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RESEARCH ARTICLE

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Does maternal inhibitory control mediate effects of a parenting intervention on maternal sensitive discipline? Evidence from a randomized-controlled trial

Laura Kolijn[1,2,3] | **Bianca G. van den Bulk**[4] | **Marinus H. van IJzendoorn**[2] | **Marian J. Bakermans-Kranenburg**[1,2,3] | **Rens Huffmeijer**[2,3,5]

[1] Department of Clinical Child and Family Studies, and Amsterdam Public Health, Vrije Universiteit Amsterdam, Amsterdam, Netherlands

[2] Leiden Consortium on Individual Development, Leiden University, Leiden, The Netherlands

[3] Leiden Institute for Brain and Cognition, Leiden University, Leiden, The Netherlands

[4] Erasmus University Rotterdam, PA, Rotterdam, The Netherlands

[5] Institute of Education and Child Studies, Leiden University, AK, Leiden, The Netherlands

Correspondence
Laura Kolijn, Department of Clinical Child and Family Studies, Vrije Universiteit Amsterdam, Van der Boechorststraat 7, Amsterdam, BT 1081, The Netherlands.
Email: laurakolijn@hotmail.com

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Abstract

The quality of parenting greatly impacts child development, highlighting the importance of support programs that effectively improve parenting. Studies on successful intervention programs define their efficacy by gains in parenting and/or child development. However, much remains unknown about the internal processes that explain how parenting interventions bring about their effects. The aims of the current randomized-controlled study were to test whether the Video-feedback Intervention to promote Positive Parenting and Sensitive Discipline (VIPP-SD) improved maternal inhibitory control (1) and whether inhibitory control mediated any effects of VIPP-SD on maternal sensitive discipline (2). In total, 66 mothers of whom a random 33% received the VIPP-SD and the others a "dummy" intervention participated in pre- and post-intervention assessments. Sensitive discipline was observed during a semi-structured limit-setting situation and inhibitory control was measured using a stop-signal task. Contrary to expectations, inhibitory control improved over time in the control group and sensitive discipline did not show the expected increase in the intervention group. Results did not support mediation. We suggest that the intervention may have induced cognitive restructuring of parenting schemas, delaying improvements in post-intervention inhibitory control and sensitive discipline. Factors that may be involved in parents' susceptibility to interventions require attention in future work.

KEYWORDS
inhibitory control, parenting intervention, sensitive discipline, SSRT, VIPP-SD

1 | BACKGROUND

Parental sensitive discipline, setting firm limits in a gentle manner, becomes relevant after the first year of life and is important for children's successful socialization (Patterson, 2002; Snyder & Stoolmiller, 2002). Several parenting support programs have been found to effectively enhance parenting practices and/or support positive

Key Finding

1. In our preregistered randomized controlled trial maternal inhibitory control did not mediate effects of the VIPP-SD on sensitive discipline.
2. Maternal inhibitory control in a stop-signal task did not improve over time in the intervention group, although time or practice-induced improvements were observed in the control group.
3. The intervention group did not show the expected increase in sensitive discipline over time. Methodological factors, most notably a limited power may have played a role.

Statement of Relevance to the field of Infant and Early Childhood Mental Health

As the quality of parenting greatly impacts child development, parents are the main target of interventions aiming to support young children's (social-emotional) development. In the same vein, parental behavior is often examined as predictor of (mal)adaptive child behavior. To better understand parenting and the efficacy of parenting support programs, it is crucial to examine the mechanisms that are potentially involved in parental behavior, and how these are affected by parenting support programs.

developmental outcomes in children, including Incredible Years (Gardner et al., 2019; Webster-Stratton, 2006), the Attachment and Biobehavioral Catch-up (ABC; Dozier et al., 2017), Parent Management Training-Oregon (PMTO; Forgatch & Patterson, 2010) and the Video-feedback Intervention to promote Positive Parenting and Sensitive Discipline (VIPP-SD; Juffer et al., 2017). The latter is the current study's focus. It is particularly suited for parents with young children and has been shown to effectively enhance parental sensitivity and sensitive discipline (Juffer et al., 2017). Still, much remains unknown about the underlying mechanisms in, for example, parental neurocognition that account for positive changes in parenting behavior. In the current randomized-controlled study, including pre- and post-intervention assessments, we aimed to gain insight into maternal inhibitory control as a potential explanatory mechanism of expected intervention effects on maternal sensitive discipline. Insight into the factors that enhance positive parenting behavior help to reveal the effective components of intervention success.

1.1 | Parental sensitive discipline

Parents are of great importance for children's cognitive, social, and emotional development (e.g., Bernier et al., 2012; Daniel et al., 2016; Hammond et al., 2012; Hughes, 2011; Merz et al., 2017; Newton et al., 2014; Van der Voort et al., 2014). Parental sensitivity, the ability to accurately perceive and interpret child signals and provide prompt and adequate responses (Ainsworth et al., 1974), has frequently been found to be an important determinant of infants' attachment security (Bakermans-Kranenburg et al., 2003; Verhage et al., 2016). In addition to sensitivity, parental sensitive discipline, that is, setting gentle but firm limits, becomes important after the first year of life when infants enter toddlerhood (Juffer et al., 2017). In toddlerhood, the development of both cognitive and motor skills enables children to more actively engage with their environment as they start to explore the world and their autonomy. Consequently, toddlers increasingly need parental monitoring and firm but gentle limit-setting.

The concept of sensitive discipline is rooted in Patterson's (1982) theory on coercive cycles, which states that difficult child behavior elicits harsh and inconsistent parenting, including corporal punishment, which subsequently leads children away from successful socialization (Patterson, 2002; Snyder & Stoolmiller, 2002). Sensitive discipline aims to prevent or break the development of coercive cycles. Research showed that effective discipline strategies, such as distraction, explaining rules and pointing out consequences of the child's behavior (characteristics of an authoritative parenting style) predict less problematic behavior in children (Pinquart, 2017; Scott et al., 2014). In contrast, ineffective discipline strategies such as commanding, psychological control, physical interference, disapproval, giving in and laxness (characteristics of authoritarian and permissive parenting styles) are related to more problematic behavior in children (Larzelere & Patterson, 1990; Martin et al., 2014; Patterson, 2002; Pinquart, 2017; Snyder & Stoolmiller, 2002; Ziv & Arbel, 2020). Problematic family life is difficult to change for the better once parenting styles have been established for some years, supporting the persistence of negative parent-child interactions. As parenting experiences leave a lifelong signature on child development, research should focus on the prevention and/or reduction of parent-child

negativity at an early stage through parenting support programs (Fisher & Skowron, 2017).

1.2 | The video-feedback intervention to promote positive parenting and sensitive discipline

The parenting support program VIPP-SD (Juffer et al., 2008, 2017) is specifically suited for parents of young children and aims to enhance their sensitive discipline strategies. The intervention is both standardized and individualized as the intervention follows a strict protocol, but the video footage used is recorded in the participating families and is unique to each family. The VIPP-SD program has been found to be effective in enhancing parental sensitivity and sensitive discipline (combined effect size $d = .47$) as evidenced by a meta-analysis including 12 randomized controlled trials (Juffer, et al., 2017). The VIPP-SD is rooted in two research traditions: Bowlby's (1980) attachment theory and Patterson's theory of coercive cycles (Patterson, 1982). When noncompliance elicits ineffective discipline strategies, a rigid negative interaction pattern between parent and child will be established (Patterson, 2002), which will become increasingly difficult to change for the better over time. The VIPP-SD aims to enhance parental sensitivity and sensitive discipline to prevent or reduce coercive cycles between parent and child, thereby prevent or reduce escalating parent-child conflicts, and to promote attachment security (Juffer et al., 2017).

The intervention consists of six home-visits in which four themes targeting parental sensitivity are covered (*Exploration versus attachment behavior*, *Speaking for the child*, *Sensitivity chain* and *Sharing emotions*) and four themes that target sensitive discipline (*Inductive discipline and distraction, Positive reinforcement, Sensitive time-out* and *Empathy for the child*). Parental sensitive discipline appeals to parents' capacity to regulate their own behavior as it is elicited by challenging, noncompliant child behavior. The themes that target sensitive discipline stimulate parents' understanding of challenging child behavior and effective limit-setting strategies. To succeed at implementing such strategies, inhibitory control capacities might be of particular importance as parents need to regulate (inhibit) their own negative emotions and behavioral responses, and remain child-focused, watch the child carefully, and wait patiently for opportunities to regulate their children's behavior accordingly. There is no simple answer as to why some parents are more competent in using positive parenting strategies than others. However, parents' ability to control their own emotions and cognitions, capacities that rely heavily on executive functioning (EF), may play a central role in effective parenting practices (Crandall et al., 2015).

1.3 | Cognitive capacities and parenting

EF is a multidimensional concept that describes a set of cognitive processes such as inhibitory control, cognitive flexibility, working memory, planning, and emotion- and self-regulation (Alvarez & Emory, 2006). These processes facilitate, guide and maintain goal-directed behavior over impulsivity. Complex human behavior such as parenting involves goal-directed behavior that requires constant adaptation to childrearing demands. Successful parenting thus involves EF and several studies have shown that lower levels of parental EF are related to negative parenting practices such as harsh and controlling parenting behavior (Bridgett et al., 2017; Crandall et al., 2015; Deater-Deckard et al., 2012), whereas higher levels of EF relate to more positive parenting practices (Chico et al., 2014; Crandall et al., 2015). Moreover, EF has been found to moderate the relation between household chaos and harsh parenting (Park & Johnston, 2020). One of EF's key elements is inhibitory control, which refers to the ability to willfully suppress or withhold prepotent/automatic responses (Li et al., 2015). Deficits in inhibitory control are related to addictive and impulsive behavior (Argyriou et al., 2017), psychiatric conditions (i.e., ADHD; Overtoom et al., 2002 and OCD; Chamberlain et al., 2006) and child maltreatment (Crandall, 2015). Higher levels of inhibitory control facilitate behavior regulation, which in the context of parenting may play a role in the extent to which parents regulate (negative) reactive/automatic responses in the presence of child misbehavior and noncompliance (Deater-Deckard et al., 2012; Kienhuis et al., 2010). Research showed that when childrearing demands increase, parental inhibitory control becomes especially important. For instance, parental inhibitory control was found to mediate negative effects of socioeconomic hardship on the quality of caregiving under stressful parenting conditions (Sturge-Apple et al., 2017). The current study describes a sample of mothers with four-year-old same-sex twins who may perceive more parenting stress and parenting difficulty compared to mothers of singletons (Andrade et al., 2014; Lutz et al., 2012; Oliveness et al., 2005). Two same-aged young children who appeal to parental attention increase childrearing demands. Thus, inhibitory control may be of particular relevance in this group.

1.4 | Inhibitory control as a mediator in the association between VIPP-SD and sensitive discipline

The basis for positive parenting behavior may be found in the interaction between cognitive skills and childrearing demands (Crandall et al., 2015). Most parenting support programs aim to enhance parenting skills by

behavior training and define their efficacy in terms of improved parenting skills and/or positive child development. Parental EF and self-regulation as contributors to the gains observed in parenting behavior and child development are often overlooked (Crandall et al., 2015; Schaffer & Obradović, 2017). However, it has been suggested that parenting skills are more likely to improve and be sustained when interventions address parental self-regulation and cognitive capacities in addition to parenting behavior (Azar et al., 2008; Bugental & Schwartz, 2009; Sanders et al., 2019; Zimmer-Gembeck et al., 2019), suggesting that the intervention might operate through (cognitive and/or emotional) control capacities. Preliminary evidence that parenting interventions improve neurocognitive control indeed point in that direction, as a recent study found improved stop signal performance (i.e., inhibitory control) and associated neural changes after a parenting video-coaching program (Giuliani et al., 2019). As inhibitory control is central to cognitive processes that facilitate and regulate goal-directed behavior and regulation of negative responses in the context of challenging child behavior constitutes a specific target of the VIPP-SD, it seems reasonable to argue that changes in parental sensitive discipline induced by the VIPP-SD may result from changes in inhibitory control.

1.5 | Current study

Our aim was to investigate whether the VIPP-SD affects parental sensitive discipline through improved inhibitory control as measured with a stop-signal task in a sample of mothers with same-sex twins. Our general research question concerned mediation: whether inhibitory control functions as a mediator of VIPP-SD effects on sensitive discipline. To investigate this question, we formulated two hypotheses: we expected that the VIPP-SD program would improve inhibitory control (1) and that the VIPP-SD would enhance sensitive discipline through improved inhibitory control (2). Our study was preregistered (Kolijn et al., 2017) and throughout the paper we will note when we deviate from the preregistration and explain adaptations and additional analyses.

2 | METHODS

2.1 | Participants

The Leiden Consortium on Individual Development (L-CID) preschooler project is a longitudinal intervention study including families with twins that were 3- to 4-years old at the time of inclusion (for details on the design see Euser et al., 2016). The current study reports on a random subsample of mothers who were invited to participate in a specific part of the study focusing on parental inhibition and EEG/ERP measures (see Kolijn et al., 2017; 2020): A total of 66 mothers (22 mothers in the intervention group and 44 mothers in the control group) were willing and eligible to participate in two additional assessments. As summarized in Table 1, mothers were on average 37.29 years old ($SD = 4.31$) and their typically developing same-sex twins were on average 4.66 years old ($SD = .60$, 52% girls) at the time of the current study's first assessment (i.e., the pre-test sensitive discipline; Figure 1). Most of the participants were married or in a registered partnership (73%), highly educated (77% had at least an undergraduate degree) and born in the Netherlands (92%). As registered, our aim was to include 100 participants. However, because we added a pre-test assessment, we could only invite the families who were not yet randomized to either the intervention or control group in the larger L-CID study. This was the case for 119 families of which 66 were willing and eligible to participate in the current assessments (see Kolijn et al., 2020 for details). Exclusion criteria were neurological and psychiatric disorders and use of psychoactive medication. There were no differences in background variables (i.e., marital status, maternal education, family SES, twin gender and twin zygosity; all $ps \geq .10$) between mothers who did ($n = 66$) and mothers who did not meet the inclusion criteria or declined to participate ($n = 53$).

2.2 | Procedure

In the larger study, families are followed for 6 years with yearly assessments, resulting in six waves of data collection: two pre- and four post-intervention assessments (Euser et al., 2016). After the first two pre-tests and before randomization, mothers in the current sub-sample were asked to participate in the two additional assessments of the current study. After the second pre-test (i.e., in between waves 2 and 3), families were randomized to either the VIPP-SD program or a dummy intervention consisting of six phone calls (see below). The current study includes data from four L-CID assessments: Wave 2 sensitive discipline data (pre-intervention; first green box in Figure 1), pre- and post-maternal inhibitory control data from the additional assessments (yellow boxes in Figure 1) and Wave 3 sensitive discipline data (post-intervention; second green box in Figure 1). All visits took place at Leiden University. Sensitive discipline was observed during the yearly visits in which the parent and both children took part. Maternal inhibitory control data were collected during two identical visits (mother only) during which mothers completed several tasks; a face processing paradigm, a stop-signal task

TABLE 1 Sample characteristics and covariates

Sample characteristics	Total $n = 66$ M (*SD*)	Intervention $n = 22$ M (*SD*)	Control $n = 44$ M (*SD*)
Age mother at T0	37.95 (*4.31*)	37.64 (*4.23*)	38.10 (*4.38*)
Age twin at T0	5.30 (*.60*)	5.23 (*.65*)	5.33 (.58)
Age mother at T3	4.13 (*3.51*)	4.96 (*5.35*)	3.75 (*2.20*)
Age twin at T3	26.54 (*5.20*)	24.46 (*4.29*)	27.58 (*5.34*)
	%	%	%
Middle SES	38	36	39
High SES	55	59	52
Single parent	5	5	5
Twin girls	52	50	52
MZ twins	58	68	52
Covariates	**M (*SD*)**	**M (*SD*)**	**M (*SD*)**
BSI – internalizing symptoms	26.54 *(5.20)*	24.46 *(4.29)*	27.58 *(5.34)**
ATQ – Orienting sensitivity	4.26 *(.78)*	4.31 *(.71)*	4.24 *(.82)*
ATQ – Effortful control	4.94 *(.61)*	5.00 *(.64)*	4.92 *(.60)*

Note. Difference between intervention and control group.
**p* < .05.

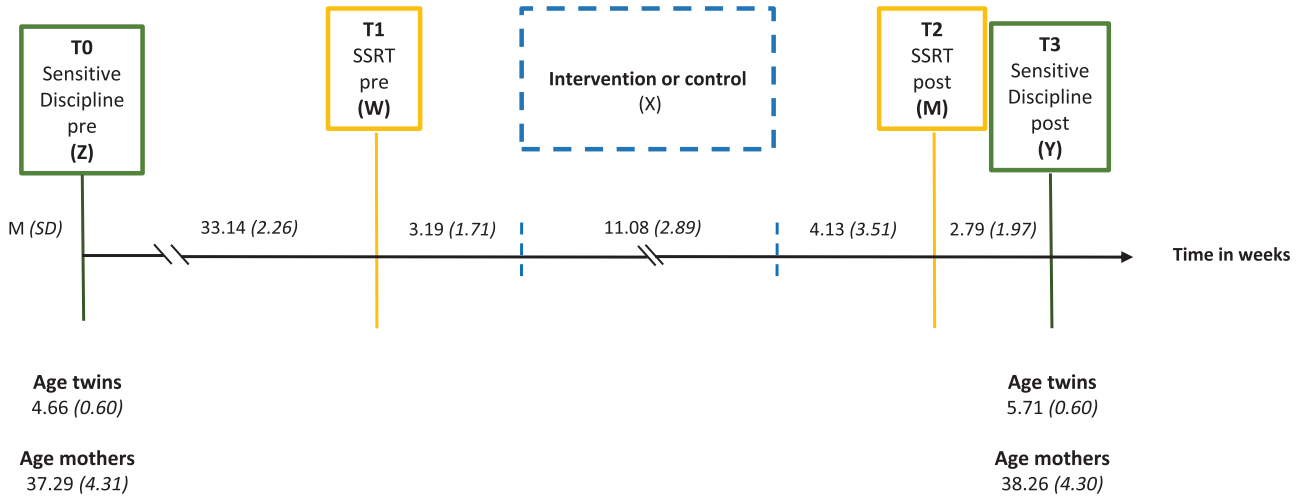

FIGURE 1 The sequence of assessments

to measure inhibitory control—both tasks included EEG-recordings—and an emotion recognition task.

In contrast with the aims described in our study protocol, the current study does not report on the neural correlates of inhibitory control, because insufficient artifact-free EEG data were available (due to excessive artifacts, particularly during unsuccessful inhibition) to allow for statistical analyses. Therefore, we only report on behavioral data. Trained research assistants collected the data during all visits and were blind to the participants' experimental condition. Informed consent was obtained at the start of the L-CID study and participants signed informed consent for the additional measures at the start of the pre-test visit. At the end of each visit, the participants received financial reimbursement (€50 for each yearly visit, €20 for each parent-only visit, and travel-expenses) and the children received a small present at each yearly visit. The Institutional Review Board of Leiden University's Institute of Education and Child Studies and the Central Committee on Research Involving Human Subjects in the Netherlands (CCMO) approved all assessments.

2.3 | Intervention program

The VIPP-SD (Juffer et al., 2008; 2017) consists of a total of six home visits. After a start-up visit, an intervener

visits the participating families at home for five bi-weekly visits during which parent-child interactions are videotaped. Using the video footage of the previous visit, parent and intervener reflect on the parent-child interaction. The intervener prepares the feedback in between the visits after analyzing the interaction. The feedback's tone of voice is strictly positive during the first two visits to establish a supportive relationship between the parent and intervener. During the later visits (3–5), besides positive feedback, corrective messages on more challenging videotaped interactions are provided. To successfully implement the VIPP-SD in the current study, the VIPP-SD manual was adapted for use in families with twins (see Euser et al., 2016 for details). All interveners were extensively trained by certified VIPP-trainers in using the VIPP-SD version 3.0 manual (Juffer et al., 2015) and conducting home visits with twins. On average, mothers who participated in the VIPP-SD program completed 5.63 out of six visits (SD = .96, n = 19; 3 participants did not start the intervention).

2.4 | Control condition

A dummy intervention was used to control for the potential effect of interacting with an expert. Using a standardized semi-structured format, trained researchers interviewed mothers over the phone about their twins. To prevent overlap with the VIPP-SD, the interview topics concerned the general development of the twins. On average, the control group completed 5.89 out of six phone calls (SD = .32, n = 44), which was not different from the number of visits completed by the intervention group (p = .27).

2.5 | Measures

2.5.1 | Sensitive discipline

To measure sensitive discipline, parent-child dyads were observed during the do not touch task—a compliance task (Kochanska & Aksan, 1995; van der Mark et al., 2002). This task elicits parental discipline behavior as the parent instructs the child to refrain from playing with or even touching a collection of attractive toys. We collected data on the *don't touch* task when the dyad was present in the laboratory's observation room. An experimenter came into the room and handed the parent a plastic instruction card before providing them with a bag full of attractive toys. The instruction card explained that the parent should unpack the bag, but the child was not allowed to touch any of the toys for two minutes. After two minutes, the child was allowed to play with only the least attractive toy for another two minutes. The task finished with the dyad playing together with all the toys for a few minutes. Parents performed the task twice, once with each co-twin. We videotaped all interactions and coded them afterwards for parental discipline behavior.

We used two revised Erickson scales (Egeland et al., 1990): the seven-point rating scale for supportive presence (one = *parent completely fails to set positive limits*, seven = *parent is skillful in providing positive limit setting throughout the session*) and the five-point rating scale for physical interference (one = *parent does not interfere physically*, five = *parent often interferes physically*). In total, five coders—trained by an expert coder—were involved in coding the videos for the pre-test and seven coders for the post-test. Videos of co-twins and videos from the same family in different assessments were never coded by the same coder. For the pre-test, the mean intercoder reliability (ICC, single measure, absolute agreement) for supportive presence was .74 (range .71–.79) with the expert coder and .76 among all coders (n = 48). For physical interference these figures were .88 (range .85–.90) and .89, respectively. For the post-test, the mean ICC for supportive presence was .79 (range .73–.88) with the expert coder and .81 (range .67–.87) among coders (n = 50). For physical interference these figures were .88 (range .80–.92) and .92 (range .85–.95), respectively. The *don't touch* task was conducted per dyad and thus every mother received two scores for supportive presence (one with each co-twin) and two scores for physical interference (one with each co-twin). For interpretation purposes, the physical interference scale was reversed so that higher scores represented higher levels of sensitive discipline on both scales. Parental supportive presence with each of their co-twins was significantly correlated (r = .56, p = <.01 for the pre-test and r = .46, p <.01 for the post-test). Physical non-interference was also significantly correlated (r = .36, p = <.01 for the pre-test and r = .54, p = <.01 for the post-test). Averaging the co-twin scores, we created one score for supportive presence and one score for physical non-interference per assessment. Parental scores for supportive presence and physical non-interference were significantly correlated per assessment (r = .37, p = <.01 for the pre-test and r = .39, p = <.01 for the post-test). Therefore, the scores were standardized and averaged, resulting in one pre-test and one post-test score for sensitive discipline. The data were approximately normally distributed, and no outliers were present (no z-scores > 3.29 or <−3.29).

2.5.2 | Inhibitory control

Using E-prime 2.0, we designed a two-choice reaction time stop-signal task with tracking procedure. The task consisted of five blocks, starting with a training block

(16 trials: four stop trials, 12 go trials), followed by four test blocks of 100 trials each (25 stop trials, 75 go trials). By including more go-than stop trials, the task elicited prepotent rapid motor responses to go-signals. The stimuli were green ("go"-signal) and red ("stop"- signal) arrows pointing either left or right. Every trial started with a white fixation cross (duration: 800–1200 ms, varying randomly) on a black background followed by a green arrow. On go-trials the green arrow was presented until participants responded, with a maximum of 1500 ms. The task continued if participants failed to respond within 1500 ms and these events were marked as go omissions. Participants responded by pressing a button on a four-key response pad: key 1 (most left key on the pad) for arrows pointing left and key 4 (on the far right of the pad) for arrows pointing right. A minority of trials were stop trials (25%) in which the green arrow was followed by a red arrow (pointing in the same direction) indicating that participants should withhold (i.e., inhibit) their response. The stop signal delay (SSD)—the time between the onset of the green arrow and appearance of a red arrow—was set to 250 ms at the start of the task and increased by 50 ms following each successful inhibition of a response and decreased by 50 ms after each unsuccessful inhibition of a response. In other words, the SSD was adapted to participants' performance, making the task more difficult following inhibitory success and less difficult following inhibitory failure. This procedure was implemented to approach a .50 probability of responding on a stop trial, increasing the unpredictability of stop signal occurrence and decreasing participants' tendency to wait for it. The trials were presented in a quasi-random order with a maximum of six consecutive go trials and a maximum of two consecutive stop trials. Participants were instructed to respond as fast as possible and at the same time try to make as few mistakes as possible. After every 100 trials there was a break in which the experimenter came in and repeated the instructions. During the task participants were seated at a desk in front of a computer screen and response box.

The Stop Signal Reaction Time (SSRT) reflects the latency of inhibitory control with faster inhibition reflecting greater skill (Logan & Cowan, 1984). Typically, the response inhibition process in the stop-signal paradigm is conceptualized as a horse race between a go-process (producing a response) and a stop-process (withholding responses) that run independently: a response is executed when the go-horse wins the race and a response is inhibited when the stop-horse wins (Band et al., 2003). This horse race model provides the theoretical justification for calculating SSRT. Excluding the practice block, we calculated the average SSRT over the four test blocks for use in subsequent analyses. To obtain reliable SSRTs the horse race model assumption that reaction time (RT) on unsuccessful stops is not longer than RT on go trials (Logan & Cowan, 1984) should be met (Band et al., 2003). As recommended by Verbruggen et al. (2019), we first checked this assumption by comparing the mean RT on go trials with the mean RT on unsuccessful stop trials for each individual participant. The assumption was violated for one participant at the pre-test. However, when examining this participant's individual blocks this was true for the first test block only. Therefore, we calculated her SSRT across the remaining three test blocks (=300 trials). Next, we checked whether the probability of responding on stop trials was within the range of .25–.75 (considered acceptable when aiming for .50, see Congdon et al., 2012). This was the case for all participants. Following guidelines reported in Verbruggen et al. (2019), we then computed SSRT for each participant using the integration method, in which go omissions (i.e., failing to respond on go trials) were replaced by the maximum RT of 1500 ms. The integration method uses the *n*th RT—the RT in the go-RT distribution that equals the participants' probability of responding on stop trials. We calculated SSRT for every participant by subtracting the mean SSD from the *n*th RT (Verbruggen et al., 2019). After winsorizing (Tabachnick & Fidell, 2013) two outliers (one at the pre-test, $z = 3.71$, and one at the post-test, $z = -3.85$), the data were normally distributed (see Table 2 for means and standard deviations). Although SSRT is the main parameter for inhibitory control, the stop-signal task also produces several other parameters: the probability of go omissions, the probability of choice errors on go trials (i.e., pressing the wrong button given the direction of the arrow), the probability of responding on stop trials, the average RT on go trials (calculated with go omissions replaced by max RT of 1500 ms), the average RT of responses on stop trials (i.e., unsuccessful stops) and the average SSD (see Table 2 for descriptives). We found six outliers on the performance parameters (pre-test probability of go omissions [$z = 4.77$, $z = 3.96$], pre-test probability of choice errors [$z = 7.96$], post-test probability of go omissions [$z = 4.35$, $z = 3.87$], and post-test probability of choice errors [$z = 4.29$]) that were winsorized.

2.5.3 | Covariates

We included three covariates in the analyses: the Brief Symptom Inventory (BSI; Derogatis, 1993), to measure self-reported psychopathological symptoms, and two dimensions of the Adult Temperament Questionnaire (ATQ; Derryberry & Rothbart, 1988); Orienting Sensitivity (OS) and Effortful Control (EC). BSI scores were included to control for the pre-existing group difference ($M_{intervention} = 24.46$, $M_{control} = 27.58$; $t\ [64] = 2.38$, $p = .02$) and temperament scores were included because of potential confounding

TABLE 2 Stop-signal task performance parameters and sensitive discipline

	Total ***n*** **= 66** **M *(SD)***	**Intervention** ***n*** **= 22** **M *(SD)***	**Control** ***n*** **= 44** **M *(SD)***
Pre-test			
p(go omission)	2.92 *(5.25)*	1.97 *(4.87)*	3.39 *(5.42)*
p(choice error|go trials)	.57 *(.86)*	.80 *(1.09)*	.45 *(.71)*
p(respond|stop trial)	53.47 *(3.32)*	52.77 *(2.89)*	53.82 *(3.49)*
RT on go trials	730.73 *(284.68)*	713.46 *(287.67)*	739.37 *(286.12)*
RT go on stop trials	624.29 *(256.25)*	621.78 *(280.45)*	625.54 *(246.67)*
SSD	528.62 *(294.38)*	514.05 *(317.84)*	535.91 *(285.48)*
*N*th RT	752.66 *(322.84)*	726.61 *(325.74)*	765.68 *(324.36)*
SSRT	223.05 *(56.31)*	212.56 *(34.62)*	228.29 *(64.21)*
Sensitive discipline	.00 *(SE = .10)*	−.04 *(SE = .15)*	.02 *(SE = .13)*
Post-test			
p(go omission)	1.74 *(3.74)*	1.20 *(3.53)*	2.01 *(3.86)*
p(choice error|go trials)	.50 *(.70)*	.71 *(0.98)*	.39 *(.48)*
p(respond|stop trial)	52.27 *(2.87)*	52.09 *(2.27)*	52.36 *(3.15)*
RT on go trials	708.72 *(263.67)*	700.26 *(284.82)*	712.95 *(255.77)*
RT on stop trials	613.78 *(242.78)*	615.08 *(267.30)*	613.13 *(232.81)*
SSD	529.39 *(289.68)*	499.95 *(303.44)*	544.11 *(284.98)*
*N*th RT	720.10 *(294.16)*	703.91 *(302.90)*	728.20 *(292.90)*
SSRT	191.05 *(43.61)*	203.95 *(32.35)*	184.60 *(47.29)*
Sensitive discipline (SD)	.00 *(SE = .10)*	−.19 *(SE = .16)*	.09 *(SE = .13)*

Note. *p* = probability and the values represent percentages. Sensitive Discipline is the composite score of two scales, and the values represent the standardized mean and standard error (*SE*).

effects (means and standard deviations are presented in Table 1). ATQ data were missing for five participants (three in the control group and two in the intervention group); we imputed their scores with the mean of the group they were assigned to. There was no significant correlation between the OS- and EC-scale ($r = -.17$, $p = .18$).

2.6 | Statistical analyses

Post-test SSRT data were missing for six mothers (three in the intervention group and three in the control group), five did not participate in the post-test and one participants' session was aborted due to illness. Post-test sensitive discipline was missing for two participants (both in the control group). We imputed these data in a conservative way by carrying the last observation forward (i.e., the pre-test, see Little & Yau, 1996). Three participants did not start the intervention due to time constraints or personal circumstances. We analyzed them in the group to which they were randomly assigned, in accordance with the intent to treat (ITT) approach (Gupta, 2011).

Before testing our hypotheses regarding sensitive discipline and SSRT, we performed preliminary analyses (not registered) to test for time and/or experimental condition effects on the other performance parameters produced by the stop-signal task. We used a total of six (one for every parameter) repeated measures analyses of variance (RM-ANOVA) with each performance parameter as dependent variable, time (two levels: pre- and post-test) as within-subjects variable and experimental condition (i.e., intervention or control group) as between-subjects variable. A table with correlations among all variables of interest and the covariates across the total sample can be found in Supplementary Table S1.

To test our first registered hypothesis— whether the intervention improved inhibitory control—we used a repeated measures analysis of covariance (RM-ANCOVA) with SSRT as dependent variable, time (two levels: pre- and post-test) as within-subjects variable, experimental condition (i.e., intervention or control group) as between-subjects variable, and BSI, OS, and EC scores as covariates.

We tested our second registered hypothesis—whether gains in inhibitory control as measured by SSRTs mediate intervention effects on sensitive discipline—using A. F. Hayes' (2018) moderated mediation analysis (Process model 10; see Figure 2 panel (a) for the conceptual model and panel B for the statistical model). In this analysis,

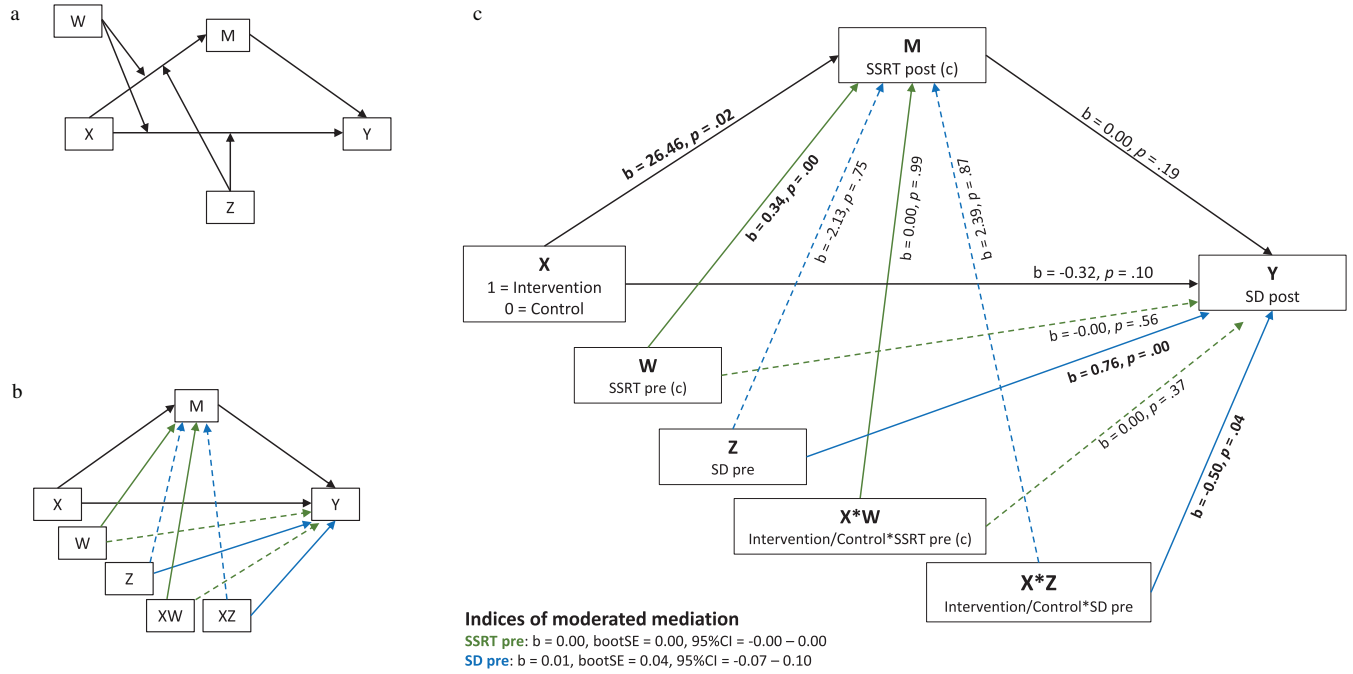

FIGURE 2 Moderated mediation as modeled in PROCESS model 10. Panel a: conceptual model, panel b: statistical model, with green arrows representing the (interaction) effects of the pre-test SSRT and blue arrows representing effects of pre-test of sensitive discipline. The solid lines in Panel b represent the associations that are most relevant to our research question. Panel b's corresponding variable names, interaction terms and regression weights can be found in panel c. Panel c: Results of the moderated mediation analysis (PROCESS model 10) with the most relevant associations represented by the solid lines. Significant associations are indicated in bold font, showing differences between the intervention and control groups in sensitive discipline and SSRT, but no evidence for mediation, (c) = centered

post-test sensitive discipline was the outcome variable, post-test SSRT the mediator, and pre-test SSRT, and pre-test sensitive discipline were modeled as moderators. The independent variable experimental condition was coded 0 for the control group and 1 for the intervention group. The analysis produces indices of partial moderated mediation, which indicate whether a moderator (SSRT [W] or sensitive discipline [Z]) is related to the size of the indirect effect (i.e., effect of the intervention on post-test sensitive discipline through post-test SSRT), independent of the other moderator (A. F. Hayes, 2018). An intervention effect on SSRT (the mediator) can appear as a significant interaction term X*W and/or a significant main effect of experimental condition. Similarly, an intervention effect on sensitive discipline (the outcome) can manifest itself as a significant interaction term X*Z and/or a significant main effect of experimental condition. Moderated mediation effects were tested using the percentile bootstrap method with 10,000 runs, and the continuous variables were centered before the analysis by subtracting the total sample mean from every individual score.

Testing the total effect of the intervention on sensitive discipline with $\alpha = .05$ in a sample of 66 mothers, the power to detect a medium-sized effect (X*Z) is .53 (G*Power 3.1.9.2; Faul et al., 2009). The power to detect mediation is at least similar, and often larger than the power to detect the overall effect (Kenny & Judd, 2014). The moderated mediation analysis models our research question most closely, however not to a full extent as the analysis fails to take the effects of both moderators at the same time (i.e., pre-test inhibitory control and pre-test sensitive discipline) into account. In addition, many coefficients that are not relevant for our research question (dotted lines Figure 2) are estimated (i.e., affecting the power of the analysis), which is undesirable given our relatively small sample. Therefore, we also performed a two-condition mediation analysis using Montoya and Hayes' (2017) MEMORE macro as an additional check for mediation per experimental group. The findings, similar to our main findings reported below, are provided in the supplementary materials.

To test the robustness of our findings, we repeated the main analyses three times: including complete cases only (1), with missing data imputed with the average of the group the participant was randomly assigned to (2), and excluding the participants who reported to use psychoactive medication (3). The findings resulting from the sensitivity analyses closely corresponded with our main findings reported below (see supplementary materials).

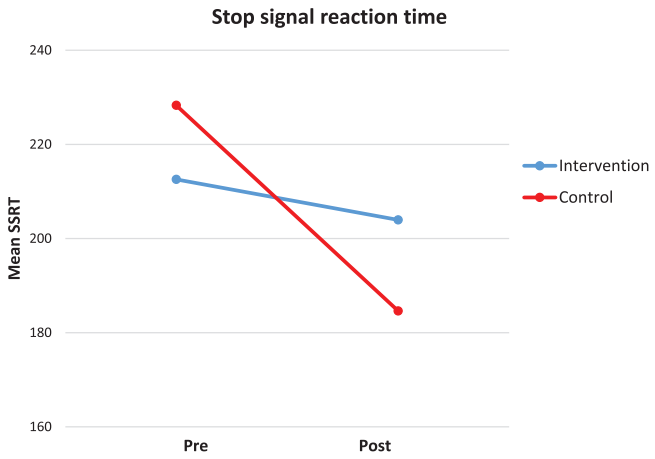

FIGURE 3 Time by group interaction on SSRT, showing a significant decrease (i.e., improved inhibitory control) over time in the control group only

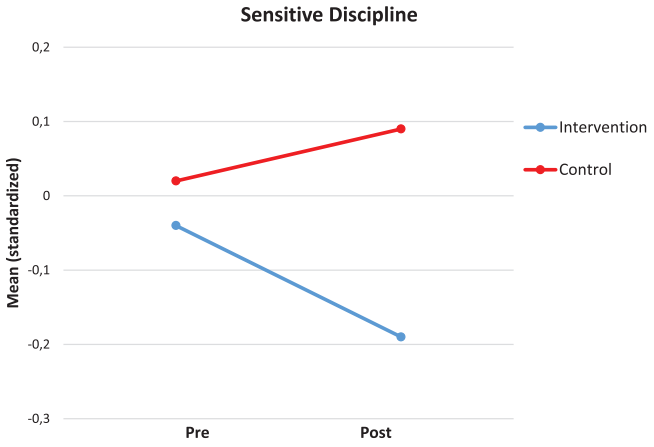

FIGURE 4 Effect of time on Sensitive Discipline. In comparison to the control group, sensitive discipline scores in the intervention group decreased over time

3 | RESULTS

3.1 | Preliminary results

Out of the six RM-ANOVA's on the stop-signal performance parameters there were effects of time on the probability of go omissions (F [1,64] = 5.87, p = .02, η_p^2 = .08) and on the probability of responding on stop trials (F [1,64] = 5.57, p = .02, η_p^2 = .08), both were lower at the post-test which is indicative of improvement over time. There was an effect of experimental condition on the probability of choice errors (F [1,64] = 4.04, p < .05, η_p^2 = .06), that is the percentage of wrong button presses given the direction of the arrow, which was higher in the intervention group (M = .76%, SD = .87) than in the control group (M = .42%, SD = .49). The means show, however, that the frequencies of choice errors were very low, namely less than 1% in both groups. Moreover, post-test probability of choice errors was unrelated to post-test SSRT (r = −.06, p = .62). Therefore, probability of choice errors was not included as covariate in further analyses. There were no other main or interaction effects (all $F_s \leq 1.01$, all $p_s \geq .32$, all $\eta_p^2 \leq .02$).

3.2 | Intervention effect on inhibitory control (Stop signal reaction time)

Results are depicted in Figure 3. The RM-ANCOVA revealed an intervention effect on SSRT as evidenced by a significant interaction effect of Time*Condition F(1,63) = 6.53, p = .01, η_p^2 = .10. Furthermore, there was a (large) main effect of Time F(1,61) = 14.49, p = < .01, η_p^2 = .19, with a decrease in SSRT over time. Finally, we found a main effect of the ATQ scale Orienting Sensitivity F(1,61) = 8.15, p = .01, η_p^2 = .12, with higher scores on Orienting Sensitivity correlating to higher SSRT scores (r = .26, p = .04). No other main or interaction effects were present (all $F_s \leq 1.34$, all $p_s \geq .25$ and $\eta_p^2 = \leq .02$). To explore the Time*Condition interaction, we performed two paired samples t-tests; one for each group. The results showed a significant decrease in SSRT scores (i.e., improved inhibition) over time in the control group (t[43] = 5.02, p < .01), but the SSRT scores in the intervention group did not significantly change over time (t[21] = 1.10, p = .29).

3.3 | Moderated mediation analysis

The moderated mediation analysis (including covariates BSI and ATQ scales) showed the intervention effect on SSRT scores in a significant difference on post-test SSRT between the intervention and control group (b = 26.46, p = .02), with lower SSRT (i.e., better inhibition) in the control compared to the intervention group. In addition, there was an intervention effect on post-test sensitive discipline, evidenced by a significant interaction between experimental condition and pre-test sensitive discipline (b = −.50, p = .04 [X*Z interaction in Figure 2 Panel (c)]). This interaction suggests that the intervention and control group differed significantly in the change in sensitive discipline from pre-test to post-test, with decreasing scores (i.e., less sensitive discipline) over time in the intervention group compared to the control group (see Figure 4). Finally, we did not find evidence for the mediation hypothesis: the association between post-test SSRT scores and post-test sensitive discipline was not significant (b = .00, p = .19), and neither were the indices of partial moderated mediation (pre-test SSRT [b = .00, bootstrapped SE = .0008, 95% confidence interval (CI): −.0013

to .0200] and pre-test sensitive discipline [b = .01, bootstrapped SE = .04, 95% (CI): −.08 to .10]).

4 | DISCUSSION

Previous research showed that the VIPP-SD effectively enhanced maternal sensitivity as well as maternal sensitive discipline (Juffer et al., 2017). The current study specifically focused on sensitive discipline, as we included a sample of mothers with children of preschool age, a developmental period characterized by increased child noncompliance, and because parental inhibitory control seems particularly relevant in the context of dealing with noncompliant and challenging child behavior. Our aim was thus to gain insight into inhibitory control as a mechanism mediating effects of the VIPP-SD on maternal sensitive discipline, the ability to effectively respond to children's noncompliance and misbehavior by setting firm limits in a gentle manner. Because this intervention trains mothers to pause (i.e., inhibit initial negative responses), observe and understand their child and respond accordingly, our first hypothesis was that the intervention would enhance inhibitory control, visible as a decline in SSRTs over time. Our second hypothesis was that improvements in sensitive discipline observed during parent-child interaction could be explained by improved inhibitory control. However, our hypotheses were not confirmed.

First, although inhibitory control improved over time (corresponding to previous research on practice-related improvements in inhibitory control; Berkman et al., 2014; Hartmann et al., 2019; Mansouri et al., 2017; Manuel et al., 2013; Roos et al., 2017), this effect was observed in the control group only. In fact, no significant reduction in SSRT from pre-test to post-test was observed in the intervention group, indicating that the intervention prevented or interfered with a time/practice-related improvement in inhibitory control. A factor that is often called upon to explain unexpected or contradictory findings is variation in motivational context that contaminates the measurement of inhibitory control, leading to incorrect conclusions. Although motivational tendencies may very well play a role in stop-signal task performance, for example, causing slower SSRT scores when participants favor correct stopping (i.e., make as few mistakes as possible) over responding as fast as possible (Leotti & Wager, 2010), it is unlikely that motivational tendencies underlie our finding. There were no differences between the groups on relevant performance parameters such as reaction time and the probability of responding on stop trials. In addition, both groups responded highly accurately on go-trials. In fact, accuracy was even slightly higher in the control group than in the intervention group.

Rather, the paradoxical effects observed here might result from the complexity of cognitive changes produced by the intervention. The intervention increases mothers' awareness of their children's as well as their own behavior, and requires them to reinterpret, reevaluate and restructure their behavioral repertoire. Such processes involve cognitive restructuring of (parenting) schemas (Azar et al., 2005), and integrating new information with prior knowledge (Lee & Seel, 2012) in order to modulate goal-directed behavior accordingly. This requires mental effort, and complex changes to cognitive architecture or a coordinated set of skills may come at initial cost to the individual operation of any or all of its constituent components (Bandura, 1978), before integration leads to improved functioning (Clark, 2013; S. C. Hayes & Wilson, 1995; Schunk, 2012). Thus, we speculate that restructuring of cognitive schemas interfered with the 'normative' time/practice-induced improvement in inhibitory control that we observed in the control group. For future studies, it is important to include long-term follow-ups to see whether those reveal the expected improvements in inhibitory control after the VIPP-SD.

Second, we did not find evidence for our mediation hypothesis that intervention effects on sensitive discipline would be induced through improvements in inhibitory control. In contrast to our expectations, the intervention group did not show the expected increase in sensitive discipline scores at the post-test. Again, the timing of changes in complex processes, such as restructuring, could have played a role here. If the intervention indeed affected parenting schemas, mothers' parenting beliefs and parental confidence, both positively related to parenting behavior (Morawska & Sanders, 2007; Schofield & Weaver, 2016), could be affected and result in temporary discomfort or hesitance about discipline strategies. This could be of particular relevance during a challenging situation like the don't touch task that strongly appeals to maternal discipline strategies; a possible explanation for our sensitive discipline findings. Again, long-term follow-ups might show increased sensitive discipline and reveal a sleeper effect in the current sub-sample and, most importantly, in the larger sample studied of the L-CID preschooler project.

Furthermore, support programs such as the VIPP-SD may have differential effects depending on the population that is examined. The current sample could be characterized as advantaged (i.e., high-SES as indicated by educational level, non-clinical and not at-risk) whereas most of the previous studies that have shown positive effects of the intervention included disadvantaged samples (i.e., low-SES and/or high-risk/clinical). Indeed, the meta-analysis that reported on the VIPP-SD's effect size included mainly low-SES, high-risk and/or clinical samples (Juffer et al., 2017). Parenting research has shown that middle- to

high-SES families experience fewer family problems of all sorts (Hoff et al., 2002), whereas low-SES is associated with more disadvantaged family functioning (see Roubinov & Boyce, 2017). Furthermore, the frequency of coercive cycles is found to be low in high-SES families (McGrath & Elgar, 2015) as are ineffective parenting behaviors that establish and maintain coercive cycles. Low-SES is found to be related to more harsh parenting (Jansen et al., 2012; Pinderhughes et al., 2000 in mothers only), corporal punishment (Ryan et al., 2016) and ineffective parenting practices (Coolahan et al., 2002). In addition, high-SES is related to parents being more knowledgeable about child development and parenting skills (Benasich & Brooks-Gunn, 1996; Morawska et al., 2009). Interestingly, studies on learning processes have revealed that instructional interventions have differential effects depending on the learner's prior knowledge (Kuldas et al., 2014; Wetzels et al., 2011), being effective in "novice" learners but sometimes ineffective or even harmful in more knowledgeable "experts" (Kalyuga et al., 2003). The VIPP-SD may similarly not have produced the expected effect on sensitive discipline behavior in the current study. Although parenting interventions may differ in efficacy along the gradient of family SES (Deković et al., 2011; McCart et al., 2006), the relationship between SES and parenting is complex (Roubinov & Boyce, 2017). Importantly, parental psychiatric difficulties are related to lower cognitive capacities (Cotter et al., 2018; Rock et al., 2014). However, psychiatric difficulties were an exclusion criterion, leaving out a group of parents that might have particularly benefitted from the intervention. Although it remains essential to evaluate the VIPP-SD's behavioral effects in the larger L-CID sample (as the current study reports on a subsample), the current study highlights the importance of examining family background characteristics as a potential moderator of parenting intervention effects in larger samples with a more varied socioeconomic background.

4.1 | Considerations for future research

Training parental EF in addition to behavioral skills remains an important topic to be addressed in future studies that examine the efficacy of parenting support programs (Azar et al., 2008; Bugental & Schwartz, 2009; Sanders et al., 2019; Zimmer-Gembeck et al., 2019). In addition to inhibitory control, several other factors may be considered as explanatory mechanisms in parenting support program efficacy. For instance, working memory, which is another key construct of EF, has also been shown to play a role in parenting behavior (Bridgett et al., 2017). Especially in samples of mothers with little or poor education (Obradović et al., 2017) and in maladaptive parenting (Deater-Deckard et al., 2009; Gonzalez et al., 2012; Sturge-Apple et al., 2014), the role of working memory is underscored. Future studies that examine cognitive mechanisms of successful intervention implementation should consider multiple key elements of EF for their potential involvement as a mediator of intervention efficacy. Furthermore, stress reactivity in terms of perceived stress, cortisol reactivity and (re)activity of the autonomic nervous system is a likely candidate, especially given that stress moderates the relation between cognitive control capacities (EF) and parenting quality (Monn et al., 2017) and given the benefits of parenting interventions in distressed families (Gardner et al., 2017). Moreover, stress may be of particular relevance for parenting in twin families given the prevalence of stress among parents of twins (Andrade et al., 2014; Lutz et al., 2012; Oliveness et al., 2005). In addition, emotion regulation uniquely predicted less positive and collaborative parent-child interactions in a diverse sample of parents and kindergarten-age children (Schaffer & Obradović, 2017), suggesting that emotion regulation might be a relevant factor when investigating mediating mechanisms of VIPP-SD effects on sensitive discipline in particular. Lastly, it is important to be aware that childhood presents a window of opportunity for promoting EF, which lays a foundation for adaptive behavior in later life. As children are the parents of the future, it is important to stimulate EF during childhood and thereby support later adaptive parenting skills.

To gain a better understanding of parental susceptibility to intervention efforts, it is important to examine factors that may moderate and/or mediate intervention efficacy. Potential moderators of intervention efficacy deserve attention, including parents' willingness to participate (Baydar et al., 2003; Spoth et al., 1998), initial problem severity (Hautmann et al., 2010; Leijten et al., 2013), clinical characteristics of the sample (Weisz et al., 2005) and parental psychiatric difficulties, which may be associated with both poor inhibitory control and parenting difficulties (Cotter et al., 2018; Rock et al., 2014).

Naturally, future studies should include samples large enough to detect behavioral effects (Taborsky, 2010). Although our within-subject design is more powerful than between-subject designs (Thompson-Campbell, 2004), our sample was relatively small and power not high. It is important to mention the more convincing results of Euser et al (2021) on intervention effects within the larger LCID sample ($n = 202$), showing positive gains in parents' sensitive disciplining behavior. Recruitment deserves attention as well, as the motivation to participate in the intervention was not clinically oriented (e.g., community samples with a quest for support or as an obligatory part of a larger support program), but involved a willingness to contribute to science. The latter is likely to attract a highly educated

sample, known for higher levels of parental investment, which limits the generalizability of our findings.

The RCT design including pre- and post-intervention assessments is a strength of the current study as it is the gold standard for capturing intervention effects and allows for causal inferences. In addition, the current study followed the most recent methodological recommendations in task design and calculation of the inhibitory control measure. Moreover, our protocol was registered at the start of the study, limiting publication bias and the number of researcher degrees of freedom (Simmons et al., 2011).

5 | CONCLUSIONS

The identification of factors that contribute to the successful implementation of parenting interventions has received increasing attention over the past years (Fisher & Skowron, 2017). The current study adds to the literature by examining intervention effects in twin families. We found no evidence for mediation of improvements in sensitive discipline after the VIPP-SD by improved inhibitory control. In contrast, we did not observe an increase in sensitive discipline and the VIPP-SD seemed to interfere with normative (time/practice-related) improvements in inhibitory control. We speculate that the complexity involved in the cognitive restructuring of parenting schemas induced by the VIPP-SD may be at the heart of our findings. Although the design of the current study has several methodological strengths, we strongly emphasize the need for replication and extension of our study among large and diverse samples of families who participate in a parenting intervention that aims to improve parenting practices, including the larger L-CID cohort. Our findings challenge the view that parenting interventions produce "simple" gains in inhibitory control (or other cognitive processes) and parental behavior across all types of families. Future studies should include a focus on the role of initial problem severity, as well as factors that contribute to intervention engagement, to enable firm conclusions about the direction of effects and mechanisms of expected change.

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DISCLOSURE STATEMENT

The authors report no conflicts of interests.

ETHICS APPROVAL AND PATIENT CONTENT STATEMENT

The Central Committee on Research Involving Human Subjects in the Netherlands (NL49069.000.14) approved the research protocol. During the first assessment, written informed consent for all aspects of the study was obtained from the participants.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request. All experiments reported here were preregistered.

PERMISSION TO REPRODUCE MATERIAL FROM OTHER SOURCES

Not applicable.

ORCID

Laura Kolijn https://orcid.org/0000-0003-3479-1958
Bianca G. van den Bulk https://orcid.org/0000-0001-9885-0967
Marinus H. van IJzendoorn https://orcid.org/0000-0003-1144-454X
Marian J. Bakermans-Kranenburg https://orcid.org/0000-0001-7763-0711
Rens Huffmeijer https://orcid.org/0000-0002-7732-5175

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