing social role models, (c) social persuasion through others, and (d) a given person's judgement about his/her physiological and emotional state (Bandura, 1977, 1994). When parenting is of interest, *maternal self-efficacy* or *maternal confidence* addresses the mother's perception of her own parenting capacities, including the perception of how well she provides adequate care for the infant, how well she understands and responds to the needs of her baby, and how competent she feels in her parenting role (Badr, 2005; Vance & Brandon, 2017).

Previous research indicates that maternal self-efficacy is a multifaceted construct associated with various factors such as maternal psychological well-being (Zietlow et al., 2014), social support (Angley et al., 2015), parenting behavior (Hsu & Lavelli, 2005), perceived infant temperament (Leerkes & Burney, 2007), and perceived infant crying behavior (Bond et al., 2001). In parallel to parenting that already begins during pregnancy, maternal self-efficacy beliefs begin to shape during this transition period as well. Hence, it is an important predictor of parental behavior as well as child development (Albanese et al., 2019; Taraban & Shaw, 2018; Vance & Brandon, 2017).

Social Support

During this transition from the prenatal to the postnatal period, mothers tend to experience stress and depressive symptoms as they try to cope with multi-faceted new challenges (Biaggi et al., 2016; Lorant et al., 2003; Reck et al., 2009). Mothers experiencing depressive symptoms tend to have problems in building a successful dyadic relationship with their infants (Flykt et al., 2010), adjusting to the challenges of early child rearing, and coping with them (Cornish et al., 2006). Furthermore, longitudinal studies show that depressive symptoms during the prenatal phase may impact early child development in a negative way, including developmental delays and regulatory problems during toddlerhood (Deave et al., 2008; Field, 2011), internalizing and externalizing problems during childhood (Field, 2011), and a lower verbal IQ at school-age (Barker et al., 2011).

To meet the challenges associated with the new life situation, social support plays a significant role. Mothers without sufficient social networks and support by their partners during pregnancy are more likely to suffer from depressive symptoms after childbirth (Nakamura et al., 2020), whereas mothers who feel supported by their partners, family and friends tend to show lower levels of emotional distress including depression and anxiety (Elsenbruch et al., 2007; Glazier et al., 2004) and a better adaptation to parenthood (Mihelic et al., 2016). Social

support is of special relevance for mothers with a lower socioeconomic status (SES), who need to cope with cumulative risk factors such as economic and health problems (Byrd-Craven & Massey, 2013) during the vulnerable phase of pregnancy.

Socioeconomic Status

The socioeconomic status (SES) defines a given person's social and material status. It not only impacts lifestyle and psychological well-being at the personal level, but also affects the children of a given family by shaping the home environment, and co-determining parental practices and resources (Anders et al., 2015; Bradley & Corwyn, 2002). Although research has identified parental education, occupation, and income as three main components of SES, there is still no single definition of how to conceptualize SES (Bradley & Corwyn, 2002). For instance, migration status is often investigated under the term SES when working with diverse samples. Immigrant populations facing social and economic problems while trying to adapt to a new cultural environment tend show higher levels of depressive symptoms (Levecque, 2014). They also experience lower levels of social support, including lack of information, guidance, positive affect from the community and social interaction with the environment (Salinero-Fort et al., 2011). This underscores the importance of considering migration status together with other socioeconomic parameters in research with parents and children.

To understand the multifaceted effects of socioeconomic status on child development, different models have been proposed, each with a different focus. The *Family Stress Model* (Conger et al., 2002; Conger & Donnellan, 2007) focuses on economic hardship and tries to explain how it relates to other familial factors. This model postulates that economic problems impact parenting behaviors by increasing stress experiences. The familial stress experience is reflected by the psychological well-being (or lack thereof) of the mother and/or father and the quality of their interparental relationship, factors known to impact parental involvement,

nurturing behaviors, and other aspects of parenting which show a direct link to children's internalizing and externalizing behaviors (Conger & Donnellan, 2007).

From a slightly different perspective, the *Family Investment Model* (Becker & Biedinger, 2016) investigates the role of parental education level, occupational status and migration background on the child's learning environment and child development. According to this model, parents invest in the future of their children by providing adequate and stimulating learning environments. The home environment or the institutional learning environment depend on the financial resources of the family, which can be linked to social, ethnic or educational background. The time a given child spends in these environments (e.g., with their parents, at childcare) and the characteristics of these environments (e.g., type of learning materials and activities offered) are known to influence child development, including cognitive development, language, and school-readiness (Becker & Biedinger, 2016).

In sum, existing models underline the need for empirical investigations addressing how socioeconomic factors influence parenting and child-related outcomes.

Infant Regulation

When investigating the relation between parenting and child-related outcomes, *infancy* - defined here as the period from birth to two years of age - is of particular interest, as *infants* largely depend upon their caregivers to fulfill their basic needs during this period (Bornstein, 2002). They also begin to develop regulatory mechanisms (e.g., thumb-sucking for soothing) when trying to adjust to their environment (Taipale, 2016). Capacities to organize sleeping and eating patterns, attention, affect, and their overt behavior are considered to be early markers of regulation development (Hemmi et al., 2011; Pauen, 2011; Zero to Three, 2005). Of these, crying, sleeping and feeding are accepted as the best indicators for early regulatory behavior, which can be observed even shortly after birth, and difficulties in these areas are referred to as

regulatory problems (Bilgin & Wolke, 2017; Hemmi et al., 2011). To illustrate this, excessive infant crying (often called "infant colic"), is observed in 5% to 19% of all infants during the first six months of life and tends to decline after this period (Lucassen et al., 2001). Despite this decline, investigating changes in regulatory capacities remains important because infants with problems in regulating their emotions, thus revealing excessive crying, sleeping, or feeding difficulties, are more likely to develop emotional and behavioral problems (e.g., externalizing problems like ADHD; internalizing problems like social anxiety) during later childhood and adolescence (Hemmi et al., 2011; Perry et al., 2018). This is even more likely to occur if infants carry multiple risks, including maternal psychopathology, being raised in poverty, or being exposed to poor parenting practices (Hemmi et al., 2011).

Infant *temperament* includes aspects of self-regulation as well (Rothbart & Posner, 2004). From a broad perspective, temperament comprises reactivity (i.e., emotional, motor and attentional reactivity) and the regulation of this reactivity in terms of effortful control (Rothbart, 2007). These relatively stable dispositions of human behavior affect one's social and emotional development, as demonstrated in multiple longitudinal studies on child development (Fu & Pérez-Edgar, 2015; Stifter & Dollar, 2016). Although temperament is assumed to have strong biological roots, it is also influenced by environmental factors like parenting behavior (Fu & Pérez-Edgar, 2015; Stifter & Dollar, 2016). These environmental influences already start to play an important role during pregnancy, mediated through stress-related hormonal changes in the mother, but they continue to affect the infant during the early years via parental practices (Möhler & Resch, 2014). Especially infants who are more temperamentally malleable tend to be more susceptible to both positive and negative parental and environmental influences (Belsky et al., 2007).

From a bidirectional perspective, however, not only infant regulation (e.g., positive and negative affectivity) is susceptible to parental influences but an infant's capacity to self-regulate

elicits positive or negative parental behavior, attitudes and practices (Beebe & Lachmann, 2015; Sameroff, 2010; Wachs & Kohnstamm, 2001).

General Research Aims/Questions and Overview of the Studies

In the light of these findings it soon becomes evident that parenting - which starts during pregnancy - and infant regulation can only be studied in relation to each other, taking into account social, economic and environmental factors (Glover & Capron, 2017; Taraban & Shaw, 2018). Longitudinal studies that start during pregnancy are still scarce, however. Therefore, this doctoral project investigates both the prenatal and the postnatal parental behavior, how it changes, and how it relates to early infant regulation. The period covered in this dissertation ranges from the last trimester of pregnancy to the second year of life of the infant. Figure 1 gives an overview over the topics that are covered in the three articles summarized in this synopsis. In short, this dissertation aims to answer these questions:

Superordinate Research Question 1:

How does parenting emerge and develop from pregnancy to the first months after birth?

Recognizing that maternal self-efficacy emerges before the child's birth and its role in early parenting and child development, the purpose of Paper 2 is to describe changes to this parameter during the transition period and the potential predictors influencing it. More specifically, it answers two main questions:

1. How does maternal self-efficacy develop between the prenatal to the postnatal period?
2. Which role do maternal characteristics (e.g., parity, educational level, migration) and prenatal environmental factors (e.g., formal and informal social support) play for the development of maternal self-efficacy?

Superordinate Research Question 2:

How are early parenting and infant regulation related?

Existing evidence on this issue seems diverse, presumably due to the broad scope of definitions for the term “regulation”, its rapid changes during the early years, and differences in the measurement methodology. Thus, Paper 1 aimed at providing a systematic review of the recent literature, thereby addressing two main questions:

3. What is already known about the relationship between parental behavior and infant regulation?
4. Are there any differences in the strength of this relationship depending on the (a) age of the infant, (b) the method of assessment, or (c) the causal direction of analyzing the relation between parental and child behavior?

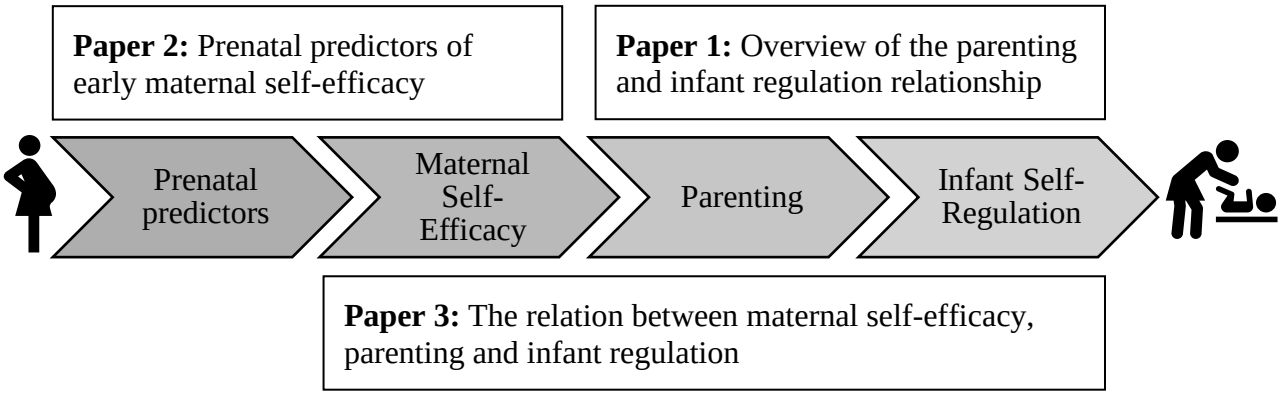
On the other hand, since not only parental behavior but also parental attitudes and beliefs seem to play a significant role in infant regulation, the effect of maternal soothing strategies – a key parental response during the first year of life – is investigated on infant regulation along with maternal self-efficacy. More specifically, Paper 3 answers two main questions:

5. What is the impact of maternal self-efficacy on infant regulatory behavior?
6. Does maternal soothing behavior play a role in this relationship?

The article empirically examines these research questions by focusing on the first six months after delivery.

Figure 1

Structure of the doctoral project



Bremen Initiative to Foster Early Childhood Development (BRISE)

This dissertation was realized as a part of the longitudinal study The Bremen Initiative to Foster Early Childhood Development (BRISE). BRISE is funded by the Federal Ministry of Education and Research (BMBF), and conducted by a research alliance including the University of Bremen and Heidelberg University. The study targets socially and/or culturally disadvantaged families living in preselected districts of Bremen/Germany. It investigates the early childhood development from the prenatal period until primary school entry.

The districts were selected according to the social structure of Bremen. They are characterized by relatively high rates of unemployment and child poverty. Families were recruited in various ways; mainly through letters, which were sent out to households in these districts, through a network of people in the health care or social work sectors, who advertised the project to target families, and through advertisements in public transports and local newspapers. The inclusion criteria were as follows: (1) living in one of the pre-determined districts; (2) being pregnant or having a baby no older than 10 weeks old; (3) presence of at least one possible risk factor for child development in the family: (a) low parental education,

(b) low family income, and (c) migration background of at least one of the infant's parents or grandparents (Schütte et. al, 2020).

Time Points of Data Collection

The dissertation contains data from the first two waves of the study that include $N = 300$ infants ($n = 150$ infants in each wave) and their mothers ($N = 292$ due to eight pairs of twins), and three measurement points. The first measurement took place ideally during the last trimester of pregnancy. If the family contacted the research team after birth, this first visit took place within 10 weeks postpartum (retrospective assessments of prenatal measures). The second measurement took place between two to four months after childbirth ($M_{age} = 98.40$ days, $SD_{age} = 25.24$). The third measurement took place between six to eight months after childbirth ($M_{age} = 222.10$ days, $SD_{age} = 25.81$). The interviews were conducted either in German, English, or in special cases in the primary language of the mothers. Table 1 shows the sampling plan and the questionnaires used at each measurement point.

Table 1

Overview of the sample size and the measures used in each empirical paper

				Measurement point 1		Measurement point 2	Measurement point 3
Paper	Mothers *N*	Infants *N*	Demographic measures	Pregnancy	Within 10 weeks after delivery	2-4 months postpartum	6-8 months postpartum
2	292	300	*Predictors:* Parity; Education; Migration	*Predictors:* Informal Support; Formal Support; Maternal Self-Efficacy; Depressive Symptoms	*Predictors:* Informal Support; Formal Support	*Outcome:* Maternal Self-Efficacy	
3	147	150				*Predictors:* Maternal Soothing Strategies; Maternal Self-Efficacy	*Outcome:* Infant Regulation

Notes. Paper 1 is a systematic review and therefore not listed in this table. Please see the articles for more information on the questionnaires.

Sample Characteristics

Mothers were between 18 and 47 years of age (M = 31.35 years, SD = 5.67 years) at the first visit, and 45% were expecting their first baby. According to the Comparative Analysis of Social Mobility in Industrial Nations (CASMIN) educational classification (Brauns et al., 2003), 68.97% were below the level of tertiary education (i.e., bachelor's degree). There was a high proportion of mothers with a migration background in the sample, including 39.10% first generation immigrants who were born outside of Germany, and 14.53% second generation immigrants born in Germany having at least one parent born abroad. The median for the household net income was 2800€ per month.

Brief Description of the Papers

(1) The Relation between Parental Behavior and Infant Regulation

Before investigating the emergence of parental attitudes and behavior, it seems useful to review relevant literature on how they relate to infant regulation.

Objectives. The aim was to investigate (a) the strength of the relation between parental behavior and infant regulation, and (b) whether this relation depends on the age of the infant, the measurement method used, or the causal direction of the relation.

Methods. The first step was to define *infant regulation*: Although *sleeping, crying and feeding* are defined as common regulatory indicators of the infancy period (Hemmi et al., 2011; Papoušek, 2004), due to contextual overlaps (e.g., positive and negative affectivity, reactivity, soothability) and strong associations with infant *temperamental characteristics* (Gartstein & Rothbart, 2003; Kaley et al., 2012), studies on sleeping, crying and feeding, and studies on infant temperament were both assessed as examples of infant regulation. A systematic review based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher et al., 2009) helped to identify, screen and select all relevant studies without missing

relevant information and to get an overview of the studies conducted recently (i.e., published after 2006).

Results. Based on a pre-screening, 107 studies were included in the systematic review. Although the results of the studies were quite heterogenous, two notable patterns emerged after grouping the studies according to infant age, measurement method and direction of the assessment: (1) There was a significant positive relation between parental behavior and infant regulation when infant regulation was measured with semi-structured methods before the first year of life and with structured measures after the first year of life. (2) Regarding the direction of this relation, the association between parental behavior and infant regulation proved to be more powerful when parental behavior was investigated as a predictor of infant regulation than vice versa. Studies investigating child behavior as a predictor of parental behavior, or assessing the relationship bidirectionally were rare.

Discussion. The results of this systematic literature review suggest the use of different measurement methods compatible with the age of the infant. In order to learn more about the relation, longitudinal studies with a bidirectional perspective that also incorporate negative parental behavior, paternal variables and demographic information are needed.

(2) The Development of Maternal Self-Efficacy during the Transition Period

According to Taraban and Shaw (2018), cognitions referring to parenting, such as sense of efficacy or confidence in one's own parenting abilities, shape parental behavior, practices and effectiveness. Hence, they can be regarded as an early indicator of parenting. The transition from pregnancy to the early months after birth is of special interest, as parental expectations change with the experience of parenthood during this period (Harwood et al., 2007). Despite this, the development of mothers' sense of efficacy in parenting from the prenatal to the postnatal period has not been investigated thoroughly so far, (a) neglecting the role of the

prenatal phase and (b) focusing mostly on its outcomes rather than its predictors (Albanese et al., 2019).

Objectives. The first aim of this study was to describe the development of maternal self-efficacy from the prenatal period to the postnatal period three months after birth. Secondly, considering the significant role of social support during pregnancy, this paper investigated the predictive role of both formal and informal support during pregnancy together with demographic factors (i.e., education level, migration, parity) on maternal self-efficacy three months after birth.

Methods. After the exclusion of one sibling from each of the eight pairs of twins from the dataset, data from a total of N = 292 mothers were analyzed. Preliminary analyses were conducted to reveal the potential differences between prenatally and postnatally recruited participants, and to test longitudinal (test-retest) measurement invariance for the prenatal and postnatal maternal self-efficacy variables. For the main analyses, (a) a dependent samples t-test checked for potential changes in maternal self-efficacy between measurement points; (b) a set of hierarchical regression analyses were performed by entering the demographic variables in the first step and social support variables in the second step to predict maternal self-efficacy after birth.

Results. Three main findings were obtained: (1) Maternal self-efficacy increased significantly between the prenatal to the early postnatal phase; (2) Previous birth experience, being born abroad, and higher levels of formal and informal social support during pregnancy all predicted higher levels of maternal self-efficacy three months after birth; (3) First-time mothers and mothers born in Germany benefited more from formal support than mothers with previous birth experience and/or born outside of Germany.

Discussion. Mothers seem to profit from experiences in the first months of parenting to gain self-efficacy in this respect. Since formal support has a substantial impact on mothers' self-efficacy development, but demographic characteristics seem to co-determine how much they profit from support, new ways to find out which subgroup of mothers needs what type of support are needed.

(3) Maternal Self-Efficacy, Soothing Behavior and Infant Regulation

After working on the prenatal factors that strengthen maternal self-efficacy, this paper shifted the focus to the early months after delivery. Despite findings indicating a close relation between maternal behavior, self-efficacy in parenting and infant regulatory capacities (Albanese et al., 2019; Samdan et al., 2020; Taraban & Shaw, 2018), the role of maternal soothing strategies in this context is still unclear.

Objectives. Paper 3 thus investigated (a) the predictive role of maternal self-efficacy at three months after birth on infant regulation (i.e., crying and sleeping behavior) at three and seven months, and (b) the role of early maternal soothing behavior at three months as a form of maternal co-regulation strategy during this process. We expected that the level of maternal self-efficacy would influence whether and how often the mother uses distant or close soothing strategies that in turn impact infant regulation.

Methods. Due to the ongoing data collection and data entry procedures, only the first wave of the BRISE study (N = 150 infants) that had already been tested at three and seven months of age could be included in this current study. As a first step, the items of the soothing strategies scale were grouped into close and distant strategies. Following that, structural equation modelling (SEM) was performed.

Results. The analyses indicated that (1) the regulatory behavior of infants at seven months reflect their regulatory behavior at three months, showing consistency over time; (2) mothers

with lower maternal self-efficacy used distant soothing strategies more often and were more likely to have infants with soothing problems and frequent continuous crying episodes at three months than mothers with higher maternal self-efficacy; (3) infants whose mothers used close soothing strategies revealed better soothability but woke up more frequently at night at three and at seven months of age.

Discussion. Since infant early regulatory behavior tends to be influenced by maternal soothing behavior (directly) and self-efficacy in parenting (indirectly), it may be helpful to support mothers to improve cognitions about their own parenting skills and knowledge about adequate parental practices and effective soothing in order to prevent infant regulation problems.

General Discussion

This dissertation focused on different factors of potential relevance for the development of early parenting and its impact on infant regulation. Despite the increasing number of studies covering related topics, longitudinal investigations focusing on the very early phases of development, including the prenatal period, and studies working with socially and/or culturally disadvantaged samples are still rare. The current dissertation aimed to fill this gap.

Mothers start interacting with their babies while they are still in the womb. They show affection, build expectations, and develop an idea of how they fill out the role of a parent (Glover & Capron, 2017; Harwood et al., 2007). As suggested by the data presented, maternal beliefs in one's own efficacy as a caregiver – an antecedent of parenting – varies with personal and environmental characteristics (Paper 2), and is directly associated with early parental behavior in terms of soothing strategies which predict infant regulation during the first year (Paper 3), thus confirming the findings of the systematic literature review (Paper 1) that parenting and infant regulation are closely related.

The Emergence of Parenting

In accordance with previous theories (Taraban & Shaw, 2018), Paper 2 showed that maternal demographic factors were associated with early parenting, more specifically with the sense of efficacy in child-rearing. As expected, mothers without previous pregnancies showed lower levels of maternal self-efficacy. On the other hand, contrary to expectations, more disadvantaged mothers, who had lower levels of education and were born outside of Germany, exhibited higher levels of maternal self-efficacy (see Paper 2). As these three demographic variables were correlated with each other, it was not possible to examine the findings separately. We can only speculate that mothers with lower levels of education have lower parental awareness of child-rearing issues (Parks & Smeriglio, 1986). In addition, mothers with a migration background who mostly come from rather collectivistic cultures in the BRISE sample, are likely to have a more traditional view of their mother role (Hofstede, 2011; Van De Vijver, 2007), and may thus feel more confident about being a good parent than mothers who struggle with their own role – presumably often experiencing a conflict between the traditional role and that of a women having her own career.

In this situation, both informal and formal support play an important role by assisting expectant mothers in emotional and informational terms. When inspecting the effect of formal support more closely, our results indicated that mothers expecting their first baby and mothers without a migration background not only used more professional support but also profited most from it. These results suggest (a) the need to reduce barriers and encourage women more directly to participate in formal support programs, and (b) consider the special needs of the subgroups (e.g., mothers with migration backgrounds) in order to reach a broader audience and increase the effectiveness of the programs. For instance, the *Nurse-Family Partnership* in the US and its German adaptation *ProKind* aim at improving maternal health, caregiving behavior

and child development in disadvantaged populations, and target first-time mothers only. The evaluations of the Nurse-Family Partnership and ProKind show increased positive parenting practices, such as greater knowledge about child rearing, higher maternal self-efficacy, and a reduction of dysfunctional caregiving among mothers who attended these programs during their first pregnancy until two years after birth (Jungmann et al., 2015; Olds et al., 2003). Following the notion that the experience of pregnancy is associated with an adaptation to the parental role (Mihelic et al., 2016), such findings suggest that preventive programs for pregnant women are needed and can be very helpful.

Shifting the focus from the transition period to the early months after delivery (see Paper 3), maternal self-efficacy at three months appeared to be a relevant predictor of later maternal parenting practices and thus proved to have an impact on infant regulation. Research shows that infants express themselves through regulatory behaviors such as crying (Stifter & Backer, 2017). When mothers feel insecure in their parental role, they tend to experience difficulties in understanding and dealing with this behavior, which might in turn influence infant regulation in negative ways (Bates et al., 2020). In our sample, mothers who felt less confident in their parenting exhibited more distant soothing strategies such as swaddling, letting the baby sooth him/herself, or letting music play. It seems like mothers who feel less capable tend to rely on external resources to sooth their infants, presumably because they do not feel confident regarding their parental skills. This has been confirmed by previous studies with different distant soothing strategies and age groups. For instance, mothers with low maternal self-efficacy have been shown to feed their toddlers in order to reduce their children's stress, which can then have negative longitudinal impact on the regulation of food intake behavior (Stifter et al., 2011).

Overall, numerous studies have already provided evidence suggesting that maternal self-

efficacy should be investigated in more detail and why it should be promoted. Corresponding findings indicate that higher levels of self-efficacy in parenting are associated with better parent-child relationships, including more effective parental behavior, better parental mental health, lower levels of depression and greater satisfaction with the parental role in mothers, as well as better child outcomes in terms of less behavior problems and better academic achievements (Albanese et al., 2019). For all these reasons, it seems important to investigate the pathways from parental cognitions to early parental practices to infant behavior.

The Relation between Early Parenting and Infant Regulation

When examining this relation between parenting and infant regulation, three aspects appear to be important: (a) measurement time, (b) measurement method, and (c) type of infant behavior (see Paper 1). Despite inconsistent or non-significant findings in the studies that use questionnaire data when assessing the relation between parenting and infant regulation, the first six months after birth constitute a time-period revealing fairly strong and stable empirical relations between parenting behavior and infant regulation, especially when semi-structured measurement methods are used. Measurement time (a): The reason for strong and stable relationships during the first six months may be due to the fact that infants largely depend upon their caregivers and have still under-developed self-regulatory abilities (Pauen & EDOS Group, 2016), which increases the impact of positive or negative parental influences. Measurement method (b): Semi-structured methods such as naturalistic observations help to capture interactive dynamics without impacting the infant behavior (Stifter & Dollar, 2016). Type of infant behavior (c): Studies assessing the relation between parental behavior and infant sleeping, crying, or feeding behaviors reveal a significant positive relation more consistently than studies assessing the relation between parental behavior and infant temperament, thus indicating a stronger situation-dependency in the former case. This has also been confirmed by Linberg and colleagues (2017) who revealed characteristics of the child in an interaction

situation as the strongest predictors of maternal sensitivity rather than overall infant temperament.

In accordance with these findings, Paper 3 showed that physical and emotional distancing from the infant lead to more frequent long crying episodes and poorer self-soothing in the infant. Mothers using close physical and emotional contact indicated that their infants were better at calming down following previous arousal than mothers using distant soothing strategies. Interestingly, however, infants of the first group of mothers who used close soothing strategies woke up more often at night, indicating poorer regulatory capacities. One reason for this result could be the effect of breastfeeding. Taking a closer look, breastfeeding emerges as an important component of close soothing strategies, and research shows that breastfed infants are more likely to wake up at night compared to bottle-fed infants, especially during the first six months (Mindell et al., 2012). On the other hand, the results may also point to the fact that infants also need to get the opportunity to learn how to regulate themselves. It seems that appropriate maternal responding is critical for positive infant regulatory outcomes (Van IJzendoorn & Hubbard, 2010).

Overall, it can be concluded that noticing and responding to infant signals in a sensitive way, and supporting infants without being over-supportive may best help children to acquire self-regulation skills. Research investigating the longitudinal effects of regulatory behavior has revealed that early self-regulatory capacities are associated with behavioral patterns later in life. For instance, children who fail to regulate their emotions early in life tend to experience behavioral problems such as externalizing symptoms more frequently when getting older. Environmental factors, especially parents, play a significant role in this process. Responding appropriately to the children, providing empathetic support, and creating an enriching environment influence this later development positively and can moderate the effect of biological components (Calkins, 2009).

Strengths, Limitations and Future Directions

The main strength of this dissertation is the combination of (a) a systematic review that specifically focused on the infancy period, providing an overview of the aspects later investigated in detail, and (b) the longitudinal assessment of these aspects that starts in the last trimester of pregnancy and covers the entire period of infancy, which will later even continue until school age. Longitudinal studies that start as early as pregnancy help to identify environmental and genetic factors underlying the later development. Furthermore, they offer the chance to take early preventive measures (Golding et al., 2009).

Previous studies dealing with maternal self-efficacy have mostly neglected the role of pregnancy, have not investigated the prenatal predictors of maternal self-efficacy, and have mostly focused on a period of development well beyond infancy (Albanese et al., 2019). This may be due to several reasons. For instance, research with infants and their parents comes with challenges such as practicability or ethical concerns (Peterson, 2016). Research with pregnant women has its own challenges, such as difficulties to organize interviews due to pregnancy-related fatigue, medical appointments, or hospital stays. The two empirical studies reported here demonstrate that it is possible to overcome these problems. To be able to reveal the effects of early parenting attitudes and practices, a focus on pregnancy and early infancy seems neccesary.

Another main strength of this dissertation is the focus on a socially and/or culturally disadvantaged population. Trying to work against an overrepresentation of Western communities with high-SES in empirical research (Henrich et al., 2010) is challenging. It is hard to reach low-SES minorities due to reasons such as mistrust of researchers, little interest in participation, or having other priorities (Stuber et al., 2020). This makes it hard to reach these populations, in particular during periods of high stress, such as the transition to parenthood (Baucom et al., 2017). All participants of the BRISE sample had at least one possible risk factor

for child development in the family, but more than half of the sample could only be recruited after the delivery. Therefore, some of the analyses in Paper 2, in which prenatal factors were investigated as predictors of maternal self-efficacy, could only be conducted with participants who were included in the study during the prenatal period and provided both prenatal and postnatal data. This decreased the sample size.

A second major limitation was the use of questionnaire data, as self-report measures are often associated with socially desirable or biased answers (see also Paper 1). For instance, although we worked with a non-clinical sample, it is expected that mothers with higher levels of depressive symptoms have a negatively biased view of their own abilities and performance (Whitton et al., 2008). Moreover, even though participants knew the interviewer already and were explicitly being told that there were no right or wrong answers before the start of data collection (thus signaling acceptance of any type of answer), mothers may have felt the pressure to meet social expectations. It is also possible that the mothers were unable to provide accurate and reliable answers to the questions about the regulatory behavior of their infants. Similarly, measurement of soothing strategies, defined as a form of co-regulation, may not adequately capture the dyadic dynamic relationship between the infant and the mother because they were assessed via a questionnaire. Future studies could benefit from direct measurements (e.g., dyadic bidirectional interactions between the mother and the infant using microanalytic video-coding) or multiple methods combining observational measures with questionnaires (Chan et al., 2021; Stifter & Dollar, 2016).

Lastly, even though it is the mothers who remain in focus when considering the months before and after birth because of the direct biological link to the child and the fact that they still serve as the primary caretakers most of the time, the role of fathers in this context is beginning to be recognized (Adamsons & Johnson, 2013; Bakermans-Kranenburg et al., 2019). In our sample – despite rather low participation rates – fathers filled out the questionnaires as well.

However, due to the ongoing data entry procedures, it has not yet been possible to use this data. Considering the differential influence of maternal and paternal behavior on the child (Cummings et al., 2004, Samdan et al., 2020), the transition to fatherhood and the link to infant regulation are worth investigating in future studies.

Implications for Practice

The relation between parenting and infant regulation seems to be very strong in the early years (Paper 1). To promote child development, early prevention programs are needed during the transition to parenthood and in the early months after delivery. The results of the present dissertation point out the need to support mothers by strengthening their parental self-efficacy beliefs (Paper 2), which would not only have a direct positive impact on their parenting behavior (Paper 3), but also on their parental ability to cope with parenting stress and on the child outcomes (Jones & Prinz, 2005). Overall, new ways to promote formal support, as well as new programs that specifically address disadvantaged subgroups are needed in order (a) to reach out to socially and/or culturally disadvantaged mothers who have smaller social networks and seem to be hesitant in using formal support, (b) to be able to intervene and guide mothers as early as possible, and thus, (c) to enhance early infant regulatory outcomes.

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List of Abbreviations

CASMIN	Comparative Analysis of Social Mobility in Industrial Nations
SES	Socioeconomic Status
SEM	Structural Equation Modeling
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Research Papers

Paper 1

The relationship between parental behavior and infant regulation: A systematic review

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The Relationship between Parental Behavior and Infant Regulation: A Systematic Review

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Abstract

The formation of early regulatory behavior during the first years is an important developmental task and predictive for self-regulatory abilities in later life. Although parental behavior is thought to be highly influential in this developmental trajectory, associations between infant regulatory behavior and parental behavior have been diverse. The current paper systematically reviews the empirical research on the relationship between behavioral indicators of infant regulation–temperamental characteristics, sleeping, crying, feeding–and parental behavior during the first two years of life. After screening 4254 articles obtained from Web of Science and PsycINFO, 107 studies were included in the systematic review. The studies fell short of integrating negative parental behavior, paternal variables and further demographic information into the research and did not reveal consistent findings. However, the studies indicated a positive relationship between parental behavior and infant regulation with differences according to age and measurement method. It appears that the use of semi-structured methods to measure infant regulation is most appropriate during the first year of life, whereas the use of structured measures is more advisable during the second year of life. In contrast, parental reports failed to show significant findings with parenting behavior at any given time. The association was more powerful when infant regulation was predicted by parental behavior than vice versa. However, the number of studies regarding the latter direction was limited. This review, thus, underlines the importance of using different measurement methods according to age, and discusses the ways to improve future research.

Keywords: infancy, regulation, temperament, sleeping, crying, feeding

The development of self-regulation starts during infancy, when infants begin to adjust themselves to their environment. The transition from a state of alertness, in which the infant needs to fulfill its basic needs through eating, crying or sleeping, to a calm and relaxed state of alert inactivity forms the origins of regulation (Taipale, 2016). Thus, capacities to organize affect (e.g., positive affect such as laughing and smiling, and negative affect such as fear and crying), attention (e.g., mother orientation), behavior (e.g., aggressive and impulsive behavior), sleeping (e.g., sleeping through the night), and eating patterns (e.g., food refusal) represent the early indicators of self-regulation (Hemmi et al., 2011; Pauen, 2011; Zero to Three, 2005). In non-optimal cases, persistent excessive crying, sleep problems, problems in feeding and eating, and other psychological symptoms such as temper tantrums or oppositional behavior constitute the symptoms of regulatory disorders during infancy (DGKJP, 2015). These behavior patterns are important, as infants who experience regulatory problems during infancy tend to show more internalizing and externalizing problems during childhood and adolescence (Hemmi et al., 2011; Perry, Calkins, Dollar, Keane, & Shanahan, 2018).

While sleeping, crying and feeding have mostly been investigated together as common regulatory indicators (Hemmi et al., 2011; Kaley et al., 2012; Papoušek, 2004), other indicators such as problems in organizing fear, anger and attention are referred to as difficult temperament (Zero to Three, 2005). Moreover, whereas the focus of indicators like sleeping, crying and feeding lies on the modulation of internal states, in which temporal changes would be expected (Mohr et al., 2019), temperamental characteristics comprise traits that can already be measured during the first months, and remain relatively stable over the course of development (Putnam, Gartstein & Rothbart, 2006; Stifter & Dollar, 2016). On the other hand, sleeping, crying and feeding cannot be separated from temperamental characteristics either, as they not only overlap with several temperamental characteristics (e.g., reactivity in terms of ease of falling asleep, soothability), but also show associations with overall infant temperament (Gartstein &

Rothbart, 2003; Hagekull, Bohlin, & Rydell, 1997; Kaley et al., 2012). The reason for this is that, temperamental characteristics underlie the development of regulatory capacities (Eisenberg, Spinrad, & Eggum, 2010; Rothbart, Ellis, & Posner, 2011), and predispose an infant's susceptibility to stressful situations (e.g., immunization procedure). Hence, individual differences in infant regulatory behavior could both be related to differences in regulatory capacities and underlying temperamental characteristics. In spite of these theoretical differences, measures of temperament often do not differentiate between underlying characteristics and regulatory capacities, making it further difficult to separate them.

Development of regulation in the first two years of life

Although self-regulation begins to emerge during the first years of life, the ability to regulate affect and behavior is restricted. Hereby, parents play a key role in supporting their infants, which is usually described as co-regulation (Berk, 2013; Pauen & EDOS Group, 2016). With the help of caregivers, infants begin regulating emotional distress and alertness, while still not being fully independent (Berk, 2013; Pauen & EDOS Group, 2016). Regulatory behavior in the first two years can be divided into three groups (Kopp, 1982): (1) the neurophysiological modulation from birth to three months, which includes the regulation of arousal and the emergence early functional behavior (e.g., sucking behavior for eating and self-soothing); (2) the sensorimotor modulation from three months till the end of the first year comprising the behavioral responses to the environmental factors (showing positive/negative affect in response to the caregiver); and (3) the control phase during the second year of life, a phase of increased awareness, in which the infant intentionally engages in social exchanges (e.g., emotion regulation).

The common examples of regulatory behavior observed during the first year are (a) using simple soothing mechanisms such as sucking on a thumb or pacifier, (b) shifting attention away from stress triggering sources, (c) modulating sleep behavior through parental soothing,

(d) taking part in daily routines such as feeding situations, and (e) responding to others in one's own way (Calkins, 2007; Murray et al., 2015; Whitebread & Basilio, 2012). Especially during this time, the role of caregivers is important. They are responsible for understanding infants' needs and answering them adequately by showing physical and emotional support, particularly during stressful situations (Murray et al., 2015; Whitebread & Basilio, 2012).

In the second year of life, infants show an increase in their cognitive abilities and voluntary behavior. On the one hand, they begin to act independently, and on the other hand, they need to go along with their caregivers' requests and adapt to the situations appropriately. Caregivers still play a significant role by increasing conscious regulatory support while teaching, modeling or speaking (Murray et al., 2015; Whitebread & Basilio, 2012). This development from non-complex behavioral mechanisms to higher-order functions paves the way for a fully functional early development (Calkins, 2007).

Measuring regulation in early childhood

To measure this regulatory behavior during early childhood, several questionnaires have been developed. These include questionnaires on temperamental characteristics or on multiple regulatory problems–including problems in sleeping, crying, and feeding–which cover a variety of infant behavior across different situations, but also parental reports such as sleep diaries that focus on a single behavior (Gartstein & Rothbart, 2003; Gross, Reck, Thiel-Bonney, & Cierpka, 2013; Richman, 1981). The low cost and easy-to-use nature of parental reports, as well as being able to measure a certain behavior across different contexts and providing comprehensive data has its advantages (Stifter & Dollar, 2016). However, parental reports are prone to subjectivity and social desirability and, hence, tend to indicate biased results. Whereas observational measures at least partly overcome this limitation, they are often limited to a single observation which may lead to differences in findings, especially when the operationalization of constructs varies across studies (Berk, 2013; Rothbart & Bates, 2006). Nevertheless, direct observations

of child behavior or parent-child interactions are conducted frequently to monitor actual behavior in a familiar environment. They are independent from the parents' interpretations, argued to be particularly valid, and are generally preferred over the parental reports (Gardner, 2000). Direct measures can be further classified into structured and semi-structured measures. Structured measures create a certain atmosphere, mostly in a standardized setting to induce a specific behavior. Despite the advantage of having the same standards for all participants, the novelty of the laboratory context may have an impact on the infant behavior and on the behavior of the dyad. Semi-structured measures yield data without the experimenter interfering in a naturalistic setting by observing and measuring the occurrence of specific behavior. They are more ecologically valid but less controlled (Stifter & Dollar, 2016). Although each measurement method has its advantages and disadvantages, small or even non-significant associations between these measurement methods raise the question, whether they measure the same constructs and how they can be compared with each other (Stifter & Dollar, 2016).

Models assessing parent-infant relationship

In accordance with the gradually increasing capacities of self-regulatory behavior during infancy, various models have been developed to explain regulation processes within the social environment. The *biopsychosocial model of self-regulation* by Calkins, Perry, and Dollar (2016) focuses on the dynamic relationship between the biology of the child, its behavior, and the environment underlying the self-regulatory processes. This dynamic relationship is responsible for the development from rudimentary to more complex aspects of self-regulation. The social level in the model includes parental behavior and its supportive role during early infancy, which helps the regulation of attention, emotion and cognition to flourish (Calkins et al., 2016). Other models particularly highlight the bidirectional relationship between parental behavior and infant regulation such as *the ice-cream-cone-in-a-can model of development in*

Sameroff's transactional approach (1983, 2010), *the mutual regulation model* by Gianino and Tronick (1988) or *the transactional model of parenting* by Wachs and Kohnstamm (2001).

According to *the ice-cream-cone-in-a-can model of development* (Sameroff, 2010; Sameroff & Fiese, 2000), self-regulation emerges and develops in a context, in which the child's self-regulation capacity is in constant interaction with caregivers' "other-regulation" behavior. Throughout development, a balance is maintained, as self-regulation gradually increases, and other-regulation decreases till the child reaches adulthood (Sameroff, 2010). According to *the mutual regulation model*, this regulation process between infant and caregiver is mutually interactive; while each person regulates his or her own behavior, they simultaneously influence (and are influenced by) the other behavior in the dyadic relationship (Beebe & Lachmann, 2015). This goes along with *the transactional model of parenting* (Wachs & Kohnstamm, 2001), which mainly focuses on the bidirectional effects between parenting and the characteristics of the child. It claims that positive or negative child regulatory behavior may elicit positive or negative parenting behavior in line with the child's behavior. This in turn again affects child behavior and creates a dynamic relationship between child and caregiver during the developmental process (Kiff et al., 2011). All of these theories agree that self-regulation is susceptible to environmental factors, especially to parental influences, and develops through the bidirectional relationship between the parent and the infant.

Parental behavioral patterns and child outcomes

When assessing parental influences on child development, an unlimited number of patterns of parental behavior exist that can be broadly grouped into the categories of positive and negative parenting (Taraban & Shaw, 2018a). Positive parenting includes dimensions such as sensitivity, warmth, responsiveness, emotional availability, involvement, and supportiveness (Lotzin et al., 2015; Power, 2016; Taraban & Shaw, 2018a). Being high or low in terms of parental sensitivity is the marker that is mostly assessed in studies, with high sensitivity

promoting a positive development through correct understanding of infants' emotional and behavioral signs and responding to them appropriately (Bigelow et al., 2010; Mastergeorge et al., 2014). Several positive developmental outcomes are associated with maternal sensitivity in areas such as attachment, language acquisition, socio-emotional, behavioral and cognitive development (Deans, 2018; De Wolff & van IJzendoorn, 1997). However, the scope of the sensitivity construct shows differences across assessment tools and overlaps with other parental behavioral patterns such as positive affect or warmth (Mesman & Emmen, 2015). Another contradictory term in the field is responsiveness. Although it can be measured by the contingency and appropriateness of parental behavior in response to infant behavior (Bornstein & Manian, 2013), some researchers consider responsiveness to be a combination of two or more parenting variables, such as a combination of sensitivity and positive regard (e.g., O'Neal et al., 2017). Yet, others use the term interchangeably with sensitivity (Gartstein, Hancock, & Iverson, 2018; Popp, Spinrad, & Smith, 2008). Moreover, emotional availability is often considered an umbrella term for several positive parenting constructs, including sensitivity (Mesman & Emmen, 2015). Emotional availability broadens the sensitivity construct by incorporating dyadic, emotional, and structural aspects together (Saunders et al., 2015). According to previous studies, early parental emotional availability is shown to be related to various developmental outcomes such as socio-emotional and behavioral development or later attachment representations (Biringen et al., 2014; Easterbrooks et al., 2012). In spite of studies examining the relationship between parental sensitivity or emotional availability with child outcomes (Deans, 2018; Easterbrooks et al., 2012), research on other positive parental behavior such as involvement or supportiveness has caught less attention and studies have failed to provide a clear separation of thematic similarities and differences between constructs.

Research focusing on the negative side of parenting during infancy is also still underrepresented. Harsh parenting and hostility describe verbal or physical expression of anger

and aggression, and are identified as common negative types of parenting behavior during infancy (e.g., Lotzin et al., 2015; Power, 2016; Taraban & Shaw, 2018). Nevertheless, differences in wording can be observed. Harsh parenting can be examined as a subcategory of hostility in some studies, whereas hostility is treated as a subcategory of harsh parenting in other studies (Conger et al., 2012; Halgunseth, 2019; Morris et al., 2002). Both of these aspects of negative parenting are associated with later emotional and behavioral problems over the course of child development (Bailey et al., 2009; Mackenbach et al., 2014). In addition, intrusiveness, emotional withdrawal, over-reactivity or parental control are further negative parental dimensions that have been investigated less frequently (Gallegos et al., 2016; Lotzin et al., 2015; Power, 2016; Taraban & Shaw, 2018).

Current review

Even though valuable review articles on the associations of parenting and infant regulation already exist, most of them focus on a single particular aspect of regulation with broader age ranges (e.g., for temperament from infancy to adolescence, see Kiff et al., 2011; for negative emotionality from infancy to preschool, see Paulussen-Hoogeboom, Stams, Hermanns, & Peetsma, 2007). However, (a) it is not easy to separate each regulatory aspect from each other, as they are linked to each other; (b) the rapid changes in regulatory capacities in the first years of life may alter their relationship with parental behavior; (c) none of the existing review articles considered the interaction between age group and measurement method when investigating the relationship between parenting and infant regulation in the first two years.

To interpret the diverging results on the development of self-regulatory behavior patterns in infancy, a comprehensive overview illustrating the reasons leading to these diverging results is necessary. Therefore, we systematically reviewed the literature, aiming at summarizing current research and assessed the relationship between early parental behavior and

infant regulation, namely, temperamental characteristics on regulation, sleeping, crying and feeding in the first two years of life. Specifically, two main research questions guide this review:
(1) Is there a (bi-directional) relationship between infant regulation and parental behavior?
(2) To what extent do these connections depend on the selected measurement tools and infant age?

Method

Search strategy

The current review followed the guidelines of the PRISMA (Preferred reporting items for systematic reviews and meta-analyses) statement including the checklist and the diagram (Moher et al., 2009). *Web of Science* and *PsycINFO* were used as databases to search for relevant papers with the following keywords: (parenting OR warmth OR sensitivity OR responsivity OR responsiveness OR emotional availability OR involvement OR sooth* OR intrusive* OR harsh OR hostility) AND (temperament OR sleep* OR cry* OR sooth* OR feed* OR satiety OR regulation) AND (infan*). The asterisk at the end of the words broadens the search by finding results that consist of the same word stem but different endings. In addition, reference lists were checked to identify additional relevant studies. The first step was to establish the number of records found each year when searching with this keyword chain and how the studies are distributed across years. This procedure revealed that there was a substantial increase in the number of relevant publications since 2000. As the increase was clearly more significant after 2006, a decision was made to search for the studies published between 2007 and 2019. The last search was conducted in December 2019. The PRISMA flow diagram in Figure 1 shows the study selection process.

Inclusion and exclusion criteria

There were seven key attributes for the inclusion/exclusion procedure: (1) the included studies were required to be empirical papers, either cross-sectional or longitudinal; (2) studies

had to assess both parental variables and child related outcomes; (3) the variables had to be measured during the first two years of the infants' lives or the mean age had to be within the first 24 months; (4) preterm infants, children with developmental risks, delays, and/or disorders were excluded; (5) only studies assessing parent-infant interaction were included, studies on experimenter-infant or professional caregiver-infant interaction were excluded; (6) studies with mentally unhealthy parents or parents with specific disorders (e.g., borderline, social phobia, alcoholism) were excluded; (7) studies focusing on only intervention outcomes were excluded. A total of four reviewers participated in the study selection process. After the first abstract screening, two reviewers separately read every study that was saved for the full text screening, and the studies that were categorized differently were discussed in order to decide whether they should be included or excluded. At the end of the procedure, 107 studies were included in this review (see Figure 1).

Descriptives

The included studies originated from different countries, yet most of them were published in the United States. The distribution of these 107 studies is as follows: 57 from the United States, nine from Canada, eight from the UK, five from the Netherlands, four from Germany, three studies from each of the following countries: Israel and Portugal; two studies from each of the following countries: Australia, China, Italy, Norway and Sweden; and one study from each of the following countries: Chile, Ecuador, Finland, Ireland and Malawi. Finally, there were three collaborative works–one from the UK and South Africa, one from the UK and Italy, and one from USA and Chile. Half of the studies (54) were longitudinal and the other half (53) were cross-sectional studies.

Of these 107 studies, 83 were coded as temperamental characteristics; 28 studies were coded as sleeping, crying, or feeding (thirteen studies on sleeping behavior, seven on feeding, six on crying behavior and two studies on sleeping, crying and feeding together). Four studies

were coded into both categories, as they included outcomes on more than one aspect together. Eighty-nine studies included only mothers, and 18 studies gave information on both parents, however the number of fathers in the sample was less than 7% in 12 of those studies. The tables in the appendix summarize the main features and major findings of the studies.

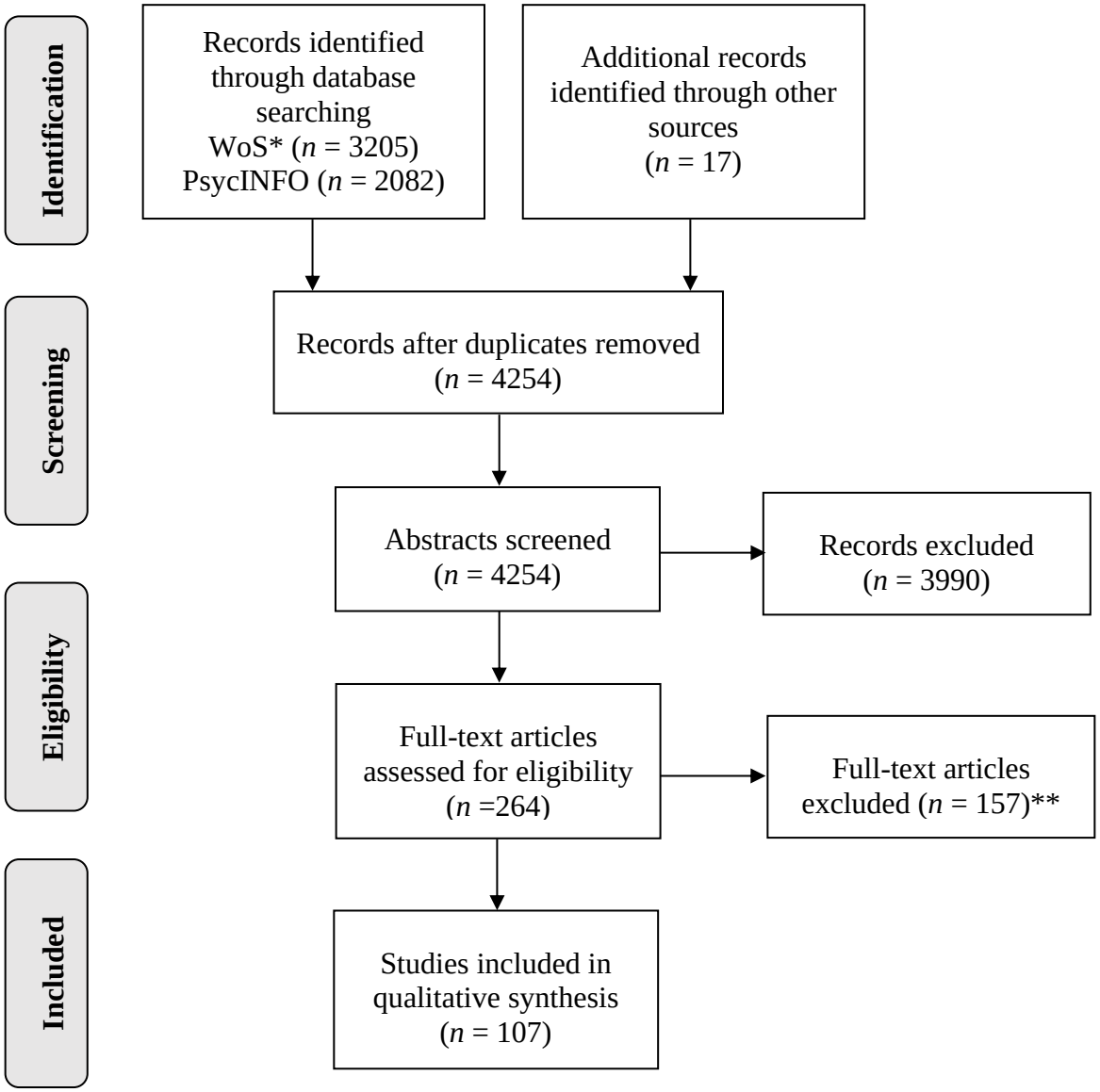

Figure 1. PRISMA Diagram

Notes. * WoS = Web of Science, ** Reasons for exclusion: without relevant parental or infant variables (*n* = 69), older age group, (*n* = 27), unpublished thesis (*n* = 13), not empirical (*n* = 12), with mentally unhealthy parents (*n* = 11), only intervention outcomes (*n* = 7), parental or infant variables as mediator or moderator, direct relationship not reported (*n* = 5), with preterm infants or non-healthy infants (*n* = 7), other language (*n* =3), with professional caregiver, (*n* = 2), animal research (*n* = 1).

Results

The results section is divided into two parts. Studies are first presented according to age groups, and then according to the measurement method.

The relationship of parental behavior and regulation: The first year of life

From birth to four months

Temperament. The earliest studies assessing the relationship between parental behavior and infant regulation were conducted during the third and fourth month of infants' lives. In a substantial number of studies, the association between positive maternal behavior such as sensitivity/responsiveness and temperamental characteristics, such as orienting, easiness, soothability and regulation of positive/negative affect was evident (Backer et al., 2018; Barbosa et al., 2019; Handal et al., 2017; Pitzer et al., 2011; Spinelli & Mesman, 2018). Nevertheless, one study revealed a significant effect of sensitivity on infant affect only for temperamentally difficult infants (Mesman et al., 2013), and another study confirmed the relationship only with paternal sensitivity, not with maternal sensitivity (Planalp, O'Neill, et al., 2019).

Sleeping, crying, feeding. Other than research on temperamental characteristics, studies assessing the relationship between parental behavior and infant sleep, crying and feeding behavior started directly after birth. Within the first three months, parental sensitivity reduced multiple regulatory problems including crying, sleeping problems and feeding problems (Bilgin & Wolke, 2017b; Richter & Reck, 2013). Whereas maternal involvement, comfort and appropriate nighttime parenting practices predicted less crying and night wakings in two studies (Ganda, Fara Ibrahim, Natchimutu, Ryan, 2011; Voltaire & Teti, 2018), the positive effect of parental sensitivity was not consistently evident when the influence of parental sensitivity on feeding problems or cry duration was assessed separately and not together (Bilgin & Wolke, 2017a; Richter & Reck, 2013; Stormark, 2007).

The effects of negative parenting on infant regulation also became apparent already in the first months. Infants of mothers, who exert more pressure and intrusiveness appeared to have more food refusing behavior and less appetite (Fildes, van Jaarsveld, Llewellyn, Wardle, & Fisher, 2015; Tambelli, Odorisio, & Lucarelli, 2014). In addition, high levels of maternal aggressive behavior were associated with excessive infant crying (Smarius et al., 2017).

Five to seven months

Temperament. Halfway through the first year, maternal sensitivity was associated with different temperamental characteristics, such as attention, resistance, orientation and positive affect (Conradt & Ablow, 2010; Crockenberg, Leerkes, & Jó, 2008; Kaitz et al., 2010; Perry, Calkins, & Bell, 2016; Planalp et al., 2019; Puura et al., 2013; Swingler, Perry, Calkins, & Bell, 2014). However, the association between maternal sensitivity and infant negative affect regulation failed to show significance in nine out of twelve studies (Backer et al., 2018; Jonas et al., 2015; Kaitz et al., 2010; Leerkes & Zhou, 2018; McMahon & Newey, 2018; Mesman et al., 2013; Mills-Koonce et al., 2007; Swingler et al., 2014; Thomas, Maconachie, Sheth, McLean, & Gottlob, 2017). The other three studies associated higher levels of maternal sensitivity with lower levels of infant distress reactions and negative affect during parent-infant interactions (Crockenberg, Leerkes, & Jó, 2008; Planalp et al., 2019; Puura et al., 2013). In addition, three studies worked with especially large samples (n >1000) and focused on a wider range of positive parental behavior in addition to sensitivity, such as positive handling, emotionality, warmth, maternal self-efficacy and non-hostility. Prady, Kiernan, Fairley, Wilson, and Wright (2014) associated higher levels of positive parenting practices with lower levels of problematic infant temperament in an economically deprived sample. Similarly, the German National Educational Panel Study (Freund et al., 2017, 2019) associated lower interaction quality with higher levels of negative affectivity only in the group with psychosocial risk factors.

In addition to these, three studies focused on negative parental behavior. These studies assessed intrusiveness, unresponsive, authoritarian and permissive parenting but did not consistently reveal significant associations with infant regulation (Norcross et al., 2017; Wang et al., 2015; Wittig & Rodriguez, 2019). Lastly, two studies assessed the relationship reversely and showed higher levels of infant negative affect as a predictor of lower levels of maternal sensitivity (Leerkes, 2010; Leerkes, Su, Calkins, Supple, & O'Brien, 2016).

Sleeping, crying, feeding. Towards the midst of the first year, higher levels of maternal sensitivity were associated with better infant acceptance of food (Costantini, Akehurst, Reddy, & Fasulo, 2018), appropriate soothing behavior led to shorter cry durations (Jahromi & Stifter, 2007), and maternal emotional availability was related to longer infant sleep durations (Jian & Teti, 2016). However, when the quality of infant sleep (total wake minutes and/or percent of sleeping time at night) was the outcome (rather than the duration), the effects of maternal emotional availability and paternal involvement failed to influence infant sleep quality (Jian & Teti, 2016; Tikotzky et al., 2015).

Studies assessing the relationship in the opposite direction did not reveal an effect of infant willingness to eat or the number of night awakenings on positive maternal behavior (Costantini et al., 2018; Kim & Teti, 2014). Instead, higher levels of infant night awakenings predicted lower levels of paternal involvement (Tikotzky et al., 2015). On the other hand, the relationship between maternal responsiveness and infant crying showed a different pattern. In contrast to the overall trend, the more frequently mothers ignored their infants' cries during the first months, the less frequently the infants cried around the age of six months (Van IJzendoorn & Hubbard, 2010).

Eight to eleven months

Temperament. Investigating the second half of the first year, studies mostly showed a significant positive relationship between parental sensitivity, positive affect, responsiveness

and infant positive affect (Frick, Forslund, Fransson, et al., 2018; Lahey et al., 2008; Malmberg et al., 2007; Martins, Soares, Martins, & Osorio, 2016; Planalp et al., 2019; Taylor, Donovan, & Leavitt, 2008) There were, however, studies with non-significant results as well. These were mainly studies with a different focus, for example assessing the relationship between parental behavior and infant temperament characteristics as a secondary research outcome (Frick, Forslund, & Brocki, 2018; Gartstein, Crawford, & Robertson, 2008; Kucirkova, Dale, & Sylva, 2018; Laake & Bridgett, 2018; Perry et al., 2016; Taylor et al., 2008). Moreover, in accordance with the results of the previous age group, the association between maternal sensitivity and infant negative affect was not confirmed in five out of seven studies (Din, Pilai Riddell, & Gordner, 2008; Frick, Forslund, Fransson, et al., 2018; Gartstein et al., 2018; Martins et al., 2016; Parade, Wong, Belair, Dickstein, & Seifer, 2019; Planalp et al., 2019; Taylor et al., 2008).

Three studies in this age group included fathers in the analysis. While Malmberg et al. (2007) found no significant differences in the relationship between infant mood and parental sensitivity between mothers and fathers, Martins et al. (2016) revealed an association between parental emotional availability and infant emotion regulation only for fathers, and Kotila, Schoppe-Sullivan, and Push (2014) revealed the positive influence of parental engagement on infant negative affect only for mothers. Similarly, the studies assessing parental behavior as an outcome rather than a predictor did not consistently yield infant affect and mood as significant predictors of positive parental behavior (Kim & Teti, 2014; Malmberg et al., 2007). Regarding negative parental behavior, higher levels of parental overreactivity and spanking was associated with higher levels of infant negative emotionality, fearfulness and fussiness (Lahey et al., 2008; Lipscomb et al., 2011).

Sleeping, crying, feeding. Whereas Teti, Kim, Mayer, and Countermine (2010) confirmed the influence of higher levels of emotional availability at bedtime on increased infant sleep duration and decreased sleep difficulties, maternal emotional availability was not

influenced by infant night awakenings (Kim & Teti, 2014). In terms of crying, one study revealed that mothers were more sensitive when their infants showed more distressed reactions such as protesting, crying and fussing when separated from a parent (Ablow et al., 2013).

Longitudinal effects between the first two years

Temperament. In addition to the relationship between parental behavior and infant regulation during the first year, parental behavior in the first year influenced infant regulation in the second year. Infants exposed to higher maternal sensitivity in the first year were better at regulating emotions during the second year of life (Bozicevic et al., 2016; Brady-Smith et al., 2013; Frick et al., 2018; Halligan et al., 2013; Ispa, Su-Russell, Palermo, & Carlo, 2017). On the other hand, there were a number of studies revealing mixed findings as well. These studies failed to confirm the positive influence of maternal sensitivity, supportiveness and emotional availability on the regulation of negative affect in a consistent way (Freund et al., 2019; Jonas et al., 2015; Kim, Stifter, Philbrook, & Teti, 2014; Leerkes, Blankson, O'Brien, & O'Brien, 2009; Scaramella, Sohr-Preston, Mirabile, Robison, & Callahan, 2008).

Studies indicated that these longitudinal effects might differ by culture and by gender. For instance, cultural effects were partially evident in studies that included participants from different cultural backgrounds. Although sensitive and supportive mothering was positively associated with better infant emotion regulation in all cultures, differences in parental behavior and infant regulation styles were evident. For instance, the use of harsh parenting was more evident in European American and African American samples in comparison to a Mexican American sample (Brady-Smith et al., 2013), and infants from individualistic societies were showing more active strategies of emotion regulation compared to infants from collectivist societies in general (Bozicevic et al., 2016). In addition to these culture-specific effects, one study investigated gender effects, and revealed the positive relationship between early maternal sensitivity and later self-control only for girls (Pitzer et al., 2011).

Furthermore, four studies examined the effects of parental behavior on infant regulation with variables on negative parental practices. Whereas two studies (Perry, Dollar, Calkins, & Bell, 2018; Scaramella et al., 2008) found increases in infant distress and negative affectivity during the second year to be the result of maternal intrusiveness and harsh parenting at year one, other studies revealed the influence of negative parenting only for fathers or failed to confirm any association (Gallegos et al., 2016; Lorber & Egeland, 2011). The other way around, only three out of ten studies confirmed a prediction of parental behavior in the second year through changes in infant regulatory capacities in the first year (Bridgett et al., 2009, 2013a; Perry, Dollar, et al., 2018). In all other studies, early infant regulation neither predicted positive nor negative parental behavior (Blissett & Farrow, 2007; Dong et al., 2018; Donovan et al., 2007; Freund et al., 2019; Ispa et al., 2017a; Parade et al., 2019; Pitzer et al., 2011).

Sleeping, crying, feeding. Four studies on sleeping, crying and feeding assessed longitudinal associations between the first and the second years of life. Whereas the association between infant feeding problems and maternal behavior was mostly confirmed in both directions (Bilgin & Wolke, 2017c; Blissett & Farrow, 2007), the positive effect of early maternal sensitivity on multiple regulatory problems, and the negative influence of sleep problems on maternal sensitivity was not significant (Bilgin & Wolke, 2017b; Parade et al., 2019).

The relationship of parental behavior and regulation: The second year of life

Twelve to seventeen months

Temperament. During the first half of the second year, the positive association between positive parenting (e.g., sensitivity, responsiveness, encouragement) and infant regulation was mostly evident (Augustine & Leerkes, 2019; Farkas et al., 2017; O'Neal et al., 2017), in spite of some studies with insignificant results (Kim et al., 2014; Woldarsky, Urzua, Farkas, & Vallotton, 2019). Furthermore, positive infant temperamental characteristics such as lower fear,

anger, negativity and better regulation predicted higher levels of maternal sensitivity and responsivity as well (Gudmundson & Leerkes, 2012; Leerkes et al., 2016; Popp et al., 2008). On the other hand, infant's negative emotionality at this age did not lead to a decrease in maternal or paternal parenting quality in the subsequent months (Padilla & Ryan, 2019).

In this age group, more studies on negative parental behavior started to emerge and showed associations with infant regulation. For instance, higher levels of harsh parenting were associated with lower levels of infant emotion regulation, and higher levels of maternal detachment and intrusive behavior were associated with higher levels of negative interactive behavior, distress and negativity, but not with frustration (Galligan et al., 2018; Mortensen & Barnett, 2017a; O'Neal et al., 2017; Szabo et al., 2008)

Sleeping, crying, feeding. At 12 months, the relationship between parental behavior and infant sleep became inconsistent across studies. One study confirmed the positive effect of maternal sensitivity on overall sleep behavior (e.g., time taken to fall asleep, number and length of night wakings and wake-up time in the morning; Priddis, 2009). The other three studies failed to find a significant association between maternal sensitivity and infant sleep duration or percentage of sleep at night (Bernier, Belanger, Tarabulsy, Simard, & Carrier, 2014; Bordeleau, Bernier, & Carrier, 2012; Tétreault, Bouvette-Turcot, Bernier & Bailey, 2016). Regarding feeding and crying, cross-sectional studies positively associated higher maternal sensitivity and responsiveness with infant acceptance of food, and negatively associated this sensitivity with crying (Flax et al., 2013; Moding et al., 2014; Stormark, 2007; Tétreault et al., 2016). However, another study failed to find an effect of early eating problems on maternal pressure to eat, monitoring or restrictive behavior during mealtime at age one (Blissett & Farrow, 2007).

Eighteen to twenty-four months

Temperament. At the end of the second year, there was a clear trend across studies showing that positive maternal behavior including sensitivity, responsiveness, supportiveness

and involvement predict infant emotion regulation (Ayoub et al., 2011; Bocknek et al., 2009; O'Neal et al., 2017; Roque & Veríssimo, 2011; Spieker et al., 2018). Nonetheless, one study associated higher levels of difficult temperament with lower levels of parental sensitivity only for fathers and not for mothers (Millikovsky-Ayalon et al., 2015). Similarly, when the relationship was assessed in the opposite direction, differences between maternal and paternal sensitivity were observed again (Fields-Olivieri et al., 2017). Whereas infants' emotion expressions were unrelated to maternal sensitivity, positive emotion expressions led to higher paternal sensitivity (Fields-Olivieri et al., 2017). Furthermore, there was a significant number of studies investigating negative parental variables which confirmed an association between maladaptive parent-infant interactions including harsh, hostile, intrusive, restrictive parenting, and reduced infant regulation of emotions (Bryan & Dix, 2009; Cerniglia, Cimino, & Ballarotto, 2014; Lorber & Egeland, 2011; Micalizzi, Wang, & Saudino, 2017; Perry et al., 2018; Pitzer et al., 2011).

Sleeping, crying, feeding. At the end of the second year of life, one study showed the positive effect of parental sensitivity on infant sleep duration only for fathers and not for mothers (Millikovsky-Ayalon et al., 2015). Another study confirmed its effect on the percentage of total sleep at nighttime only at 24 months and not at 18 months (Tétreault et al., 2016). In addition, one contrasting result associated higher maternal sensitivity with more sleep awakenings (Weinraub et al., 2012).

Analyzing results depending on the 'Measurement Method'

With regard to the operationalization of parenting, most studies only focused on observational methods. Yet, when it comes to the way infant regulation was measured, studies varied immensely. Figure 2 shows the number of significant findings according to age and measurement method, that is, semi-structured measures, structured measures, and parental reports.

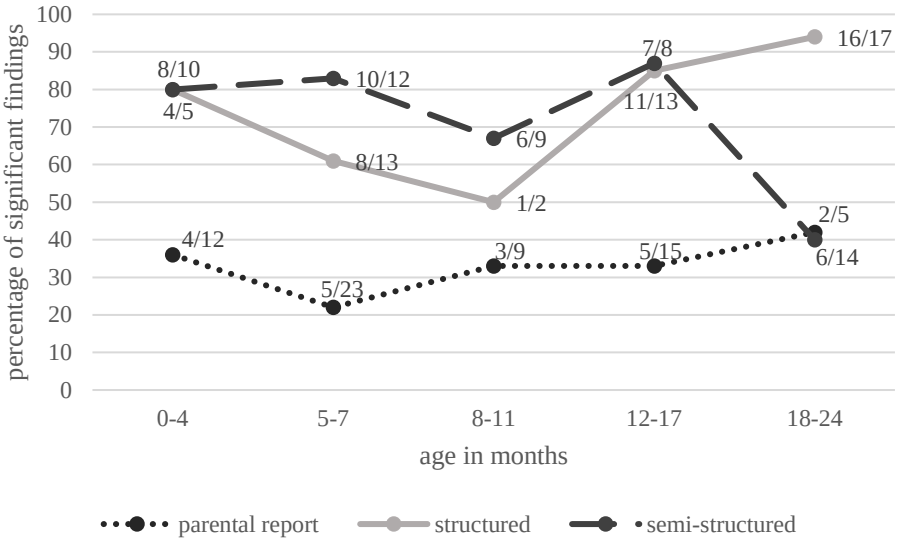

Figure 2. The percentage of significant findings on the relationship between parental behavior and infant regulation depending on infant age and the measurement method of regulation, including studies on temperamental characteristics and sleeping, crying, feeding. The numbers on the graph indicate the ratio of significant findings to the number of all findings at that age group.

Semi-structured measures

Semi-structured measures include observations of mother-infant interactions without experimenter interference, such as **play sessions** or **daily routines**. They revealed consistent and significant results during the first 17 months, when the relationship between parental behavior and infant temperamental characteristics was investigated using correlation or when infant regulation was assessed as the outcome. According to these studies, positive parenting constructs (e.g., sensitivity, responsiveness, supportiveness, structuring) were positively associated with better regulation of infant behavior, including regulation of distress and other negative affect (Brady-Smith et al., 2013; Galligan et al., 2018; Kaitz et al., 2010; Malmberg et al., 2007; Martins et al., 2016; O'Neal et al., 2017; Puura et al., 2013; Szabo et al., 2008; Taylor et al., 2008). Nevertheless, studies assessing infant regulation as a predictor of parental behavior

did not yield consistent results (Fields-Olivieri et al., 2017; Malmberg et al., 2007; Nordahl et al., 2016; Parade et al., 2019).

Apart from observations of play situations or daily routines, four additional studies specifically focused on infant distress behavior during **immunization**. The relationship between maternal structuring (mother's structuring and stimulating behavior such as using toys to keep the infant busy) and infant distress was not significant (Din et al., 2008). However, maternal sensitivity, emotional availability and non-intrusiveness had a positive influence on infant pain-related distress, in accordance with the findings from play sessions and daily routines (Atkinson et al., 2015; Badovinac et al., 2018; Din et al., 2008; Din Osmun et al., 2014).

In order to assess **sleeping, crying and feeding**, the **observation** of parent-infant interactions during play sessions, feeding situations or sleep states was the most common direct measurement method. Findings yielded almost only significant associations between parental behavior and infant regulation. According to these studies, sensitivity to infant cues during meal time had a positive effect on infant willingness and acceptance of food, whereas low levels of maternal responsiveness and excessive involvement were associated with more food rejection (Costantini et al., 2018; Flax et al., 2013; Moding et al., 2014; Tambelli et al., 2014). In terms of sleep, infants with mothers who showed higher levels of emotional availability and appropriate nighttime parenting practices slept longer and woke up less often at night during the early months of life (Philbrook & Teti, 2016; Voltaire & Teti, 2018). On the other hand, whereas the positive effect of positive parental behavior (e.g., involvement, comfort, soothing) on infant crying that was confirmed in two studies (Ganda et al., 2011; Jahromi & Stifter, 2007), it was reversed in two other studies. These studies showed that, sensitive behavior such as rocking, eye-gaze or face-to face contact before the immunization procedure was associated with increased levels of infant crying during injection (Stormark, 2007). Likewise, more

frequent maternal unresponsiveness to infant crying was associated with lower levels of infant crying in the subsequent months (Van IJzendoorn & Hubbard, 2010).

Apart from the observational methods, four out of 13 sleep studies used **actigraph monitors**. However, findings on the relationship between parental behavior and sleep were mostly insignificant. Whereas one out of four studies showed a positive association between positive parental behavior and sleep duration, none of the studies found a relationship with sleep quality (Bernier et al., 2014; Jian & Teti, 2016; Parade et al., 2019; Tikotzky et al., 2015).

Structured measures

In contrast to semi-structured measures, the use of structured measures started to generate more significant findings after the first year. These measures mostly assessed temperament in laboratory settings with tasks such as the Still-Face-Paradigm (SFP; Tronick et al., 1978), the Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith & Rothbart, 1993, 1996, 1999) and other structured procedures such as arm restraint, limitation and novelty tasks. Additionally, there were nine studies that implemented the Bayley Scales of Infant Development (BSID-II, Bayley-III; Bayley, 1993, 2006).

Most of the studies that conducted the **Still-Face-Paradigm** showed that positive maternal behavior, such as higher levels of maternal sensitivity, responsiveness and non-hostility, were positively associated with infant attention to the mother, higher levels of infant positive affect, and better regulation of negative affect (Barbosa et al., 2019; Conradt & Ablow, 2010; Handal et al., 2017; Spinelli & Mesman, 2018). Additionally, positive maternal behavior was negatively associated with infant resistance as well (Conradt & Ablow, 2010). The studies that used **Lab-TAB** and further **distress-eliciting tasks** focused mostly on negative affect, such as the regulation of reactivity in distress situations. Most of the findings from Lab-TAB suggested maternal sensitivity as a significant predictor of infant regulation in distress situations, including fear and frustration (Bozicevic et al., 2016; Frick et al., 2018; Gartstein et

al., 2018; Halligan et al., 2013), whereas harsh parenting predicted increases in infant distress (Scaramella et al., 2008). Although this pattern was also observed through further distress eliciting tasks in some studies (Crockenberg et al., 2008; Leerkes et al., 2016; Roque & Veríssimo, 2011), a significant number of studies revealed mixed findings or failed to find an association between maternal behavior and infant affect when using the SFP and other distress-eliciting tasks (Augustine & Leerkes, 2019; Kim et al., 2014; Leerkes et al., 2009; McMahon & Newey, 2018; Mesman et al., 2013; Mills-Koonce et al., 2007; Norcross et al., 2017; O'Neal et al., 2017; Planalp et al., 2019; Swingler et al., 2014). Some of them showed a significant relationship only for temperamentally difficult infants, some in certain situations (e.g., during a book reading activity), and some for specific subscales, such as for maternal non-hostility or negative maternal behavior. In addition, the results of the studies that included both parents indicated that infant emotion regulation was positively associated with paternal emotional availability and negatively associated with paternal emotional withdrawal, but not significantly associated with maternal emotional availability or withdrawal, indicating a stronger relationship between infant regulation and paternal behavior (Gallegos et al., 2016; Martins et al., 2016).

The only **standardized test** to measure infant regulation was the Bayley Scales (Bayley, 1993; Bayley, 2006). Its Behavior Rating Scale (BRS) included various regulatory behavior such as negative affect, attention or adaptation to change. These studies were conducted after the first year of life and confirmed both the positive effect of supportive and sensitive mothering, and the negative effect of maternal detachment and harsh parenting on infant emotion regulation (Ayoub et al., 2011; Bocknek et al., 2009; Brady-Smith et al., 2013; Halligan et al., 2013; Ispa et al., 2017a; Mortensen & Barnett, 2017a; O'Neal et al., 2017; Spieker et al., 2018). Nevertheless, infant regulation did not appear to predict harsh or sensitive parenting (Ispa et al., 2017a; Mortensen & Barnett, 2017a). The studies on **sleeping, crying and feeding** did not include any standardized measures.

Parental reports

Parental report measures failed to show the expected relationship across all age groups. Here, questionnaires such as the Infant Behavior Questionnaire (IBQ; Rothbart 1981, 1986; IBQ-R; Gartstein & Rothbart, 2003; IBQ-R-VSF; Putnam, Helbig, Gartstein, Rothbart & Leerkes, 2014), the Early Childhood Behavior Questionnaire (Putnam, Gartstein, & Rothbart, 2006) and the Infant Characteristics Questionnaire (ICQ; Bates, Freeland & Lounsbury, 1979) were implemented. However, Rothbart's IBQ – Revised (Gartstein & Rothbart, 2003) was by far the most frequently used method for assessing temperamental characteristics. As a result, the studies did not focus on situational emotion regulation, but rather on characteristics of temperament such as overall reactivity, difficulty, soothability, positive or negative affectivity.

Apart from a few studies that associated high levels of responsiveness, warmth, engagement and low levels of negative parenting (i.e., hostility, overreactivity, intrusiveness) with less problematic infant temperament, better regulatory capacities and higher levels of positive affectivity (Gartstein et al., 2018; Lahey et al., 2008; Lipscomb et al., 2011; Micalizzi et al., 2017; Perry, Dollar, et al., 2018; Prady et al., 2014), most studies reported either non-significant relationships or mixed results (e.g., Backer et al., 2018; Bosquet Enlow et al., 2019; Frick et al., 2018; Kaitz et al., 2010; Kucirkova et al., 2018; Laake & Bridgett, 2018; Szabo et al., 2008; Thomas et al., 2017). For instance, two studies reported the positive association between positive parental behavior and infant affect regulation only for infants older than 18 months (Donovan et al., 2007; Jonas et al., 2015), one study confirmed this relationship only for at-risk infants (Freund et al., 2017), another study showed a significant association between maternal behavior and infant fearfulness but not with anger (Bryan & Dix, 2009); and one study revealed the negative relationship between parental sensitivity and difficult temperament only for fathers (Millikovsky-Ayalon et al., 2015).

Furthermore, studies assessing infant regulatory problems as predictors of negative parental behavior did not yield consistent findings either. Whereas four studies from three research groups revealed the detrimental effects of low infant regulatory capacity and high negative affectivity on negative parental behavior (Bridgett et al., 2009, Bridgett et al., 2013; Perry et al., 2018, Popp et al., 2008), others revealed either non-significant findings or evidence for some subscales that did not show consistency across studies (Blissett & Farrow, 2007; Cerniglia, Cimino, & Ballarotto, 2014; Fields-Olivieri et al., 2017; Freund et al., 2019; Kim & Teti, 2014; Nordahl et al., 2016; Padilla & Ryan, 2019). Overall, questionnaires failed to consistently reveal the expected relationship between temperamental characteristics and parental behavior.

Of the studies that included parental reports for assessing **sleeping, crying, and feeding**, nine studies used **questionnaires**, and seven studies used **sleep diaries**. The results showed more consistency compared with studies on temperamental characteristics that used questionnaires. In spite of some variability depending on age or sub-variables, the trend of infant regulatory behavior being positively influenced by positive parental behavior was evident (Bilgin & Wolke, 2017b, 2017c; Fildes et al., 2015; Millikovsky-Ayalon et al., 2015; Richter & Reck, 2013; Smarius et al., 2017; Teti et al., 2010; Weinraub et al., 2012). One study suggested that the effects might be stronger for crying and sleeping behavior, and failed to find an effect on feeding (Richter & Reck, 2013). Moreover, two other studies suggested that the effects might differ between mothers and fathers or through situational influences (Millikovsky-Ayalon et al., 2015; Richter & Reck, 2013).

The results from sleep diaries were more heterogeneous than questionnaires. For example, Priddis (2009) assessed variables such as sleep duration, time it took the child to fall asleep, number and length of waking times, and built a composite score of good and poor sleepers. Their results showed that good sleepers seem to have mothers with higher maternal

sensitivity. In accordance with the findings obtained from actigraph monitors (Bernier et al., 2014; Tikotzky et al., 2015), positive parental behavior did not show an effect on infant sleep duration, when sleep diaries were used in the studies (Bernier et al., 2014; Bordeleau, Bernier, & Carrier, 2012). However, the trend that positive parental behavior reduces sleep disruption (e.g., number of wake episodes, percentage of nighttime sleep, total time infant was awake at night) was evident in some studies (Teti et al., 2010; Tétreault et al., 2016; Tikotzky et al., 2015).

Discussion

The amount of research relating parenting behavior to infant regulation is growing. Whereas approximately one third of the reviewed studies were published between 2007 and 2012, the number doubled over the next six-years with two thirds of the reviewed studies being published between 2013 and 2019. The thematic distribution of these studies is, however, uneven. The number of studies investigating temperamental characteristics is nearly three times higher than studies on concrete behavioral regulation challenges–sleeping, crying, and feeding–although infantile colic, sleep and feeding disorders are among the most common disorder patterns in early childhood, with around 20% of prevalence in the first two years of life (Schieche et al., 2004; von Hofacker et al., 2004; Ziegler et al., 2004). Although studies with clinical samples were excluded during our database search–as the focus of this review was the association between parental behavior and the behavioral regulation of healthy infants–the limited number of studies demonstrates that these three important behavioral aspects of infant regulation are rarely investigated, compared to temperamental characteristics in the healthy population. Collectively, the studies did not reveal consistent findings, but they indicated a positive relationship between parental behavior (e.g., sensitivity, responsiveness, supportiveness, positive affect) and infant regulation, and suggested differences according to age, measurement method and infant behavior.

Age-related differences

Regarding the age-related findings, a U-shaped trajectory was observed. The earliest studies around thee to four months revealed a positive association between maternal sensitivity/responsivity and infant regulation. However, inconsistent findings started to emerge around six months after birth. These inconsistencies in the findings mostly concerned negative affectivity but not positive affectivity. Only a few studies were able to confirm the relationship between parental behavior and negative affectivity between 6 to 12 months. This relationship, however, started to emerge again after the first year of life. Previous research on the development patterns of negative temperament showed that, distress, fear and reactivity start to show instability after 3 months, especially during the 3 to 12 months period, indicating a U-shaped development (Carranza Carnicero, Pérez-López, González Salinas, & Martínez-Fuentes, 2000; Rothbart, 1986). Thus, inconsistencies in studies on parenting and infant regulation might be a reflection of the temperamental changes occurring during this particular period of development. Moreover, twin studies have revealed that negative affect including anger, fear, and frustration has genetic roots (Deater-Deckard et al., 2007; Mikolajewski et al., 2013). While the genetic origin plays a more important role for negative affect, positive affect is more susceptible to environmental influences (Baker et al., 1992). Hence, it is possible that negative affect is less affected by parental behavior compared with other regulatory aspects such orienting or positive affect, and show an insignificant relationship with parental behavior in studies.

Method-related differences

With regard to the inconsistent findings, most of the studies that did not reveal a significant relationship between parenting and infant temperamental characteristics assessed the relationship as a secondary outcome in their studies using parental reports on temperament. Parental reports, however, may not be accurate when assessing the negativity dimension of

temperament during infancy (Stifter, Willoughby, & Towe-Goodman, 2008). These non-significant results, especially concerning affect, seem to be linked to the measurement method, as semi-structured and structured tasks revealed more consistent findings than questionnaires. Previous research also criticized the validity of the parental reports on infant temperament, as they yield only low correlations with temperament ratings assessed through observational instruments, but rather significant correlations with parents' own personal characteristics (Seifer et al., 2004; Seifer, Sameroff, Barrett, & Krafchuk, 1994; Stifter & Dollar, 2016).

In addition, the constructs that are measured with parental reports (e.g., negative affectivity) may be different from what is measured with semi-structured or structured methods as associations between these methods are generally small or insignificant (Stifter & Dollar, 2016). Questionnaires may assess more stable biological components of temperamental characteristics than structured or semi-structured methods, such as the impulsivity component of temperament influenced by dopamine receptor genes (Propper et al., 2008). In contrast, regulatory behavior measured by semi-structured measures may be more prone to parental influence, as they focus on interactional aspects of regulation.

However, this was not the case for sleeping behavior. Studies conducted with semi-structured measures (i.e., actigraphs) and parental reports (i.e., sleep diaries) both showed inconsistent findings, especially in terms of sleep quality. Even though actigraphy is accepted as an important tool to assess sleep patterns, it has two limitations when using it with infants. Its reliability is low when detecting brief wakefulness during sleep episodes, leading to poor results concerning sleep quality; and it is susceptible to external movements, which can easily affect the results (Horne & Biggs, 2013). Sleep diaries, on the other hand, are criticized for delivering subjective data (Jian & Teti, 2016), but are frequently used due to their low cost and ease-of-use (Tremaine et al., 2010).

With regard to the structured measures, studies focus mostly on the rudimentary aspects of regulation such as controlling emotions and responses, which cannot be observed during the first year (Rothbart & Goldsmith, 1985; Stifter & Dollar, 2016). Negative affect was the temperamental characteristic that was most frequently measured in laboratory tasks. Nevertheless, variability was still apparent in actual set-ups and in findings. Although both of the two frequently used structured tasks–the SFP and Lab-TAB tasks–measured negative affect in distress situations, the first one focused more on higher-order facets of temperament, whereas the latter mostly measured lower-order facets (e.g., fear and frustration). However, it is assumed that the measurement of temperament by higher-order facets is susceptible to subjectivity, as they are derived from parent questionnaires (Stifter & Dollar, 2016). As a possible consequence of this difference with regard to the content of the negative affect, the results of the studies conducted with the SFP showed inconsistencies, whereas the studies with Lab-TAB indicated the positive influence of maternal sensitivity on the regulation of fear and frustration.

Age & method interaction in findings

The investigation of findings according to age and measurement method indicated that the differences in the operationalization of regulation and infants' age-specific characteristics cause differences in findings and make certain methods more suitable for certain age groups. More specifically, this review suggests the use of semi-structured measures to assess infant regulation before the first year and structured measures after the first year. The early significant results through semi-structured measures and its decline after 18 months can be understood by considering developmental changes in the first two years of life. A distinctive bond is formed between the infant and the primary caregiver around six to 18 months, in which infants start to show separation anxiety (Siegler et al., 2016). This possibly makes it harder to conduct structured measures in laboratory settings, as their fearful or inhibited nature would affect the flow of the task (Stifter & Dollar, 2016). By contrast, semi-structured measures that take place

in familiar home environments are less complicated to carry out during this period. On the other hand, the period of irritability, resistance and anger that starts around 18 months–the terrible twos–(Belsky et al., 1996; Kopp, 1992) encourages researchers to conduct more structured measures to control the situation as much as possible. Thus, although structured and semi-structured measures of infant regulation both show equal results in the studies directly after birth, this pattern changes around 6 months. Semi-structured measures seem to be more suitable between six to 18 months, and the use of structured assessments increases rapidly in the studies during the second year of life, showing significant associations with parental behavior especially after 18 months.

When the use of structured measures is further investigated, the Behavior Rating Scale of the BSID-II was preferred in the late infancy period, whereas studies in the early infancy period mostly measured regulation through the SFP. However, during the eight-11-month-period in-between, the number of studies conducting structured measures was low. This is due to the characteristics of the measurement methods. For instance, a review of the history of the SFP shows that the mean age of the infants in the SFP studies is around five months, with most of the studies accumulated around two to six months (Adamson & Frick, 2003). This indicates that the suitability of a measurement method for certain age groups depends on it characteristics. Taken together, a gap appears in reliable and valid structure assessment tools to assess infant behavioral regulation during the second half of the first year that meet the characteristics of the age group.

Comparing results on temperamental characteristics vs. sleeping, crying, feeding

When comparing studies regarding their findings on temperamental characteristics with studies on sleeping, crying, and feeding, the studies examined did not reveal many differences. This suggests that the interaction with the measurement method and age stays almost the same regardless of the differences between constructs. However, the findings from sleeping, crying

and feeding studies were slightly more consistent than studies on the temperamental characteristics of regulation. Taking this and the insignificant findings of the studies with temperament questionnaires into account, there may not be a strong association between overall parenting and the stable aspects of infant regulation, but rather a situational/ temporary association between parental behavior and infant regulatory capacity, depending on the context. That is, both parental behavior and infant regulation are susceptible to change as a result of how the other interaction partner behaves in context–in accordance with the mutual regulation model (Gianino & Tronick, 1988) or the transactional model of parenting (Wachs & Kohnstamm, 2001)–but this may not have long-lasting effects.

Moreover, the expected association was mostly evident in the opposite direction as well, when parental behavior was assessed as the outcome of infant sleeping, crying and feeding behavior, in contrast to the findings from temperament research. Whereas temperament is considered an early indicator of personality that is relatively stable (Slobodskaya & Kozlova, 2016; Stifter & Dollar, 2016), sleeping, crying and feeding are more visible and temporary aspects of behavior than temperamental characteristics. Therefore, parents may become less irritated and less affected by those temperamental characteristics when they are attributed to the infant's personality.

Among these studies, crying was the least investigated infant regulatory behavior, possibly because of the commonly used temperament subscale negative affect, which mostly contains crying behavior together with other variables such as fearfulness, fussiness and anger (Gartstein & Rothbart, 2003; Lahey et al., 2008). However, a differentiated investigation of crying in connection with parenting behavior is of particular interest. First of all, the negative affectivity subscale used in temperament questionnaires cover infant behavior in a variety of situations that assess trait-like features (Rothbart, 2011; Shiner et al., 2012) rather than situation-dependent temporary changes that can be observed through studies on crying.

Secondly, the studies in this review showed a different pattern than expected, regarding the relationship between parental behavior and infant crying. Rather than a negative association between maternal sensitivity and infant crying behavior–as shown in the original study by Bell & Ainsworth (1972)–higher levels of infant crying were associated with higher levels of sensitive and responsive maternal behavior in two studies (Stormark, 2007; and the replication study by Van IJzendoorn & Hubbard, 2010). Although previous literature suggests that mothers respond more quickly when an alarm situation is detected as a result of infant crying (Wood & Gustafson, 2001), the way in which higher levels of positive parenting would lead to higher levels of infant crying has not yet been clarified yet (Crockenberg, 1986; Stormark, 2007; Van IJzendoorn & Hubbard, 2010).

Paternal parenting behavior

The studies in the review were limited in the investigation of paternal variables. Although the number of studies investigating the influence of paternal influences on child development and father-child interactions is increasing (Lamb & Tamis-Lemonda, 2004), only 15 % of the studies in our review included both mothers and fathers. Even though there are not enough studies to draw conclusions about whether maternal and paternal behavior have different effects on infant regulation, those studies with both parents showed that the relationship between paternal behavior and infant regulation might be stronger than between maternal behavior and infant regulation. This can be explained by two complementary theories. "The fathering vulnerability hypothesis" postulates that fathering is more susceptible to family problems than mothering is (Cummings et al., 2004). It is possible that clear definitions of the maternal role and the expectations that are connected with it prevents the spillover effects of one aspect influencing the other, in contrast to the less clear parental role for the father (Cummings et al., 2010). Although it was originally developed to explain the effects of interparental conflict on fathering, the theory that negativity in the parental relationship affects

father-child relations more than mother-child relations can be transferred to explain the effects of infant negativity on fathering as well.

Similarly, according to the "differential reactivity hypothesis", children are more susceptible to the negativity of the fathers in family settings than that of their mothers (Cummings et al., 2004). From a child's perspective, hostility and anger expressions coming from the father lead to more distress reactions, whereas behavior that is threatening the emotional attachment plays a more important role with the mothers (Goeke-Morey & Cummings, 2007). In accordance with these theories, fathers are expected to be more strongly affected by infant distress or reactivity than mothers are, and similarly, infants are expected to be more strongly influenced by the negativity of their fathers than negativity of their mothers.

Mediators and moderators of the association between parental behavior and infant regulation

Although the direct association between parental behavior and infant regulation was the point of interest in this review, there are other factors mediating or moderating this relationship. For instance, Gudmundson and Leerkes (2012) focused on the moderating role of maternal coping styles on the relationship between maternal sensitivity and infant temperamental reactivity, and suggested that an engaged coping style (e.g., making an active effort to overcome a problem or seek help), compared to a disengaged coping style (e.g., trying to avoid the problem and the negative feelings), is not only important for a better mother-child relationship but also for adaptive child outcomes. Beside maternal differences, studies revealed other possible mediators or moderators. Perry et al. (2016) failed to show a direct influence of maternal sensitivity on infant behavior regulation. Their results, however, indicated that this relationship could be mediated through infant physical regulation in terms of vagal withdrawal– a decrease in the activity of the vagus nerve–which suggests that the association between parental behavior and infant behavioral regulation can be dependent on the maturation of the

vagal system. The activity of the vagal nerve decreases in stress situations so that heart rate and attention can be increased to cope with the demands of the challenging situation (Perry et al., 2016). If not, emotion regulation does not function properly and the expected association with parental behavior fails as well. Not only the vagal system, but also other physical mechanisms can be responsible for this association. For instance, Swingler et al. (2014) reported that the effect of maternal sensitivity on infant regulation of negative affect and distraction was moderated by infant neurophysiological functioning in terms of frontal baseline EEG asymmetry, as the prefrontal cortex is responsible for the regulation of emotional behaviors. Regarding the studies on sleeping, crying and feeding, similar mechanisms can be observed as well. According to Jian & Teti (2016), the influence of maternal emotional availability on infant sleep is moderated by infant surgency. In other words, highly surgent infants are affected strongly by their mothers' emotional availability, which possibly increases their sense of security and positively affects their sleep.

These findings are highly consistent with the view of Crockenberg (1986), who pointed out the characteristics of the caregiver and the caregiving environment being responsible for the inconsistent results in studies assessing the relationship between parenting and infant temperament. They are also in line with the biopsychosocial model of self-regulation (Calkins et al., 2016), highlighting the importance of the dynamic relationship between child biology, behavior and environment throughout the development of self-regulation. Especially individual characteristics seem to play an important role in this process. According to the differential susceptibility model, the effects of different contexts (e.g., parenting behavior) on child development are dependent on the child's genetic predispositions and sensitivity to context (Ellis et al., 2011). For instance, the study by Leerkes et al. (2009) indicates that maternal sensitivity affects infant distress regulation differently for temperamentally high and low reactive infants. This knowledge is important for two reasons. First, it suggests that emotional

and behavioral reactivity of the infant would moderate associations between parenting and regulatory outcomes. Secondly, it suggests interpreting the findings of the reviewed studies with caution, as it is possible that a low distress reaction could both mean a better regulation of distress, as well as a lower responsiveness to the distress situation. Hence, for an infant not to exhibit much distress reaction does not necessarily imply good regulatory capacities.

Overall, the various moderators indicate that, along with the methodological and age-related influences, the association between parental behavior and infant regulation is prone to be affected by biological, psychological and social factors. As these factors could affect the strength of the relationship, it is important that researchers consider these factors when building their theoretical framework.

Direction of the relationship between parental behavior and infant regulation

With regard to the direction of the relationship between parenting and infant regulation, most studies either assessed parental behavior as predictors of infant regulation or reported only correlations between these variables without specifying a direction. In order to be able to move further and discover whether early parenting may in fact predict later regulatory outcomes longitudinal cohort studies are of great interest. These studies such as ALSPAC (The Avon Longitudinal Study of Parents and Children) and MCS (The Millennium Cohort Study) from the UK, ECLS (The Early Childhood Longitudinal Study) and SECCYD (Study of Early Child Care and Youth Development) from the US, or LSAC (The Longitudinal Study of Australian Children) from Australia measure early parenting behavior such as sensitivity, warmth, harsh parenting, parental involvement and home learning environment during the first years, and investigate their longitudinal effects throughout life. Their results indicate that lower levels of maternal sensitivity and responsiveness, and higher levels of harsh parenting during infancy are associated with lower levels of social competence and higher levels of externalizing behavior problems during preschool, especially for children with difficult temperamental traits (Reinelt,

Samdan, Kiel, & Petermann, 2019 for an overview). On the other hand, higher levels of negativity, irritability and difficulty in soothing of these temperamentally difficult children during childhood and adolescence are predictive of higher levels of negative parenting behaviors as well (Scaramella & Leve, 2004). Yet, such studies investigating child behavior as a predictor of parental behavior are scarce (Paschall & Mastergeorge, 2016), although the need for a bidirectional investigation has been called upon for more than 50 years (e.g., Bell, 1968), and models highlighting the bidirectional relationship between parental behavior and infant regulation (e.g., the transactional model of parenting) are widely accepted. In particular, a bidirectional longitudinal investigation of the relationship between child regulation and parenting starting during infancy would allow to investigate the developmental dynamics of the relationship, and to reveal whether there are specific sensitive periods during which child regulation is more susceptible to parenting and vice versa (Feldman, 2015).

Due to the low number of longitudinal studies investigating this association bidirectionally, a pattern for specific sensitive periods cannot be observed among the investigated studies. These studies, however, indicate that both sensitive and harsh parenting have significant influence on how infants regulate themselves in the subsequent months, and this association seems to be stronger than it is in the opposite direction (Costantini et al., 2018; Ispa et al., 2017; Malmberg et al., 2007; Mortensen & Barnett, 2017). Though inconsistent, the studies analyzing this association in the opposite direction report increases in sensitivity and decreases in negative parental behavior through infant expression of positive affect and better regulation (e.g., Bridgett et al., 2013; Popp et al., 2008). However, when infants are distressed or have problems regulating basic behavior, parents do not consistently respond in a negative way; the association with negative parenting is less often significant during the infancy period (e.g., Blissett & Farrow, 2007; Freund et al., 2019; Padilla & Ryan, 2019). Altogether, despite the presence of a bidirectional relationship between parenting and infant regulation, the strength

of this relationship can be different depending on the direction. This can be one of the reasons why less amount of research is done in this area and raises the question of publication bias.

Limitations and implications for future studies

In spite of the extensive information on the relationship between parental behavior and infant regulation obtained by the studies in this review, they remained limited considering the association between infant regulation and paternal behavior. As the number of fathers involved in childcare has increased in the last years due to the changing roles of fathers in society (Macfadyen et al., 2011), involving fathers in the research design is important to reveal the specific relationships between family members and to enhance parent-infant relationships that every member of the family can profit from. Intervention programs that target both parents can have positive effects on various aspects of family functioning, such as coparenting, maternal well-being, parent-child relationship, and infant regulation (Feinberg & Kan, 2008).

In addition to the limited number of studies with paternal variables, the studies were also limited when investigating the relationship with infant regulation relying on negative parental behavior. During the first year, negative parenting mostly showed itself through intrusive behavior, exerting pressure or showing unresponsiveness during daily routines, whereas aggressive, restrictive, harsh and hostile behavior was often investigated after the first year. This trend is in line with previous studies on parenting, which indicated very few negative interactions and very low levels of harsh parenting in the first year and increases in negative and harsh parental attitudes such as aggression and inconsistency during the second year (Kim, Pears, Fisher, Connely, & Landsverk, 2010; Straus & Field, 2003; Thomson et al., 2014). However, studies in this review suggest that a significant link between parental intrusiveness, pressure, unresponsiveness and infant regulation can be observed even as early as three months, despite the limited number of studies. Therefore, future studies can focus on which kind of negative parental behavior is mostly apparent in the families during early infancy.

According to Belsky (1984), parenting is a complex construct with various predictors, including both parent and child characteristics. However, the current review has only dealt with healthy infants and healthy parents, excluding parents with psychopathology, preterm infants or infants with developmental disorders. Nevertheless, these studies could provide valuable information to draw comparisons and to see how the relationship between infant regulation and parenting differs from healthy populations. Other predictors such as socioeconomic status, culture, minority status or gender that affect parenting and child development through constant interaction have not been widely integrated in the current literature as well. There were only a few studies in this review that included these factors (Bozicevic et al., 2016; Brady-Smith et al., 2013; Freund et al., 2017; Pitzer et al., 2011; Prady et al., 2014). Especially culture may involve major differences in parenting behavior, such as differences in approaching children, parenting tasks or parental expectations (Bornstein, 2015). These differences in parenting influence how children organize their emotions and behavior (e.g., cultures encouraging emotional expressivity and children showing negative emotions overtly) from the very beginning of their lives (Jaramillo et al., 2017). Therefore, research should not be limited to samples from democratic and industrialized Western societies with higher levels of education and good socioeconomic status in order not to make false generalizable conclusions (Bornstein, 2015; Henrich et al., 2010).

Another shortcoming of the studies was the limited investigation of the predictor role of infant regulation. Longitudinal studies should be conducted to assess cross-lagged effects in the interplay of infant regulatory capacities and parenting, shedding light on the causality of the association and on possible sensitive periods, in which connections between infant regulatory capacities and parenting are particularly strong. As publication bias might contribute to the low number of studies investigating regulation as a predictor for parenting, pre-registration of studies and hypotheses is advisable. In addition to overcoming the publication bias, pre-

registration would also clarify primary and secondary research objectives and enable to distinguish between confirmatory and exploratory analyses (van ’t Veer & Giner-Sorolla, 2016). Among the studies assessed in this review, none was pre-registered and most hypotheses were unspecific. For instance, in longitudinal studies with multiple measurement points, hypotheses often did not state in advance, at which measurement points associations between parenting and regulation were expected. Besides, in most cases only general hypotheses regarding parenting and regulation were formulated without mentioning subcategories of parenting or regulation, although the analyses were conducted separately for various subscales of the constructs. In order to solidify knowledge on the association of parenting and regulation, future studies need to be more confirmatory (Wagenmakers et al., 2012).

In addition to these general recommendations, the limited number of studies on crying, feeding and sleeping is self-evident. Especially studies on the relationship between parental behavior and crying are underrepresented in the review, as crying is hidden in the negative affectivity construct, which includes subscales such as discomfort, anger/frustration and fear as well. However, since studies in this review revealed a different pattern of the relationship between parenting and crying, as opposed to studies investigating parenting and negative affect, research on crying should be conducted separately from negative affect, in order to see its specific associations with parental behavior. In addition to the limited number of studies on sleeping, crying and feeding, these studies are limited in the conceptualization of the regulation construct as well. For instance, regulatory behavior such as following satiety cues, self-soothing behavior or falling asleep independently are not assessed specifically in the reviewed studies. Lastly, the reviewed studies regarding this area of research are limited in their sample sizes (i.e., mostly less than 100 participants), and are, thereby, restricted in providing reliable and generalizable findings. Therefore, researchers should consider enlarging their sample sizes when conducting further research on sleeping, crying and feeding.

Conclusion

Positive parental behavior leads to better regulatory behavior during infancy, and this association is stronger than in the opposite direction. However, studies on positive parental behavior are mostly limited to maternal sensitivity. In particular, negative parental behavior is less investigated. Whereas parental reports on infant regulation fail to show a significant association with parental behavior, semi-structured methods are successful during the first year, as are structured measures during the second year of life. This underlines the use of age-appropriate measurement methods when assessing infant regulation. Further research needs to shift the attention to sleeping, crying and feeding behavior, widen the scope by integrating fathers and negative parental behavior into their research, and create diversity in their samples.

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Declaration of Interest

None.

APPENDIX

Table A.1

Studies on temperamental characteristics included in the systematic review

Authors	Country	Age	*N*	Type of study	Parenting	Regulation	Results
Atkinson et al. (2015)	Canada	2, 4, 6, 12 months	580	Longitudinal	Maternal emotional availability during immunization: observation at 2, 4, 6 and/or 12 months	Infant pain-related distress during immunization: observation at 2, 4, 6 and/or 12 months	↑ Maternal emotional availability → Pain related distress ↓ across all ages
Augustine & Leerkes (2019)	USA	14 months	208	Cross-sectional	Maternal sensitivity: fear and anger task	Infant distress: fear and anger task	Maternal sensitivity fear task ↔ Infant distress (-) Maternal sensitivity anger task ↔ Infant distress (n.s.)
Ayoub et al. (2011)	USA	14, 24 months	1488	Longitudinal	Maternal sensitivity, maternal stimulation: semi-structured play	Infant self-regulation: coping with the demands of BSID-II	↑ Maternal sensitivity → Infant self-regulation ↑ Maternal stimulation → Infant self-regulation (n.s.)
Backer et al. (2018)	USA	4, 6 months	131	Longitudinal	Mother-infant dyad characteristics at medical setting: observation at 6 months	Infant characteristics: IBQ at 4 and 6 months	"Well-regulated" infants: 4-month IBQ Orienting and soothability ↑ (distress n.s.) Associations with 6 month scores n.s.
Badovinac et al. (2018)	Canada	2, 6, 12 months	81	Longitudinal	Parental sensitivity during immunization: observation of at 2, 6 and 12 months	Pain-related distress during immunization: observation at 2, 6 and 12 months	↑ Parental insensitivity → Pain related distress ↑ across all ages
Barbosa et al. (2019)	Portugal	3 months	121	Cross-sectional	Maternal behavior: SFP; free play	Infant behavior regulation: SFP	Maternal sensitivity ↔ Infant social-positive oriented behavior (+) Maternal controlling ↔ Infant social-positive oriented behavior (-) Maternal responsiveness ↔ Infant social-positive oriented behavior (+)

Blissett & Farrow (2007)	UK	6, 12, 24 months	99	Longitudinal	Maternal control of feeding: questionnaire at 12 and 24 months	Infant temperament: ICQ at 6 and 12 months	Infant difficulty and inadaptability at 6 months → Maternal monitoring to eat, maternal pressure to eat, maternal eating restrictions 12 months (n.s.) Infant difficulty, persistence, inadaptability at 12 months → Maternal monitoring to eat, maternal pressure to eat, maternal eating restrictions 24 months (n.s.)
Bocknek et al. (2009)	USA	24 months	803	Cross-sectional	Parental supportiveness: semi-structured play task	Infant emotion regulation: BSID-II	Parental supportiveness ↔ Infant emotion regulation (+)
Bosquet Enlow et al. (2019)	USA	6 months	53	Cross-sectional	Maternal emotional support: free play	Infant temperament: orienting/regulation subscale of IBQ-R	Maternal emotional support ↔ Infant temperament (n.s.)
Bozicevic et al. (2016)	UK & South Africa	3, 24 months	48	Longitudinal	Maternal sensitivity and responses to infant distress: during daily routines at 3 months	Infant emotion regulation strategies: Lab-TAB at 24 months	↑ Maternal sensitivity & acknowledgment of distress → Infant emotion regulation ↑ (partially moderated by culture)
Brady-Smith et al. (2013)	USA	12, 24 months	1666	Longitudinal	Maternal supportiveness: Three Bag Task at 12 months	Infant emotional regulation: BSID-II & Three Bag Task at 24 months	↑ Supportive mothering → Emotional regulation ↑ (cultural differences partially observed)
Braungart-Rieker et al. (2010)	USA	4, 8, 12, 16 months	143	Longitudinal	Maternal sensitivity: free play situation at 4, 8, 12 and 16 months	Infant fear and anger reactivity: Lab-TAB at 4, 8, 12 and 16 months	↑ Maternal sensitivity → Increase in fear reactivity ↓ Maternal sensitivity → Change in anger reactivity (n.s.)
Bridgett et al. (2009)	USA	4, 6, 8, 10, 12 months	156	Longitudinal	Negative parenting: PS at 18 months	Infant temperament: IBQ-R at 4, 6, 8, 10 and 12 months	↓ Infant regulatory capacity → Negative parenting ↑ ↑ Negative emotionality → Negative parenting ↑
Bridgett et al. (2013)	USA	4, 6, 8, 10, 12, 18 months	159	Longitudinal	Negative parenting: PS at 18 months	Infant positive emotionality: IBQ-R at 4, 6, 8, 10, 12 months	↑ Infant positive emotionality during first year → Negative parenting ↓
Bryan & Dix (2009)	USA	14-27 months (M = 20)	114	Cross-sectional	Maternal supportive behavior: semi-structured play	Activity, anger proneness, social fearfulness: TBAQ	Infant social fearfulness ↔ Maternal synchrony (+), maternal asynchrony (n.s.), maternal restrictiveness (-)

							Infant anger proneness ↔ Maternal synchrony (n.s.), maternal asynchrony (n.s.), maternal restrictiveness (n.s.)
Cerniglia et al. (2014)	Italy	24 months	77	Cross-sectional	Mother–infant and father–infant interactions: observation during feeding	Infant temperament: QUIT	↑ Infant negative emotionality → Maladaptive mother–infant interactions during feeding ↑ (no direct effects for the fathers)
Conradt & Ablow (2010)	USA	5 months	91	Cross-sectional	Maternal sensitivity: modified SFP	Infant reactivity and regulation: modified SFP	↑ Maternal sensitivity → Infant attention to mother ↑ ↓ Maternal sensitivity → Infant resistance ↑
Crockenberg et al. (2008)	USA	5-6 months	64	Cross-sectional	Maternal behavior (attentional control of the infant): structured frustration task at 6 months	Infant temperament: distress subscales of IBQ at 5 months Infant temperament: structured frustration task at 6 months	Maternal behavior ↔ Infant distress (n.s.) Maternal behavior ↔ Infant regulatory behavior
Din Osmun et al. (2014)	Canada	2, 4, 6 months	255	Longitudinal	Parental emotional availability: during immunization at 2, 4, 6 months	Pain-related negative affect: during immunization at 2, 4, 6	↑ Parental emotional availability → Infant negative affect ↓
Din et al. (2008)	Canada	3-20 months (M = 9)	73	Cross-sectional	Maternal emotional availability: observation during immunization	Pain-related negative affect: during immunization	↑ Total emotional availability → Infant distress reactivity ↓ ↑ Maternal nonintrusiveness, sensitivity → Infant distress reactivity↓ Maternal structuring, nonhostility → Infant distress reactivity (n.s.)
Dong et al. (2018)	China	6, 10, 14 months	92	Longitudinal	Maternal behavioral control: free play at 10 and 14 months	Infant temperament (fearfulness and distractibility): ITQ-R at 6 months	Maternal behavioural control at 10/14 months ↔ Infant temperament (n.s.)
Donovan et al. (2007)	USA	6, 9, 12, 24 months	62	Longitudinal	Maternal responsiveness and positive affect: free play at 9 and 24 months	Infant temperament: ITQ at 6 months, ECBQ at 24 months Infant positive affect: free play at 9 months	Infant temperament at 6 months & affect at 9 months ↔ Maternal responsiveness & affect at 24 months (n.s.) Maternal responsiveness & affect at 9 months ↔ Infant temperament & affect at 24 months (n.s.)

							Maternal responsiveness & affect at 24 months ↔ Infant temperament & affect at 24 months (+)
Farkas et al. (2017)	Chile	12 months	103	Cross-sectional	Parental sensitivity (responsiveness, playful encouragement, warm attunement): sensitivity scale	Socioemotional skills: BSID-III	Parental playful encouragement ↔ Infant socioemotional scores at 12 months (+) (maternal responsiveness and warm attunement n.s.)
Fields-Olivieri et al. (2017)	USA	18 months	120	Cross-sectional	Parental sensitivity and affect: unstructured home observation	Infant temperamental traits: TBAQ-R Infants' observed emotional states: unstructured home observation	Infant neg. affectivity & neg. emotion expression → Maternal sensitivity (n.s.) ↑ Infant neg. emotion expression → Maternal pos. affect ↓ ↑ Infant neg. affectivity, neg. emotion expression → Maternal neg. affect ↑ Infant neg. affectivity → Paternal sensitivity (n.s.) ↑ Infant positive emotion expression → Paternal sensitivity and pos. affect ↑ ↑ Infant neg. emotion expression → Paternal neg. affect ↑
Freund et al. (2017)	Germany	6-8 months	2190	Cross-sectional	Interaction quality: standardized interview, semi-structured play	Infant temperament: IBQ-R	Non-risk group: Interaction quality ↔ Negative affectivity & regulatory capacities (n.s.) Risk group: Negative affectivity ↔ Interaction quality (-) Regulatory capacity ↔ Interaction quality (n.s.)
Freund et al. (2019)	Germany	7, 13 months	2194	Longitudinal	Maternal interaction quality: emotionally supporting interaction during semi-standardized play situations at 7 and 13 months	Negative Affectivity: IBQ-R at 7 and 13 months	Risk group: Maternal interaction quality at 7 months ↔ Infant negative affectivity at 7 months (n.s. at 13 months) Full sample: Maternal interaction quality at 7 months → Infant negative affectivity at 13 months (n.s.)

							Infant negative affectivity at 7 months→ Maternal interaction quality at 13 months (n.s.)
Frick et al. (2018)	Sweden	10 months	112	Cross-sectional	Maternal sensitivity: semi-structured play session	Infant temperament: 10 months: IBQ-R	Maternal sensitivity ↔ Infant temperament (n.s.)
Frick, Forslund, Fransson et al. (2018)	Sweden	10, 18 months	124	Longitudinal	Maternal sensitivity: semi-structured play at 10 months	Infant temperament: IBQ-R-VSF at 10 months Distress regulation: Lab-TAB at 18 months	Maternal sensitivity ↔ Negative affectivity (ns.) ↑ Maternal sensitivity → Latency to distress and emotion regulation ↑
Gallegos et al. (2016)	USA	8, 24 months	125	Longitudinal	Parental emotional withdrawal: free play & observation of routine caregiving tasks at 8 months	Toddler emotion regulation: problem solving task at 24 months	↑ Paternal emotional withdrawal → Infant adaptive emotion regulation ↓ Maternal emotional withdrawal → Infant adaptive emotion regulation (n.s.)
Galligan et al. (2018)	USA	12 months	83	Cross-sectional	Maternal intrusion behavior: during free play	Infant distress: during free play	↑ Maternal intrusion behaviour → infant distress ↑ ↑ Infant distress → Maternal intrusion behavior ↑
Gartstein, Crawford, & Robertson (2008)	USA	6-12 months (M = 9)	65	Cross-sectional	Maternal sensitivity: semi-structured play	Infant temperament: IBQ-R	Maternal sensitivity ↔ Infant orienting (n.s.) ↑ Maternal synchrony/reciprocity → Infant orienting ↓
Gartstein et al. (2018)	USA	4, 6, 8, 10, 12 months	148	Longitudinal	Parent–infant interaction: free play and teaching task at 4 months	Reported positive affect: IBQ-R at 6, 8,10 and 12 months Observed fear and positive affect: Lab-TAB at 6, 8,10 and 12 months	↑ Maternal positive emotional tone → Mother reported positive affect at 6 months↑ ↑ Maternal responsiveness → Mother reported positive affect at 6 months & throughout time↑ ↑ Maternal responsiveness → Observed fear at 6 months ↓ (n.s. for observed positive affect)

Gudmundson & Leerkes (2012)	USA	16 months	118	Cross-sectional	Reported Maternal Sensitivity: CTNES Observed Maternal Sensitivity: Limitation Task & Novelty Task	Temperamental reactivity: combination of TBAQ, Limitation Task and Novelty Task	↑ Infant temperamental reactivity → Maternal observed sensitivity ↓ Infant temperamental reactivity → Maternal reported sensitivity (n.s.) Infant temperamental reactivity → Maternal reported insensitivity ↑ when maternal engaged coping low; n.s. when maternal engaged coping high
Halligan et al. (2013)	UK	3, 12, 18 months	121	Longitudinal	Maternal sensitivity: play sessions at 3, 12 and 18 months	Emotion regulation: BSID-II and Lab-TAB at 12 and 18 months	↑ Maternal sensitivity at 3 months→ Infant emotion regulation at 12 & 18 months↑
Handal et al. (2017)	Ecuador	4 months	26	Cross-sectional	Maternal interactive style / Responsiveness: modified SFP	Infant positive and negative affect: modified SFP	Maternal contingent-responding interactions ↔ Infant positive affect (+) Maternal attention seeking play ↔ Infant positive affect (-)
Ispa et al. (2017)	USA	12, 24 months	296	Longitudinal	Maternal sensitivity: Three Bag Task at 12 and 24 months	Infant regulation: BSID-II at 12 and 24 months	Maternal sensitivity at 12 & 24 months ↔ Infant regulation at 12 & 24 months (+) ↑ Maternal sensitivity at 12 months → Infant regulation at 24 months↑ Infant regulation at 12 months → Maternal sensitivity at 24 months (n.s.)
Jonas et al. (2015)	Canada	3, 6, 18 months	170	Longitudinal	Maternal sensitivity: free interaction at 3 & 6 months	Infant temperament: IBQ-R at 3 & 6 months and ECBQ at 18 months	Maternal sensitivity at 3 months ↔ Infant negative affectivity at 3, 6 and 18 months (n.s.) Maternal sensitivity at 6 months ↔ Infant negative affectivity at 3 & 6 months (n.s.) ↓ Maternal sensitivity at 6 months → Infant negative affectivity at 18 months↑
Kaitz et al. (2010)	Israel	6 months	230	Cross-sectional	Maternal sensitivity: teaching task	Infant involvement: teaching task Infant temperament (fussiness): ICQ	Maternal sensitivity ↔ Infant involvement (+) Maternal sensitivity ↔ Infant fussiness (n.s).

Kim et al. (2014)	USA	12, 18 months	144	Longitudinal	Maternal emotional availability (EA): observations at bedtime at 12 and 18 months	Infant temperament: IBQ-R at 12 months and ECBQ at 18 months	Maternal EA at 12/18 months ↔ Negative affectivity, self-comforting, tension reduction at 12/18 months (n.s.)
						Infant emotion regulation: Toy removal task at 12 and 18 months	Maternal EA at 12/18 months → Infant emotion regulation at 12/18 months (n.s.; moderated by attachment security)
Kim & Teti (2014)	USA	6, 9 months	106	Longitudinal	Maternal emotional availability (EA): observations at bedtime at 9 months	Infant temperament at 6 months: IBQ-R	↑ Infant neg. affectivity → Maternal EA ↓ Infant orienting/regulation → Maternal EA (n.s.)
Kotila et al. (2014)	USA	3, 6, 9 months	182	Longitudinal	Parental engagement: questionnaire at 3, 6 months	Infant temperament: IBQ-R (negative affect and effortful control subscales) at 3, 6, 9 months	↑ Mother engagement 6 months → Infant negative affect 9 months ↓ ↑ Mother engagement 3 months → Infant effortful control 9 months ↑ Father engagement → Infant negative affect and effortful control (n.s.)
Kucirkova et al. (2018)	UK	10 months	65	Cross-sectional	Maternal interaction quality: CIS	Infant temperament: ICQ	Maternal interaction quality ↔ Infant temperament categories (n.s.)
Laake & Bridgett (2018)	USA	10 months	118	Cross-sectional	Maternal intrusiveness and support: free play	Infant temperament (positive, negative affectivity): IBQ-R	Maternal intrusiveness & support ↔ Infant positive and negative affectivity (n.s.)
Lahey et al. (2008)	USA	0-11 months (M = 6)	1854	Cross-sectional	Parenting (maternal responsiveness, spanking): Infant/Toddler Short Form of HOME-SF	Infant temperament (activity level, predictability, positive affect, fearfulness, fussiness): IBQ	Maternal responsiveness ↔ Infant positive affect (+) Maternal responsiveness ↔ Infant fearfulness & fussiness (-) Spanking ↔ Infant positive affect (-) Spanking ↔ Infant fearfulness & fussiness (+)
Leerkes (2010)	USA	6 months	101	Cross-sectional	Maternal sensitivity: emotion-eliciting novelty and limiting tasks	Infant Affect: emotion-eliciting novelty and limiting tasks	↑ Infant distress → Maternal sensitivity ↓

Leerkes et al. (2009)	USA	6, 24 months	376	Longitudinal	Maternal sensitivity to distress and nondistress: play at 6 months	Affect dysregulation: clean-up task at 24 months	Maternal sensitivity to distress/nondistress → Infant affect dysregulation (n.s.) Temperamentally reactive infants: ↑ Maternal sensitivity to distress → Infant affect dysregulation ↓ Temperamentally low reactive infants: ↑ Maternal sensitivity to distress→ Infant affect dysregulation ↑
Leerkes et al. (2016)	USA	6, 12 months	259	Longitudinal	Maternal sensitivity: distress eliciting tasks at 6 and 12 months	Infant distress: distress eliciting tasks at 6 and 12 months	↑ Infant distress at 6 & 12 months → Maternal sensitivity at 6 & 12 months ↓
Leerkes & Zhou (2018)	USA	6, 12 months	259	Longitudinal	Maternal sensitivity: distress eliciting tasks at 6 and 12 months	Infant negative affect: IBQ-R-VSF at 6 months	Infant negative affect ↔ Maternal sensitivity at 6/12 months (n.s.)
Liang et al. (2019)	China	6 months	96	Cross-sectional	Maternal sensitivity to infant distress: MBQS	Infant temperamental withdrawal: IBQ subscale	Maternal sensitivity to infant distress ↔ Infant temperamental withdrawal (n.s.)
Lipscomb et al. (2011)	USA	9 months	382	Cross-sectional	Parental overreactivity: with questionnaire	Infant negative emotionality: fussy-difficult-demanding subscale from the ICQ	↑ Parental overreactivity at 9 months → Infant negative emotionality at 9 months ↑
Lorber & Egeland (2011)	USA	3, 6, 24 months	267	Longitudinal	Negative parenting: observation during feeding at 3 and 6 months Maternal hostility: during problem-solving tasks at 24 months	Infant anger: during problem-solving tasks at 24 months	Negative parenting 3/6 months → Infant anger (n.s.) ↑ Infant anger → Mother hostility ↑ ↑ Mother hostility → Infant anger ↑
Malmberg et al. (2007)	UK	10-12 months	97	Cross-sectional	Maternal and paternal sensitivity and mood: structured play	Infant mood: semi-structured play	↑ Parental sensitivity → Infant mood ↑ Infant mood → Parental sensitivity (n.s.) (No differences between parents)
Martins et al. (2016)	Portugal	10 months	50	Cross-sectional	Maternal and paternal emotional availability: observation of daily routines and free play	Infant emotion regulation: problem-solving task	Infant emotion regulation ↔ Paternal EA (+) Infant emotion regulation ↔ Maternal EA (n.s.)

McMahon & Newey (2018)	Australia	7 months	76	Cross-sectional	Maternal emotional availability: SFP	Infant negative affect: SFP	Infant negative affect ↔ Maternal non-hostility (-) Infant negative affect ↔ Maternal sensitivity, structuring, non-intrusiveness (n.s.)
Mesman et al. (2013)	Nether-lands	3, 6 months	115	Longitudinal	Maternal sensitivity: SFP at 3 and 6 months	Infant temperament: ICQ at 3 and 6 months Infant affect: SFP at 3 and 6 months	Maternal sensitivity ↔ Infant temperament (n.s. both at 3 & 6 months) ↑ Maternal sensitivity at 3 months → Infant positive affect at 3 months↑ only for temperamentally difficult infants Maternal sensitivity → Infant positive & negative affect (n.s. both at 3 & 6 months)
Micalizzi et al. (2017)	USA	24 months	313	Cross-sectional	Negative Parenting: PFQ and a semi-structured interview	Difficult temperament: TBAQ-R	Negative parenting ↔ Difficult temperament (+)
Millikovsky-Ayalon et al. (2015)	Israel	12-36 months (M = 24)	51	Cross-sectional	Parental sensitivity: parent–child feeding interaction	Child temperament: fussy-difficult scale of the ICQ	Infant fussy temperament ↔ Paternal sensitivity (-) Infant fussy temperament ↔ Maternal sensitivity (n.s)
Mills-Koonce et al. (2007)	USA	6 months	173	Cross-sectional	Maternal sensitivity: free play, book reading, challenge tasks (SFP and Lab-TAB)	Infant negative affect: free play, book reading, challenge tasks (SFP and Lab-TAB)	Maternal sensitivity ↔ Infant negative affect during book reading (-) Maternal sensitivity ↔ Infant negative affect during free play and challenge tasks (n.s.)
Mortensen & Barnett (2017)	USA	14, 24 months	310	Longitudinal	Harsh parenting: Three Bag Task and semi-structured play situation at 14, 24 months	Infant emotion regulation: BSID-II at 14, 24 months	14-month harsh parenting ↔ 14-month infant emotion regulation (-) 24-month harsh parenting ↔ 24-month infant emotion regulation (n.s.) ↑ 14-month harsh parenting → 24-month emotion regulation ↓ 14-month emotion regulation → 24-month harsh parenting (n.s.)

Norcross et al. (2017)	USA	6 months	259	Cross-sectional	Insensitive (intrusive and unresponsive) maternal behavior: arm restraint task, novelty toy task, SFP	Infant affect: arm restraint task, novelty toy task, SFP	Observed infant negative affect ↔ Intrusive maternal behavior (+) Observed infant affect ↔ Unresponsive parenting (n.s.)
Nordahl et al. (2016)	Norway	12 months	726	Cross-sectional	Paternal positive involvement and negative reinforcement: free-play, clean-up and structured play tasks	Infant temperament (distress to limitations): IBQ-R	Distress to limitations → Paternal involvement and negative reinforcement (n.s)
O'Neal et al. (2017)	USA	14, 24 months	1718	Longitudinal	Maternal responsiveness and detachment: High Chair and Three Bag Task at 14 months	Infant distress: High Chair at 14 months Infant negativity: Three Bag Task at 14 months	↑ Three Bag responsiveness → Emotion regulation ↑ High Chair responsiveness → Emotion regulation (n.s.) ↑ Three Bag and High Chair detachment → Emotion regulation ↓
						Infant emotion outcomes at 24 months: BSID-II	Maternal responsiveness ↔ Infant distress & negativity (-) Maternal detachment ↔ Infant distress & negativity (+)
Padilla & Ryan (2019)	USA	14, 24 months	283	Longitudinal	Parenting quality during Three Bag Task: sensitivity, intrusiveness, stimulation, positive regard, negativity, detachment at 24 months	Temperament (negative emotionality and sociability): with parental reports at 14 months	Infant negative emotionality → Maternal/Paternal parenting quality (n.s.)
Parade et al. (2019)	USA	8, 15 months	131	Longitudinal	Maternal sensitivity: MBQS at 15 months	Temperamental difficulty: home observations at 8 months	Maternal sensitivity ↔ Infant temperamental difficulty (n.s.)
Perry et al. (2016)	USA	5, 10 months	410	Longitudinal	Maternal sensitivity: semi-structured play and peek a boo task at 5 months	Infant regulation (mother-orientation and distraction): arm-restraint procedure at 5 and 10 months	Maternal sensitivity ↔ Mother orientation at 5 months (+) Maternal sensitivity ↔ Mother orientation at 10 months (n.s) Maternal sensitivity ↔ Distraction at 5/10 months (n.s.)

Perry et al. (2018)	USA	5, 10, 24 months	388	Longitudinal	Maternal intrusiveness: peek a boo at 5 and 10 months	Infant negative affectivity: IBQ-R at 5 & 10 months, ECQB at 24 months	↑ Infant negative affectivity at 5 & 10 months → Maternal intrusiveness at 10 & 24 months ↑ ↑ Maternal intrusiveness at 10 months → Infant negative affectivity at 24 months ↑
Petrenko et al. (2018)	USA	4, 6, 8 months	179	Longitudinal	Parenting behavior (positive and negative parenting): free-play task at 6 months	Infant temperament (orienting/regulation and negative affectivity): IBQ-R at 4 and 8 months	Positive/negative parenting ↔ Infant temperament at 4 and 8 months (n.s.)
Pitzer et al. (2011)	Germany	3, 24 months	384	Longitudinal	Maternal responsivity: semi-structured play at 3 months Maternal restrictive guidance and empathy: picture book reading task at 24 months	Infant temperament (easiness and self-control): combination of standardized parent interview and semi-structured play and book reading at 3 months and 24 months	Boys: Maternal responsivity at 3 months ↔ Easiness at 3 & 24 months (+) (self-control n.s.) Maternal restrictive guidance at 24 months ↔ Self- control at 24 months (-) (easiness n.s.) Girls: Maternal responsivity at 3 months ↔ Easiness at 3 months and self-control at 24 months (+) (self-control at 3 n.s.) Maternal restrictive guidance at 24 months ↔ Self- control at 24 months (-) (easiness n.s.)
Planalp et al. (2019)	USA	3, 5, 7 months	135	Longitudinal	Parental sensitivity: SFP at 3,5 and 7 months	Infant affect: SFP, 3, 5 and 7 months	Maternal sensitivity at 3 months ↔ Infant positive/negative affect at 3 months (n.s.) Paternal sensitivity at 3 months ↔ Infant positive affect (+) negative affect (-) at 3 months Maternal/paternal sensitivity at 5 months ↔ Infant positive affect at 5 months (+) (negative affect n.s.) Maternal sensitivity at 7 months ↔ Infant negative affect at 7 months (-) (positive affect n.s.) Paternal sensitivity at 7 months ↔ Infant positive affect (+) negative affect (-) at 7 months

Popp et al. (2008)	USA	18 months	245	Cross-sectional	Maternal responsivity: free play and clean-up interactions	Infant temperament: ECBQ	↑ Regulated temperament → Maternal responsivity ↑
Prady et al. (2014)	UK	6 months	1306	Cross-sectional	Parenting practices: questionnaire	Mothers' perception of the infant's difficulties: ICQ	↑ Positive parenting practices (high self-efficacy, high warmth, low hostility) → Problematic infant temperament ↓
Puura et al. (2013)	Finland	7 months	39	Cross-sectional	Maternal sensitivity & structuring: free play	Infant distress: free play	Maternal sensitivity ↔ Infant distress (-) Maternal structuring ↔ Infant distress (n.s.)
Roque & Verissimo (2011)	Portugal	18 - 26 months (*M* = 21)	55	Cross-sectional	Constrained and involved maternal behavior during emotion regulation paradigm	Emotion regulation: positive affect, fear and frustration/anger during emotion regulation paradigm	↑ Maternal involvement → Infant emotion regulation ↑
Scaramella et al. (2008)	USA	12, 24 months	47	Longitudinal	Harsh and supportive parenting responses: clean-up task 12 and 24 months	Infant distress reactivity: modified Lab-TAB at 12 and 24 months	Harsh parenting at 12 months → Increase in infant distress Infant distress at 12 months → Increase in harsh parenting (n.s.) Supportive parenting at 12 months → Decline in infant distress reactivity (n.s.) Infant distress reactivity at 12 months → Decline in supportive parenting
Spieker et al. (2018)	USA	21, 24 months	123	Longitudinal	Parental sensitivity to non-distress and distress: teaching interaction at 21 months	Regulatory outcomes: BSID-II at 24 months	↑ Parental sensitivity → Infant emotional regulation ↑
Spinelli & Mesman (2018)	Nether-lands	3 months	70	Cross-sectional	Maternal sensitivity and infant-directed speech: SFP	Infants' expression and regulation of negative emotion: SFP	Maternal sensitivity ↔ Infant negative affect (-) Maternal sensitivity ↔ Infant negative affect regulation during SFS (n.s.) ↑ Maternal sensitivity + infant directed speech during SFS → Infant negative affect regulation ↑
Swingler et al. (2014)	USA	5 months	233	Cross-sectional	Maternal sensitivity: semi-structured play and peek-a-boo task	Infant regulation and reactivity: arm restraint procedure	↑ Maternal sensitivity → Infant orientation ↑ Maternal sensitivity → Infant distraction behavior & negative affect (n.s.)

Szabó et al. (2008)	Nether-lands	17 months	112	Cross-sectional	Maternal sensitivity & intrusiveness: structured play	Infant negative behavior (anger, dislike and hostility): structured play Infant temperament (frustration, soothability, activity level): ECBQ	↑ Maternal sensitivity → Infant negative interactive behavior ↓ Maternal sensitivity ↔ Infant frustration and soothability (n.s.) Maternal intrusiveness ↔ Infant frustration (n.s.) Maternal intrusiveness ↔ Soothability (-)
Taylor et al. (2008)	USA	6, 9 months	70	Longitudinal	Maternal behavior (quality of maternal affect and responsive behavior): free play at 9 months	Infant temperament: ITQ at 6 months Infant positive affect: free play at 9 months	Maternal behavior ↔ Infant temperament (n.s.) Maternal behavior ↔ Infant affect (+)
Thomas et al. (2017)	Canada	3, 6 months	254	Longitudinal	Maternal Sensitivity: teaching task at 6 months	Infant temperament (negative affectivity): IBQ-R at 3 months Emotion regulation: Lab-TAB at 6 months	Maternal sensitivity ↔ Negative affectivity (n.s.) Maternal sensitivity ↔ Emotion regulation (n.s.)
Wang et al. (2015)	USA	6 months	148	Cross-sectional	Maternal negative intrusiveness: free-play at 6 months	Infant difficult temperament: IBQ-R at 6 months	Maternal negative intrusiveness ↔ Infant difficult temperament (n.s.)
Wittig & Rodriguez (2019)	USA	6, 18 months	203	Longitudinal	Parenting styles: PAQ at 6 and 18 months	Infant temperament: IBQ-R-VSF at 6 months	Maternal authoritative parenting at 6 months ↔ Infant negative affectivity (-) and orienting/regulatory capacity (+) at 6 months (n.s. for authoritarian/permissive parenting, and for paternal parenting at 6 months) Maternal permissive parenting at 18 months ↔ Infant negative affectivity (+) at 6 months (n.s. for authoritative/authoritarian parenting, for orienting/regulatory capacity) Paternal authoritative parenting at 18 months ↔ Infant orienting/regulatory capacity (+) at 6 months (n.s. for authoritarian/permissive parenting, for negative affectivity)

Woldarsky et al. (2019)	USA + Chile	12 months	147	Cross-sectional	Maternal sensitivity: ESA	Infant temperament: IBQ-R-VSF	Maternal sensitivity ↔ Infant temperament (n.s.)

Notes: (+) and (–) indicate a positive or a negative correlation, arrows indicate the direction of the relation between the variables. BSID-II: Bayley Scales of Infant Development Second Edition (Bayley, 1993), BSID-III: Bayley Scales of Infant Development Third Edition (Bayley, 2006), CIS: Caregiver Interaction Scale (Arnett, 1989), CTNES: Coping with Toddlers' Negative Emotions Scale (Spinrad, Eisenberg, Kupfer, Gaertner, & Michalik, 2004), ECBQ: Early Childhood Behavior Questionnaire (Putnam, Gartstein, & Rothbart, 2006), EITQ: Early Infant Temperament Questionnaire (Medoff-Cooper, Carey, & McDevitt, 1993), ESA: Adult Sensitivity Scale (Santelices et al., 2012), HOME-SF: Home Observation for Measurement of the Environment (Caldwell and Bradley 1984), IBQ: Infant Behavior Questionnaire (Rothbart 1981; Rothbart, 1986), IBQ-R: Infant Behavior Questionnaire-Revised (Gartstein & Rothbart, 2003), IBQ-R-VSF: Infant Behavior Questionnaire – Very Short Form (Putnam, Helbig, Gartstein, Rothbart & Leerkes, 2014), ICQ: Infant Characteristics Questionnaire (Bates, Freeland & Lounsbury, 1979), LAB-TAB: Laboratory Temperament Assessment Battery (Goldsmith & Rothbart 1993; Goldsmith & Rothbart, 1996; Goldsmith & Rothbart, 1999), MBQS: Maternal Behavior Q-Sort (Pederson & Moran, 1995; Pederson, Moran, & Bento, 2009), PAQ: Parental Authority Questionnaire (Boppana & Rodriguez, 2017), PFQ: Parent Feelings Questionnaire (Deater-Deckard, 1996), PS: The Parenting Scale (Arnold, O'Leary, Wolff, & Acker, 1993), QUIT: The Italian Questionnaires on Temperament (Axia, 2002), RITQ: Revised Infant Temperament Questionnaire (Carey & McDevitt, 1978), SFP: The Still Face Paradigm (Tronick, Als, Adamson, Wise, & Brazelton, 1978), TBAQ: Toddler Behavior Assessment Questionnaire (Goldsmith, 1996), TBAQ-R: Toddler Behavior Assessment Questionnaire-Revised (Goldsmith, 1996).

Table A.2

Studies on sleeping, crying and feeding included in the systematic review

Authors	Country	Age	*N*	Type of study	Parenting	Regulation	Results
Ablow et al. (2013)	USA	9 months	53	Cross-sectional	Maternal sensitivity: GRS of mother–infant interaction	Infant protest, cry, fuss: play and separation sessions	↑ Infant distress → Maternal sensitivity ↑
Bernier et al. (2014)	Canada	12, 24 months	63	Longitudinal	Maternal sensitivity: MBQS at 12 months	Infant sleep: actigraph monitor and sleep diary: nighttime sleep duration and proportion of nighttime sleep at 24 months	Maternal sensitivity → Infant sleep duration and proportion (n.s.)
Bilgin & Wolke (2017a)	UK	at term, 3, 18 months	105	Longitudinal	Maternal sensitivity: at term: BCHAPS at 3 months MISPA at 18 months: POSER	Feeding problems: standard structured interview	↓ Maternal sensitivity at 3 months → Infant feeding problems at 18 months↑ ↑ Infant feeding problems at 3 months → Maternal sensitivity at 18 months ↓ (Effects n.s. from birth to 3 months of age.)
Bilgin & Wolke (2017b)	UK	at term, 3, 18 months	105	Longitudinal	Maternal sensitivity at term: BCHAPS at 3 months: MISPA at 18 months: POSER	Crying, sleeping and feeding problems: standard structured interview at term, 3 and 18 months	↑ Maternal sensitivity at term → Multiple regulatory problems at 3 months ↓ Maternal sensitivity at 3 months → Multiple regulatory problems at 18 months (n.s.) Multiple regulatory problems → Maternal sensitivity (n.s.)
Blissett & Farrow (2007)	UK	6, 12, 24 months	99	Longitudinal	Maternal control of feeding: questionnaire	Infant mealtime negativity: CFAQ	Infant mealtime negativity at 6 months → Maternal monitoring to eat, pressure to eat and eating restrictions 12 months (n.s.) ↑ Infant mealtime negativity at 12 months → Maternal pressure to eat 24 months ↑ (maternal monitoring to eat & eating restrictions n.s.)

Bordeleau et al. (2012)	Canada	12 months	55	Cross-sectional	Maternal sensitivity: MBQS at 12 months	Infant sleep duration: sleep diary at 12 months	Maternal sensitivity ↔ Infant sleep duration (n.s.)
Costantini et al. (2018)	UK & Italy	5, 7 months	37	Longitudinal	Maternal feeding behavior: observations during meal	Infant willingness to eat: observations during meal	Synchrony during feeding at 5 months ↔ Infant willingness to eat at 5 & 7 months (+) Infant willingness to eat at 5 months ↔ Synchrony during feeding at 7 months (n.s.) Co-eating at 5 months ↔ Infant willingness to eat at 5 months (+) (n.s. at 7 months) ↑ Maternal pushing at 5 & 7 months ↔ Infant willingness to eat at 5 & 7 months ↓
Fildes et al. (2015)	UK	3 months	1920	Cross-sectional	Maternal control: questionnaire	Infant general appetite: questionnaire	↑ Maternal pressure → Infant appetite ↓ ↑ Maternal restriction → Infant appetite ↑
Flax et al. (2013)	Malawi	6-17 months (M = 15)	16	Cross-sectional	Maternal responsiveness: observations during mealtime	Infant acceptance of food: observations during mealtime	↑ Maternal responsiveness → Infant acceptance of food ↑
Ganda et al. (2011)	Ireland	first 48 hours	34	Cross-sectional	Maternal involvement and comfort: observation during newborn screening examination	Infant crying: observation during newborn screening examination	↑ Maternal involvement and comfort → Infant cry ↓
van IJzendoorn & Hubbard (2010)	Nether-lands	2-9 months	50	Longitudinal	Maternal responsiveness: observations at home	Duration and frequency of infant crying: observations at home	↑ Frequency of unresponsiveness at 2 months → Frequency of cry at 5 and 7 months ↓ (n.s. at 9 months) ↑ Frequency of cry at 2 months → Frequency of unresponsiveness at 9 months ↓ (n.s. at 5 & 7 months) Duration of unresponsiveness ↔ Duration of cry (n.s.)

Jahromi & Stifter (2007)	USA	2, 6 months	128	Longitudinal	Maternal soothing behavior: during inoculation at 2 & 6 months	Infant irritability: during inoculation at 2 and 6 months Infant negative reactivity: cry intensity and duration during inoculation at 2 and 6 months	Maternal soothing behavior at 2 months → Cry intensity at 6 months (n. s.) ↑ Maternal soothing behavior at 2 months → Cry duration at 6 months ↓
Jian & Teti (2016)	USA	1, 3, 6 months	72	Longitudinal	Emotional availability: parent-infant interactions at bedtime	Sleep duration, quality and wake minutes: Actigraphy wristwatches from 1 to 6 months	↑ Maternal EA at bedtime → Infant sleep duration ↑ (temperamentally highly surgent infants are affected strongly from EA) Maternal EA → Infant wake minutes & sleep quality (n.s.)
Kim & Teti (2014)	USA	1, 3, 6, 9 months	106	Longitudinal	Mothers' emotional availability at bedtime: observations at 9 months	Infant sleep: The Infant Sleep Diary at 1, 3, 6 months	Frequency & length of infant night awakenings across 6 months → Maternal EA (n.s.)
Millikovsky-Ayalon et al. (2015)	Israel	12-36 months (*M* = 24)	51	Cross-sectional	Parental sensitivity: parent-infant feeding interactions	Infant sleep: screening questionnaire	Infant sleep disturbance ↔ Paternal sensitivity (-) Infant sleep disturbance ↔ Maternal sensitivity (n.s.)
Moding et al. (2014)	USA	12 months	89	Cross-sectional	Maternal responsiveness: Novel Food Task	Infant's acceptance and rejection of a novel food: Novel Food Task	↑ Maternal responsiveness → Acceptance of the novel food ↑ ↓ Maternal responsiveness → Rejection of the novel food↑
Parade et al. (2019)	USA	8, 15 months	131	Longitudinal	Maternal sensitivity: MBQS at 15 months	Sleep efficiency and sleep variability with actigraph at 8 months	Maternal sensitivity ↔ Sleep efficiency and sleep variability n.s.
Philbrook & Teti (2016)	USA	1, 3, 6 months	109	Longitudinal	Maternal emotional availability: bedtime and nighttime observation at 1, 3 and 6 months	infant sleep: video recordings at 1, 3 and 6 months	↑ Maternal EA → Infant distress ↓ ↑ Infant distress → Maternal EA ↑ ↑ Maternal EA → Infant sleep duration ↑ Infant sleep duration → Maternal EA (n.s.)
Priddis (2009)	Australia	7-18 months (*M* = 13)	61	Cross-sectional	Maternal sensitivity: CARE	Infant sleep behavior: sleep diary	Good sleepers: Maternal sensitivity ↑ Poor sleepers: Maternal sensitivity ↓

Richter & Reck (2013)	Germany	3 months	57	Cross-sectional	Mothers' social positive engagement: observations during play and SFP	Infant regulatory problems: SFS	↓ Maternal positive interaction during challenging reunion → Crying, whining and sleeping difficulties ↑ Maternal positive interaction during play → Crying, whining, sleeping (n.s.) Maternal positive interaction during play & Challenging reunion → Feeding (n.s.)
Smarius et al. (2017)	Nether-lands	3-6 months (*M* = 3)	3369	Cross-sectional	Maternal aggressive behavior: questionnaire	Excessive crying: questionnaire	Maternal aggressive behavior ↔ Infant excessive crying (+)
Stormark (2007)	Norway	3, 15 months	18	Longitudinal	Maternal affective involvement: observation during inoculation	Crying duration: observation during inoculation	↑ Eye-gaze at 3 months → Infant cry duration at 3 months ↑ ↑ Eye-gaze, rocking, face to face contact at 15 months → Infant cry duration at 15 months ↑
Tambelli et al. (2014)	Italy	4 months	167	Cross-sectional	Maternal representations: IRMAN	Infant food Refusal Behavior: video-recordings during breastfeeding	Nonintegrated/ambivalent mothers: Food refusal behavior ↑
Teti et al. (2010)	USA	1-24 months (*M* = 10)	45	Cross-sectional	Emotional availability: observations during bedtimes and at night	Infant sleep disruption: infant sleep diary Infant sleep difficulties: ISQ	Maternal EA ↔ Infant sleep disruption (-) Maternal EA ↔ Infant sleep difficulties (-)
Tétreault et al. (2016)	Canada	12, 18, 24 months	200	Longitudinal	Maternal sensitivity: MBQS at 12 months	Infant sleep: sleep diary at 12, 18, 24 months	↑ Maternal sensitivity → Percentage of nighttime sleep at 24 months ↑ Maternal sensitivity → Percentage of nighttime sleep at 12/18 months (n.s.)
Tikotzky et al. (2015)	Israel	3, 6 months	57	Longitudinal	Paternal involvement: at 3 & 6 months Nighttime involvement: BISQ Daytime Involvement: PIQ	Night wakings: sleep diary at 3 and 6 months Long wake episodes, sleep efficiency and sleep minutes: actigraph at 3 and 6 months	Paternal general involvement at 3 & 6 ↔ Night wakings at 3 & 6 months (-) Paternal general involvement at 3 & 6 ↔ Long wake episodes at 6 months (-) (n.s. at 3 months) Paternal general involvement at 3 & 6 ↔ Infant sleep duration & efficiency at 3 & 6 months (n.s.)

Voltaire & Teti (2018)	USA	1, 3, 6, 9 months	155	Longitudinal	Nighttime parenting practices: videos of bed-time routine at 1 and 3 months	Infant night wakings: videos of bed-time routine and sleep diary at 1 to 9 months	↑ Appropriate/warranted nighttime parenting practices → Infant night wakings in the first 3 months ↓ (n.s. for 6 to 9 months)
Weinraub et al. (2012)	USA	6, 21 months	1200	Longitudinal	Maternal sensitivity: videotaped mother–infant interaction at each age	Nighttime sleep awakenings: standardized interview	↑ Maternal sensitivity → Sleep awakenings ↑

Notes: (+) and (–) indicate a positive or a negative correlation, arrows indicate the direction of the relation between the variables. BCHAPS: Boston City Hospital Assessment of Parental Sensitivity (Zahr & Cole, 1991), BISQ: Brief Infant Sleep Questionnaire (Sadeh, 2004), CARE: Child–Adult Relationship Experimental Index (Crittenden, 1979–2004), CFAQ: Child Feeding Assessment Questionnaire (Harris & Booth, 1992), GRS: Global Rating Scales of mother-infant interaction (Murray,Fiori-Cowley, Hooper, & Cooper, 1996), IRMAN: Interview of Maternal Representations After the Birth (Ammaniti & Tambelli, 2010), ISQ: Infant Sleep Questionnaire (Morrell, 1999), MBQS: Maternal Behavior Q-Sort (Pederson & Moran, 1995; Pederson, Moran, & Bento, 2009), MISPA: Mother-Infant Structured Play Assessment (Wolke, Gutbrod & Meier, 2001), PIQ: Parental Involvement Questionnaire (Tikotzky, Sadeh & Glickman-Gavrieli, 2011), POSER: Play Observation Scheme of Emotion Rating(Wolke, 1986), SFP: The Still Face Paradigm (Tronick et al., 1978); SFS: Fragebogen zum Schreien, Füttern und Schlafen (Groß, Reck, Thiel-Bonney, & Cierpka, 2007).

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Paper 2

Maternal self-efficacy development from pregnancy to three months after birth

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Maternal self-efficacy development from pregnancy to three months after birth

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Data sharing and data availability statement

Sharing research data is not possible at this stage due to data protection reasons. It is planned that the data will be transferred to a repository at a later date.

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Maternal self-efficacy development from pregnancy to three months after birth

Abstract

The present study uses a prospective longitudinal study design to investigate the development of maternal self-efficacy in the transition phase to parenthood, drawing on a large sample of socially and/or culturally disadvantaged families (*N* = 292). Parity, maternal education, migration, informal and formal social support are considered as potential predictors. Results indicate that previous birth experience, being born abroad, and higher levels of formal and informal social support during pregnancy jointly predict higher levels of maternal self-efficacy three months after birth. First-time mothers and mothers born in Germany (where the study was conducted) benefit more from formal support than mothers with previous experience and mothers born outside of Germany. Overall, maternal self-efficacy increased significantly. Implications for prenatal maternal care are discussed.

Keywords: maternal self-efficacy, maternal confidence, transition to parenthood, prenatal social support

Introduction

Becoming a parent comes with challenges in adapting to the parenting role and taking care of the infant (Shrestha et al., 2019). Even though this is equally true for both men and women (Bakermans-Kranenburg et al. 2019), women are often in focus with respect to the transition from the prenatal to the early postnatal phase. They undergo major bodily changes while carrying a child, giving birth, and recovering from this experience, and still serve as primary caregivers for young infants in most families (Slade et al., 2009).

How well mothers manage to meet these challenges has consequences not only for themselves but also for their offspring (Glover & Capron, 2017). Among the many factors known to impact a mother's adaptation to parenthood are socio-demographic variables like maternal education and migration background (Wang et al., 2021; Fair et al., 2021), previous birth experiences (McCarter-Spaulding & Kearney, 2001), mental health (Glover & Capron, 2017; O'Donnell et al., 2014), social support during pregnancy (Mihelic et al. 2016), and prenatal expectations related to one's own role as a parent (Harwood et al., 2007). These factors are likely to influence the sense of maternal efficacy which is known to play a key role for later parenting (Taraban & Shaw, 2018; Vance & Brandon, 2017). A better understanding of how maternal self-efficacy develops during the transition to parenthood, and how different factors determine its quality, can help promote maternal health and child development. However, prospective longitudinal studies simultaneously considering multiple determinants and taking into account vulnerable populations are still missing. The present study fills this gap.

The Role of Maternal Self-Efficacy

The concept of self-efficacy refers to the belief in one's own ability to successfully accomplish a particular behavior, task or performance (Bandura, 1994). In the context of parenting, a mother's confidence in her own ability to care for the infant, and to respond to the infant's

needs is of special interest. The terms *maternal self-efficacy* and *maternal confidence* show a great deal of conceptual overlap, as they both cover aspects of self-appraisal and self-knowledge (Vance & Brandon, 2017). However, to avoid inaccuracies in the operationalization of the construct (Wittkowski et al., 2017), the present study exclusively refers to the term self-efficacy.

A recent literature review on parental self-efficacy (Albanese et al., 2019) reveals that 115 studies explored the consequences of parental self-efficacy, whereas only 18 studies investigated its determinants. Mothers with higher levels of self-efficacy in parenting have been shown to provide a better home learning environment, to establish a better parent-child relationship, and to have children who reveal better social skills and less externalizing behavior than mothers with low self-efficacy in parenting (see Albanese et al., 2019 for a review). This raises the question as to how maternal self-efficacy develops.

Studies addressing this question often neglect the changes in maternal self-efficacy from the prenatal to the postnatal phase (Albanese et al., 2019). This seems surprising, given that high levels of anticipated maternal self-efficacy during pregnancy can pave the way for a successful transition to parenthood (Biehle & Mickelson, 2011). Previous studies found a slow but gradual increase in maternal self-efficacy during pregnancy (Wernand et al., 2006), and a steeper increase during the postnatal period, especially a few weeks after giving birth, when mothers typically receive positive feedback from the infant because they have already learned how to interpret his/her signals (Gross & Marcussen, 2017; Law et al., 2019). Hence, the transition phase seems to be a critical period for the development of maternal self-efficacy, and more studies clarifying the interplay of factors underlying this development are needed. In this context, socio-demographic variables, social support, and maternal mental well-being play a key role.

The Role of Socio-Demographic Factors

Socioeconomic status (SES) can be defined as a person's social and material status. It is mostly determined by income, education, and occupation (Bradley & Corwyn, 2002). A lower SES is associated with less access to resources, less knowledge of child rearing, higher distress levels (Roubinov & Boyce, 2017), as well as with lower parental self-efficacy, less parental educational orientation, and a lower quality of interaction among family members (Anders et al., 2015; Tazouti & Jarlégan, 2016). When exploring the impact of SES on child development, it is considered better to use specific SES indicators (e.g., O'Connell, 2019).

(1) The *education level* of parents plays a special role in child-rearing practices (Ghosh & Rausch, 2020). Investigations into the effects of maternal education level on maternal self-efficacy provide mixed results, but those with diverse or disadvantaged samples indicate lower maternal self-efficacy among mothers with lower education backgrounds (e.g., Wang et al., 2021).

(2) Mothers with a *migration background* have a smaller social network and are more likely to experience social isolation during pregnancy (Fair et al., 2020). Greater maternal acculturation conflict and increased discomfort with the new culture can lower maternal self-efficacy among immigrant women during pregnancy and beyond (Boruszak-Kiziukiewicz & Kmita, 2020).

(3) *First-time mothers* tend to be more strongly affected by experiences related to delivery and dealing with a very young infant, which increases their vulnerability for developing depressive symptoms (Martínez-Galiano et al., 2019). They often feel less competent as a parent than experienced mothers (McCarter-Spaulding & Kearney, 2001). It thus seems very likely that they will seek more formal support and benefit more from that support in order to increase maternal self-efficacy.

The Role of Social Support

As suggested by Veiel (1985), it is useful to distinguish between the type, the source, and the assessment focus of social support. Here, we focus on the source of social support. Family, friends and relatives mainly provide *informal support* at the emotional level, whereas professionals mainly provide *formal support* by offering informational assistance and guidance (Leahy-Warren, 2005).

The few studies that have assessed the impact of *informal support* on maternal self-efficacy during pregnancy have revealed that higher support goes along with higher maternal self-efficacy before giving birth (Gao et al., 2012; Ginja et al., 2018). This positive association was also reported for the postpartum period (Leahy-Warren et al., 2012), although the effects were small. So far, evidence has been based on cross-sectional data only.

Formal support by professionals includes participation in birth preparation courses, visiting counselling centers or midwives' practices. This is assumed to enhance early parenting practices and increase maternal sensitivity and reciprocity in interactions with the infant by increasing maternal knowledge of infant care (Mercer & Walker, 2006). Psychoeducational classes for pregnant women can improve postnatal maternal self-efficacy (Gao et al., 2012), although the effects of such educational interventions are not yet fully understood (Gagnon & Sandall, 2007). When formal and informal social support are both considered in parallel, insufficient informal support during pregnancy seems to increase the risk for postpartum depression, whereas the role of formal support remains unclear (Nakamura et al., 2020).

The Role of Maternal Mental Health

The perinatal and postnatal periods constitute periods of high vulnerability for experiencing depressive symptoms (Le Strat et al., 2011). Especially disadvantaged populations with low SES or migration status who are exposed to cumulative stressors carry an increased risk for

depression (Anderson et al., 2017). Although higher levels of depressive symptoms seem to be associated with lower levels of maternal self-efficacy, longitudinal investigations on this relation are still rare and indicate differences according to the time of measurement and sample characteristics (Porter & Hsu, 2003; Takács et al., 2019).

The Current Study

Given that maternal self-efficacy emerges before the child is born and plays a vital role for child development, but is not yet well understood in terms of its determinants, this research investigates the formation of maternal self-efficacy during the transition period, thereby monitoring the joint impact of socio-demographic variables as risk factors, and prenatal formal and informal support as protective factors. Maternal mental health during pregnancy (i.e., depressive symptoms) serves as a control variable. Differing from previous studies, our analyses will be based on a prospective longitudinal study design and a socially and/or culturally disadvantaged sample.

Hypothesis 1: We expect to find (1a) lower levels of postnatal maternal self-efficacy in first-time mothers, less-educated mothers, and mothers with migration experiences. (1b) Furthermore, we expect that mothers with more prenatal social support (formal and informal) show higher postnatal maternal self-efficacy. (1c) Finally, the impact of prenatal formal support on postnatal maternal self-efficacy should vary by parity, education level, and migration status of the mother. More specifically, we speculate that mothers with lower education levels, first-time mothers, and those with migration experience should benefit more from formal support in terms of increasing their sense of maternal self-efficacy.

Hypothesis 2: We expect maternal self-efficacy to increase from the prenatal to the postnatal period. This has already been demonstrated for rather homogeneous samples (Gross & Marcussen, 2017; Law et al., 2019; Porter & Hsu, 2003), but will now be tested using a socially and culturally more diverse sample.

Hypothesis 3: Finally, we assume that mothers with higher formal support during pregnancy show a stronger increase in maternal self-efficacy from the prenatal to the postnatal period, as formal support gives guidance and prepares mothers for their parenting role.

Method

Sample

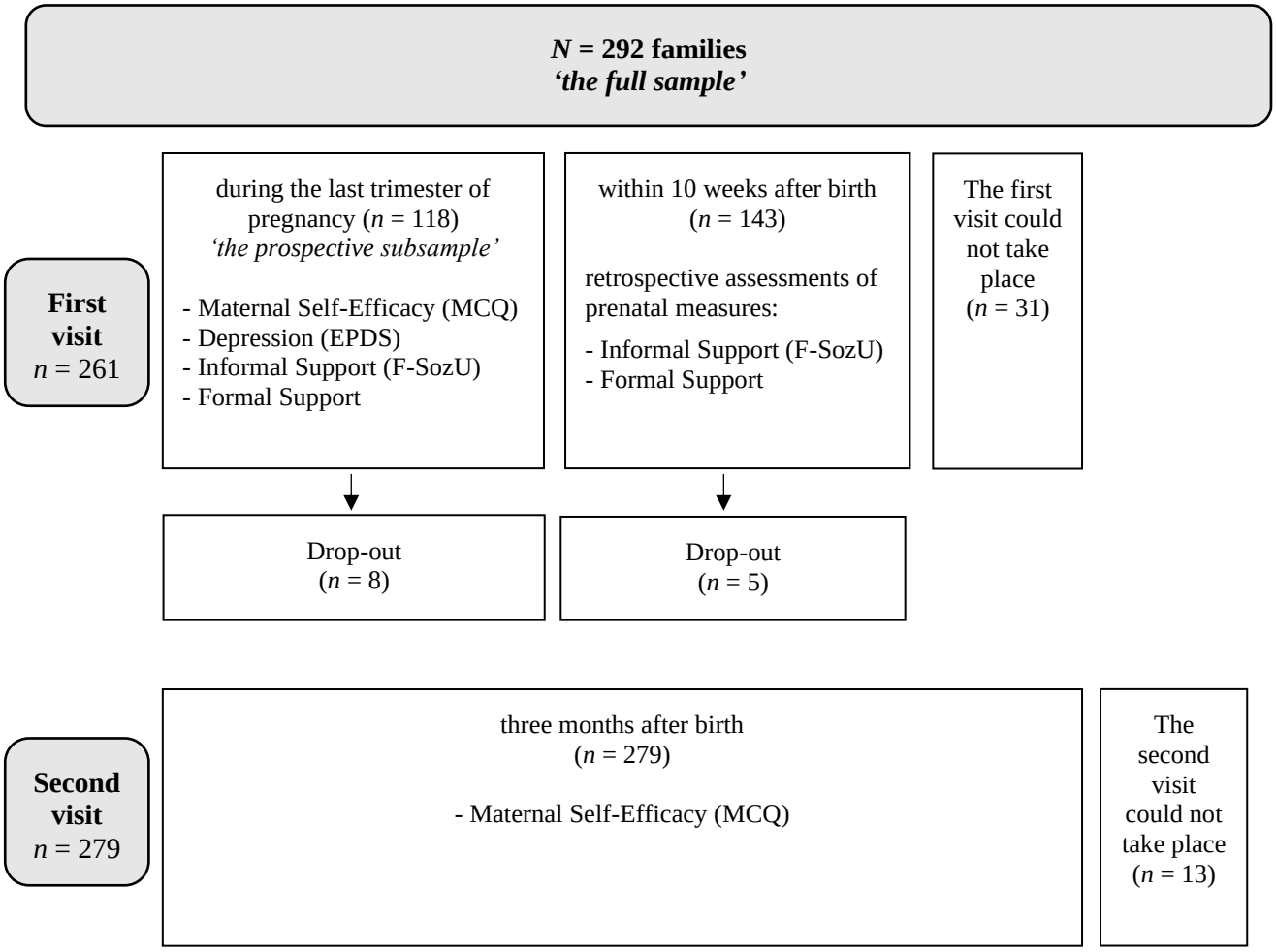
The sample includes mothers from socially and/or culturally disadvantaged families living in Bremen, a medium-sized German city, and participating in the longitudinal BRISE Project (The Bremen Initiative to Foster Early Childhood Development, 1st & 2nd wave). Families that have at least one potential risk factor for child development were included in the study. Risk factors included a low level of parental education (i.e., at least one parent with no more than a secondary education or no vocational training), low family income due to at least one parent being unemployed or a low-wage earner, and migration background of at least one of the newborn's parents or grandparents (Schütte et al., 2020). Each family interested in participating was included in the study either when the mother was pregnant or within 10 weeks after delivery. An ethics commission approved the study and all participants gave their written consent to participate.

Time Points of Data Collection

A total of N = 292 families participated in the first two waves of the *BRISE* study. The first visit to the household was carried out either during the last trimester of pregnancy (n = 118), or within 10 weeks after giving birth (n = 143, retrospective assessments of prenatal measures), depending on when families contacted the research team.

The second visit took place around three months after birth (M = 14.01 weeks). N = 261 mothers participated in the first visit, and N = 279 mothers participated in the second visit. A

detailed diagram shows the sampling plan and the questionnaires used at each measurement point (see Figure 1).



Note. EPDS = The Edinburgh Postnatal Depression Scale, F-SozU = The Social Support Questionnaire, MCQ = The Maternal Confidence Questionnaire.

Figure 1. The sampling plan

Sample Characteristics

Mothers of the full BRISE sample (N = 292) were between 18 and 47 years of age (M = 31.25 years, SD = 5.70 years), and 45% were expecting their first baby. According to the Comparative Analysis of Social Mobility in Industrial Nations (CASMIN) educational classification (Brauns et al., 2003), 69% were below the level of tertiary education (i.e., bachelor's degree). Of the mothers interviewed, 39% were first generation immigrants who were born outside of Germany. The most frequently encountered countries were Nigeria (n = 11), Syria (n = 9), Ghana (n = 8), Kazakhstan (n = 8), and Turkey (n = 8). Mothers either had sufficient proficiency in German or English, a companion to provide translation during the interviews, or a research staff member who conducted the interviews in their primary language. Table 1 gives a comprehensive overview of descriptive statistics. The reasons for missing data are as follows: (a) Due to the characteristics of the specific time period (e.g., appointments due to pregnancy, fatigue and hospital stays before and after birth) in which the first visit was conducted and the demographic variables were measured, it was not possible to conduct this first visit to all families, which resulted in missing data on demographic variables; (b) some mothers were hesitant to share their household income or were not able to provide the information.

Table 1. Descriptive statistics

	n	valid %
Age		
18-30 years	123	42.41
30-35 years	93	32.07
35-47 years	74	25.52
missing	2	
Partner		
yes	231	90.23
no	25	9.77
missing	36	
Parity		
primipara	117	45.00
multipara	143	55.00
missing	32	
Education		
higher education	81	31.03
academic secondary school	60	22.99
lower secondary school	64	24.52
in school / primary school	56	21.46
missing	31	
Migration		
no migration background	134	46.37
born in Germany but at least one parent born abroad	42	14.53
born abroad	113	39.10
missing	3	
	Median	Interquartile range
Monthly household net income, in €	2800	1425-4000
missing	63	

Measures

The central outcome variable of interest is maternal self-efficacy. Predictors of maternal self-efficacy are demographic variables and social support. Given that maternal self-efficacy and depressive symptoms both refer to self-related feelings and expectations, depressive symptoms serve as a control variable.

Prenatal and Postnatal Maternal Self-Efficacy

Two subscales of the Maternal Confidence Questionnaire (MCQ; Parker & Zahr, 1985), knowledge and feelings about parenting, were administered to assess prenatal and postnatal maternal self-efficacy on a 5-point Likert scale. Total scores of the 11 items range from 11 to 55. An example item reads as: 'I will know what makes my baby happy' (for the prenatal period) and 'I know what makes my baby happy' (for the postnatal period). The original English version was translated into German and then reviewed by a second bilingual psychologist. Cronbach's alpha for the internal consistency in the present study was $\alpha = .78$ for the prenatal and $\alpha = .70$ for the postnatal period. The questionnaire was administered twice: first during the last trimester of pregnancy and second around three months after birth. As maternal self-efficacy comprises beliefs and feelings, it was not administered retrospectively to the mothers who joined the study only after delivery.

Demographic Variables

Three demographic variables, all referring to the mother, were of interest in the given context: (1) *Education level* according to the CASMIN educational classification, coded from zero (in school) to nine (higher tertiary education). Following previous studies along similar lines, these values were recoded as one for tertiary education (i.e., at least bachelor's degree) and zero for non-tertiary education (e.g., de Haan, 2011, Foster et al., 2016). (2) *Migration status*: Zero was defined as being born in Germany, and one was given to mothers who were born outside of

Germany. (3) *Parity*, being coded as zero for first-time mothers (i.e., no previous pregnancy) and one for all others.

Prenatal Social Support

A 14-item short version of the Social Support Questionnaire (F-SozU; Fydrich et al., 2009) assessed perceived informal social support from family, friends and relatives during pregnancy on a 5-point Likert scale. Total scores range from 14 to 70. An example item reads as: 'There are people who share both joy and sorrow with me'. Cronbach's alpha for the internal consistency in the present study was $\alpha = .94$. To assess formal social support, mothers were asked whether they visited family counselling centers, or participated in courses on birth preparation or child-rearing. If so, mothers indicated the names of the three most important support programs and how often they participated in them. Response options were (1) once, (2) less than once a month, (3) once or twice a month, and (4) weekly. Numerical codes were summed up for each target, resulting in a total frequency value ranging from zero (no formal support) to 12. Social support was assessed during the last trimester of pregnancy or retrospectively within 10 weeks of delivery for mothers who joined the study after delivery.

Prenatal Depressive Symptoms

Depressive symptoms during pregnancy were measured with the German version of the Edinburgh Postnatal Depression Scale (EPDS; Herz et al., 1997). It consists of 10 items, each scored from zero to three, with three items reverse-coded, yielding a score range between zero to 30. The EPDS can be used during pregnancy, with a cut-off score of 13 or higher, to identify women with high symptom levels (Bergink et al., 2011; Levis et al., 2020). Cronbach's alpha was $\alpha = .90$, thus revealing high internal consistency. The EPDS was administered during the last trimester of pregnancy. As the scale measures depressive symptoms over the past seven days

and aims to assess feelings, it was not administered retrospectively to mothers who joined the study after delivery.

Results

Preliminary Analyses

Mothers who provided prenatally prospective (n = 118) and postnatally retrospective data (n = 143) were compared on all variables of interest. Independent samples t-tests, Mann-Whitney U-tests, or chi^2-tests were conducted according to the level of measurement to detect significant differences between the two groups. No significant differences were found (ps > .05). Thus, both groups could be combined (see Online Supplement A for details).

Longitudinal (test-retest) measurement invariance (MI) was tested using an item-parceling approach (Matsunaga, 2008) in Mplus (Version 8.1) to ensure that changes in maternal self-efficacy can actually be attributed to changes in the level of the construct. First, an exploratory principle component analysis was conducted and a single-factor-structure was observed both in the screeplot and in Velicer's minimum average partial (MAP) test, fulfilling the unidimensionality assumption of the item-parceling approach (Little et al., 2002). Then, a three-parcel structure was applied as recommended (Matsunaga, 2008) by using a balancing approach based on the factor loadings by matching the item with the highest loading with the item with the lowest loading, and items with the second highest and second lowest loadings, etc. (Little et al., 2013). The results indicate strong factorial (metric) invariance with χ^2 (15) = 233.22, p = <.001, *RMSEA* = .062, and *CFI* = .978.

An a priori power analysis was conducted using G*Power 3.1.9.7 (Faul et al., 2009) with a medium effect size (f^2 = .15) and an alpha of .05 to determine the sample size necessary for the intented linear regression analyses. Results showed that a total sample of 109 participants was required to achieve a power of .80.

Descriptive Data

Participants reached a mean of M = 41.67 (SD = 5.11) in *maternal self-efficacy* during pregnancy, and M = 44.01 (SD = 5.19) after birth (possible range: 11-55), which suggests that mothers mostly perceived themselves as being efficient and confident both in their future and in current parenting skills.

Likewise, *informal support* was quite high in the present sample with a mean of M = 58.72 (SD = 12.72, possible range: 14-70), indicating that most mothers felt well supported by family and friends. With regard to *formal support*, 44.0% of the mothers did not attend any courses or events related to pregnancy and child rearing, 21.6% participated in only one, 16.6% in two, and 17.8% in three or more courses or events. Of the 145 mothers who used formal support at least once, the large majority (n = 116) took part in birth preparation courses, whereas less than 1/3 (also) took part in parenting courses (n = 39), or visited family counselling centers (n = 41).

With respect to *maternal depressive symptoms*, mothers reached a mean of M = 8.00 (SD = 6.81) points on the EPDS, with 21.8% scoring above the cut-off value of 13, thus indicating a minor or major depression (Herz et al., 1997; Levis et al., 2020). This rate is higher than the estimated prevalence for the German population among young mothers (i.e., 10-15%; e.g., Sonnenmoser, 2007), presumably due to the inclusion of socially and/or culturally disadvantaged mothers.

Postnatal Maternal Self-Efficacy

Intercorrelations: Maternal Self-efficacy, Demographic Characteristics, Social Support

As expected, first-time mothers attended significantly more parental courses or events than mothers with prior birth experience (see Table 2). At the same time, they scored lower on maternal self-efficacy at three months after giving birth. Maternal education level correlated

significantly with all variables. Mothers with a tertiary education reported using more informal and formal support, but at the same time they achieved comparably lower postnatal maternal self-efficacy scores than mothers without a tertiary education. Interestingly, immigrant mothers reported using less informal and formal support during pregnancy, but achieved higher postnatal maternal self-efficacy scores.

Table 2. Correlations between study variables in the full sample

	1	2	3	4	5	6
1. Parity	1					
2. Education	-.16*	1				
3. Migration	.10	-.25**	1			
4. Informal Support	-.05	.16*	-.30**	1		
5. Formal support	-.33**	.32**	-.19**	.18**	1	
6. Postnatal maternal self-efficacy	.15*	-.18**	.18**	.20**	-.06	1

Note. Point-biserial correlation coefficient was used for all correlations with parity, education and migration, and Pearson correlation coefficient for the remaining variables. *$p < .05$, **$p < .01$.

Prenatal Predictors of Postnatal Maternal Self-Efficacy

A hierarchical linear regression analysis was conducted with the full sample to further test the predictive role of parity, education, and migration; the role of formal and informal social support during pregnancy; and the interaction between demographic variables and formal support on postnatal maternal self-efficacy (Hypothesis 1). The demographic variables were entered in the first step, and the social support and interaction variables were entered in the second step. Table 3 shows the results.

Table 3. Hierarchical linear regression with the full sample predicting postnatal maternal self-efficacy

Predictor variables	*b*	SE	β	*t*	*p*	adj. R^2	ΔR^2
Step 1						.052	.065
Constant	-.78	.62		-1.25	.211		
Parity	1.18	.65	.12	1.81	.071		
Education	-1.32	.72	-.12	-1.84	.067		
Migration	1.39	.68	.14	2.06	.041*		
Step 2						.200	.164
Constant	-1.45	.59		-2.47	.014*		
Parity	2.55	.83	.26	3.07	.002**		
Education	-1.92	.98	-.18	-1.97	.050		
Migration	4.28	.80	.42	5.33	.000***		
Informal support	.11	.02	.28	4.46	.000***		
Formal support	.52	.17	.36	2.99	.003**		
Parity x Formal support	-.38	.19	-.19	-2.03	.043*		
Education x Formal support	-.01	.20	-.01	-.06	.953		
Migration x Formal support	-.86	.20	-.35	-4.23	.000**		

*$p < .05$, **$p < .01$, ***$p < .001$.

The results of the second step are as follows: In accord with our initial hypotheses, previous birth experience, and a higher use of informal and formal support during pregnancy predicted higher levels of maternal self-efficacy after birth. In contrast to our expectations, a lower level of education (marginally) and migration background contributed positively to postnatal maternal self-efficacy. In addition, the interaction between parity and formal support, and the interaction between migration and formal support significantly predicted postnatal maternal self-efficacy. More specifically, formal support turned out to be especially helpful for first-time mothers and for mothers born in Germany (see Figure 2).

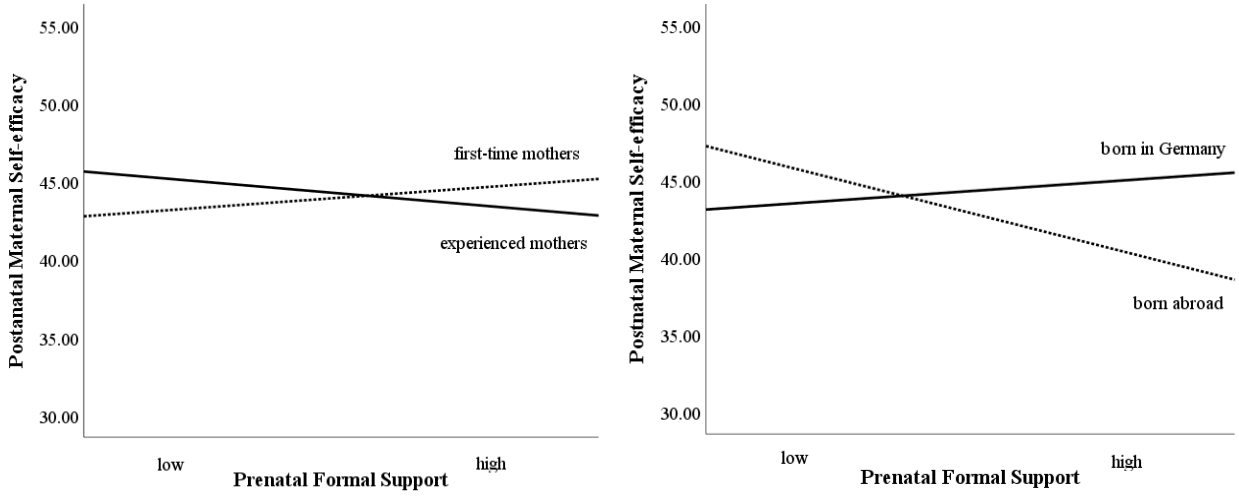


Figure 2. Relationship between Prenatal Formal Support and Postnatal Maternal Self-Efficacy Moderated by Parity and Migration

Including social support (formal and informal) and interaction terms of formal support with demographic characteristics (parity, education, migration) in the model explained an additional 16.4% of the variance in postnatal maternal self-efficacy, with the total model accounting for 20% (adjusted R^2) of variance, F (5, 219) = 8.11, $p < .001$. Hence, social support can be regarded as a critical predictor of postnatal maternal self-efficacy.

Maternal Self-Efficacy from the Prenatal to the Postnatal Period

With regard to Hypotheses 2 and 3 concerning the development of maternal self-efficacy, analyses could only include the subsample recruited prenatally.

Development of Maternal Self-Efficacy from the Prenatal to the Postnatal Period

Consistent with Hypothesis 2, the paired samples t-test indicated a significant increase in maternal self-efficacy between pregnancy (M = 41.67, SD = 5.11) and three months after birth (M = 44.01, SD = 5.19). This difference, 2.34, BCa 95% CI [-3.25, -1.41], was significant t(105) = -5.00, $p < .001$, and represented a medium-sized effect, d = .45.

Prenatal Predictors of the Changes in Maternal Self-Efficacy

To test the predictors of this change, a set of hierarchical linear regression analyses was performed (Hypothesis 3). In the first step, prenatal maternal self-efficacy and demographic variables (i.e., parity, education, migration) were entered to predict postnatal maternal self-efficacy. In the second step, formal and informal support as well as interaction terms between formal support and demographic variables were added.

The results of the second step are as follows: Previous birth experience, being an immigrant, as well as getting higher informal and formal support during pregnancy significantly predicted the increase in maternal self-efficacy from the prenatal to postnatal period. In addition, the interaction between parity and formal support was significant in predicting the change in maternal self-efficacy, suggesting that formal support was especially helpful for first-time mothers. The model explained 44% of variance (adjusted R^2) in postnatal maternal self-efficacy, F (5, 91) = 9.70, $p < .001$. Table 4 shows the results of the regression analysis.

Table 4. Hierarchical linear regression with the prospective subsample predicting the change in postnatal maternal self-efficacy from prenatal maternal self-efficacy

Predictor variables	*b*	SE	β	*t*	*p*	adj. R^2	ΔR^2
Step 1						.316	.344
Constant	-.52	.82		-.64	.525		
Prenatal m. self-efficacy	.52	.09	-.51	5.59	.000***		
Parity	1.18	.88	.11	1.34	.182		
Education	-.88	.97	-.08	-.91	.367		
Migration	.46	1.02	.04	.45	.656		
Step 2						.439	.146
Constant	-1.53	.79		-1.94	.056		
Prenatal m. self-efficacy	.48	.09	.47	5.18	.000***		
Parity	4.26	1.16	.41	3.66	.000***		
Education	-1.81	1.34	-.16	-1.36	.179		
Migration	2.80	1.27	.24	2.20	.030*		
Informal support	.09	.03	.23	2.85	.005**		
Formal support	.81	.23	.50	3.52	.001**		
Parity x Formal support	-.85	.28	-.33	-2.99	.004**		
Education x Formal support	-.06	.29	-.03	-.22	.830		
Migration x Formal support	-.51	.30	-.18	-1.70	.093		

*$p < .05$, **$p < .01$, ***$p < .001$.

To check for the robustness of the results, we conducted the same kind of regression analysis including depressive symptoms as an additional predictor in Step 1. The pattern of results mainly remained unchanged. Depressive symptoms significantly and negatively predicted the changes in maternal self-efficacy, but not in Step 2 after the inclusion of social support. Parity and migration background, formal and informal social support still predicted the change in maternal self-efficacy. Also, the interaction of formal support and parity remained significant. However, no significant interaction of formal support and migration background could be observed, although the direction of the effect was similar. The total model

accounted for 44% of variance (adjusted R^2), F (5, 90) = 8.74, $p < .001$. Online Supplement B shows the results of the regression analysis.

Discussion

This prospective longitudinal study examined the role of demographic variables (parity, education background, migration status) and social support (formal, informal) for maternal self-efficacy development from the preterm to the postterm period by testing a non-clinical but culturally and/or socially disadvantaged diverse sample. Overall, maternal self-efficacy increased from the prenatal to the postnatal period. Levels of postnatal maternal self-efficacy were lower in first-time mothers and in women born in Germany. With regard to social support, mothers with more prenatal social support (formal and informal) showed higher postnatal maternal self-efficacy and a higher increase in maternal self-efficacy from the prenatal to postnatal period. First-time mothers as well as those without migration experience profited most from formal support services. In the following paragraphs, each of these findings will be discussed in more detail.

Socio-Demographic Variables

As predicted, first-time mothers reported lower levels of maternal self-efficacy than mothers with previous pregnancies (see also Gameiro et al., 2009), presumably because they still lack the experience of adapting to parenthood. It should be noted, though, that being a first-time mother was also associated with a higher educational level and with being born in Germany (see Table 2).

Mothers with a higher level of education reported less maternal self-efficacy regarding their child rearing skills than mothers with a lower level of education. Earlier studies based on comparably small samples did not find any association between maternal education and maternal self-efficacy (e.g., Loo et al., 2006, N = 40), whereas studies based on larger data sets

reported a negative association (e.g., Gross & Marcussen, 2017, N = 150), as in the present sample. Mothers with a higher level of education may show an increased awareness of the multifaceted challenges associated with child-rearing and may thus express self-doubts more often (Parks & Smeriglio, 1986). They probably also have higher self-expectations than less-educated mothers and may thus be afraid of not living up to their own standards (Gross & Marcussen, 2017).

Contrary to our expectations, we found that mothers born abroad exhibited higher maternal self-efficacy than mothers born in Germany throughout their pregnancy and beyond. However, since all three critical demographic variables were correlated in the present sample, it is not possible to interpret individual relations separately. Immigrant mothers tended to also have a lower educational status, and a lower level of education is typically associated with a lower parental awareness of child-rearing issues (Parks & Smeriglio, 1986). Hence, we cannot rule out that immigrant mothers in our sample were less critical about themselves in terms of their own skills, thus reporting higher levels of maternal self-efficacy.

It should be noted, however, that most mothers born abroad came from countries with a collectivistic social structure (e.g., Nigeria, Syria, Ghana, Kazakhstan, Turkey), in which traditional familial roles have a high value (Hofstede, 2011), and traditional gender-role beliefs dominate (van de Vijver, 2007). These mothers mostly migrated due to economic problems in their home countries, marriage purposes, or political reasons such as war. There were only very few mothers in our sample who migrated from European countries with individualistic social structures (e.g., France, Italy, Poland). One could thus speculate that those mothers from collectivistic societies have already acquired some experience in taking care of younger siblings or other small children before giving birth. In addition, their cultural norms about the natural nurturing role and competence of mothers, or cultural differences in parental cognitions and attributions could have influenced their self-ratings in terms of maternal self-efficacy. For

instance, parents from diverse cultures mostly show different patterns in the attributions of success and failure in caregiving, with some believing in controllable causes (e.g., one's own parental behavior) and others believing in uncontrollable causes (e.g., luck). This reflects differences in how mothers adapt to their parenting roles, and differences in parenting behavior (Bornstein et al., 2011).

Social Support

The presented findings demonstrate the benefits of providing pregnant mothers with community services and birth preparation courses, as both forms of social support during pregnancy were positively associated with postnatal maternal self-efficacy, explaining a substantial proportion of variance (i.e., about 20%) even when being entered into the regression analysis after critical demographic variables.

Based on her own findings, Leahy-Warren (2005) argued that although partners, family members, or neighbors might provide emotional support, information and appreciation from professionals such as local doctors, nurses or midwives are most effective in increasing maternal self-efficacy regarding infant care. This is presumably due to the fact that professionals are regarded as experts and their affirmation is thus most effective in boosting a mother's self-confidence as a caretaker. Differing from Leahy-Warren (2005), the current study indicates that social support from both informal and formal resources increased maternal self-efficacy. In Leahy-Warren's study, the way of assessing maternal self-efficacy focused exclusively on specific infant care practices (e.g., feeding, bathing) - aspects for which domain-specific knowledge from a professional would be of significant importance. However, in the present study, maternal self-efficacy was measured more broadly, meaning that mothers would also benefit from general affection, appreciation and a sense of security from people they trust to increase their self-efficacy.

While informal support was generally high in the present sample, this was not the case for formal support. Although formal support programs were mostly available for free, only about half of the mothers took advantage of corresponding services. Time constraints due to taking care of older siblings, or already having used formal support services during previous pregnancies may explain why this was the case in experienced mothers. Reasons for why this was also true of mothers with a lower level of education or a migration background may be multifaceted. Some mothers may not have felt the need for formal support (as they revealed high maternal self-efficacy anyway), while others may not have known about formal services and programs (Brandt & Hagge, 2020). In addition, some mothers born abroad may have hesitated to participate because of language problems, or because they assumed that these programs are not consistent with their own cultural beliefs and traditions (e.g., Greene, 2007), as they mostly migrated from countries that have a different social structure than Germany. Further studies are needed to clarify this.

The impact of prenatal formal support turned out to be strongest for first-time-mothers and mothers born in Germany. This indicates that first-time-mothers and mothers born in Germany are not only more likely to seek formal support, but also profit most from this type of support with respect to their maternal self-efficacy development. These results suggest that courses or programs need to address the special needs of subgroups rather than offering the same content to all (e.g., the Nurse Family Partnership, targeting only first-time disadvantaged mothers).

Maternal Mental Health

As expected, mothers with higher levels of depressive symptoms during pregnancy showed lower maternal self-efficacy after giving birth (see also Takács et al., 2019). Feeling depressed and feeling less capable of dealing with an infant both reflect rather low expectations regarding one's own resources to master the existing and upcoming challenges. This is consistent with

previous results that mothers suffering from depressive symptoms during pregnancy carry an increased risk of feeling overwhelmed once the baby is born (Le Strat et al, 2011).

Methodological Considerations

Number of Measurement Points

Previous studies show partly contrasting results in the course of maternal self-efficacy development shortly after birth. Gao et al. (2014), as well as Gross and Marcussen (2017) reported declines in maternal and paternal self-efficacy around one month postpartum. Law and colleagues (2019) found a steep increase thereof between three to six weeks postpartum, and Gao and colleagues (2014) observed a significant increase in maternal self-efficacy between six weeks and three months after birth. Overall, existing evidence suggests that parental self-efficacy may show a temporary decline postpartum before increasing again. This would be consistent with the model of transition to parenthood by Gloger-Tippelt (1988), which states that parents often have mixed feelings during the first eight weeks postpartum because they easily feel overwhelmed and exhausted due to lack of sleep, but also euphoric about having a child, whereas the subsequent phase, starting at about four months (i.e., 2nd measurement point of the present study) is accompanied by more positive feelings and mastery experience. Following Nesselroade (1991), this highlights the need for studies covering short-term variability (e.g., measurement bursts, periodic measurements on shorter time scales) to better understand patterns of changes.

Choice of Variables

This study focused on demographic variables and social support in relation to maternal confidence. However, additional variables might be relevant as well. For instance, Loo and colleagues (2006) reported that the early regulatory behavior of Chinese infants was associated with maternal self-efficacy. Moreover, problems in sleeping, crying and feeding during the first

years impact parental behavior (Samdan et al., 2020). As prenatal formal support programs often cover topics of handling the child (e.g., breastfeeding, carrying the child, soothing), future studies should include infant characteristics as predictors of maternal self-efficacy and potential moderators of the effects of the use of prenatal formal support programs.

Data Quality

A systematic review (Boruszak-Kiziukiewicz & Kmita, 2020) recently pointed out that measures of parental self-efficacy typically rely on self-reports, which always carry the risk of being biased. This, however, can hardly be prevented as the concept refers to personal feelings and expectations. Potentially biasing factors should be controlled for if possible, to account for this problem. This has been done in the present study.

This study did not evaluate the effect of a specific intervention program, but rather examined the use of common formal support services primarily targeting pregnant women, such as birth preparation courses. However, formal support services vary regionally, as well as by culture. Therefore, researchers often apply simple yes/no questions or ask mothers to simply list the services and programs they used to assess formal support during pregnancy (e.g., Nakamura et al., 2020). Although we concede that this does not correspond to a highly standardized and differentiated assessment, the reported findings nonetheless demonstrate the positive effect of formal support.

Lastly, due to the high number of families who actively joined the BRISE study after their child was born, some data on the prenatal period was either missing or could only be collected retrospectively. Although this led to methodological difficulties, we decided to combine the samples as they proved to be largely comparable with respect to critical variables.

Conclusion

Using a prospective longitudinal study design and testing families from a socially/culturally disadvantaged sample, the present study revealed an increase in maternal self-efficacy from the prenatal to the postnatal period. Migration experience and parity contributed to predicting postnatal maternal self-efficacy, even when controlling for depressive symptoms during pregnancy. In addition to informal support, formal support turned out to improve maternal self-efficacy – especially in first-time mothers and mothers born in Germany.

Online Supplement A

Preliminary Analyses to Detect Differences between the Prospective Subsample (prenatally recruited) and the Retrospective Subsample (postnatally recruited)

Table A1. Results of the t-tests

	Prospective subsample		Retrospective subsample		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
Maternal age	30.79	5.98	31.37	5.59	259	-0.81	.418
Prenatal informal support	58.08	14.17	59.25	11.41	208	-0.70	.485
Prenatal formal support	2.75	3.31	2.92	3.45	259	-0.38	.701
Postnatal maternal self-efficacy	43.96	5.19	44.77	4.70	238	-1.27	.205

Table A2. Result of the Mann-Whitney U Test

	Prospective subsample	Retrospective subsample	*z*	*p*
	Mean rank	Mean rank		
Maternal education level	134.04	128.49	-0.60	.549

Table A3. Result of the Chi^2 Test

		Prospective subsample	Retrospective subsample	χ^2	*p*
		n (%)	*n* (%)		
First baby	yes	50 (42.7%)	67 (57.3%)	0.44	.507
	no	67 (46.9%)	76 (53.1%)		

Online Supplement B

Additional Hierarchical Regression Analysis Including Depressive Symptoms as a Control Variable

Table B. Hierarchical linear regression with the prospective subsample predicting postnatal maternal self-efficacy (with 'depressive symptoms' as a control variable)

Predictor variables	*b*	SE	β	*t*	*p*	adj. R^2	ΔR^2
Step 1						.356	.388
Constant	-.44	.79		6.30	.000***		
Prenatal m. self-efficacy	.48	.09	.47	5.23	.000***		
Depressive symptoms	-.17	.06	-.22	-2.62	.010*		
Parity	1.09	.86	.11	1.28	.205		
Education	-1.42	.96	-.13	-1.47	.145		
Migration	.93	1.01	.08	.93	.357		
Step 2						.436	.105
Constant	-1.46	.80		3.53	.001**		
Prenatal m. self-efficacy	.46	.09	.46	4.98	.000**		
Depressive symptoms	-.05	.07	-.07	-.71	.480		
Parity	4.14	1.18	.40	3.51	.001**		
Education	-1.90	1.35	-.17	-1.41	.161		
Migration	2.78	1.27	.24	2.18	.032*		
Informal support	.08	.04	.20	2.16	.033*		
Formal support	.78	.23	.49	3.36	.001**		
Parity x Formal support	-.83	.29	-.32	-2.90	.005**		
Education x Formal support	-.07	.29	-.03	-.23	.818		
Migration x Formal support	-.49	.30	-.18	-1.61	.112		

*$p < .05$, **$p < .01$, ***$p < .001$.

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Paper 3

From co-regulation to self-regulation: Maternal soothing behavior and self-efficacy related to infant regulation at 3 and 7 months

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From co-regulation to self-regulation: Maternal soothing behavior and self-efficacy related to infant regulation at 3 and 7 months

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Abstract

Existing evidence suggests that both maternal self-efficacy and co-regulation affect infant regulation and represent a reciprocal process. Co-regulation is defined as a social interaction where individuals dynamically coordinate their actions with each other. The interpersonal mechanisms underlying these associations are not yet fully understood. The present study examines the potential role of maternal soothing strategies to explain the association of maternal self-efficacy with infant regulation, infant crying, and sleeping behavior. Questionnaire data of N = 150 mothers aged 19 to 37 years with mixed ethnic and educational backgrounds were collected at the infants' ages of three and seven months. Two types of maternal soothing strategies were distinguished: *close soothing*, involving close physical and emotional contact, and *distant soothing*, involving physical and emotional distancing from the infant. Structural equation modeling (*SEM*) was applied: A cross-sectional *SEM* at three months indicated that

maternal self-efficacy is associated with reported infant regulation through distant soothing strategies. Low maternal self-efficacy was associated with frequent maternal use of distant soothing strategies, which in turn was related to reported infant regulation problems, such as non-soothability and greater crying frequency. Frequent use of close soothing strategies predicted reported infant sleeping behavior, such as frequent nighttime awakenings. An additional longitudinal *SEM* further indicated that the effects of close soothing strategies persisted at least until the infants' age of seven months. In sum, the study indicated how low maternal self-efficacy, increased use of distant soothing strategies, and reported early infant regulation problems are intertwined and that, due to their persisting positive effect on infant soothability, close soothing strategies better support infant development. Using close soothing strategies, nevertheless, seems to require sensitivity of the caregiver to provide appropriate learning opportunities for the infant to calm him/herself and to develop a balanced feeding and sleeping rhythm.

1. Introduction

Human infants can hardly survive without others taking care of their basic needs (Harrist and Waugh, 2002). To make sure that infants receive this kind of support, special neural and hormonal responses are elicited that make adults feel attracted to babies (e.g., Luo et al., 2015). In addition, intuitive parenting behavior is activated (Papoušek, 1989). Natural response patterns can, however, be disturbed, for example, due to increased levels of stress (e.g., Crnic and Ross, 2017), or a mental health problem of the caregiver (e.g., postpartum depression, Field, 2010).

Parents' treatment of and reactions to their offspring at a young age are known to have important implications for children’s later physical and mental health (e.g., Lobo and Lunkenheimer, 2020). It is also known to impact *self-regulation* development, here defined as children’s ability

to modulate their own reactivity (Rothbart et al., 2011). Numerous studies show that poor parental co-regulation is associated with impaired self-regulation skills in young children, whereas supportive parental co-regulation is associated with better self-regulation competencies (Blackman, 2017; Ispa et al., 2017; Mohr et al., 2019; Raghunath et al., 2020). Persistent regulation problems in infancy and early childhood often co-exist with diminished abilities linked to self-regulation, like executive functioning, effortful and cognitive control, executive attention, or working memory (e.g., Beauchaine and McNulty, 2013; Nigg, 2017). Low self-regulation is also associated with behavioral problems (e.g., Olsen et al., 2019; Schmid et al., 2010) and reduced academic performance during elementary school years (Kiel et al., 2018; Lunkenheimer et al., 2011; Robson et al., 2020), antisocial behavior in adolescence (Dishion and Patterson, 2016), as well as low academic competence, increased health issues, and low economic success in adulthood (Robson et al., 2020, Moffitt et al., 2011).

Thus, negative consequences of regulation problems in early childhood may persist over the years (Halligan et al., 2013; Schmid et al., 2010), rendering it highly important to explore the mechanisms that underlie the development of self-regulation starting in early infancy. Given that parental co-regulation is essential for self-regulation development during infancy and beyond (e.g., Pauen and the EDOS group, 2016), understanding mechanisms underlying the effects of parental co-regulation is central to understanding the emergence of self-regulatory abilities in young children.

1.1 Parent-infant co-regulation

Early parent-infant co-regulation, also called *pre-dyadic regulatio*n or *dyadic co-regulation* (Sansavini et al., 2015; Taipale, 2016), is generally an interaction process between infants and parents on emotional and behavioral levels (Aureli et al., 2017). Newborns cannot yet distinguish between their own feelings and the feelings of the other person and are emotionally

dependent on external support to regulate their needs (Taipale, 2016). Co-perception of the child's signals, such as reflecting internal states through mimicking or verbalization by the parents, is explained as the beginning of parent-child co-regulation (Demetriou, 2000; Pauen and EDOS group, 2016). Consequently, co-regulation is one part of the process between parent and child both at the behavioral (e.g., supporting child self-control) and mental level (e.g., motivational, emotional, cognitive processes), which contributes to the formation of the child's self-regulation and self-reflection (Pauen and EDOS group, 2016). However, infants differ in terms of how quickly they learn to regulate their own physiological, emotional, and mental states (Rothbart and Derryberry, 1981). Babies with an 'easy temperament' (Thomas and Chess, 1977) typically have a stable biological rhythm and a positive approach to new situations. They are usually in a good mood and do not get upset easily. In the clinical literature, infants with regulation problems show the opposite characteristics: They are reported to have sleeping or eating difficulties, to get upset easily, and/or to cry persistently (Bilgin and Wolke, 2017b; Papoušek, 2004). Nevertheless, co-regulation is a mutual developmental process. The more infants take on an active role in these interactions, the more parents subside their supporting behaviors (Evans and Porter, 2009; Kochanska and Aksan, 2004). During development, infants will gradually learn to regulate their needs and emotions and, thereby, acquire self-regulation skills.

1.2 Infant regulation in dealing with states of increased arousal

The earliest indicators of self-regulation in infancy refer to biological rhythmicity (e.g., Öztürk Dönmez and Bayik Temel, 2019; Williams et al., 2017), attentional control (e.g., Rothbart et al., 2011), the expression of positive and negative emotions (e.g., Diamond and Aspinwall, 2003), and self-soothing (Sadeh et al., 2010). These capacities can be inferred from infants' feeding and sleeping behavior (e.g., the time they take to fall asleep and sleep duration,

frequency of night-time awakenings, ability to self-soothe when waking up at night), their ability to engage or disengage in terms of their attention, the amount, duration, and intensity of their crying, and how well they can soothe themselves when getting upset or excited. However, especially during the early months of life, infants rely heavily on their caregivers to interpret their needs and inner states (e.g., Pauen and EDOS group, 2016). This is where parental co-regulation comes into play, especially when considering situations involving feeding, sleeping, crying, and self-soothing.

1.3 Parental co-regulation strategies

Quantifying parental co-regulation in interactions with young infants is difficult. Some researchers study interactions between a parent and their infant, taking into account the behavior of both partners (e.g., in the still-face paradigm; Feldman et al., 2010). Other authors focus on self-reported parental strategies for regulating their infants' inner states and needs (e.g., Groß et al., 2013).

Soothing practices as types of co-regulatory responses play a key role in infant crying and sleeping behavior (e.g., Groß et al., 2013). Young infants have limited options to express their inner states (Gross and Cassidy, 2019) and often cry when they experience some kind of discomfort (Illingworth, 1955). In situations when crying cannot be attributed to an obvious and easy to remedied reason, a trial-and-error approach for developing a set of (successful) soothing techniques is needed to reduce the infant's negative arousal. For instance, persistent crying despite satisfied hunger (e.g., Howard et al., 2006) requires parents to explore other reasons and soothing techniques, such as offering a pacifier (Howard et al., 2003). The first phase of adaption for parents and newborns typically lasts until the second month after birth (i.e., Trevarthen and Aitken, 2001), followed by a time of relative stability regarding infants' limited self-regulation capacities.

Infant carrying describes another way of soothing and caring for infants (Gammie, 2013). This natural approach helps to establish bio-behavioral synchrony between a parent and his/her child based on heart sounds, visual-affective social cues (e.g., eye contact), and physical proximity (Feldman et al., 2011). It often involves skin-to-skin contact, which is known to be highly efficient in supporting the physiological regulation of young infants (Charpak et al., 2005; World Health Organisation [WHO], 2003). *Parental rocking of the baby* and *speaking to the baby* often accompany infant carrying; and also have calming effects (Dayton et al., 2015; Groß et al., 2013; Möller et al., 2019). Carrying the infant leads to the release of oxytocin in both mother and infant (Welch and Ludwig, 2017), and is associated with a reduction in crying and infant heart rate (Esposito et al., 2013).

Some parents use *tight swaddling* (i.e., wrapping the infant in a cloth, thereby restricting movements of the limbs). Although swaddling can be effective when dealing with premature babies or infants with brain damage (Lipton et al., 1965; van Sleuwen, Engelberts, et al., 2007), evidence referring to the average population did not reveal any positive effects (van Sleuwen, L'Hoir, et al., 2007). Tight swaddling limits infants' expressive capacity and prevents close physical contact with the caregiver; therefore, it remains controversial.

Furthermore, *musical toy*s are used for soothing purposes to provide distraction and entertainment (Dayton et al., 2015). Even though this is often recommended as an effective element for establishing a bedtime routine and may provide some comfort when the infant needs stimulation, it can be counterproductive in meeting the infant's natural need for social support and closeness (i.e., Allen et al., 2016).

Another controversial approach is to wait and let the infant cry until he/she gets tired and falls asleep. Although some experts recommend to refrain from *ignoring infant crying*, as it can lead to unhealthy degrees of arousal (Ludington-Hoe et al., 2002) and can disrupt the attachment

process (Bell and Ainsworth, 1972), some recent findings suggest no adverse effects on attachment and behavioral development (Bilgin and Wolke, 2020).

Finally, parents who feel highly stressed, helpless, or overwhelmed may become aggressive towards a crying infant and then use harsh parenting practices such as *slapping* (Reijneveld et al., 2004), *shaking* the infant (Reijneveld et al., 2001), or *using medication* (Dayton et al., 2015). These soothing techniques are generally considered to disrupt the attachment process and may affect the infant's physical and mental health (Reijneveld et al., 2001).

According to Feldman and colleagues (2011), these different soothing techniques can be broadly divided into ***distant soothing (DS)*** and ***close soothing (CS) strategies.*** Distant soothing strategies involve physical and emotional distancing of the caregiver from the child, whereas CS strategies involve emotional and physical contact between the caregiver and the infant. Based on this scheme, *offering breast- or bottle feeding, carrying the baby around, speaking or singing to the baby,* and *rocking the baby* would count as CS strategies because they indicate physical and emotional proximity. The use of CS strategies during early infancy is associated significantly shorter infant crying phases (Jahromi et al., 2004; Spinrad et al., 2004). By contrast, *ignoring infant crying* or *tight swaddling* in response to negative arousal, and to some extent, also *playing a musical toy* are considered DS strategies because these strategies involve physical and emotional separation from the infant. Harsh parenting strategies (i.e., *slapping, shaking, giving medication*) are extreme forms of distant soothing and constitute a separate category as they also count as child maltreatment (Reijneveld et al., 2004).

1.4 Sensitivity and responsivity of parental co-regulation

In cases where caregivers regularly fail to provide co-regulation of infant needs, negative effects on children's stress responses and health during adolescence and early adulthood have been

observed (Davidov and Grusec, 2006; Leerkes et al., 2009). When parents show too much co-regulation and thus display intrusive behavior, it can also have negative effects (Feldman et al., 2010). Hence, it seems important to apply situation-adequate soothing strategies. Sensitive and responsive parental behavior indicates the parent's ability to respond appropriately to the child's physical and emotional needs (Bornstein and Manian, 2013; Fonagy et al., 2018). High sensitivity, i.e. the appropriateness and promptness of parental responses, is known to promote child development (Bigelow et al., 2010; Mastergeorge et al., 2014).

What determines how well caregivers manage to provide adequate and supportive co-regulation? One important predictor seems to be caregiver self-efficacy in their parenting abilities (Aranda, 2013; Wilson et al., 2014).

1.5 Maternal confidence and self-efficacy

The concepts of maternal confidence or maternal self-efficacy are both grounded in the self-efficacy theory of Bandura (1977). The theory postulates that the general belief in one's own ability to show a given behavior increases the likelihood of its occurrence. Maternal self-efficacy typically refers to a mother's belief in her ability to provide sensitive and responsive care to her child (Hess et al., 2004; Vance and Brandon, 2017), as well as a sense of competence in relation to the maternal role (Badr, 2005; Troutman et al., 2012).

Caregiver self-efficacy is associated with more effective (Aranda, 2013; Wilson et al., 2014) and supportive parenting practices (Ardelt and Eccles, 2001; Glatz and Buchanan, 2015; Hess et al., 2004), including the use of CS strategies (e.g., Gärtner et al., 2018). High maternal self-efficacy has also been shown to correlate with the adaptive, social-emotional, and cognitive outcomes of the child (Coleman and Karraker, 2003). In contrast, low maternal self-efficacy has been found to correlate with more problems in infant sleeping, feeding, and crying during

the first four months (Cook et al., 2019; Matthies et al., 2017). Infants of mothers with low maternal self-efficacy are described as more restless and difficult and as less predictable in their co-regulatory behavior (Zahr, 1991). Furthermore, they show more negative emotionality (Coleman and Karraker, 2003; Troutman et al., 2012).

1.6 Relating maternal self-efficacy and soothing strategies to infant regulation

Existing evidence suggests that caregiver co-regulation (especially parental soothing behavior) is systematically linked to infant regulation. In general, CS strategies seem to be linked to better infant regulation than DS strategies, but in addition to the type of strategy, the frequency and appropriateness of its application should also be considered. Parent's self-efficacy affects their preferred soothing strategies as a caregiver (Dayton et al., 2015). Based on these arguments, it is assumed that maternal self-efficacy influences the type and frequency of soothing strategies, which in turn are related to the type and frequency of regulatory problems in the infant.

1.7 Current study

In this study, we assessed maternal self-efficacy and soothing strategies at the infant's age of three months and infant regulation at both three and seven months using maternal report, thus conducting cross-sectional as well as longitudinal analyses. We aim to investigate how maternal self-efficacy and soothing strategies are related to infant regulation in the first months of life and hypothesize the following:

(1) Mothers with low maternal self-efficacy use more DS strategies whereas mothers with high maternal self-efficacy use more CS strategies. (2) Frequent use of DS strategies is associated with more infant regulation problems, whereas CS strategies are assumed to be related to fewer regulation problems. (3) Infant regulatory behaviors remain largely stable between three and

seven months of age. (4) Choice and frequency of CS vs. DS strategies link maternal self-efficacy to maternal reports of infant regulation.

2. Methods

2.1 Participants

Overall, 150 mothers, aged 19 to 37 years (*Mdn* = 32 years, interquartile range = 8 years), with a median of upper secondary education (i.e., level 3: 11 to 13 years of education) according to the International Standard Classification of Education (ISCED11; UNESCO Institute for Statistics, 2012), participated in the first wave of the Bremen Initiative to Foster Early Childhood Development (BRISE). The total sample of infants (*N* = 144; 79 males) were aged 2 to 4 months (*Mdn* = 3 months, IQR = 1 month) at measurement time point T1, and 6 to 10 months (*Mdn* = 7 months, IQR = 1 month) at measurement time point T2.

Overall, 71% of the mothers in this study had a migration background. Among these mothers, 40% were second-generation immigrants born in Germany but with at least one parent born abroad, and 31% were first-generation immigrants born outside Germany. The countries of migration in descending order of frequency ($n > 2$) were: Syria, Nigeria, Iraq, Kazakhstan, Russia, Turkey, Afghanistan, Egypt, Italy, and Ukraine. The longitudinal BRISE study targets children whose parents are socially or culturally challenged. The children and their families live in disadvantaged areas of Bremen identified by known social and demographic risk factors associated with disparities in child development (Spiess et al., 2008). For study inclusion, parents had to have at least one of the following risk factors: a low parental education level (as described by at least one parent with no more than a secondary school diploma or no vocational training), low family income due to at least one parent being unemployed or a low-wage earner, or a migration background of at least one parent or grandparent. Families were recruited by a

network of gatekeepers (e.g., midwives, gynecologists, social workers) and through public advertisements (Schütte et al., 2020). Families interested in participating were individually screened via phone calls. Basic knowledge of German or English language were required in this screening process to ensure comprehension in the interviews. A national ethics committee approved the study and all participants gave their signed consent for participation.

2.2 Procedure

As an ongoing longitudinal study, BRISE collects data at multiple measurement time points: in the last trimester of pregnancy or shortly after birth (T0), around three months (T1), and around seven months (T2). Mothers were interviewed at home twice, using a structured questionnaire when their infants were about three and seven months old. These age periods were chosen to cover the very beginnings of self-regulation development. The questionnaire included questions on maternal self-efficacy (3 months, T1) and soothing behavior (3 months, T1) as well as infant regulation (i.e., crying, sleeping, self-soothing, 3 and 7 months, T1 and T2).

Interviews were conducted in either German or English, depending on which language the caregiver understood best. In rare cases when families had limited English and German proficiency, families were assigned interviewers who spoke the language of the caregiver (Arabic, Russian or Turkish) in addition to German or English.

2.3 Measures

Maternal self-efficacy was measured at an infant age of three months (T1) using the Maternal Confidence Questionnaire (MCQ; Badr, 2005; Parker and Zahr, 1985). The MCQ has been utilized in several countries and shows good reliability and validity measures (Badr, 2005). For the current study, the subscales *knowledge* (six items; e.g., “I know when my baby wants to play with me”) and *feelings* (five items; e.g., “Taking care of the baby frustrates me”) were

assessed. The original English version of the MCQ was translated into German and then reviewed by a second bilingual psychologist. All items were answered on a five-point Likert scale and demonstrated similar reliability to the original samples, indicating a successful translation. The complete questionnaire shows sufficient internal consistency (ω = .97, as calculated according to McDonalds omega which is equivalent to the alpha coefficient; McNeish, 2018).

Maternal soothing strategies were also measured at T1 by items describing different types of *soothing strategies* (Dayton et al., 2015) and items from the subscale *co-regulation* from the Questionnaire for Crying, Feeding, and Sleeping (Groß et al., 2013). A total of 10 items, each referring to one soothing strategy, were translated into German and then reviewed by a second bilingual psychologist. The items were assessed on a six-point Likert scale (never, less than 1-2 times per week, 1-2 times per week, 3-6 times per week, one-time daily, several times daily). The complete questionnaire of soothing types shows sufficient internal consistency (ω = .94; McNeish, 2018). Following Feldman and colleagues (2011) the soothing strategies were categorized into DS and CS strategies. For the complete questionnaire, see Table A in the supplement.

Infant regulation was measured at T1 and T2 (infant age of three and seven months) in terms of crying, self-soothing, and sleeping behavior based on maternal reports. Crying behavior was assessed by the frequency of crying and whining (at least 30 minutes continuously) on a five-point Likert scale (1 = never, 5 = four – six times a day) of a recent typical week (Groß et al., 2013). Infant ability to calm down after the use of soothing strategies was assessed on a four-point Likert scale (i.e., non-soothability: 1 = never, 4 = always; Groß et al., 2013). Sleeping behavior was assessed based on how long it took the infant to fall asleep (Pairfam, 2019), and

the frequency of night-time awakenings (1 = not at all, 4 = five times or more per night; Nationales Bildungspanel [NEPS], 2019).

2.4 Data analysis

First, we analyzed each variable at the descriptive level. Second, we selected items from the soothing questionnaire that best represented close and distant soothing for subsequent model-testing. The main research questions were then analyzed utilizing *structural equation modeling* (*SEM*) via path and latent factor analysis (e.g., Geiser, 2011; Hayduk and Glaser, 2000; Reinecke, 2014).

A cross-sectional *SEM* was performed for measurement point T1 (i.e., infant mean age: 3 months). Maternal self-efficacy was included as a manifest predictor of DS and CS strategies as well as infant regulation. Ordinal-scaled variables for infant regulation (i.e., infant soothability and crying behavior, as well as the frequency of night-time awakenings) at T1 were included in the *SEM* as categorical variables.

In an additional *SEM*, maternal self-efficacy and soothing strategies at T1 were combined with measures for infant regulation at T2 (i.e., 7 months of age) to test for longitudinal effects. Infant regulation at T1 was included as a covariate. Consequently, *SEMs* with continuous, latent, and categorical variables were used, whereby a logistic regression and integration analysis was calculated in the case of continuous dependent variables (Muthén and Muthén, 1998-2017).

The plausibility of both models was verified by descriptive statistics, partial construction of the model (Geiser, 2011), and model fit indices of logistic regression (i.e., Wald test of parameter constraints; Hosmer et al., 2013). Instead of using the common model fit parameters such as $\chi 2$ statistics or RMSEA, that are suitable for interval-scaled variables, the Wald Test for analyses with ordinal-scaled variables (Kwan and Chan, 2011) was applied. The comparison of infant

regulation from T1 to T2 was performed using nonparametric statistics (chi-square test, Cramer's V; Acock and Stavig, 1979). Statistics were performed with IBM SPSS 25 and Mplus Version 8.4 (2020). Only cases containing more than 70% of the responses were included. Cases with missing values above 70% were excluded pairwise. For the remaining variables, missing values were estimated by FIML within the framework of the *SEM* via Mplus (Enders, 2010).

3. Results

3.1 Descriptive statistics

A total of $N = 140$ mothers filled out the maternal self-efficacy questionnaire at T1. Their mean score was $M = 44.12$ (maximum: 55) with a standard deviation of $SD = 4.63$ and a range of 31 to 55. Overall, mothers in the present sample revealed rather high levels of self-efficacy.

Migration background was not significantly associated with maternal self-efficacy, soothing strategies, or with infant regulation at three or seven months (all correlations $p > .05$; Bonferroni-corrected).

Correlation analyses of the questionnaire data revealed that higher maternal self-efficacy was associated with lower scores on non-soothability ($r_s = -.34$, $p < .001$) and less infant crying ($r_s = -.30$, $p < .001$) at three months of age (T1). However, it was not associated with any of the infant regulation variables at seven months (T2; all correlations $p > .05$; Bonferroni-corrected).

Table 1 reports the descriptive statistics for the soothing items sorted into the two categories distant and close soothing (DS, CS) based on their content (see also introduction).

Table 1

Descriptive statistics for soothing strategies

Type of soothing	Items		*N*	*Mean* (*SD*)**
Distant soothing	DS1*	I let my baby cry until he/she calms herself	137	1.36 (0.88)
	DS2*	I wrap my baby very tightly in a cloth	137	1.72 (1.25)
	DS3	I play music to my baby (e.g., with a clock, a musical cuddly toy or a mobile)	138	4.15 (1.82)
	DS4	I slap my baby	137	1.16 (0.77)
	DS5	I shake my baby	136	1.11 (0.70)
	DS6	I give my baby medication (e.g., Paracetamol, Novalgin, Parkemed)	137	1.05 (0.28)
Close soothing	CS1*	I carry my baby around	138	5.33 (1.27)
	CS2*	I rock my baby in my arms	135	5.08 (1.50)
	CS3*	I talk or sing to my baby in a soothing tone	137	5.48 (1.00)
	CS4	I breastfeed my baby or give him/her the bottle	138	4.49 (1.98)

Notes. *Items included in further analyses. **Range: 1 (never) to 6 (several times daily).

Even though data sets for each variable were mostly complete with only a few dropouts, most items referring to DS strategies were chosen very rarely in the present sample. In contrast, CS strategies were reported to be used very often, suggesting that the majority of mothers chose positive parenting strategies. Few mothers reported using distant/harsh soothing techniques such as slapping (DS4: $n = 6$), shaking (DS5: $n = 4$), or medication (DS6: $n = 5$). It should be noted, though, that some participants made comments revealing that they interpreted DS4 as tapping the baby gently on the back ($n = 2$), and DS6 as providing medical care when the infant is sick ($n = 2$). Hence, data for DS4 to DS6 is determined as non-interpretable and excluded from further analyses. The soothing strategy DS3 (playing music to the infant) was the only item with a very high value on the DS dimension. Correlational analysis revealed that this item correlates significantly with other CS items (i.e., CS4, CS4, CS5), thus being unspecific in terms of the distinction between DS and CS. Given the widespread use of DS3 and CS4 and the fact that they do not seem to distinguish well between mothers who tend to use CS strategies vs. DS strategies, we decided to exclude these two items from further analyses. In sum, we thus

selected DS1 and DS2 to represent DS strategies and CS1, CS2, and CS3 to represent CS strategies in the subsequent SEM.

3.2 Stability of infant regulation during infancy

As displayed in Table 2, mothers reported low levels of infant crying and non-soothability at both T1 and T2. On average, infants were reported to require 20 minutes to fall asleep and to wake up twice at night at both time points. Overall, mothers' responses regarding the regulation of their three-month-old infants are similar to the responses regarding the regulation of their seven-month-old infants (see Table 2: falling asleep duration and all-remaining variables).

Correlations between items of infant regulation showed non-significant relations except for infant non-soothability and crying at T1 (r_s = .25, p = .002; Bonferroni-corrected). All items revealed significant but small to moderate interrelations between T1 and T2, revealing systematic stability in infant regulation measures between three and seven months of age (see Table 2).

Table 2

Descriptive statistics for different infant regulation problems at T1 and T2

Infant regulation		T1[a]	T2[b]	Interrelation T1 to T2
	N	*M (SD)*	*M (SD)*	
Non-soothability	142	1.38 (0.58)	1.26 (0.55)	.22[c*]
Crying	143	1.68 (0.94)	1.30 (0.61)	.30[c***]
Falling asleep duration	132	22.62 (21.88)	20.18 (20.44)	.34[d**]
Night-time awakenings	143	2.23 (0.73)	2.42 (0.95)	.39[c***]

Notes. [a]Measurement point T1 infants aged *Mdn* = 3 months; [b]Measurement point T2 infants aged *Mdn* = 7 months; [c]Interrelation for ordinal scaled items via *Cramer's V*; [d]standardized regression coefficients *ß*.
$^{*}p \leq .05$; $^{**}p \leq .01$; $^{***}p \leq .001$.

A chi-square test revealed a significant interrelation of non-soothability, crying, and nighttime awakening with a medium effect size (see Table 2). The regression analysis referring to the duration of falling asleep is also significant across both T1 and T2 (see Table 2). This indicates that the dimensions of infant regulation behavior were stable across both assessments.

3.3 Cross-sectional SEM analysis of maternal self-efficacy, soothing and infant regulation at 3 months of age

Figure 1 shows the structure equation model testing the associations between DS vs. CS strategies, maternal self-efficacy, and reported infant regulation cross-sectionally for T1. Although maternal self-efficacy was correlated with various dimensions of infant regulation, when soothing strategies were taken into account, direct and indirect associations between maternal self-efficacy and infant regulation variables were no longer significant. When soothing behavior was included, maternal self-efficacy affected soothing behavior, which in turn affected infant regulation. More specifically, low maternal self-efficacy levels significantly increased the frequency of use of DS strategies, explaining 10.9% of its variance. Frequent use of DS strategies predicted maternal ratings of infant regulation, showing a significant association with higher non-soothability and higher crying frequency. Infant sleep behavior was not directly predicted by DS strategies. It should be noted that the items DS1 and DS2 showed only moderate loadings on the latent variable of DS, thus indicating that each item covers a different aspect of distant soothing. Maternal self-efficacy did not predict the use of CS strategies, explaining only 0.1% of its variance. As expected, frequent use of CS strategies is associated with maternal ratings of less non-soothability of the infant. Interestingly, it also predicted the frequency of night-time awakenings. Falling asleep duration, as one dimension of infant regulation, was neither predicted by CS nor by DS maternal strategies.

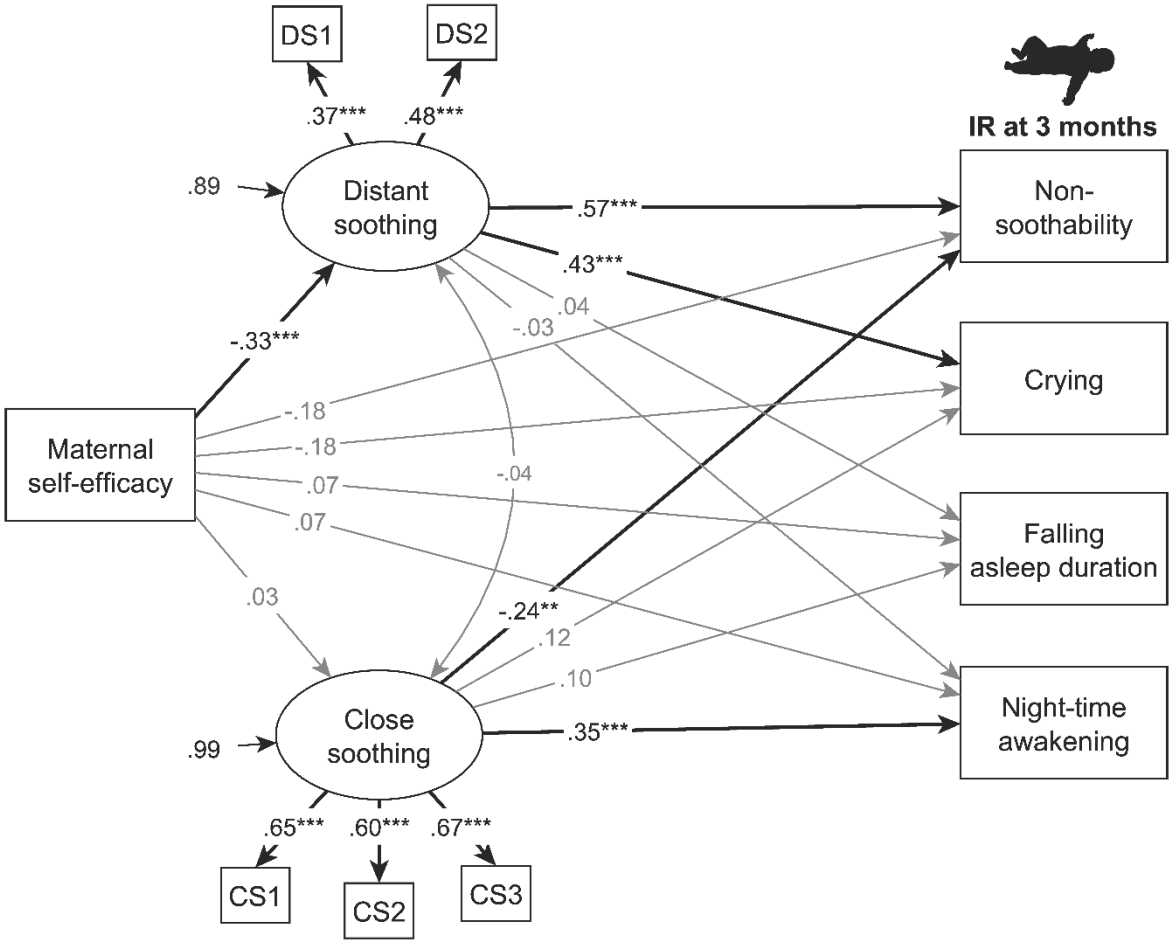

Figure 1 Structural equation model of maternal self-efficacy, soothing strategies, and infant regulation at 3 months.

Notes. The model shows the association of maternal self-efficacy levels and the frequency of distant and close soothing use on infant crying and sleeping behavior.

N = 143. Estimated values of standardized regression coefficients of multiple logistic regression analyses. DS1 = I let my baby cry until he/she calms herself; DS2 = I wrap my baby very tightly in a cloth (swaddling); CS1 = I carry my baby around; CS2 = I rock my baby in my arms; CS3= I talk or sing to my baby in a soothing tone; IR = Infant regulation. R-Square: DS = 10.9% p = .286, CS = 0.1% p = .913, non-soothability = 49.0% p = .003, crying = 28.1% p = .025, falling asleep duration = 1.5% p = .586, night-time awakenings = 13.2% p = .114. Model fit information: Wald test of parameter constraints = 82.870, $df(3)$, $p < .001$, indicates that the overall effect of rank of logistic regression is statistically significant (Hosmer et al., 2013).

$^{*}p \leq .05$; $^{**}p \leq .01$; $^{***}p \leq .001$.

3.5 Longitudinal SEM analysis of maternal self-efficacy, soothing at 3 months and infant regulation at 7 months of age

In order to address how early maternal self-efficacy and soothing strategies effect maternal reports on infant regulation longitudinally, a second *SEM* was conducted relating maternal self-efficacy and soothing strategies at T1 to infant regulation at T2, while controlling for infant regulation at T1. Figure 2 displays the results of the longitudinal analysis. In contrast to the first *SEM*, frequent use of DS strategies did not show a significant association with non-soothability and crying frequency at T2 when being controlled for infant regulation at T1. Neither CS nor DS strategies at T1 were related to the duration of falling asleep at T2, mirroring findings of the cross-sectional analysis. Frequent use of CS strategies at T1 was associated with better soothability and more frequent night-time awakenings of infants at T2, indicating that the influence of early soothing strategies on maternal ratings of infant regulation persists with higher estimated *ß*-values compared to the cross-sectional *SEM* at three months.

Taking the results of both *SEMs* together, lower levels of maternal self-efficacy at T1 were found to be associated with the use of DS strategies at T1. Increased use of DS strategies at T1 was further related to increased non-soothability and crying in maternal reports at T1. However, neither early maternal self-efficacy nor DS strategy use at T1 were significantly associated with infant regulation at T2 when initially reported levels of infant regulation were controlled. While no direct link between maternal self-efficacy and CS strategies was found, high use of CS strategies supported infant soothability and led to more night-time awakenings in maternal reports within the first seven months of life.

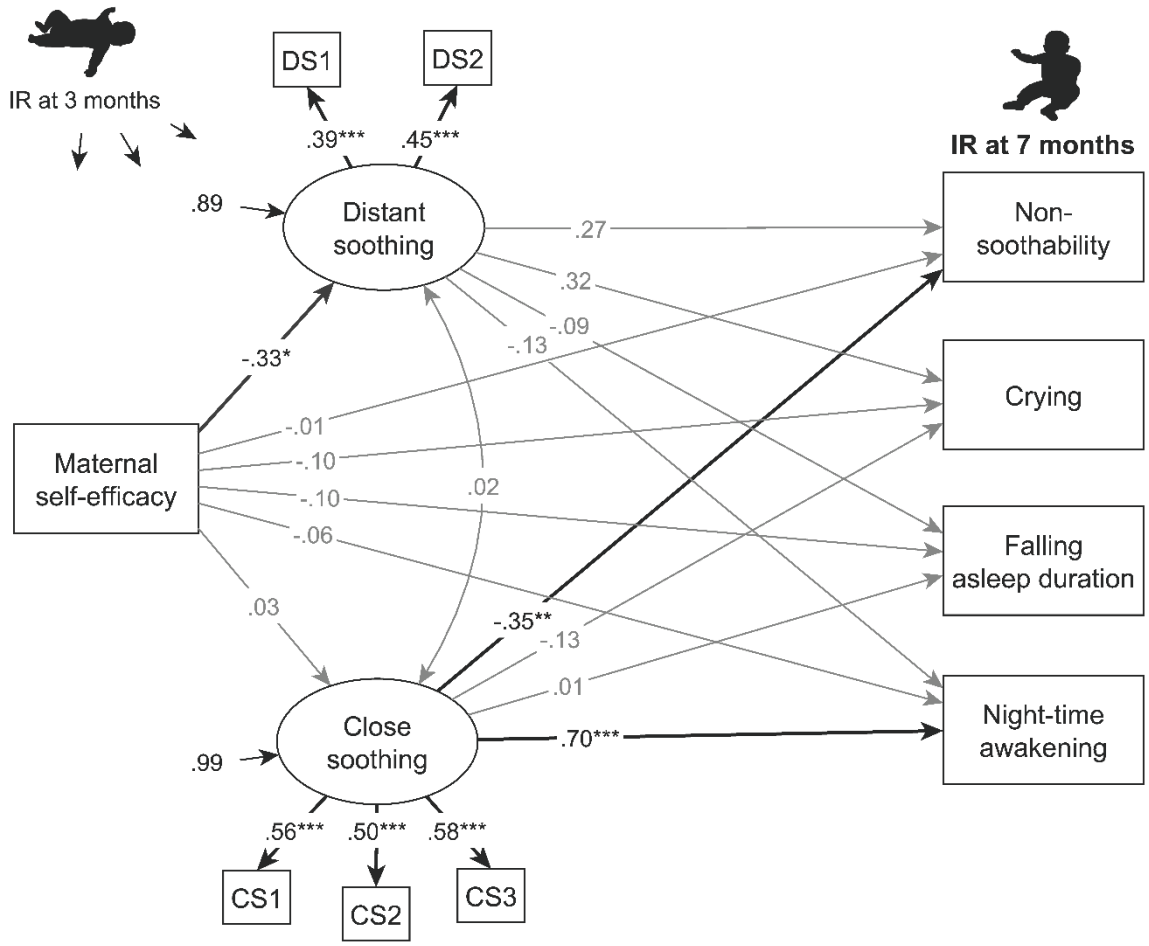

Figure 2. Structural equation model of maternal self-efficacy and soothing strategies at 3 months, and infant regulation at 7 months (controlling for infant regulation at 3 months).

Notes. The longitudinal model shows the association of maternal self-efficacy levels and the frequency of use of distant and close soothing strategies at T1 (3 months, left-hand side) to infant regulation (infant crying and sleeping behavior, right-hand side) at T2 (7 months) after controlling for infant regulation at T1.

N = 143. Estimated values of standardized regression coefficients of multiple logistic regression analyses. DS1 = I let my baby cry until he/she calms herself; DS2 = I wrap my baby very tightly in a cloth (swaddling); CS1 = I carry my baby around; CS2 = I rock my baby in my arms; CS3= I talk or sing to my baby in a soothing tone; IR = Infant regulation. R-Square: DS = 10.7% p = .300, CS = 0.1% p = .916, non-soothability = 19.4% p = .074, crying = 15.3% p = .323, falling asleep duration = 1.2% p = .775, night-time awakenings = 49.9% p = .017. Model fit information: Wald test of parameter constraints = 74.675, $df(3)$, $p < .001$, indicates that the overall effect of rank of logistic regression is statistically significant (Hosmer et al., 2013).

$^{*}p \leq .05$; $^{**}p \leq .01$; $^{***}p \leq .001$.

4. Discussion

The present study investigates the associations between maternal self-efficacy, soothing strategies, and infant regulation in very young infants based on maternal report, thereby focusing on the role of soothing strategies in the well-documented relation between maternal self-efficacy and infant regulation problems (Cook et al., 2019; Matthies et al., 2017). In line with the literature, we found associations between maternal self-efficacy and soothing strategies, and between soothing strategies and maternal ratings of infant regulation, with fairly stable infant regulatory behaviors throughout early infancy. Maternal self-efficacy correlated with infant regulation at three months. Importantly, this relation disappeared when soothing strategies were also considered in structure equation modelling. In addition, the correlation between maternal self-efficacy (assessed at 3 months) and infant regulation at seven months was no longer significant which points to the high dynamic in early caregiver-child interactions during the first year of life.

Looking more closely at different types of soothing strategies, we found that mothers with low maternal self-efficacy used more DS strategies but did not vary in terms of CS strategies when the use of CS strategies was generally very high. Nonetheless, the use of CS strategies was systematically related to infant non-soothability and nighttime awakenings at both measurement points (i.e., at 3 and 7 months), whereas DS strategies were associated with regulation problems (non-soothability and crying) only at three months of age and did not predict maternal ratings of infant regulation at seven months when baseline manifestations of regulation problems were controlled. To better understand these findings, results for each measurement point will be discussed in more detail.

4.1 Maternal self-efficacy, soothing strategies, and infant regulation at 3 months

4.1.1 Distant soothing strategies

Consistent with the existing literature, our data showed that low maternal self-efficacy is associated with less effective (Aranda, 2013; Wilson et al., 2014) and less supportive parenting practices (Ardelt and Eccles, 2001; Glatz and Buchanan, 2015; Hess et al., 2004). The data also supported the relation between DS strategies and infant regulation difficulties like non-soothability or a greater frequency of infant crying at three months of age (e.g., Gärtner et al., 2018; Jusienė and Breidokienė, 2019; Sanders and Woolley, 2005). According to Papoušek (2004), maternal self-efficacy, distant soothing strategies, and infant regulation are closely intertwined. Frequent and persistent crying of the infant reduces the intuitive competence and self-efficacy of caregivers, which promotes more frequent use of distant or negative soothing strategies, thus leading to even more infant crying. In line with this interpretation, a recently introduced model on the origins and evolution of maternal self-efficacy postulates feedback loops between child behavior, maternal emotional and cognitive processes, maternal behavior, and maternal self-efficacy (Cao et al., 2022). Furthermore, de Cock and colleagues (2015) demonstrate that adults who hear a child cry for 10 minutes feel increasingly incompetent and less confident as a parent in the future. Hence, it seems plausible to assume that frequent infant crying increases feelings of helplessness in caregivers, which may in turn increase the use of DS strategies (see Papoušek, 2004). What holds true for infant crying, however, may not apply equally to other regulative problems. The current study did not reveal any significant association between DS strategies and infant sleep regulation at three months of age. In an attempt to better understand this finding, it seems useful to first take a closer look at results regarding CS strategies.

4.1.2 Close soothing strategies

In contrast to the findings regarding DS strategies, maternal self-efficacy was not associated with CS strategies. This may be attributed in part to a lack of variance regarding CS, as CS strategies were used very often by mothers in the present sample, as indicated by high group means and low standard deviations on this variable. Nonetheless, we found that mothers who used more CS strategies were better able to soothe their infant than mothers who reported less frequent use of CS strategies, which is largely consistent with previous work (Hunziker and Barr, 1986; Klamann et al., 2019).

Interestingly, we found a positive link between CS strategies and night-time awakenings of the infant. If the infant wakes up at night, CS strategies such as picking the child up, feeding, rocking, and singing may not always necessary. Moreover, they could prevent the baby from developing self-soothing skills (for a review see Sadeh et al., 2010). Mothers who prefer CS strategies often also prefer co-sleeping or sleeping in the same room as their infant which increases the likelihood of waking up the baby at night (Teti et al., 2016; Volkovich et al., 2015; Voltaire and Teti, 2018). Similarly, breastfeeding the baby as a CS strategy may increase the likelihood of night-time awakenings of the child since breastfed infants tend to wake up more frequently in comparison to infants fed with formula (Mindell et al., 2012). Mothers who use fewer CS strategies may be less likely to notice nighttime awakenings because they refrain from co-sleeping. At the same time, their infants may develop proper sleep rhythms more quickly as nighttime awakenings do not lead to maternal interventions like breast-feeding, cuddling, or other activities that prevent the baby from falling back to sleep unassisted.

4.2 Maternal self-efficacy, soothing strategies and infant regulation at 7 months

4.2.1. Distant soothing strategies

We further examined the persistent effects of early maternal self-efficacy and DS on maternal ratings of infant regulation problems, and these were diminished. Although infant regulatory skills at three and seven months were intercorrelated, indicating that infants who are better at regulating themselves continue to do so, the longitudinal model did not link early maternal DS behavior at three months with infant regulation at seven months when controlled for infant regulation at three months - a pattern confirmed by a recent comprehensive literature review by Samdan et al. (2020) that focuses on the relationship between infant regulation and parental behavior. According to this literature review, the strong empirical relations often found between infant regulation and parental behavior during the first postnatal months tend to decline in strength until the end of the first year of life. Hence, the longitudinal dynamics including changes of maternal self-efficacy and adaptation of maternal soothing strategies always need to be taken into account (see also Cao et al. 2022).

At first sight, finding a positive link between DS and infant crying only at the age of three months might argue against the long-term relevance of negative feedback-loops in mutual caregiver-child regulation. Bilgin and Wolke (2020) as well as Van IJzendoorn and Hubbard (2010) showed that leaving infants to 'cry it out' only a few times shortly after birth is associated with less frequent crying at three months. In the light of such findings, one could speculate that the use of DS strategies (e.g., ignoring infant crying) at three months can reduce infant crying und non-soothability at seven months, because "benign neglect" of whining may stimulate infants to acquire skills for dealing with mild stress on their own (Van IJzendoorn and Hubbard, 2010). Mothers of difficult-to-soothe infants use DS strategies more often (e.g., letting the

infant cry) and this may reduce the infant's demand for maternal attention resulting in a decrease in crying and non-soothability at seven months.

This is not to say that letting your infant cry is a good strategy to promote self-regulation development. Importantly, it is the frequency and the appropriateness of a given strategy in a given context that influences infant regulation development in either a positive or negative way (Bilgin and Wolke, 2017a; Mastergeorge et al., 2014). In the present case, long-term positive effects induced by moderate use of DS and frequent use of CS strategies (which can both be used in parallel – depending on the specific context) may have leveled each other out, thus explaining the non-significant association between DS strategies at T1 and infant crying at T2, despite positive associations between both variables at T1.

4.2.2. Close soothing strategies

In our longitudinal analysis, we found that frequent use of CS strategies at three months remained significantly associated with maternal ratings of better soothability at seven months, even after controlling for maternal reports on infant regulation at three months. Thus, CS strategies appear to represent sensitive parental behavior with persisting positive effects.

At the same time, giving the infant the opportunity to calm down without help is also important and interventions may not always be necessary. Just as with three-month-olds, the frequent use CS strategies may also hinder seven-month-olds from developing proper self-soothing skills. Consistent with this observation, we found a positive association between maternal CS strategies and reported infant night-awakenings at seven months.

During the first months, infants' nocturnal crying can be easily misinterpreted as hunger crying by the caregiver, resulting in more-than-necessary feeding of the infant during a sensitive period for the development of a stable sleeping rhythm (Burnham et al., 2002). Considering that recent

longitudinal studies on cognitive development in the first year of life show positive associations between optimal sleep of 8-month-old infants in their home environment and their cognitive abilities and language development at the age of 14 months (Hernandez-Reif and Gungordu, 2022), parental responsivity must to be balanced with the childs actual needs. As early child regulation is influenced by both genetic-biological factors as well as parenting behavior (Samdan et al., 2020), more studies are needed that investigate the positive and negative effects of CS and DS strategies (especially at night) during the first year of life.

4.3 Limitations and future research

The first limitation that should be addressed in future studies is the operationalization and assessment of DS and CS strategies. For our analysis, only those strategies were selected that (a) were used by a substantial number of participants, (b) were understood correctly, and (c) provided clear examples for DS and CS, respectively. Despite the fact that we assessed a fairly broad range of different strategies derived from the literature, several strategies were used only rarely by our participants. Among those participants who did report their use, some misinterpreted their meaning (i.e., “I slap my baby”, “I shake my baby"). Other items turned out to be rather unspecific for DS or CS strategies, respectively (i.e., “I play music to my baby”, “I breastfeed my baby or give him/her the bottle"). Despite the fact that only two items remained to assess DS, and only three items to assess CS, both our theory-based structural equation models using these constructs revealed a fairly good fit to the empirical data. However, future studies would profit from a broader range of items for each construct that can be applied interculturally.

Furthermore, the items of maternal soothing strategies did not take into account the infant’s state (e.g., crying, fussing) at the time the strategy was used either. Thus, it only covers the more general concept of parental co-regulation. Mothers could have been asked about the

soothing level of the infant (non-soothability) after the use of the soothing strategies. Ideally, future studies should explore parent-child interactions by assessing video-microanalysis to document the dynamics of self- and co-regulation in more detail.

In addition, both maternal and infant data in the current study were derived only from questionnaires filled out by mothers, as is often the case, especially in longitudinal studies. Although we cannot rule out the possibility that these assessments may be biased, Glascoe (2003) argues that parents' ratings of their child's development are as reliable and valid as expert assessments in developmental screenings, regardless of place of residence, parents' health status, and socioeconomic status. Nevertheless, language barriers of non-native parents may lead to misunderstandings and invalid answers. To prevent this, questionnaires were filled out by an interviewer explaining items upon request in the present case. This procedure can, however, increase the likelihood that parents give socially desired responses.

With respect to future research, our work indicates the need for more studies relating caregiver characteristics, interactive behaviors, and infant regulation outcomes to each other. For instance, potential covariates such as co-sleeping, breastfeeding, education, and poverty may have a considerable effect on parents' perception of infant crying and sleep problems (i.e., Birmingham et al., 2017; Sidor et al., 2013). By testing comprehensive models rather than reporting only single correlations, it is possible to learn more about the interplay between these factors.

4.4 Implications for practice

Maternal involvement and comfort reduces infant crying and distress (Ganda et al., 2011), which leads to a more profound parent-child relationship (Blackman, 2017). Experts highlight the importance of having higher levels of self-efficacy in parenting but also using appropriate

parenting practices during the day and at night for better parent-child relationship and child behavioral outcomes (Albanese et al., 2019; Higley and Dozier, 2009; Sadeh et al., 2010; Volkovich et al., 2015). Thus, courses and programs on feeding, infant-care or parenting which start during pregnancy can help expectant mothers to develop maternal self-efficacy, and to learn and use appropriate soothing strategies (Samdan et al., 2022).

Intervention programs for caregivers who have difficulties regarding co-regulation should focus on two aspects: (1) to improve caregivers' knowledge about and confidence in their own parenting skills, and (2) to teach caregivers effective ways to calm down the infant and to support self-regulation development, considering the actual needs of the infant (e.g., when he/she is actually in need of body contact or stimulation). For example, offering stimulation or body contact, or providing objects to play with while infants avert their gaze can be regarded as intrusive behavior (Atzil et al., 2011; Feldman et al., 2011). Likewise, providing close soothing at night even when the infant does not really ask for it, can be intrusive, too. Thus, it is not only a question of using distant or close strategies. Rather, caregiver should use a soothing strategy that is appropriate for the given situation and for the infant at a given time.

5. Conclusion

Using a prospective longitudinal study design and interviewing mothers from mixed ethnic and educational backgrounds, the present study revealed that mothers who have lower self-efficacy in parenting use more distant strategies to soothe their infants. They report higher levels of infant crying and non-soothability when their infants are three months old. Regarding longitudinal effects, mothers who use more close soothing strategies continue to report better infant soothability, but also more frequent nighttime awakenings when their infants are seven months old. Overall, the results indicate that future studies as well as intervention programs should take into consideration both maternal self-efficacy and soothing strategies and highlight

the importance of using sensitive maternal behavior, but also allowing the infants to learn regulate themselves.

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Declaration of Interest

None.

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Declaration of own contribution to the studies

1st Publication:

The relationship between parental behavior and infant regulation: A systematic review

The publication was completed under the supervision of Dr. Tilman Reinelt. Gizem Samdan, Prof. Dr. Franz Petermann and Dr. Tilman Reinelt developed the research questions and the hypotheses together. Dr. Natalie Kiel, Selina Rothenfußer and Dr. Claudia Zierul helped with the review of the literature. The manuscript was written independently by Gizem Samdan.

2nd Publication:

Maternal self-efficacy development from pregnancy to three months after birth at 3 and 7 months

The publication was completed under the supervision of Prof. Dr. Sabina Pauen. Gizem Samdan and Dr. Tilman Reinelt developed the research questions and the hypotheses together. Data collection was conducted by a team of researchers working on the BRISE study, including Gizem Samdan. Statistical analyses were performed by Gizem Samdan in consultation with Dr. Tilman Reinelt. Regular meetings were held with the author team to discuss the structure of the paper. The manuscript was written predominantly by Gizem Samdan in close cooperation with Dr. Tilman Reinelt at each step.

3rd Publication:

From co-regulation to self-regulation: Maternal soothing behavior and self-efficacy related to infant regulation

The publication was completed under the supervision of Dr. Charlotte Herzmann. Dr. Natalie Kiel and Dr. Charlotte Herzmann developed the research questions and the hypotheses together. Data collection was conducted by a team of researchers working on the BRISE study, including

Gizem Samdan. Statistical analyses were performed by Dr. Natalie Kiel in consultation with all co-authors. Gizem Samdan held regular meetings with Dr. Natalie Kiel to analyze and interpret the results. Gizem Samdan contributed significantly on the preparation of the manuscript by working on the whole manuscript intensively several times.

Declaration in accordance to § 8 (1) c) and d) of the doctoral degree regulation of the Faculty

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FAKULTÄT FÜR VERHALTENS- UND EMPIRISCHE KULTURWISSENSCHAFTEN

Promotionsausschuss der Fakultät für Verhaltens- und Empirische Kulturwissenschaften der Ruprecht-Karls-Universität Heidelberg / Doctoral Committee of the Faculty of Behavioural and Cultural Studies of Heidelberg University

Erklärung gemäß § 8 (1) c) der Promotionsordnung der Universität Heidelberg für die Fakultät für Verhaltens- und Empirische Kulturwissenschaften / Declaration in accordance to § 8 (1) c) of the doctoral degree regulation of Heidelberg University, Faculty of Behavioural and Cultural Studies

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Ich erkläre, dass ich die vorgelegte Dissertation in dieser oder einer anderen Form nicht anderweitig als Prüfungsarbeit verwendet oder einer anderen Fakultät als Dissertation vorgelegt habe. / I declare that I did not use the submitted dissertation in this or any other form as an examination paper until now and that I did not submit it in another faculty.

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