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The role of infant attention and parental sensitivity in infant cognitive development in the Netherlands and China

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ABSTRACT

Infant attention and parental sensitivity are important predictors of later child executive function (EF). However, most studies have investigated infant and parent factors in relation to child EF separately and included only mothers from Western samples. The current study examined whether both infant attention at 4 months and parental sensitivity at 4 and 14 months were related to infant EF (i.e., inhibition, working memory, and cognitive flexibility) at 14 months among 124 Dutch and 63 Chinese first-time mothers and fathers and their infants. Findings revealed that parental sensitivity at 4 months was not correlated with infant EF abilities at 14 months. However, infant attention at 4 months was significantly related to 14-month working memory, but not to inhibition and cognitive flexibility. Maternal sensitivity at 14 months was significantly related to 14-month inhibition, but not to working memory and cognitive flexibility. No country differences were found in the relation among 4-month infant attention, parental sensitivity, and EF outcomes. Results show that both infant and parent factors are associated with early EF development and that these correlates of early EF skills may be similar in Western and non-Western samples.

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Introduction

Executive function (EF) is an umbrella term referring to a set of higher-order cognitive processes that includes goal-directed actions such as working memory, inhibition, and cognitive flexibility (e.g., Hughes & Ensor, 2005). Individual differences in EF emerge as early as infancy, are moderately stable across toddlerhood to preschool age (e.g., Bernier, Carlson, & Whipple, 2010; Carlson, Mandell, & Williams, 2004), and continue to develop until they start to decline during late adulthood (Hendry, Jones, & Charman, 2016). This has important implications for child development because individual differences in EF are correlated with academic achievement (e.g., Best, Miller, & Naglieri, 2011), antisocial behaviors (Hughes & Ensor, 2011), and social understanding (Devine & Hughes, 2014). As such, it is critical to better understand predictors of individual differences in children's very early EF. Predictors of child EF include infant attention (e.g., Cuevas & Bell, 2014) and parental sensitivity during early childhood (e.g., Bernier et al., 2010; Towe-Goodman et al., 2014). However, despite the recent emergence of studies on the role of mothers' caregiving characteristics and infant skills in early EF development, there remain several gaps in the current literature. Notably, the majority of extant studies have focused on either infant or caregiver factors, failing to consider the two together. Similarly, most studies have been limited to a Western context and have focused on the role of mothers, thereby ignoring more than half the world population. Because some studies have shown that the association between parental behaviors and infant development is dependent on country (e.g., Lansford et al., 2016), it is important to carry out research in non-Western countries to understand the generalizability of research findings and theories from Western contexts to non-Western populations. Addressing these gaps, the current study investigated infant attention at 4 months and sensitive caregiving of both mothers and fathers at 4 and 14 months as predictors of EF at 14 months in the Netherlands and China.

Infant attention and EF

Few studies have focused on individual differences in EF during the first 2 years of life. Infant attention has been widely viewed as an important precursor of EF (e.g., Cuevas & Bell, 2014; Frick et al., 2018; Hendry et al., 2016). Garon and colleagues suggested that EF develops hierarchically, with attention setting the stage for key EF components such as holding information in mind and delaying a response (Garon, Bryson, & Smith, 2008; Garon, Smith, & Bryson, 2014). The development of attention is necessary for information processing and any goal-directed task (e.g., Garon et al., 2014). Individual differences in infant visual attention have been measured by the duration of looking, which is not only reliable and stable within individuals (e.g., Colombo, Mitchell, & Horowitz, 1988) but also correlated with EF at 14 months (e.g., Devine, Ribner, & Hughes, 2019). Infants who spend less time looking at novel stimuli are considered to be more efficient in processing information and have higher cognitive performance than infants who look longer. Cuevas and Bell (2014) found that shorter looking times at 5 months (indicating more effective information processing) were correlated positively with EF abilities at 24, 36, and 48 months after controlling for verbal ability concurrently. Moreover, single tasks measuring early EF have difficulties in capturing the "pure" aspect of EF due to the unclear relations between the tasks. The current study adopted a task battery that is argued to be a better measure of EF during the first 2 years of life (e.g., Devine et al., 2019; Garon et al., 2008). To date, relatively few studies have examined the relation between infant attention and child EF in non-English-speaking Western and non-Western samples. Regarding non-English-speaking samples, one study found that newborn visual attention was associated with behavioral problems at 7 years in Italy (Papageorgiou, Farroni, Johnson, Smith, & Ronald, 2015). Two other studies were conducted in the Netherlands. One study showed that two indicators of attention (longer fixations and less variation in fixation duration) during infancy predicted higher levels of effortful control during toddlerhood (Geeraerts et al., 2019). The second Dutch study also supported the contribution of selective attention to working memory and inhibition among preschoolers (Veer, Luyten, Mulder, van Tuijl, & Sleegers, 2017). As far as we know, no studies focusing on the relation between infant attention and later cognitive abilities have been conducted in non-Western samples. Although conceptual and direct replication of studies within similar contexts are important, it behooves the field to move beyond a Western context to test and better understand the generalizability of theories built from data on child development in Western contexts and primarily rooted in Western tradition to non-Western populations. There is evidence that Chinese children outperform children in Europe and North America on all measures of EF during the preschool and middle childhood years (e.g., Sabbagh, Xu, Carlson, Moses, & Lee, 2006; Wang, Devine, Wong, & Hughes, 2016). These marked contrasts between Western and Chinese children make China a particularly interesting context to study whether these differences already occur during early childhood and whether similar precursors may contribute to the development of EF of Chinese and Western children. To our knowledge, there are no studies on infant attention in relation to infant EF development in China. Our first aim therefore was to replicate and extend existing work by examining the relation between attention at 4 months and EF at 14 months in both a non-English-speaking Western sample and a non-Western sample.

Parental sensitivity and child EF

For the past several decades, empirical studies have highlighted that the quality of parental behaviors is associated with child EF development (e.g., Bernier et al., 2010; Blair et al., 2011; Hughes & Devine, 2019). A meta-analytic review of 42 studies demonstrated that diverse parental behaviors such as positive parenting (e.g., responsiveness, sensitivity) and cognitive stimulating (e.g., scaffolding) were positively associated with EF capacity (at 46 months on average), whereas negative (e.g., controlling) parenting was inversely related to EF capacity (Valcan, Davis, & Pino-Pasternak, 2018). Attachment theory, for example, provides a possible explanation for the relation between parenting and child EF development. According to attachment theory (Bowlby, 1969, 1982), repeated infant–caregiver interactions construct an "internal working model" in infants consisting of expectations about how caregivers would respond to infants' emotions and behaviors. Securely attached children, who regard their parents as a secure base, have fewer worries about being abandoned and spend less time on checking the availability of parents. Their cognitive resources therefore are "freed up" to explore the environment, which can stimulate their EF development (e.g., Bernier, Carlson, Deschênes, & Matte-Gagné, 2012). Secure attachment in turn is fostered by caregivers' abilities to respond promptly and appropriately to children's signals (Ainsworth, Bell, & Stayton, 1974).

Sensitivity is a central dimension of parenting, referring to a caregiver's ability to perceive and accurately interpret the signals and communications in a child's behavior and, given this understanding, to respond appropriately and promptly (Ainsworth et al., 1974; Mesman & Emmen, 2013). A systematic literature review by Deans (2018) summarized high maternal sensitivity related to positive child outcomes such as higher cognitive abilities and socioemotional abilities. Sensitive caregiving highlights caregivers' ability to detect children's signals and adjust their behaviors to fit children's needs. For example, when children switch attention to a new toy, sensitive parents notice and respond positively to this signal and modify their behavior to interact appropriately with children in this new context. Thus, children may be encouraged by parents' response in their reciprocal verbal and nonverbal exchanges and may maintain the engagement and exploration in their surroundings (Mills-Koonce et al., 2015). Bernier et al. (2010) found that maternal sensitivity at 12 to 15 months was weakly related to EF at 26 months. Blair et al. (2011) also found that positive parenting including sensitivity was related to higher levels of child EF at 36 months in a sample of low-income families. Most studies conducted in non-English-speaking Western countries also support the contribution of sensitive responsive parenting to child EF. For example, two studies in the Netherlands found a positive relation between maternal sensitivity and EF among preschoolers (Kok et al., 2014; Lucassen et al., 2015). A German study showed that higher parental involvement or parental responsibility predicted fewer errors in an EF task (i.e., the Erikson Flanker task) among children at 9 and 11 years (Sosic-Vasic et al., 2017).

Studies on child EF in China

Parents socialize infants guided by certain societal norms, values, and behaviors, which in turn influence infant development. This means that parenting and infant development may be shaped by cultural differences (e.g., Bornstein, 2015). The Chinese culture emphasizes social harmony and expects individuals to sacrifice themselves in order to achieve group goals; thus, Chinese parents are likely to encourage children to be interdependent and to inhibit their personal desires. Given the unique influence of Confucianism and China's cultural and geopolitical history, Chinese parenting is different from parenting in Western countries. Traditionally, Chinese parenting is characterized as more controlling and harsher than Western parenting (e.g., Ng, Pomerantz, & Deng, 2013). A meta-analysis and a review showed that although there were some differences in the pattern of insecure attachment among Chinese and Western children (van IJzendoorn & Kroonenberg, 1988), the percentage of secure attachment was similar across countries, with the majority of Chinese children being securely attached, which supports the normativity hypothesis of attachment (Mesman, van IJzendoorn, & Sagi-Schwartz, 2016). Moreover, empirical studies in China showed that mothers' sensitivity contributed to the security of infants' attachment relationship (Ding, Xu, Wang, Li, & Wang, 2012), and securely attached infants displayed higher cognitive abilities than insecurely attached infants (Ding, Xu, Wang, Li, & Wang, 2014). These findings are in line with Western studies that a sensitive and responsive environment facilitates infants' secure attachment and cognitive development (e.g., Bernier et al., 2010; Hughes & Ensor, 2009). Thus, the mean level of parenting may differ between Western and Chinese parents, but the association between parenting and child outcomes may be similar in the two countries.

As far as we know, only two studies have investigated the association between sensitivity and child EF abilities among mothers with a Chinese background. One study suggested that neither sensitivity nor country was a significant predictor of children's cognitive development (0–3 years) among European and Chinese Canadian mothers (Chan, 2015). However, all participants in this study were living in Canada (potentially highlighting more cultural similarity than difference), and thus it is unlikely that data were representative of parents living in China. The other study also failed to find a significant association between maternal sensitivity at 9 months and EF abilities at 3 years in a Chinese sample (Cheng, Lu, Archer, & Wang, 2018), although this study included only parents and children living in China. As such, it is difficult to know whether the failure to replicate findings related to associations between maternal sensitivity and child EF is due to aspects of country or simply an absence of the phenomenon. To address this gap, the current study investigated the role of parental sensitivity in infant cognitive development in the Netherlands and China. Potential similarities and differences between these countries regarding the correlates of infant EF were explored.

Studies of fathers' influence on child EF

Although most studies of sensitivity and child EF abilities have focused exclusively on mothers and children (e.g., Blair et al., 2011), there is strong theoretical and empirical evidence to believe that fathers' parenting has a unique impact on cognitive development (e.g., Malmberg et al., 2016; Meuwissen, & Carlson, 2015). Fathers can also be attachment figures to infants, and the father–infant relationship is somewhat independent of mother–infant attachment security, with a modest intercorrelation (e.g., van IJzendoorn & De Wolff, 1997). However, how mother–infant security and father–infant attachment security affect developmental outcomes is an unsettled issue due to the mixed results on issues such as whether one parent contributes more than the other to child outcomes (Dagan & Sagi-Schwartz, 2017). For early EF development, whether the father–child relationship has an impact on children's cognitive abilities is also understudied. Fathers are more likely to regard themselves as an active playmate and engage children in physical play (e.g., Malmberg et al., 2016), whereas mothers generally respond more to children's attention and are more emotionally available (e.g., Volling, McElwain, Notaro, & Herrera, 2002). These differences may contribute to different aspects in EF development. Empirical studies have shown that the quality of father–child interactions during mutual play at 18 months and fathers' controlling behaviors during a jigsaw puzzle task were associated with child EF at 3 years (e.g., Bernier et al., 2012). Only two studies to our knowledge have investigated maternal and paternal sensitivity together in relation to the development of child EF. Towe-Goodman et al. (2014) suggested an emergent role of paternal sensitivity such that paternal sensitivity during toddlerhood (24 months) was more strongly related to 36-month-old EF abilities than paternal sensitivity during infancy (7 months). In contrast, the contribution of maternal sensitivity to EF abilities was stable from infancy to toddlerhood. The other study (Lucassen et al., 2015) found that maternal sensitivity at 4 years was concurrently linked to EF, whereas there was no relation between paternal sensitivity and EF. Inconsistent evidence for the association between paternal sensitivity and EF underscores the need to further investigate this issue. Moreover, none of the studies has looked at whether sensitivity is related to EF during the first 2 years of life. Such work is important because early childhood underlies rapid growth in EF.

To date, a small number of studies have focused on the effect of both infant and parental factors on EF development (e.g., Matte-Gagné & Bernier, 2011). Only one study to our knowledge has considered infant attention and sensitivity together as predictors of EF development. This study considered a fairly homogeneous sample of Swedish infants and their mothers and found that infant sustained attention at 10 months predicted infant inhibition at 18 months over and above maternal sensitivity (Frick et al., 2018). Maternal sensitivity was a predictor only for emotion regulation but not for EF, and paternal sensitivity was not assessed. Our second aim therefore was to examine the unique associations among infant attention, maternal and paternal sensitivity, and EF in the Netherlands and China during the first 2 years of life. We hypothesized that infant attention contributes to EF in both countries. Because there is no study investigating the relation between infant attention and later EF in China, the question of whether the relation is different across countries was addressed in an exploratory manner. Because infant–mother attachment security and infant–father attachment security are independent of one another, and results of empirical studies of sensitivity and EF studies have been inconsistent, we hypothesized that mothers and fathers may contribute to different aspects of infant EF, and that these relations are similar in the Netherlands and China.

The current study

The overarching goal of this study was to investigate both infant (attention at 4 months) and caregiving (maternal and paternal sensitivity at 4 and 14 months) factors in the prediction of 14-month-old EF in both the Netherlands and China. We tested both a longitudinal model with maternal and paternal sensitivity at 4 months and infant attention at 4 months predicting 14-month EF and a concurrent model with maternal and paternal sensitivity at 14 months and 4-month attention predicting 14-month EF. We also explored country differences in EF skills and in the roles of child attention and caregiver sensitivity in the development thereof.

Method

Sample

Participants were 124 Dutch and 63 Chinese first-time mothers and fathers and their healthy 4-month-old infants (Netherlands [NL]: 45% boys; China: 51% boys) as part of a cross-cultural longitudinal study of child development and the transition to parenthood. Dutch families were recruited at pregnancy fairs, yoga classes, and midwifery practices throughout the whole country, whereas Chinese families were recruited at a regional maternity and child hospital, through word of mouth, and using online groups in Shenzhen, China. A small number of parents did not participate in one of the visits due to sickness or a busy schedule (NL: 3 mothers and 5 fathers at 4 months, 1 mother and 8 fathers at 14 months; China: 1 mother and 4 fathers at 4 months, 2 mothers and 6 fathers at 14 months). All participating parents were first-time parents who were 21 years or older during pregnancy and had a singleton infant. Parents were native Dutch or Chinese (Mandarin or Cantonese) speakers. Participants who had a history of any mental illness or substance misuse (self-reported) were excluded. The data collection at 4 months took place from May 2015 to December 2015 in the Netherlands and from July 2016 to January 2017 in China. All families were visited again after

10 months. Home visits were supposed to be scheduled 2 weeks before or 2 weeks after the dates on which children were 4 and 14 months old. However, some families (NL: 1 family at 14 months; China: 7 families at 14 months) were visited earlier (M = 3.9 weeks, range = 0.32–16.2) and some families (NL: 9 families at 4 months, 9 families at 14 months; China: 1 family at 4 months, 38 families at 14 months) were visited later (M = 6.2 weeks, range = 0.12–15.8) than this range due to illness of children or busy schedule of parents.

Demographic information is summarized in Table 1. Dutch fathers on average were older than Chinese fathers, $t(177) = 2.61$, $p < .05$, $d = 0.43$. There were no differences in maternal age, $t(183) = 1.53$, $p = .127$. Most parents were highly educated. Dutch fathers on average had lower educational levels than Chinese fathers, $\chi^2(2) = 17.90$, $p < .001$, $\varphi = .33$, and the same was true for mothers, $\chi^2(2) = 10.28$, $p = .006$, $\varphi = .23$. Both Dutch and Chinese families had incomes that were about 16% higher than the average national level (the average level in Shenzhen for Chinese families; Centraal Bureau voor de Statistiek, 2019; Shenzhen Statistics Bureau, 2018).

Procedure

Mothers and fathers were visited separately in their homes when infants were 4 and 14 months of age, and each home visit lasted 90 to 120 min. Infants participated for 10 to 18 min in the infant tasks and the infant–parent interaction without using a pacifier. Breaks were provided for them between each task. The order of home visits was counterbalanced. All fathers and mothers signed an informed consent form for their own participation as well as for their infants' participation. Families received a small gift for the infants and a small amount of money for themselves after each visit (NL: 10 euros; China: 50 yuan). They also received a DVD with a compilation of video footage from different home visits at the end of the study. The study was approved by the ethics committee of Leiden University in the Netherlands and Shenzhen University in China.

During the 4-month home visit, infants completed a measure of visual attention during the first home visit (either mother or father visit, depending on the order). After the infant task, the parent and infant played freely as they normally would without toys for 5 min. Questionnaires about parents' background information (e.g., education) were completed before or after each home visit.

During the 14-month home visit, we administered an age-appropriate battery of EF tasks in a fixed order: inhibition (Prohibition task; Friedman, Miyake, Robinson, & Hewitt, 2011), working memory (Multi-location Search task; Miller & Marcovitch, 2015), and cognitive flexibility (Ball Run task; Hughes & Ensor, 2005). After all infant tasks, parents and infants played freely with toys for 5 min.

Table 1
Demographic information for mothers, fathers, and infants in the Netherlands and China.

	The Netherlands			China		
	M	*SD*	Range	*M*	*SD*	Range
4-month age (months)	4.31	0.43	3.43 to 5.55	4.27	0.35	3.34 to 5.29
14-month age (months)	14.19	0.52	9.47 to 16.07	14.83	1.16	11.92 to 18.48
Mothers (years)	30	3.83	21 to 42	30	2.91	22 to 37
Fathers (years)	32	4.12	23 to 46	31	3.97	24 to 45
Mothers (ladders)	7.21	1.10	4 to 9	5.67	1.41	3 to 9
Fathers (ladders)	7.17	1.26	2 to 10	5.65	1.29	3 to 9
SESZ	0.10	0.71	−1.65 to 1.27	−0.16	0.66	−1.56 to 1.62
Education						
	High	Moderate	Low	High	Moderate	Low
Mothers (%)	72	12	16	70	30	0
Fathers (%)	58	16	26	76	21	3

Note. Ladder: parental scores of Ladder of Subjective Social Status; highly educated: a bachelor degree or higher; moderately educated: a postsecondary or short-cycle tertiary education; lowly educated: an upper secondary degree or less. SESZ, mean standardized score across the four indicators of parental socioeconomic status.

Infant attention at 4 months

The Attention task (Cuevas & Bell, 2014) was used to test the time of infants' gaze on and away from a toy. The infant was seated on the parent's lap facing the examiner, who kneeled approximately 1.1 m in front of the infant. The "Whoozit Baby's Friend" toy with facial features in a heart or flower shape attached with seven bell feet was used. The examiner rattled the stimulus three times and held still until the infant looked away for at least 3 s. At this point, the examiner lowered the toy and repeated the procedure for three more trials. The order of the holding position (left or right) was counterbalanced across infants. The examiner adopted a pleasant neutral face and remained quiet for the duration of the task. Infant gaze was recorded using a camera on a tripod behind the examiner. The footage was coded offline using JHab (Java Habituation Software, Version 1.0.0; Casstevens, 2007). We recorded the amount of time that the infant spent looking at the stimulus on each trial. Inter-rater reliability based on 45 cases was acceptable for all four trials (.77 < intraclass correlation [ICC] < .98). The median looking duration across the four trials was calculated (Cuevas & Bell, 2014). Longer looking times are thought to be related to poor cognitive abilities (e.g., Colombo, 2001).

Parent–infant sensitivity

At 4 months, parental sensitivity was assessed in a situation where the infant was on the parent's lap and the parent was asked to play with the infant for 5 min without toys. At 14 months, parents were asked to play with the infant with toys available for 5 min. Sensitivity was coded according to an adaptation of the Maternal Care Scales developed by Ainsworth et al. (1974). The degree of maternal and paternal sensitivity was assessed according to (a) awareness of the signals, (b) an accurate interpretation of them, (c) an appropriate response to them, and (d) a prompt response to them. The scores range from 1 (*highly insensitive*) to 9 (*highly sensitive*). All videos were coded by 18 independent coders (4 months: 11 coders, 3 of which were Chinese coders; 14 months: 7 coders, 1 of which was a Chinese coder). Videos were subtitled in English if the language of the coder did not match that of the parent. The father and mother within one family were coded by two independent coders across time (i.e., the same infant could not be coded by the same coder with the other parent at both 4 and 14 months). A quarter of the videos were double-coded per wave for reliability. Intercoder reliabilities (ICC, single rater, absolute agreement) were > .70 for all dyads on all scales.

Infant EF at 14 months

At 14 months, infants completed a short battery of tasks (lasting 8–10 min) developed by Devine et al. (2019). Infants were seated on a parent's lap or in a boosting chair in front of a table. Parents were instructed to remain silent and not to influence infants' behaviors through either gesture or vocalization. Breaks were provided after each task, and infants were praised at the end of each task to maintain their interest in the tasks.

Inhibition. The Prohibition task was used as a measure of inhibition (Friedman et al., 2011). In this task, the infant was asked to resist touching an attractive toy. The examiner showed the infant a shiny glitter wand ("Mystic Glitter Wand") for up to 15 s, drawing attention to the wand. Then the examiner twisted the wand upside down so that the glitter in the wand moved and placed the wand within arm's reach of the infant, put one hand up, and said, "Look, [infant's name]. No, don't touch." After this, the examiner turned around for up to 30 s. The camera was placed next to the examiner and positioned toward the infant's face. Scores on this task were collapsed into two categories (touch and no touch before 30 s). Double-coding of 60 videos revealed high levels of inter-rater agreement (ICC = .99, $p < .001$). Infants received a score of 0 if they touched the toy before 30 s or a score of 1 if they waited.

Working memory. The Multi-location Search task was included as a measure of working memory (Miller & Marcovitch, 2015). The infant was asked to find three toy cars (i.e., red, yellow, and, blue plastic cars) hidden in three toy garages with colored doors (i.e., red, yellow, and blue doors) with a short delay of 5 s between each search. The examiner introduced the infant to the three toy cars and attracted the infant's attention as each car was placed into a color-corresponding garage (i.e., the blue car in the blue garage, the yellow car in the yellow garage, and the red car in the red garage).

Then the examiner covered the garage with a white board (29.7 × 42 cm) for 5 s to block the infant's view and counted out loud. After this, the examiner said, "Where is the car?" If the infant succeeded in getting a car, the infant could briefly play with the car and was praised by the examiner. Because all garages had cars in them, infants were always successful on the first trial. The retrieved car was taken from the infant, and the examiner showed the infant that the car was being placed in a bag behind the examiner. Before the next trial, the examiner pointed to the empty garage and closed it. For the subsequent trials, if the infant pointed to the empty garage, the examiner said, "It's not there. Let's have another go," and closed the garage. The procedure was discontinued if the infant failed to find a toy for three consecutive trials or when the infant retrieved all three cars. The total number of cars that the infant successfully retrieved was coded as the total number of cars retrieved. Scoring took place offline, and double-coding of 60 videos revealed excellent inter-rater reliability for each trial (kappa = 1.00). Two indicators were calculated to reflect the total number of searches required to find the second and third cars (0 = did not find, 1 = 3 searches, 2 = 2 searches, 3 = 1 search).

Cognitive flexibility. The Ball Run task was designed as an age-appropriate shifting task measuring cognitive flexibility based on the Trucks task developed by Hughes and Ensor (2005). The adapted ball run toy has three circular holes on the top running from left to right (i.e., green, yellow, and red) and a metal chute for the ball to roll down to the bottom of the toy. The front side (facing the infant) of the toy was covered with a transparent plastic panel, whereas the other side (facing the examiner) was accessible. The examiner closed two holes by using two metal brackets and opened only one hole (i.e., green or red). The middle yellow hole was blocked during the whole task. A switch-activated speaker was placed on the floor of the toy and played 5 s of a Dutch or Chinese nursery song when pressed. The examiner held the toy seating opposite the infant. In the rule learning phase, the examiner introduced the toy to the toddler by showing the toddler how to activate the musical switch by placing either the green ball in the green hole (on the left-hand side of the toy) or the red ball in the red hole (on the right-hand side of the toy) (counterbalanced across infants). After the ball rolled down, music played as a reward. Then the examiner handed the ball directly over the middle of the toy to the infant and said, "Now you try." Infants were praised for each correct placement and were reinforced through activation of the musical switch. If they put the ball in a closed hole, the examiner said, "Oh, it didn't work."

If the infant scored four or more trials correctly (NL: n = 48, China: n = 25), the examiner proceeded to the reversal phase. Before this phase, the examiner took the ball that was used in the learning phase (e.g., the green ball) and placed it in a bag in view of the toddler. The examiner then retrieved a different ball (e.g., the red ball) and attracted the infant's attention while proceeding to close the open hole (e.g., the green hole) and open the closed hole (e.g., the red hole). The examiner demonstrated the placement of the new ball into the newly open hole (on the opposite end of the toy) and cheered when the music played. The examiner handed the ball to the infant as before and completed a further six trials. Scoring took place offline, and double-coding of 60 videos revealed excellent inter-rater reliability for each trial (kappa = 1.00). Infants' performance on each trial was scored as pass (1) or fail (0). Infants who did not pass to the reversal phase received a score of 0 on each trial in the reversal phase. A latent factor score was created, including the score of all trials in the learning and reversal phases.

Socioeconomic status (control variable)

Parents completed the Ladder of Subjective Social Status (Singh-Manoux, Adler, & Marmot, 2003), which indicates their rating on a 10-rung ladder, with the top referring to the best income, employment, and education and the bottom referring to the worst. Results of prior studies suggest that ratings of subjective social status are an equal—and at times better—predictor of outcomes such as health (Singh-Manoux, Marmot, & Adler, 2005) and cognitive skills, including EF (Ursache, Nobles, & Blair, 2015). The educational level of parents was correlated with the ladder scores in both mothers (r = .23) and fathers (r = .20). Those two scores were aggregated by calculating the mean standardized score across the four indicators of parental socioeconomic status (SES), α = .64 (Devine et al., 2019).

Results

Preliminary results

Descriptive statistics were computed for EF and sensitivity variables in the Netherlands and China (Table 2). In the Prohibition task, 11% of Chinese infants and 34% of Dutch infants did not touch the wand (waited for 30 s). Dutch infants displayed higher inhibition than Chinese infants, $\chi^2(1) = 10.31$, $p = .001$, $\varphi = .25$. In the Multi-location Search task, 43% of Chinese infants and 47% of Dutch infants successfully retrieved two cars, whereas a small number of them (17% of Chinese infants and 16% of Dutch infants) retrieved three cars. In the Ball Run task, 38% of Dutch infants and 33% of Chinese infants proceeded to the reversal phase. There were no differences between Dutch and Chinese infants on the Multi-location Search task, $t(182) = 0.25$, $p = .802$, and Ball Run task, $t(182) = -0.92$, $p = .361$. For parental sensitivity at 14 months, both Dutch mothers, $t(182) = 6.15$, $p < .001$, $d = 0.92$, and fathers, $t(88.66) = 4.50$, $p < .001$, $d = 0.76$, showed higher sensitivity than Chinese mothers and fathers.

Analytic strategy

We used structural equation modeling in Mplus 8 (Muthèn & Muthèn, 2017) to examine the unique influence of country of origin, infant attention, and parental sensitivity on infants' performance on the three measures of EF at 14 months. Given that age varied at each time point, we controlled for concurrent age in our analyses. First, we created EF factor scores by testing a measurement model based on Devine et al. (2019). We adopted a latent factor score approach in order to obtain error-free estimates of performance on each task. Scores from each task (i.e., Multi-location Search and Ball Run) were permitted to load onto two correlated factors. Each factor was permitted to correlate with the categorical indicator for the Prohibition task. We used a mean- and variance-adjusted weighted least-squares estimator and obtained an acceptable model fit, $\chi^2(89) = 179.63$, comparative fit index (CFI) = .97, Tucker–Lewis index (TLI) = .97, root mean squared error of approximation (RMSEA) = .074. Consistent with findings reported by Devine et al. (2019), there were no significant correlations among the three EF scores ($-.10 \leq r \leq -.05$). We created factor scores for the Multi-Location Search task and the Ball Run task by imputing plausible values for each latent variable using Bayesian estimation in Mplus (Asparouhov & Muthén, 2010).

Then we specified two models in which we simultaneously regressed each of the 14-month measures (i.e., Prohibition task, Multi-location Search factor scores, and Ball Run factor scores) onto a dummy variable representing country of origin (0 = Netherlands, 1 = China) and measures of maternal

Table 2
Descriptive statistics for executive function tasks and parental sensitivity in the Netherlands and China.

Measure	The Netherlands				China			
	M	*SD*	Range	*N*	*M*	*SD*	Range	*N*
4 months								
Infant attention	6.70[a]	5.54	0 to 26.89	117	5.75[a]	5.99	0.75 to 23.97	62
Maternal sensitivity	5.14	1.93	1 to 9	121	5.10	1.68	2 to 9	62
Paternal sensitivity	5.55	1.90	1 to 9	119	5.10	2.02	1 to 8	59
14 months								
Working memory (FS)	0.00	0.69	−1.08 to 1.95	123	−0.02	0.71	−1.07 to 1.61	61
Cognitive flexibility (FS)	−0.07	0.89	−1.48 to 2.29	123	0.05	0.81	−1.36 to 1.83	61
Maternal sensitivity	6.59	1.27	3 to 9	123	5.26	1.60	1 to 8	61
Paternal sensitivity	5.96	1.53	2 to 9	116	4.60	2.02	1 to 8	57
	Touch	Wait	*N*		Touch		Wait	*N*
Inhibition[b]	65.8	34.2	114		89.1		10.9	55

Note. FS, factor scores.
[a] Median.
[b] Percentage score.

and paternal sensitivity at 4 months (Model 1) and 14 months (Model 2). To examine relations between attention and EF, we regressed each of the 14-month measures onto a dummy variable measuring attention at 4 months (0 = below median looking time, 1 = above median looking time). We controlled for potential confounds by regressing each of the 14-month measures onto family SES, infant age in 14 months, and infant biological sex (0 = girl, 1 = boy). We allowed each of the 14-month EF variables to covary in the model. We also permitted each of the predictor variables to covary. Given the categorical nature of one outcome variable (i.e., Prohibition), we used a mean- and variance-adjusted weighted least-squares estimator (WLSMV) and all cases with available data. The main variables had missing values on attention (4% missing), maternal sensitivity (4 months [4 M] and 14 months [14 M]; 2% missing), paternal sensitivity (4 M: 5% missing; 14 M: 8% missing), inhibition (10% missing), working memory (3% missing), and cognitive flexibility (6% missing). Little's (1988) MCAR (missing completely at random) test (Little, 1988) was not significant, $\chi^2(37) = 36.05$, $p = .513$. Missing values were estimated in Mplus using a mean- and variance-adjusted weighted least-squares estimator (Asparouhov & Muthén, 2010).

Predictors of EF at 14 months

Correlations for main variables are displayed in Table 3. Model 1 (longitudinal model) was just-identified, meaning that there were 0 degrees of freedom (i.e., there was an equal number of model parameters and variances/covariances in the sample matrix) (Brown, 2015). Although model fit indices cannot be estimated for just-identified models, parameter estimates can still be calculated and interpreted (Brown, 2015). A summary of each of the key regression paths is included in Table 3. The model accounted for 16% of the variance in inhibition, 4.2% of the variance in working memory, and 5.7% of the variance in cognitive flexibility. Four features of this model deserve note. First, there were no unique associations among any of the EF outcome measures (inhibition and working memory: standardized estimate = − .13, *SE* = .10, *p* = .20; inhibition and cognitive flexibility: standardized estimate = − .01, *SE* = .12, *p* = .93; working memory and cognitive flexibility: standardized estimate = − .04, *SE* = .07, *p* = .59). Second, there were cross-cultural differences in performance on inhibition, whereby Dutch infants performed better on average than Chinese infants. These differences held when controlling for covariates (i.e., family SES, infant age, and infant biological sex). There were no other cross-cultural differences in performance on EF tasks at 14 months. Third, there were no unique longitudinal associations between either maternal sensitivity or paternal sensitivity at 4 months and performance on any of the EF tasks at 14 months. Fourth, infant attention at 4 months was negatively associated with working memory at 14 months. Infants with longer looking times (who have difficulty in disengaging and/or worse information processing) performed worse on working memory 10 months later than infants with short looking times.

In Model 2, we examined the concurrent associations between parental sensitivity and EF at 14 months (Table 4). The model was identical to Model 1 but included measures of paternal and maternal sensitivity at 14 months instead of 4 months. The model was just-identified with 0 degrees of freedom. The model accounted for 18.9% of the variance in inhibition, 7.8% of the variance in working memory, and 4.7% of the variance in cognitive flexibility. There was a significant but weak unique association between maternal sensitivity and inhibition performance at 14 months such that infants of mothers with high levels of sensitivity were more likely than their peers to wait. There was a modest but nonsignificant association between paternal sensitivity and infants' performance on working memory. There were no other significant links between parental sensitivity and performance on the EF tasks at 14 months.

Moderating effects of country

To examine the consistency of the longitudinal relations between parental sensitivity and infants' EF across countries, we extended Model 1 by adding a multiplicative interaction term between country and paternal sensitivity at 4 months and between country and maternal sensitivity at 4 months (Model 3). To investigate the potential moderating effect of country on the concurrent relations between 14-month parental sensitivity and EF, we extended Model 2 by adding a multiplicative

Table 3
Correlations for pooled data and for Dutch and Chinese samples.

		1	2	3	4	5	6	7	8	9	10	11
	Pooled data											
1	M. Sens 4											
2	F. Sens 4	.16*										
3	M. Sens 14	.23**	−.01									
4	F. Sens 14	−.01	.22**	.18*								
5	Country	−.01	−.11	−.42***	−.36***							
6	Biological sex	−.15*	−.04	−.12	.02	.07						
7	Age at 14	.01	−.06	−.13	−.11	.36***	.05					
8	SES	.22**	.16*	.13	.27***	−.17*	−.04	.02				
9	Attn. 4	.09	.06	.12	.02	−.07	−.12	.06	.13			
10	Inb. 14	.08	.08	.32***	.08	−.36***	−.17	−.12	.06	.00		
11	WM 14	.05	.11	.11	.18	−.02	.03	−.09	−.01	−.15	−.10	
12	CF 14	−.05	−.07	−.04	−.04	.07	.08	.11	.16*	−.01	−.05	−.05
	Netherlands											
1	M. Sens 4											
2	F. Sens 4	.20*										
3	M. Sens 14	.25**	−.19*									
4	F. Sens 14	.00	.16	−.08								
5	Country	x	x	x	x							
6	Biological sex	−.19*	−.11	−.19*	.05	x						
7	Age at 14	.02	.11	−.06	−.06	x	−.06					
8	SES	.25**	.15	.00	.22*	x	−.01	.04				
9	Attn. 4	.11	−.05	−.05	−.17	x	−.18	.14	.10			
10	Inb. 14	.09	.03	.24*	−.10	x	−.09	.07	−.00	−.07		
11	WM 14	.02	.09	.06	.18	x	.14	−.14	.02	−.24**	−.12	
12	CF 14	−.07	−.04	−.05	−.01	x	.06	.03	.16	−.05	−.04	.02
Table 3 continued												
		1	2	3	4	5	6	7	8	9	10	11
	China											
1	M. Sens 4											
2	F. Sens 4	.08										
3	M. Sens 14	.23	.14									
4	F. Sens 14	−.10	.21	.20								
5	Country	x	x	x	x							
6	Biological sex	−.08	.11	.03	.06	x						
7	Age at 14	.02	−.14	.08	.05	x	.10					
8	SES	.15	.14	.16	.12	x	−.05	.19				
9	Attn. 4	.04	.24	.21	.18	x	.01	.06	.16			
10	Inb. 14	−.09	.06	−.08	.12	x	−.15	−.09	.02	.15		
11	WM 14	.12	.14	.23	.23	x	−.21	−.05	−.08	.05	.02	
12	CF 14	.00	−.13	.07	.00	x	.11	.16	.21	.11	.04	−.23

Note. Correlations between categorical variables are tetrachoric. 4, 4 months; 14, 14 months; M. Sens, mother sensitivity; F. Sens, father sensitivity; SES, socioeconomic status; Attn., visual attention; Inb., inhibition; WM, working memory; CF, cognitive flexibility.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

interaction term between country and 14-month maternal sensitivity and between country and 14-month paternal sensitivity (Model 4). In both models, we mean-centered the measures of maternal and paternal sensitivity prior to creating the multiplicative interaction terms (Hayes, 2018). Both Model 3 and Model 4 were just-identified. Table 5 shows the unstandardized and standardized path estimates for the interaction terms in each model. Together, these results demonstrate that country did not significantly moderate the association between 4-month parental sensitivity and 14-month EF or between 14-month parental sensitivity and 14-month EF.

We performed a post hoc power analysis using Monte Carlo simulation in Mplus 8. Using 10,000 replications, we tested whether a sample size of 187 was sufficient to detect a small-to-medium effect

Table 4
WLSMV estimator unstandardized and standardized estimates for Model 1 and Model 2.

	Inhibition			Working memory			Cognitive flexibility		
	B	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Model 1: Longitudinal									
Maternal sensitivity at 4 months	0.029	0.053	.05	0.020	0.030	.05	−0.033	0.031	−.07
Paternal sensitivity at 4 months	0.015	0.049	.03	0.040	0.032	.11	−0.036	0.033	−.08
Family socioeconomic status	−0.030	0.134	−.02	−0.011	0.084	−.01	0.242	0.094	.20**
Infant attention at 4 months	−0.092	0.211	−.05	−0.216	0.109	−.15*	−0.024	0.129	−.01
Country	−0.767	0.243	−.36**	0.012	0.130	.008	0.109	0.147	.06
Infant biological sex	−0.292	0.197	−.15	0.038	0.107	.03	0.108	0.124	.06
Infant age at 14 months	0.023	0.112	.02	−0.067	0.056	−.08	0.077	0.080	.08
Model 2: Concurrent									
Maternal sensitivity at 14 months	0.129	0.063	.20*	0.070	0.042	.14	−0.007	0.047	−.01
Paternal sensitivity at 14 months	−0.029	0.069	−.05	0.080	0.043	.20+	−0.024	0.038	−.05
Family socioeconomic status	−0.006	0.134	−.004	−0.036	0.084	−.03	0.223	0.093	.18*
Infant attention at 4 months	−0.117	0.215	−.06	−0.215	0.107	−.15*	−0.035	0.130	−.02
Country	−0.637	0.269	−.30*	0.195	0.150	.13	0.073	0.167	.04
Infant biological sex	−0.270	0.197	−.14	0.028	0.106	.02	0.132	0.124	.08
Infant age at 14 months	−0.018	0.113	.02	−0.074	0.051	−.08	0.082	0.082	.08

Note. WLSMV, mean- and variance-adjusted weighted least squares, Country: the Netherlands = 0, China = 1. Biological sex: girl = 0, boy = 1.
+ $p < .10$.
* $p < .05$.
** $p < .01$.

(i.e., $R^2 = .05$) in the regression paths representing the relations between parental sensitivity and each measure of EF. The sample of 187 provided adequate coverage (≥.937 for each parameter of interest) and sufficient power (≥.957 for each parameter of interest) to detect small-to-medium unique effects. Note that we also conducted the analyses using raw scores from each EF task and obtained the same overall pattern of results (see online supplementary material).

Discussion

The current study included both infant (attention at 4 months) and caregiving (maternal and paternal sensitivity at both 4 and 14 months) factors in the prediction of infant EF task performance at 14 months in the Netherlands and China. Our findings showed that (a) infant attention at 4 months is negatively associated with working memory at 14 months, (b) maternal sensitivity at 14 months is positively associated with infant inhibition concurrently, and (c) there are no country differences in the prediction of infant EF at 14 months. We now consider each of our findings in more detail.

First, in line with our expectation, more effective infant attention at 4 months was related to higher levels of working memory (one aspect of EF) at 14 months. This result extended prior work on early infant predictors of EF in both Dutch and Chinese samples (Cuevas & Bell, 2014) and replicated a very recent study using the same measures in the same age group in British families showing that infant attention at 4 months was associated with working memory but not with inhibition and cognitive flexibility at 14 months (Devine et al., 2019). The development of infant attention starts with the orienting system, which is vital for infants to engage with novel stimuli. Later, the development of the anterior attention system facilitates infants' ability to select and focus on the stimuli, as well as the later ability of shifting between objects (Garon et al., 2008; Hendry et al., 2016). With those emerging systems of attention, infants are able to process information from their surroundings (Garon et al., 2014). Infants with more efficient attention (shorter looking time) are more likely to demonstrate recognition memory, which may lay an important foundation to any goal-directed (cognitive demand) tasks (Colombo et al., 1988). Another explanation is that because infant looking time is related to later general intelligence (Kavšek, 2004), infant attention may be a general indicator of cognitive performance.

Table 5
WLSMV unstandardized and standardized estimates for Model 3 and Model 4.

	Inhibition			Working memory			Cognitive flexibility		
	B	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Model 3: Longitudinal									
Maternal sensitivity at 4 months (centered)	0.065	0.074	.12	0.008	0.036	.02	−0.044	0.039	−.09
Paternal sensitivity at 4 months (centered)	−0.003	0.082	−.01	0.034	0.041	.09	−0.021	0.044	−.05
Family socioeconomic status	−0.034	0.134	−.02	−0.009	0.084	−.01	0.243	0.094	.20**
Infant attention at 4 months	−0.110	0.210	−.06	−0.220	0.113	−.15*	−0.011	0.134	−.01
Country	−0.771	0.245	−.36**	0.014	0.130	.01	0.109	0.148	.06
Infant biological sex	−0.294	0.208	−.15	0.031	0.107	.02	0.114	0.128	.07
Infant age at 14 months	0.030	0.101	.03	−0.064	0.058	−.07	0.071	0.080	.07
Country × Maternal Sensitivity at 4 months	−0.122	0.169	−.12	0.017	0.075	.06	−0.038	0.080	.04
Country × Paternal Sensitivity at 4 months	0.043	0.152	.05	0.043	0.079	.03	−0.034	0.090	−.05
Model 4: Concurrent									
Maternal sensitivity at 14 months (centered)	0.251	0.085	.38**	0.045	0.057	.09	−0.030	0.072	−.05
Paternal sensitivity at 14 months (centered)	−0.120	0.127	−.22	0.081	0.056	.20	−0.034	0.055	−.07
Family socioeconomic status	0.032	0.127	.02	−0.039	0.083	−.02	0.224	0.093	.18*
Infant attention at 4 months	−0.143	0.205	−.07	−0.220	0.104	−15*	−0.045	0.131	−.03
Country	−0.673	0.272	−.32*	0.209	0.155	.13	0.090	0.164	.05
Infant biological sex	−0.227	0.196	−.11	0.018	0.107	.01	0.123	0.127	.07
Infant age at 14 months	0.021	0.116	.02	−0.076	0.050	−.09	0.079	0.083	.08
Country × Maternal Sensitivity at 14 months	−0.320	0.176	−.32^{+}	0.060	0.091	.08	0.049	0.113	.06
Country × Paternal Sensitivity at 14 months	0.228	0.237	.28	−0.007	0.087	−.01	0.016	0.078	.02

Note. WLSMV, mean- and variance-adjusted weighted least squares, Country: the Netherlands = 0, China = 1. Biological sex: girl = 0, boy = 1.
$^{+}$ $p < .10$.
* $p < .05$.
** $p < .01$.

Second, maternal sensitivity at 14 months was associated with infant inhibition at 14 months; however, the relations between paternal sensitivity and all EF outcomes were not significant. The result for mothers supports studies indicating a positive relation between maternal sensitivity and infant EF (e.g., Blair et al., 2011; Mills-Koonce et al., 2015). The father result was in line with some previous studies indicating that the predictive effect of father–infant attachment security on paternal sensitivity and infant outcomes was weaker than mother–infant attachment security on maternal sensitivity and infant outcomes (Aviezer, Resnick, Sagi, & Gini, 2002; Steele, Steele, Croft, & Fonagy, 1999). However, it is not clear why maternal sensitivity was associated with one aspect of EF (inhibition) specifically, whereas paternal sensitivity was not. In the current study, parental sensitivity was measured by the Ainsworth Sensitivity Scales during free play, which broadly examines parental responses to all infant signals in all manners of play and does not distinguish between subtypes or situations. More studies are needed to investigate the relation between different types of sensitivity and infant EF development. It may be that sensitivity in more cognitively stimulating contexts is more relevant for EF development than sensitivity in a caregiving situation, for example, sensitivity in free play. In general, sensitive parents are better at noticing infants' signals and providing appropriate emotional and verbal support. Showing empathy, engagement, and response in both failure and success may give infants a sense of security and facilitate their persistence and focused attention; thus, children may be better able to increase both their concentration and their exploration (Mills-Koonce et al., 2015). Those concentrated and exploratory behaviors are demonstrated to be important for cognitive demand tasks.

Third, both maternal sensitivity and paternal sensitivity at 4 months were not significantly related to three EF abilities at 14 months in our study. This result is partly consistent with the work by Towe-Goodman et al. (2014) suggesting that paternal sensitivity during late infancy and beyond is more salient for EF development than during early infancy. During early infancy, caregiving activities occupy most of parents' time. The interaction between parent and infant such as playful and exploratory interactions during the second year of life may be more meaningful for EF development (Lamb, 1997). It is important to note that our findings indicate that there are only concurrent, but not longitudinal (developmental) links between parental sensitivity and EF. This suggests that the association might be infant driven in that parents might exhibit greater sensitivity when playing with infants who show higher levels of inhibition or working memory.

Fourth, contrary to our hypothesis, neither maternal nor paternal sensitivity generally predicted cognitive flexibility at 14 months. An explanation may be the sensitivity of measurement. Compared with free play, a problem-solving situation may evoke more cognitive stimulation strategies (e.g., autonomy support) structuring from parents. Parental autonomy support, one of the cognitive stimulation strategies, may be more effective in fostering infant EF abilities if this is done sensitively (e.g., Valcan, et al., 2018). One study assessing infants aged 12 to 15 months showed that maternal autonomy support during problem-solving tasks instead of general sensitivity was the strongest factor to EF at 26 months (Bernier et al., 2010). Sensitive cognitive stimulation during a problem-solving situation may be a more sensitive predictor of infant cognitive flexibility. Multiple parenting constructs (e.g., autonomy support) in multiple situations in relation to EF abilities are needed to be included in further studies (e.g., Hughes & Devine, 2019).

Last, Dutch parents showed higher sensitivity on average than Chinese parents. Chinese parents may still be influenced by the tradition of controlling parenting (e.g., Ng et al., 2013). In addition, Dutch infants showed higher inhibition on average than Chinese infants. This result contradicts other studies in the level of EF between Chinese and Western children (Sabbagh et al., 2006; Wang et al., 2016). Those country comparisons, however, have focused on children older than 3 years. Participants in the current study were 14 months old. Normally, children at 3 years go to kindergarten or day care in both countries. Compared with more freestyle Dutch kindergartens or schools, Chinese kindergartens are more rule directed, group based, and school achievement related, which may more strongly stimulate child EF (Zhu & Zhang, 2008). Culturally unique expectations of Chinese parents and teachers stressing the importance of self-control in daily life, and intensive trainings for memorizing Chinese characters in kindergarten and school, may result in the early maturity in EF among Chinese children (e.g., Tobin, Hsueh, & Karasawa, 2009). Although there were mean-level differences in sensitivity and inhibition between the Netherlands and China, no interaction effects between country and any of the predictors (attention at 4 months and maternal and paternal sensitivity at 4 and 14 months) were found in relation to three EF outcomes (working memory, cognitive flexibility, and inhibition). In other words—and consistent with our prediction—the relations between all predictors and outcomes were similar in the two countries. This finding is in line with a systematic literature review by Mesman, van IJzendoorn, and Bakermans-Kranenburg (2012), who suggested that although mean-level sensitivity can be different between ethnic groups, the association between sensitivity and child outcomes during early childhood is similar across ethnicities.

The current study addressed several limitations of previous research by considering both infant and caregiving factors in relation to individual differences in EF during the first 2 years of life and by including maternal and paternal sensitivity during early and later infancy. The cross-country design in the Netherlands and China provided an opportunity to investigate the similarity and difference in the precursors of early childhood EF in a Western country and an Eastern country. Despite these strengths, a few limitations should be noted. First, our sample included almost exclusively families from middle to high socioeconomic classes. Research has shown that parents from lower SES may suffer more stress, which in turn might influence both parental behaviors and infant EF development (e.g., Mesman et al., 2012). Future studies should include more diverse samples with families from low, middle, and higher socioeconomic backgrounds and from different ethnic backgrounds. Second, a commercially available toy was used to measure infants' attention. Prior exposure to this toy may have influenced infant attention. However, even though we did not systematically assess infants' familiarity with the toy, based on responses of parents during the task, we think it is unlikely that a substantial number of the infants were already familiar with this toy. Third, the infant age range was broad at each time point. Due to illness of infants and busy schedules of parents, some visits were scheduled earlier or later than originally planned. We controlled for concurrent age in our analyses and found that age did not contribute to the results. In addition, longitudinal studies across infancy to the preschool period are necessary to better understand the development of EF.

To our knowledge, this is the first study to examine infant, maternal, and paternal factors in relation to EF development during early childhood in both a Western and non-Western context. Overall, parent factors at 4 months were not related to infant EF abilities at 14 months, suggesting that individual differences in 14-month EF might not be stable enough to be reliably predicted from earlier patterns. Nevertheless, attention at 4 months and mothers' sensitivity at 14 months were significantly related to EF at the same time point. Future studies are needed to confirm our results and should include more diverse parenting behaviors. The absence of country differences in the relation between 4-month infant attention, parental sensitivity, and EF outcomes suggests that contributions of precursors on early EF abilities may be similar in Western and non-Western samples. Conducting cross-country research including both Western and non-Western countries can contribute to reducing the research gap, with the majority of existing research in child EF being based on a so-called WEIRD (Western, educated, industrialized, rich, and democratic) cultural database (Henrich et al., 2010). From a sociocultural and cognitive science perspective, investigating EF in different countries can help to identify the key factors of enhancing EF in different contexts as well as to test the universality assumptions of developmental processes (e.g., Brady, Fryberg, & Shoda, 2018). Our findings extend the existing literature on early precursors and correlates of infant EF, emphasize the importance of combining infant and caregiving perspectives, and show both similarities and contrasts across mothers and fathers.

CRediT authorship contribution statement

Wei Li: Conceptualization, Investigation, Writing – original draft, Data curation, Resources, Visualization, Validation, Project administration. **Rory T. Devine:** Methodology, Formal analysis, Software, Resources, Validation. **Andrew Ribner:** Software, Resources, Validation. **Rosanneke A.G. Emmen:** Writing – review & editing, Validation, Supervision, Project administration. **Mi-lan J. Woudstra:** Investigation, Resources, Data curation, Validation, Project administration. **Marjolein C. E. Branger:** Investigation, Resources, Data curation, Validation, Project administration. **Lamei Wang:** Writing – review & editing, Supervision. **Joost van Ginkel:** Methodology. **Lenneke R.A. Alink:** Writing

– review & editing, Supervision, Validation, Project administration. **Judi Mesman:** Writing – review & editing, Supervision, Validation, Project administration, Funding acquisition.

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Appendix A. Supplementary data

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