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Review

Sensitive responsiveness in expectant and new fathers

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Abstract

Fathers have an increasingly important role in the family and contribute through their sensitive responsiveness to positive child development. Research on parenting more often included fathers as caregivers in the past two decades. We present a neurobiological model of sensitive responsive parenting with a role for fathers' hormonal levels and neural connectivity and processing of infant signals. We tested this model in a research program ("*Father Trials*") with correlational and randomized experimental studies, and we review the results of these studies. So far, interaction-focused behavioral interventions seem most promising in supporting fathers' sensitive responsiveness, even though the mechanisms are still uncharted.

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Fathers in the picture[1]

Fathers' involvement in raising their children has significantly increased in Western, industrialized nations. In 1970, fathers in four such countries (Belgium, France, the German Democratic Republic, and the United States) worked an average of 50.5 h per week outside the home and spent only 11.8 min per day on child care during workdays, which doubled to 25.3 min on the weekends [1]. Men began to take on more active roles in child care between 1970 and 1980. One generation later, fathers in five countries (Australia, Denmark, France, Italy, and the United States) spent an average of 34.5 h per week on paid work and dedicated an average of 1.2 h per day to child care on both weekdays and weekends, a three-to six-fold increase compared to their fathers' involvement [2,3]. Societal changes thus demonstrate the influence of the societal context: increased free time and mothers' participation in the labor force provided opportunities for more father–child interaction.

Sensitive responsive parenting

Sensitivity predicts infant attachment in mothers and fathers

Sensitive responsiveness (or: sensitivity) is defined as the ability to perceive and interpret the child's signals and communications accurately and given this understanding, to respond to them appropriately and promptly [4]. Maternal sensitive responsiveness is a replicated predictor of infant attachment security, that is, the extent to which the infant uses the parent as a secure base from which to explore the environment and as a safe haven to turn to in times of distress. The most recent meta-analysis shows an effect size of $r = .26$, based on 159 studies with in total $N = 21{,}483$ mother-child dyads [5]. The number of studies on fathers was only 22 ($N = 1626$), illustrating their minority (but upcoming) role in parenting research. The effect size was similar, $r = .21$.

An earlier meta-analysis including 16 studies had shown weaker associations between fathers' sensitivity and infant-father attachment, $r = .12$ [6]. In the recent one, associations for fathers were stronger with the increasing age of their children [5]. These findings suggest increased father involvement in recent years and with older children. Increased involvement may in turn lead to stronger predictions of father–child interactions for attachment quality.

[1] Since this paper includes sections on the neurobiology of parenting, which is not necessarily the same for men and women, 'fathers' in this article refers to men with male sex and primary or secondary caregiver roles.

Sensitivity predicts various other developmental outcomes

Parental sensitivity also predicts other child outcomes in the social and cognitive domains. Sensitive caregiving is meta-analytically related to less child internalizing (anxious, depressed) ($r = -.08$) and externalizing ($r = -.14$) behavior problems, with no difference between the predictive power of mothers' and fathers' sensitive parenting [7]. It is related to better language development [8], executive functioning [9], and school achievement [10]. In a population-based cohort study, higher levels of parental sensitivity in early childhood were associated with larger total brain volume and grey matter volume, markers of more optimal brain development, when children were eight years old. Associations were similar for fathers' and mothers' sensitivity [11], suggesting an important role of both fathers and mothers in child brain development.

Differences in sensitivity between mothers and fathers

Studies observing sensitivity in both mothers and fathers sometimes report similar levels of sensitivity (e.g., Ref. [12]), but more often document differences, with mothers rated higher. The differences between fathers' and mothers' sensitivity can be substantial (e.g., Refs. [13,14]). In line with a similar strength of the association between sensitivity and attachment in mothers and fathers, lower levels of sensitivity in fathers translate into lower infant-father attachment security in studies that measured attachment in the same children with both their mothers and fathers (for a meta-analysis, see Ref. [15]). This finding also indicates that the instrument for observing sensitivity in mothers is not less valid when used with fathers.

Enhancing fathers' sensitivity?

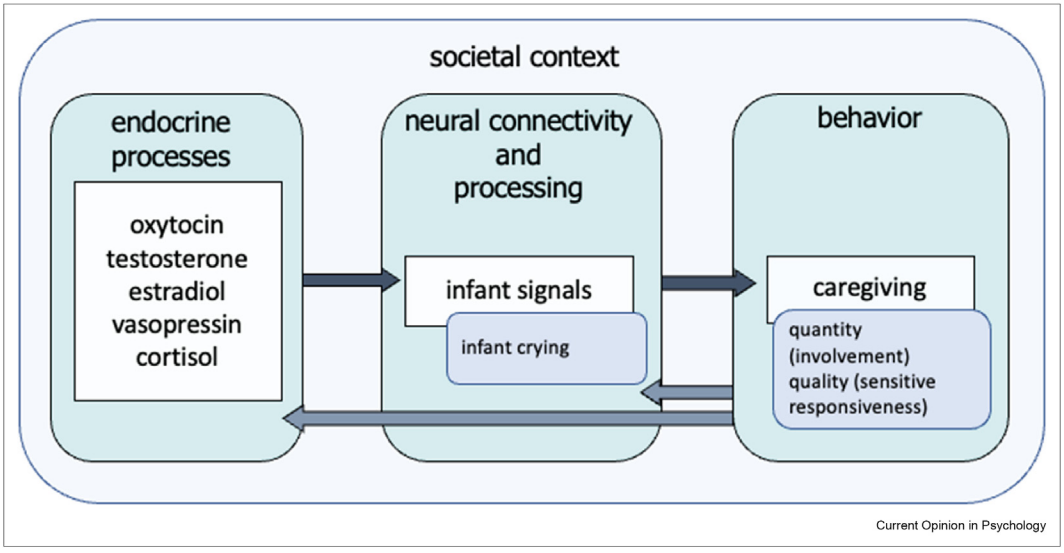
Given the predictive power of caregiver sensitivity for child developmental outcomes in many domains, and increased involvement of fathers in caregiving over the years, stimulating paternal sensitivity deserves our attention. Nevertheless, intervention studies aiming at promoting sensitive responsiveness, especially in the first years of the child's life, usually target mothers rather than fathers. This is no wonder; including fathers in (intervention) studies requires creativity to reach them and flexibility to adapt sessions to their availability [16,17]. As a result, studies on fathers tend to have modest sample sizes, and need replication before strong conclusions can be drawn. With this caveat in mind, we review our studies on a neurobiological model of sensitive responsive parenting in fathers (Figure 1), including correlational studies on the neurobiology of fathering (that may help or hamper sensitive father–child interaction) and randomized controlled trials aiming at increasing fathers' sensitivity.

The neurobiology of fathering

Neural processing of infant signals

Sensitive responsiveness starts with the perception of the child's signals. Because infant crying is a crucial attachment signal, often calling for parental action, neural reactivity in response to infant cry sounds has been measured in various studies as a way to examine a prerequisite of caregiver sensitivity. A meta-analytic combination of these studies (total $N = 350$) showed that when exposed to infant cry sounds, parents more than non-parents engage a cortico-limbic sensorimotor integration network that may promote efficient processing and emotional responding to infant cries.

Figure 1



A neurobiological model of sensitive responsive parenting, taking the societal context into account.

Controlling for parenthood, men more than women show activation in brain regions related to semantic processing, supporting cognitive (mentalizing) activity, whereas women preferentially recruit a circuit extracting emotionally relevant information from the cry sound [18]. Stated boldly, men's brain responses to infant crying move in the direction of women's once they become fathers. Importantly, brain functioning may be *dependent on* parenting involvement, rather than *determining* parenting behavior (see Figure 1). We found that in first-time fathers with a 2-month-old infant, time spent in childcare was positively related to amygdala connectivity with the supramarginal gyrus, postcentral gyrus, and the superior parietal lobule—regions within the mentalizing network associated with empathy and social cognition [19].

Parenting-related hormones

Neural reactivity and connectivity may change under the influence of hormonal changes. Such changes are evident for women in the perinatal period, but have also been reported for men [20,21]. The most replicated finding is that fathers have lower testosterone levels than non-fathers [22], although only a few studies in this meta-analysis had longitudinal designs. In our own study, hormone levels assessed in first-time fathers at 24 weeks of pregnancy and 10 weeks after birth showed a drop in testosterone and vasopressin, somewhat lower cortisol and slightly higher oxytocin levels at the postnatal assessment, and no changes in estradiol [20].

Exploratory analyses revealed that in fathers with high estradiol levels, higher postnatal testosterone was associated with lower sensitivity in interaction with their newborn. Higher testosterone had been found meta-analytically related to lower parenting quality, but the interplay with estradiol needs explanation. In animal studies, paternal behavior is suggested to be promoted by the aromatization of testosterone into estradiol. The combination of low testosterone and high estradiol would be associated with paternal sensitivity. It might be that at two months postpartum some new fathers are still in the transition to higher levels of estradiol (through aromatase of testosterone) supporting paternal sensitivity [20].

No association between sensitive responsiveness and oxytocin was found [20]. A recent review shows mixed results for the association between oxytocin and sensitivity in fathers [23]. In two within-subject randomized controlled studies, we found that oxytocin administration stimulated fathers' sensitive play with their toddlers [24,25]. However, this finding was not replicated in a recent study on fathers with infants [26]. Meta-analytic evidence suggests that the effects of oxytocin administration may be dependent on fathers' early childhood experiences. In individuals with more childhood adversity positive responses to intranasally administered oxytocin tend to be smaller or absent (combined effect size $r = .01$) compared to individuals with less childhood adversity ($r = .12$) [27].

Hormonal effects on neural processing of infant signals

Interestingly, we do find a rather consistent effect of oxytocin administration on parenting-related neural reactivity to infant crying in the amygdala. Oxytocin decreases activation in the amygdala, a brain region involved in fear and threat detection, in fathers [28] and mothers [29]. Others have found increased neural responses in fathers in brain regions involved in reward, empathy, and attention when viewing pictures of their toddlers after nasal administration of oxytocin [30]. These findings suggest that oxytocin may pave the neural way for sensitive responsiveness. Yet, the brain-behavior gap seems to prevent consistent findings on fathers' parenting behavior. The more eye-catching neural effects compared to behavioral effects may also reflect false positive and/or negative findings, a genuine risk in these mostly small-sample studies. More research on larger samples is needed, preferably with standardized paradigms and accessible data, enabling individual participant data (IPD) meta-analysis [31].

Randomized controlled interventions

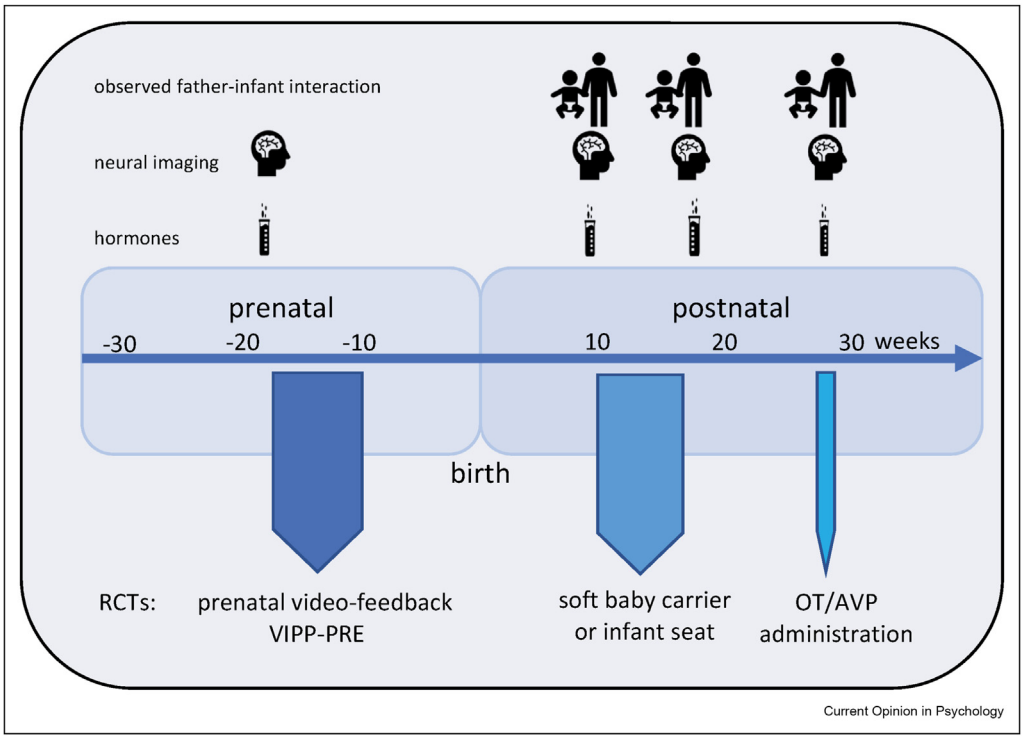
Testing the neurobehavioral model of fathering

In "Father Trials", a series of randomized controlled trials (RCTs), we tested our model of sensitive fathering with hormonal and behavioral interventions in three different RCTs with non-overlapping samples (Figure 2). In the hormone intervention study, we administered oxytocin and vasopressin, a hormone that has been found to promote attention to infant stimuli, and suggested to be particularly relevant to paternal behavior based on animal studies [2,20]. We tested the immediate effects on fathers' neural processing of infant signals and their behavior with their young infants. In one behavioral intervention, first-time fathers with a two-month-old infant received either a soft baby carrier or an infant seat, and were instructed to use the tool frequently for three weeks, and as much as they liked for another four months. In the other intervention, we adapted the Video-feedback Intervention to promote Positive Parenting (VIPP, [32]) for prenatal use with fathers, using ultrasound imaging to visualize the baby between the 21st and 32nd week of pregnancy. Did these interventions affect fathers' parenting?

Effects of increasing oxytocin and vasopressin levels

Sniffing oxytocin or vasopressin did not lead to more sensitive responsiveness — in fathers with adverse childhood experiences it even led to somewhat lower

Figure 2



Father Trials: A series of randomized controlled trials (RCTs) with behavioral and hormonal interventions.

paternal sensitivity [26], in line with meta-analytic findings [27]. In spite of the effects on the neural processing of infant signals that were found for both oxytocin and vasopressin administration [28], we must conclude that the evidence for behavioral effects of a sniff is insufficient to support the use of nasal sprays with oxytocin or vasopressin in the hope of promoting parents' sensitive responsiveness.

Effects of baby carrying

The use of a soft baby carrier, a device that had successfully enhanced mothers' responsiveness in a study funded by the baby carrier company [33], did not bring about the same effect in fathers [34]. Although the amount of time fathers used the baby carrier was positively associated with fathers' sensitivity after the intervention (r = .29), the carrier group did not differ from the control group.

One explanation may be the relatively brief intervention period. In consultation with expert baby carrier consultants, fathers were asked to use the carrier for three weeks, for at least 6 h per week, spread over a minimum of four days. Unfortunately, many fathers used it less often; average use was 4–5 h in the first week, and 3.5 h in the second and third weeks. Longer and/or more intensive use of a soft baby carrier may be more effective in promoting fathers' sensitive responsiveness.

An alternative explanation is that interaction-focused interventions directly aiming at adequate responses to infant signals are needed to promote paternal sensitivity. A promising result from the baby carrier intervention is that it affected neural responses to infant crying, especially in fathers with experiences of childhood abuse, who tend to show hypo-reactivity to infant signals. For this group, using a baby carrier may support the accurate perception of infant signals [35]. The intervention did not affect fathers' oxytocin or cortisol levels.

Effects of prenatal video feedback

In three sessions of the Video-Feedback Intervention to Promote Positive Parenting - Prenatal (VIPP-PRE), fathers were invited to interact with the unborn infant by softly massaging the mother's abdominal wall, talking, and singing to the infant. The infant was made visible through ultrasound, and the intervener supported the interaction by "speaking for the baby". In the second and third sessions, the intervener reviewed the recordings of the previous session together with the father,

pausing at relevant moments to comment on the video fragments, with the aim of promoting fathers' sensitivity [36,37]. Fathers in the control group received three phone calls, asking about their experiences and thoughts regarding the pregnancy. In both groups, information on the developmental stage of the fetus was provided.

Fathers in the VIPP-PRE group showed more sensitive responsiveness in the interaction with their child at 2 months after birth [38]. The intervention did not affect fathers' oxytocin or cortisol levels, but impacted fathers' testosterone levels between pre-test and post-test, in that they increased in the control group but decreased in the VIPP-PRE group [39]. Lower testosterone levels in fathers have been found meta-analytically related to higher parenting quality [22].

Conclusions

In sum, fathers' involvement in childcare has substantially increased in the past decades, and their sensitive responsiveness is predictive of positive child developmental outcomes in the cognitive and socio-emotional domains. Correlational studies have documented associations between fathers' hormones, behavior, and brain functioning, but do not (yet) add up to a straightforward model as in Figure 1. The reality may be that the components of the model are multidimensional and interact in complex ways not covered by current research designs and measures.

So far only interaction-focused behavioral interventions seem promising in supporting fathers' sensitive responsiveness, even though the mechanisms are still uncharted. Manipulating hormonal levels (e.g., a sniff of oxytocin) produces diverging results, possibly depending on parents' own childhood experiences or the myriad of interactions in the hormonal system [20]. Manipulating the brain, e.g. through transcutaneous vagus nerve (TVN) stimulation, has been used in non-parenting contexts [40], but does not seem a plausible approach to enhance sensitive parenting. Based on the current evidence, there is no quick and easy way to stimulate sensitive responsiveness in fathers — nor in mothers, for that matter. Promoting fathers' involvement in caregiving, supported by generous parental leave facilities and interaction-based parenting support, seems the safest way to move forward.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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