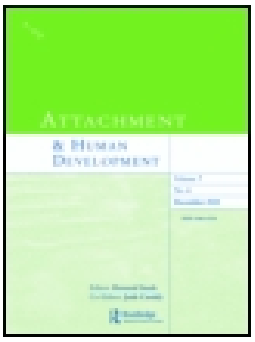

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Vasopressin and parental expressed emotion in the transition to fatherhood

Anna M. Lotz[a,b], Jolien Rijlaarsdam[c], Jurriaan Witteman[b,d], Willemijn Meijer[a], Kim van Dijk[a,b], Marinus H. van Ijzendoorn[e] and Marian J. Bakermans-Kranenburg[a,b]

[a]Clinical Child & Family Studies, Faculty of Behavioral and Movement Sciences, Vrije Universiteit, Amsterdam, the Netherlands; [b]Leiden Institute for Brain and Cognition, Leiden University Medical Center, Leiden, the Netherlands; [c]Department of Child and Adolescent Psychiatry/Psychology, Erasmus MC-University Medical Center Rotterdam, Rotterdam, the Netherlands; [d]Leiden University Centre for Linguistics, Leiden University, Leiden, The Netherlands; [e]Department of Psychology, Education and Child Studies, Erasmus University Rotterdam, Rotterdam, The Netherlands

ABSTRACT

In the last decades, parenting researchers increasingly focused on the role of fathers in child development. However, it is still largely unknown which factors contribute to fathers' beliefs about their child, which may be crucial in the transition to fatherhood. In the current randomized within-subject experiment, the effect of nasal administration of vasopressin (AVP) on both Five Minute Speech Sample-based (FMSS) expressed emotion and emotional content or prosody was explored in 25 prospectivefathers. Moreover, we explored how the transition to fatherhood affected these FMSS-based parameters, using prenatal and early postnatal measurements. Analyses revealed that FMSS-based expressed emotion and emotional content were correlated, but not affected by prenatal AVP administration. However,child's birth was associated with an increase in positivity and a decrease in emotional prosody, suggesting that the child's birth is more influential with regard to paternal thoughts and feelings than prenatal AVP administration.

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Five Minute Speech Sample; vasopressin; paternal sensitivity; emotional prosody

Parenting research has long focused on mothers and their role in child development. This is not surprising given that mothers are generally the primary caregivers within families (Cabrera, Tamis-Lemonda, Bradley, Hofferth, & Lamb, 2000). However, over the last decades a change in family life has occurred, with an increasing role for fathers in caregiving, as also reflected in research on fathers (see Cowan & Cowan, 2019, in a special issue of *Attachment and Human Development* on fathers; Cabrera et al., 2000). This is considered to be a positive development since paternal involvement and sensitivity, reflecting the quantity and quality of fathers' caregiving investments, contribute to positive development and well-being of the child (Barker, Iles, & Ramchandani, 2017; Brown, Mangelsdorf, & Neff, 2012; Cabrera et al., 2000; Pleck, 2012). Indeed, both paternal involvement and paternal sensitivity have been associated with father-child attachment security (Brown et al., 2012; Lucassen et al., 2011). In the current

CONTACT Marian J. Bakermans-Kranenburg m.j.bakermans@vu.nl Clinical Child & Family Studies, Faculty of Behavioral and Movement Sciences, Vrije Universiteit, Amsterdam, the Netherlands

study, we explore one of the factors that may influence paternal sensitivity and involvement, in particular in the period around the birth of the first child, namely fathers' thoughts and feelings regarding their child and their relationship with the child, using the Five Minute Speech Sample.

The transition to fatherhood is often perceived as a life-changing event. During the first few weeks to months after their child's birth, first-time fathers experience changes in the relationship with their partner, as well as difficulties in finding a new work–family balance. In addition, they may be confronted with their unrealistic expectations of fatherhood and frustrations about their paternal (in-)competence (e.g. Deave & Johnson, 2008; Genesoni & Tallandini, 2009; Goodman, 2005; May & Fletcher, 2013). Within this time-window, most new fathers have to adapt their ideas about fatherhood and consider what type of father they want to be. This regulation of paternal emotions, thoughts, and behaviors might facilitate or hamper an emotionally rewarding feeling when being with the child (Goodman, 2005).

The neuroendocrine system might be involved in the regulation of paternal behavior. In the past decades, neuroendocrine research has provided ample evidence that the parent–child interaction and caregiving behaviors are influenced by neuropeptides and hormones, including oxytocin (OT), vasopressin (AVP), testosterone (T), and prolactin (Prl) (e.g. Abraham & Feldman, 2018; Feldman & Bakermans-Kranenburg, 2017; Rilling & Mascaro, 2017). Although the vast majority of this work focused on mothers, there is evidence that hormonal levels are associated with paternal behavior and father–child interactions. More specifically, multiple studies have shown a relation between OT and typical paternal behavior observed during father–child interactions, such as responsive structuring and stimulatory touch (e.g. Feldman, Gordon, Schneiderman, Weisman, & Zagoory-Sharon, 2010; Naber, Poslawsky, Van Ijzendoorn, Van Engeland, & Bakermans-Kranenburg, 2013; Naber, van IJzendoorn, Deschamps, van Engeland, & Bakermans-Kranenburg, 2010). Furthermore, lower salivary T levels have been associated with increased participation of fathers in child care and quality of caregiving, both prenatally (Bos et al., 2018; Edelstein et al., 2017) and postnatally (Bos et al., 2018; Gettler, McDade, Feranil, & Kuzawa, 2011).

The neuroendocrine system might play a role in the transition to fatherhood as well. Although the hormonal changes in fathers during pregnancy are not as pronounced as those of mothers, Prl was found to increase in first-time fathers during the course of pregnancy (Storey, Walsh, Quinton, & Wynne-Edwards, 2000), T was found to decrease during pregnancy and thereafter (Edelstein et al., 2015; Storey et al., 2000), and was reported to remain significantly lower during fatherhood (Gettler et al., 2011). As suggested by Bos (2017), inter-individual variation in the endocrine system may be related to variability in parenting style, due to variation in peripheral and central hormone levels and variation in the sensitivity of the brain and peripheral nodes of endocrine axes for these hormones. Most endocrine research has focused on OT and T, and the potential role of AVP has been somewhat neglected. To address this gap in the literature, the current study focused on the role of AVP in first-time fathers.

Research in non-monogamous and biparental mammals indicates that AVP is involved in the development of paternal behavior. For example, the central administration of AVP in non-monogamous male meadow voles that were pup-unresponsive activated paternal behavior (Parker & Lee, 2001). Furthermore, in biparental male prairie voles, AVP injections in the lateral septum dose-dependently increased paternal behavior while AVP-induced paternal behavior decreased after blocking the $V1_a$ receptor with an antagonist (Wang, Ferris, & De Vries, 1994). Moreover, in both male and female prairie voles, an increase of AVP mRNA was observed after birth of offspring (Wang, Liu, Young, & Insel, 2000). In humans, there is evidence that AVP is involved in paternal behavior, as well. Apter-Levi, Zagoory-Sharon, and Feldman (2014) showed that plasma AVP was positively related to observed stimulatory contact in parent–child interactions for both mothers and fathers (Apter-Levi et al., 2014). However, in a sample of fathers Atzil, Hendler, Zagoory-Sharon, Winetraub, and Feldman (2012) observed a negative relation between plasma AVP and brain areas involved in empathy and social cognition in response to short video clips of own infant versus an unfamiliar infant. In the same vein, Abraham et al. (2017) found that AVP might be associated with a negative co-parenting style. Thus, AVP has not always been shown to support sensitive (co-)parenting.

Nevertheless, experimental manipulation of AVP levels through nasal administration revealed that AVP might promote orientation towards babies (Cohen-Bendahan, Beijers, van Doornen, & de Weerth, 2015) and is involved in the processing of auditory infant stimuli (Thijssen et al., 2018) in first-time fathers-to-be. Furthermore, it might be suggested that AVP is involved in distinguishing between own and unknown infant (Alyousefi-van Dijk et al., 2019). Interestingly, no effect of AVP administration was observed in the neural response to infant stimuli in fathers of toddlers (Li, Chen, Mascaro, Haroon, & Rilling, 2017). It may thus be the case that AVP is particularly relevant during the transition to parenthood (Alyousefi-van Dijk et al., 2019).

Parental sensitivity, defined as the parent's ability to perceive, to adequately interpret and to react to infants' signals in an accurate way (Ainsworth, Bell, & Stayton, 1974), is usually studied during parent-infant interactions. Obviously, alternative approaches should be considered when investigating dimensions of parenting in prospective first-time fathers, who are transitioning to parenthood. When parenting sensitivity cannot easily be assessed because of the absence of a baby, parental thoughts and feelings about their child and about the relationship with their child may be relevant. One of the possibilities to measure these is the Five Minute Speech Sample (FMSS), which has been adapted for use with expectant fathers (Lambregtse-van den Berg et al., 2013). Originally, the FMSS had been developed by Magaña et al. (1986) as a psychiatric research tool; relatives of psychiatric patients were interviewed to assess the quality of their relationships with the patient and relatives' feelings about the patient (Magaña et al., 1986; Vaughn & Leff, 1976). During the last decades, the FMSS has been adapted for parenting research and implemented in the field of parenting and developmental research, both focusing on healthy families and families in which the parent or child suffers from a psychiatric disorder (Weston, Hawes, & Pasalich, 2017). Parents are asked to respond to one or two general questions and to talk for 5 min about their future or current child and the relationship with their child. The overall outcome of the assessment is referred to as Expressed Emotion (EE), indicating positive and negative thoughts and feelings about the child and the relationship with the child. Some previous research indicate that EE might be associated with the quality of parent–child relationship and the wellbeing of the child (Sher-Censor, 2015). For example, it has been shown that parental EE and the constituting constructs, criticism (CRIT) and emotional over-involvement (EOI) are associated with the child's lower emotional and physical well-being (reviewed by Sher-Censor, 2015). One study found a significant link between mothers' EE and children's disorganized attachment at 6 years of age (Jacobsen, Hibbs, & Ziegenhain, 2000), but another study failed to find such an association (Gravener et al., 2012).

Furthermore, positive and negative associations are found between the EE and observed positive and negative parenting, respectively (Weston et al., 2017). Moreover, it has been shown that the FMSS coding system can be used for prenatal assessments (Lambregtse-van den Berg et al., 2013), and that prenatal EE might predict postnatal parental sensitivity of both mothers and fathers, up to several years after birth (Lucassen et al., 2015).

Hormones in general, and AVP in particular, might influence the emotional content of parental descriptions of their child (i.e. *what* they are saying, also called emotional semantics) as well as *how* parents talk about their offspring (i.e. emotional prosody). Given the rapid developments in computerized text analysis in the past 20 years, automatic computer coding of the FMSS recordings might reveal response patterns that are meaningfully related to respondent's FMSS-based expressed emotion, as coded by trained raters. Such automatic coding enables sentiment analysis, with ratings for subjectivity (objective vs subjective) and polarity (positive vs negative) of the content of the text in a standardized manner. In addition to content analysis, automatic coding can be used to determine the emotional prosody of the responses. Previous research has shown that emotional prosody is expressed acoustically primarily in fundamental frequency, the energy distribution of the frequency spectrum, and the temporal domain (Banse & Scherer, 1996). For example, it has been shown that the fundamental frequency is higher in recordings characterized by anger, fear, and joy, while it is lower in recordings characterized by sadness (Pittam & Scherer, 1993). Thus, automatic coding may provide additional information about the FMSS.

The current study aims to explore (i) the extent to which coder-rated expressed emotion and computer-coded emotional content are associated, (ii) the effect of AVP administration on FMSS-based expressed emotion, emotional content, and emotional prosody, and (iii) the effect of the transition to fatherhood on FMSS-based expressed emotion, emotional content, and emotional prosody. Concerning the first question, we speculate that ratings by human coders and computer-coded variables will be (at least partly) associated because polarity, positive comments, and critical comments are all based on indicators of positivity and negativity in the speech sample. Due to the absence of research on the role of AVP or the baby's birth in fathers' speech about their baby, no a priori hypotheses are presented for the effects of AVP and the transition to fatherhood on the FMSS variables.

Methods

Participants

Twenty-five prospective fathers participated in the study. They were recruited through midwives and ads on Leiden University affiliated webpages. All participants cohabitated with their pregnant partners, spoke Dutch fluently, were in good physical and mental health (i.e. had no psychiatric, neuroendocrine, or neurological diagnosis), and had no significant intake of alcohol or drugs. At the time of the first assessment, the mean age of the participants was 31.92 years ($SD = 4.30$) and educational levels were high, with 80% of the fathers having obtained a higher education degree, and 20% having completed only secondary school. The mean gestational age of the unborn infants was 27.02 weeks ($SD = 4.91$) at the time of the first assessment. At the time of the postnatal assessment ($n = 20$), 29 weeks ($SD = 5.27$) after the first assessment, the mean age of the infants was 15.66 weeks (SD = 2.36). Average birth weight of the child was 3586.30 g and reported health of the child was very good; with 90% reported as excellent or very good, 5% reported as good, and 5% reported as moderate. All children except one were born full-term, one child was born after 36 weeks gestational age. Fifteen infants were male, nine were female, and the sex of one infant was not reported. The study was approved by the Ethics Committees of the Institute of Education and Child Studies at Leiden University and the Leiden University Medical Centre, as well as the Central Committee on Research Involving Human Subjects. All participants signed informed consent.

Procedure

Participants were invited for two assessments during the pregnancy (n = 25), with an intervening period of 7 days, and a follow-up assessment after birth (n = 20). All assessments took place at the Leiden University Medical Centre (LUMC). Briefly, each assessment consisted of three parts: 1. nasal spray administration; 2. neural measures with (f)MRI; and 3. behavioral measures, including the Five Minute Speech Sample (FMSS). More detailed descriptions about the other measures can be found elsewhere (Thijssen et al., 2018; van 't Veer, Thijssen, Witteman, van IJzendoorn, & Bakermans-Kranenburg, 2019). Following all assessments, participants completed some online and e-diary questionnaires at home.

During the first two assessments, participants self-administered a dose of either 20 IU vasopressin (AVP, Vasostrict, Par Pharmaceutical) or a placebo (PL, Chlorobutanol, LUMC pharmacy) using Syringe MAD-nasal devices (Teleflex, Morrisville), with equal distribution across both nostrils, under supervision of a research assistant. The order of receiving either AVP or PL nasal sprays during the first and second assessments was counterbalanced and unknown to both participant and researchers. During the follow-up (postnatal) assessment, all participants self-administered a placebo. The average time between the administration of the nasal spray and the FMSS was 155 min (*SD* = 10) for PL, 154 min (*SD* = 8) for AVP, and 153 min (*SD* = 9) in the postnatal assessment.

Measures

Five Minute Speech Sample (FMSS). We used an adaptation of the original FMSS paradigm (Daley, Sonuga-Barke, & Thompson, 2003; Lambregtse-van den Berg et al., 2013; Magaña et al., 1986). Participants were instructed to talk for 5 min about their unborn child (first two visits) and their newborn child (third visit); "What do you hope or expect your child will be like and how would you like to relate to your child?". To prevent prolonged silences, we asked an additional question 3 min later: "What do you think it will be like when your child has grown up?". Recordings were performed using a TASCAM DR-05 digital recorder (TASCAM, division of TEAC America, Montebello California) at 16-bit resolution and a 44.1 khz sampling rate. The recordings were subsequently transcribed using PRAAT software (Boersma & Weenink, 2018) for automated acoustic and text analysis as well as manual coding of content. A random sample of 12% of the prenatal transcripts was transcribed by two raters, allowing for an automatic inter-rater reliability analysis using the F1 metric, the harmonic mean of recall and precision ranging between 0 and 1, after each pair of transcripts was aligned using the Needleman-Wunsch algorithm. This procedure was performed initially on a selection of transcripts to improve the transcription protocol and for the final reliability analysis (Garrard, Haigh, & de Jager, 2011). The inter-rater reliability of FMSS transcripts as measured with the mean F1 metric was .77, which is adequate (Garrard et al., 2011). A third rater was trained to transcribe the postnatal recordings. Two transcripts were manually compared with the transcripts of the two other raters and showed adequate reliability.

To score FMSS-based expressed emotions, two FMSS coding manuals developed for prospective parents (Lambregtse-van den Berg et al., 2013) and new parents (Daley et al., 2003) were combined to match our study population of fathers in the transition to parenthood. The resulting coding system consisted of six scales: initial statement, warmth (with three subscales, tone of voice, spontaneity, and concern & empathy), relationship, emotional over-involvement, critical comments, and positive comments. For critical comments as well as positive comments, the frequencies were coded. Critical comments were scored when high expectations were set, e.g. "I hope my child will be very smart and athletic, otherwise, I would be very disappointed." Positive comments were coded when the participant talked about his child with praise, approval, or appreciation, e.g. "I will love my child whatever it will be like." The other scales were rated on 3-point rating scales as either 1 = low, 2 = moderate, 3 = high (or 1 = negative, 2 = neutral, 3 = positive).

High Expressed Emotion (EE) was scored when at least one of the following scales was rated as 1 (negative or low): initial statement, warmth, relationship, and emotional over-involvement, *and* more critical comments than positive comments were observed. A borderline EE score was assigned if only one of these two criteria was met. Raters were trained by two of the authors (JR, AL) and inter-rater reliability was assessed based on 10 transcripts. Following previous research inter-rater reliability was assessed based on the EE scores; however, due to limited variation in EE scores no ICC could be calculated. We additionally assessed the coding reliability for each of the six scales. Only for positive comments and critical comments, adequate reliabilities were achieved (positive: ICC ≥ .89; critical: ICC ≥ .60). Although the low ICCs may be attributable to a low number of speech samples in the training set or limited variance in scores, we took a conservative approach by only analyzing the number of positive and critical comments. In case of disagreement, consensus scores were used in further analyses.

To score FMSS-based emotional content and prosody, the emotional content and the acoustic parameters reflecting emotional prosody of the FMSS were analyzed using automated analyses with python and PRAAT, respectively. Firstly, using the sentiment analysis module of the PATTERN package (De Smedt & Daelemans, 2012) the polarity score and the subjectivity score of each text were calculated. Polarity scores were calculated by matching content words against a dictionary containing positivity ratings of each word and subsequently standardizing the total score between −1, indicating a maximally negative content of the text, and +1, indicating a maximally positive content of the text. Subjectivity scores were calculated based on the total number and degree of subjectivity of each word (matched against a dictionary with subjectivity scores for each adjective as rated by human raters) and standardized between 0 and 1. For example, the phrase "He will join the soccer team" would be rated low on subjectivity, whereas the phrase "I would find it amazing when he would join the soccer team" would be assigned a high subjectivity score. One subject yielded a total word count of <100 for the PL condition and was excluded from the emotional content analysis since low word count may compromise the reliability of the polarity and subjectivity scores.

Furthermore, acoustic parameters implicated in emotional prosody (Banse & Scherer, 1996) were analyzed for each total FMSS recording (excluding silences, noise, and utterances produced by the interviewer). Acoustic parameters included the median of fundamental frequency (F_0), the standard deviation of F_0, the median of the first formant (F_1), the standard deviation of intensity, spectral slope, and speaking rate (number of words per minute). Fundamental frequency corresponds perceptively to pitch, while the first overtone (formant) corresponds to openness of the mouth. Spectral slope (the degree of attenuation of larger frequencies) corresponds perceptively to "timbre" of the voice, and intensity to loudness.

Covariates

We assessed potentially confounding effects of the current mood of the participants, as assessed by the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). Participants filled in this questionnaire on average 36 min before the start of the FMSS (PL: $\Delta t = 36$ min, $SD = 4$ min; AVP: $\Delta t = 36$ min, $SD = 3$ min; postnatal assessment: $\Delta t = 31$ min, $SD = 3$ min). Internal consistency of the positive (POS) and negative (NEG) scales were adequate to high in all conditions (Placebo POS $M = 31.96$, $SD = 7.52$, $\alpha = .92$; NEG $M = 13.32$, $SD = 2.98$, $\alpha = .66$; AVP POS $M = 32.04$, $SD = 6.56$, $\alpha = .88$; NEG $M = 13.96$, $SD = 3.63$, $\alpha = .71$; postnatal assessment POS $M = 29.55$, $SD = 6.70$, $\alpha = .88$; NEG $M = 14.95$, $SD = 3.53$, $\alpha = .66$). Participant mood was not affected by AVP administration (POS AVP vs PL: $Z = -0.07$, $p = .95$; NEG AVP vs PL: $Z = -0.55$, $p = .65$) or birth (POS PL vs post: $Z = -1.81$, $p = .07$; NEG PL vs post: $Z = -1.36$, $p = .19$). Moreover, as shown in Table 1, positive comments and critical comments were not related to positive and negative affect scores in all three conditions. Therefore, the current mood of the participant was not taken into account as a covariate in the main analyses.

Statistical analysis

The analyses is proceeded in four steps. In the first step, we examined possible relations between demographic variables and FMSS-based expressed emotion (positive comments, critical comments), emotional content (i.e. subjectivity, polarity) and emotional prosody variables. Furthermore, associations between FMSS-based expressed emotion and current mood status were examined. For correlations with demographic variables, both parametric and non-parametric tests were performed since the sample size was relatively small and not all variables met the normality assumption. Pearson correlations are reported when Spearman correlations revealed the same outcome. These analyses were performed using data from the PL condition. Differences in emotional status and talkativeness related to AVP administration or the birth experience were examined with

Table 1. Spearman correlations between the Five Minute Speech Sample variables and Positive and Negative Affect Schedule (PANAS) measured in the placebo, vasopressin, and postnatal condition.

FMSS	Positive affect PL	Negative affect PL	Positive affect AVP	Negative affect AVP	Positive affect post	Negative affect post
Positive comments	.01	.15	−.18	−.18	−.01	−.19
Critical comments	.01	.33	−.13	−.01	−.08	.15

separate Wilcoxon Matched-Pairs Tests. Possible correlations for positive comments and critical comments across the two prenatal assessments were calculated with both Pearson and Spearman correlations. Pearson correlations are reported when Spearman correlations revealed the same value. In the second step, we tested the extent to which coder-rated expressed emotion and computer-coded emotional content were associated, checking both Pearson and Spearman correlations. In the third step, we examined the effect of AVP administration on the FMSS variables. Effects on positive comments, critical comments, and emotional content were examined using Wilcoxon matched-pairs tests. Although the distribution of emotional content met the parametric assumptions, we report non-parametric tests to enable a comparison with the positive comment and critical comment variables. The effect of AVP administration on emotional prosody was analyzed using multivariate repeated measures ANOVA with AVP as within-subjects factor and the acoustic parameters as dependent variables. In the final step, we explored the effect of the transition to fatherhood on both FMSS-based expressed emotion and emotional content. Similar analyses as described in step three were performed, only for the multivariate repeated measures ANOVA prenatal and postnatal measures were chosen as within-subjects factor.

All analyses were carried out with the software IBM SPSS Statistics version 23. Given the explorative nature of the study, we used non-corrected significance levels of $p < 0.05$, and two-way exact p-values are reported for all Wilcoxon matched-pair tests.

Results

Descriptive statistics

To assess possible associations with demographic variables and current mood, bivariate correlations were performed. In the PL condition, correlations of FMSS-based expressed emotion (positive comments, critical comments) and emotional content (i.e. subjectivity, polarity) and emotional prosody variables with demographic variables were small to moderate in magnitude (see Table 2). Paternal age was negatively correlated to subjectivity, and positively correlated to F_0 SD and spectral slope. The age of the child at the postnatal assessment was positively correlated to the father's subjectivity as assessed in the FMSS. The total number of words spoken in the FMSS was not affected by AVP administration or birth (effect of hormone: $Z = -0.07$, $p = .96$; effect of birth: $Z = -0.24$, $p = .82$), and not taken into account in further analyses. The correlations for positive and critical comments at the two prenatal assessments were $r = .23$ ($p = .28$) and $r = .54$ ($p < .01$), respectively.

Associations between expressed emotion and emotional content

The number of positive comments was positively related to polarity ($r = .32$, $p = .13$; $r_s = .45$, $p = .03$) and subjectivity ($r = .48$, $p = .02$) in the placebo condition. The number of critical comments was negatively related to polarity ($r = -.45$, $p = .03$) and subjectivity ($r = -.47$, $p = .02$). These correlations did not remain significant after AVP administration for positive comments (polarity: $r = .31$, $p = .14$; subjectivity: $r = -.04$, $p = .86$) and critical comments (polarity: $r = -.01$, $p = .97$; subjectivity: $r = .21$, $p = .34$). Spearman correlations did not

Table 2. Pearson correlations between the Five Minute Speech Sample variables measured in the placebo prenatal and postnatal condition and demographics.

FMSS	Age	Education	Pregnancy duration	Age of child
Positive comments	−.05	.23	−.22	.35
Critical comments	.27	.20	.36	.16
Subjectivity	−.41*	−.01	−.18	.63**
Polarity	−.29	−.09	−.14	.25
Intensity SD	−.04	−.15	.20	−.06
F0 median	−.34	.13	−.21	.20
F0 SD	.46*	.10	.28	.09
F1 median	−.35	−.04	−.17	.13
Spectral slope	.56**	.20	−.09	−.27
Speak rate	.03	.35	−.22	−.11

Correlations between FMSS variables and participant age, education, and pregnancy duration in the prenatal placebo condition, and age of child in the postnatal session. Spearman correlations did not differ from the Pearson correlations shown above. *p < 0.05, **p < 0.01.

significantly differ from Pearson correlations, except for the association between positive comments and polarity (as shown above).

The influence of AVP

As shown in Table 3, analyses revealed that the numbers of positive comments ($Z = -1.37$, $p = .18$, $d = 0.34$) and critical comments ($Z = -1.33$, $p = .20$, $d = 0.25$) in the speech sample were not affected by administration of AVP. Moreover, hormone administration had no effect on polarity ($Z = -1.06$, $p = .30$, $d = 0.23$) or subjectivity ($Z = -0.06$, $p = .48$, $d = 0.01$). Lastly, multivariate repeated measures ANOVA did not reveal an effect of AVP administration on emotional prosody ($F[6,18] = 0.64$, $p = .70$, $\eta^2 = .18$).

The influence of birth

Table 4 shows the effects of the birth of the child on positive and critical comments, emotional content (i.e. polarity and subjectivity), and emotional prosody parameters. The number of positive comments ($Z = -2.17$, $p = .03$, $d = 0.49$), but not the number of critical comments ($Z = -0.78$, $p = .51$, $d = 0.22$) differed after the birth of the first child, with an increase in positivity after birth. Polarity ($Z = -0.20$, $p = .43$, $d = 0.07$) and subjectivity ($Z = -0.04$, $p = .71$, $d = 0.01$) were not influenced by the birth of the child. However, as shown in Table 4, emotional prosody parameters changed after the birth of the child ($F[6,14] = 4.12$, $p = .01$, $\eta^2 = .66$). Post hoc analyses revealed that variation in intensity decreased from pre-birth ($M = 9.53$, $SD = 1.36$) to post-birth ($M = 8.69$, $SD = 1.27$); $F(1,19) = 6.02$, $p = .02$, $\eta^2 = .24$. Furthermore, first formant decreased from pre-birth ($M = 1.17$, $SD = 0.13$) to post-birth ($M = 1.08$, $SD = 0.11$); $F(1,19) = 27.07$, $p < .01$, $\eta^2 = .59$. A trend was observed for decreased speak rate after birth (PL: $M = 2.31$, $SD = 0.66$; post: $M = 2.26$, $SD = 0.63$); $F(1,19) = 3.65$, $p = 0.07$, $\eta^2 = .16$.

Table 3. The effect of vasopressin administration on Five Minute Speech Sample parameters.

		Mean (*SD*) PL	Mean (*SD*) AVP	Test statistic parametric	p-value	Effect size (*d*)	Test statistic non-parametric	*p*-value
Word count		711.36 (201.77)	705.76 (207.20)				−0.07 (z)	.96
Positive comments		2.28 (2.25)	3.04 (2.26)			0.34	−1.37 (z)	.18
Critical comments		0.52 (1.00)	0.80 (1.29)			0.25	−1.33 (z)	.20
Polarity		0.21 (0.09)	0.19 (0.08)			0.23	−1.06 (z)	.30
Subjectivity		0.66 (0.07)	0.66 (0.05)			0.01	−0.06 (z)	.48
Emotional prosody				0.73	.48	.16		
	F_0 median	93.29 (10.50)	93.85 (12.03)					
	F_0 SD	60.10 (15.24)	57.36 (11.00)					
	F_1 median	1.10 (0.12)	1.10 (0.13)					
	Intensity SD	8.54 (1.34)	8.79 (1.98)					
	Spectral slope	−0.01 (0.00)	−0.01 (0.00)					
	Speak rate	2.32 (0.66)	2.31 (0.69)					

Only the comparison in emotional prosody was tested parametrically with a multivariate repeated ANOVA and effect size is calculated in η^2. All other comparisons are examined with separate Wilcoxon Matched-Pairs Tests. Mean and SD for parameters included in emotional prosody are shown separately.

Table 4. The influence of birth on Five Minute Speech Sample parameters.

		Mean (*SD*) PL	Mean (*SD*) post	Test statistic parametric (*F*)	p-value	Effect size (*d*)	Test statistic non-parametric (*Z*)	*p*-value
Word count		711.36 (201.77)	688.60 (195.22)				−0.24	.82
Positive comments		2.28 (2.25)	4.05 (3.00)			0.49	−2.17	.03
Critical comments		0.52 (1.00)	0.80 (1.06)			0.22	−0.78	.51
Polarity		0.21 (0.09)	0.21 (0.07)			0.07	−0.20	.43
Subjectivity		0.66 (0.07)	0.67 (0.06)			0.01	−0.04	.71
Emotional prosody				4.12	.01	.66		
	F_0 median	93.29 (10.50)	94.08 (10.77)					
	F_0 SD	60.10 (15.24)	65.29 (15.85)					
	F_1 median	1.10 (0.12)	1.08 (0.11)					
	Intensity SD	8.54 (1.34)	8.69 (1.27)					
	Spectral slope	−0.01 (0.00)	−0.01 (0.00)					
	Speak rate	2.32 (0.66)	2.26 (0.63)					

Only the comparison in emotional prosody was tested parametrically with a multivariate repeated ANOVA and effect size is calculated in η^2. All other comparisons are examined with separate Wilcoxon Matched-Pairs Tests. Mean and SD for parameters included in emotional prosody are shown separately.

Discussion

In the current study, we investigated the effect of vasopressin on FMSS characteristics in men in the transition to fatherhood, and the influence of the birth of the child on paternal speech about their infant and their relationship with the infant. Furthermore, we explored whether computerized coding was meaningfully related to traditional rater-based coding of FMSS variables. Analyses revealed that rater-based FMSS expressed emotion (positive comments and critical comments) and automatically coded emotional content (polarity and subjectivity) were correlated. No effect of AVP was observed on FMSS-based variables, but the birth of the child influenced both FMSS-based expressed emotion and emotional prosody parameters.

Starting with the associations between coder-rated and computer-rated FMSS variables, we can conclude that computerized coding is a promising addition to traditional coding. Higher numbers of positive comments and lower number of critical comments were associated with higher polarity and subjectivity. These meaningful associations point to automatic computer coding of the FMSS recordings as a valuable addition to the traditional Expressed Emotion coding of the FMSS coding in both clinical and research settings. At this point, the modest correlations do not suggest that the traditional EE coding of the FMSS could be replaced by automatic coding, given the remaining substantial non-overlap between the measures. Future studies relating the distinct FMSS ratings to observed parenting behavior may reveal what part of the variance in parenting can be explained by the traditional and computerized coding procedures separately and in tandem.

Moreover, AVP administration did not influence the FMSS-based variables. Speech style and content during the FMSS may be independent of paternal AVP levels, although AVP has been related to other fathering dimensions in the past (e.g. Abraham & Feldman, 2018; Thijssen et al., 2018). Alternative explanations for the absence of the expected associations are the following. First, a training effect might have influenced the results. That is, participants performed the FMSS in the AVP and placebo conditions in a relatively short time-window, which may have resulted in memorized answers. To our knowledge, this is the first study using a small time-window of 7 days between two FMSS recordings, and indeed, scores of the two sessions were correlated. Future research should address the effect of the duration of the intervening period between two assessments of the FMSS. Second, it might be argued that the intranasally administered AVP did not reach or could not affect the neurobiological systems involved in FMSS responses of prospective fathers. However, the intranasal administration of AVP has been shown to result in increased AVP concentrations in both cerebrospinal fluid and blood plasma of healthy adult men and women within 10 min, with effects still present after 80 min (Born et al., 2002). Furthermore, studies have shown that neurobiological systems involved in the processing of cry sounds (Thijssen et al., 2018), processing of infant-related visual stimuli (Cohen-Bendahan et al., 2015) and the activation of protective parenting (Alyousefi-van Dijk et al., 2019) are affected by the AVP nasal administration in prospective fathers. However, it remains unknown what specific neurobiological effects are evoked by AVP administration. Third, the time-window between the administration of AVP and the start of the FMSS might play a role. In the current study, the FMSS started on average 155 min after AVP administration. This time-window is relatively large compared to previous AVP studies: ranging between 45 and 150 min (Alyousefi – van Dijk et al., 2019; Cohen-Bendahan et al., 2015; Li et al., 2017; Thijssen et al., 2018) and might have resulted in attenuation of the effect of AVP administration. Finally, it should be noted that the sample size was limited, and thus the statistical power to find effects was modest. The current sample consisted of men with a relatively high educational level, cohabiting, and living in a Western country. This small exploratory and hypothesis-generating study should be replicated in larger samples and in non-Western cultures to examine the replicability and generalizability of the results.

The birth of the first child, however, did influence several FMSS-based variables. Specifically, we observed an increase in the number of positive comments and a decrease in emotional prosody. The increase of positive FMSS content could be due to the experience of fathering, as the paternal emotions, thoughts, and behavior may facilitate emotional rewarding feelings about the child (Goodman, 2005), although no influence of birth on the reported positive or negative affect states was observed in the current study. The observed changes in emotional prosody variables after birth might well be due to decreased parental sleep; increased tiredness may affect prosody (Hagen, Mirer, Palta, & Peppard, 2013; McGlinchey et al., 2011). Moreover, possible maturation effects on the voice (see, e.g., Lortie, Rivard, Thibeault, & Tremblay, 2017) that might affect emotional prosody cannot be excluded since no control non-father group was included. Future studies should explore possible influences of depressive mood and sleep quality on emotional prosody. Interestingly, in contrast to the observed influence on positive comments, no effect of birth was observed on the emotional content variables. Future research should address this discrepancy.

In order to study FMSS-based expressed emotion in men transitioning into fatherhood, we combined two FMSS coding manuals that were originally developed for prospective parents (Lambregtse-van den Berg et al., 2013) and new parents (Daley et al., 2003), respectively. Following previous research, we aimed to assess the EE scores of the FMSS recordings. However, different configurations of the individual scale scores may lead to similar overall EE scores, at the cost of meaningful variation. Indeed, in some studies, this underlying variation and additional speech sample information that could be missed in the dichotomous EE scale have been used. For example, Daley et al. (2003) successfully used all preschool subscales in their study of mothers of preschool children. Moreover, Baker, Heller, and Henker (2000) and Wamboldt, O'Connor, Wamboldt, Gavin, and Klinnert (2000) related adjusted scale scores for positive affect and worry, emotional overinvolvement, and number of positive remarks to self-reported parental functioning and observed parent–child interactions and found diverging predictions for individual scales, which support their predictive validity as separate scales (Baker et al., 2000; Wamboldt et al., 2000).

In the current study, we explored paternal thoughts and feelings via the FMSS. One of the reviewers suggested that it might be interesting to examine whether indicators of indirect parenting, such as statements about provisioning and protection (e.g. for protection see Bakermans-Kranenburg & van IJzendoorn, 2017), can be measured with the FMSS. We explored post hoc whether such statements were present in our current dataset, and indeed we found evidence for the presence for these dimensions of indirect care (e.g. "I hope we are able to set apart some money for her"; "I hope we can prevent that she is being bullied"), suggesting that future research could include these indicators for indirect care in the FMSS.

Unfortunately, scoring these individual scales is not always straightforward, and after thorough training, we achieved inter-coder reliability for two of them. This might be due to differences in the study population compared to other studies. Future research should examine for more individual scale scores whether they can be trained to reliability, maybe with a more detailed coding manual, and whether the scales (combined and uniquely) are associated with observed parental sensitivity, infant-father attachment quality, and paternal indirect care.

In summary, the current study is the first to examine the effect of AVP on FMSS-variables in men in the transition into fatherhood, a unique time-window characterized by changes in the regulation of parental emotions and behaviors. Based on our findings, it may be concluded that FMSS-based variables may be independent of AVP in prospective fathers. Moreover, we explored the possibility of using a computerized assessment of possible correlates of sensitivity and identified meaningful relations between traditionally rated expressed emotion and computer-rated emotional content and emotional prosody. Our findings suggest that such automatic coding of the speech samples provides useful additional information and can be used to develop less time-consuming and more reliable coding procedures of the FMSS.

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ORCID

Marinus H. van Ijzendoorn http://orcid.org/0000-0003-1144-454X
Marian J. Bakermans-Kranenburg http://orcid.org/0000-0001-7763-0711

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