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Effects of male postpartum depression on father–infant interaction: The mediating role of face processing

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ABSTRACT

It is estimated that postpartum depression affects up to 25% of men. Despite such high prevalence, the majority of studies on postpartum depression are focused on mothers, and the role of paternal depression and its effects on infant development have been overlooked by researchers and clinicians. The present study aimed to fill this gap by investigating the effect of paternal postpartum depression on father–infant interactions. In addition, we examined whether differences in face recognition mediated the effects of paternal postpartum depression on father–infant interactions. A total of 61 father–infant dyads (17 postpartum depression, 44 controls) took part in the study. Results revealed that compared to controls, fathers with postpartum depression had a worse pattern of interaction with their infants on measures of responsiveness, mood, and sensitivity; they also had greater difficulty in recognizing happy adult faces, but greater facility in recognizing sad adult faces. Depressed fathers attributed greater intensities to sad adult and infant faces. The tendency to attribute greater intensity to sad adult faces was confirmed as a partial mediator of the effect of paternal postpartum depression on measures of father responsiveness and as a full mediator of the effects of paternal depression on father sensitivity. Clinical implications and suggestions for further studies are discussed.

KEYWORDS
face recognition, father–infant interaction, father postpartum depression

RESUMEN

Se estima que la depresión posterior al parto afecta hasta un 25% de los hombres. A pesar de tan alta prevalencia, la mayoría de los estudios sobre la depresión posterior al parto se enfocan en las madres, y los investigadores y clínicos han pasado por alto el papel de la depresión paterna y sus efectos en el desarrollo del infante. El presente estudio se propuso llenar ese vacío investigando el efecto que la depresión paterna posterior al parto tiene en las interacciones papá-infante. Adicionalmente, examinamos si las diferencias en reconocer las caras mediaron los efectos que la depresión paterna posterior al parto tiene en las interacciones papá-infante. Sesenta y una díadas papá-infante (17 en el grupo de depresión posterior al parto, 44 en el grupo de control) participaron en el estudio. Los resultados revelaron que, comparados con el grupo de control, los papás con depresión posterior al parto presentaban un peor patrón de interacción con sus infantes en medidas de capacidad de respuesta, estado de ánimo y sensibilidad; ellos también tuvieron mayores dificultades en reconocer caras adultas felices, pero con mayor facilidad reconocieron caras adultas tristes. Los padres deprimidos atribuyeron una mayor intensidad a las

caras tristes de adultos e infantes. Se confirmó la tendencia de atribuir una mayor intensidad a las caras adultas tristes como un mediador parcial del efecto que la depresión paterna posterior al parto tiene sobre la calidad de respuesta del papá y como un completo mediador de los efectos que la depresión paterna tiene sobre la sensibilidad del papá. Se discuten las implicaciones y sugerencias clínicas para futuros estudios.

PALABRAS CLAVES

depresión paterna posterior al parto, reconocimiento de la cara, interacción papá-infante

RÉSUMÉ

On estime que la dépression postpartum affect jusqu'à 25% des hommes. En dépit d'une telle prévalence élevée la majorité des études sur la dépression postpartum porte sur les mères et le rôle de la dépression paternelle et de ses effets sur le développement du nourrisson a été négligé par les chercheurs et les cliniciens. Cette étude s'est donné pour but de remplir ce fossé en recherchant l'effet de la dépression postpartum sur les interactions père-nourrisson. De plus, nous avons examiné si les différences dans la reconnaissance faciale ont assuré la médiation des effets de la dépression paternelle postpartum sur les interactions père-nourrisson. 61 dyades père-bébé (17 dépression postpartum, 44 contrôles) ont pris part à l'étude. Les résultats ont révélé que, comparés aux contrôles, les pères avec la dépression postpartum faisaient état d'un pattern d'interaction avec leur bébé pire sur les mesures de réactivité, d'humeur et de sensibilité. Ils avaient aussi plus de difficulté à reconnaître les visages adultes heureux mais une plus grande facilité à reconnaître les visages adultes tristes. Les pères déprimés ont attribué de plus grandes intensités aux visages tristes de l'adulte et du bébé. La tendance à attribuer une plus grande intensité aux visages tristes de l'adulte a été confirmée comme un médiateur partiel de l'effet de la dépression paternelle postpartum sur la réaction du père et comme un médiateur total sur les effets de la dépression paternelle sur la sensibilité du père. Les implications cliniques et des suggestions de recherche sont discutées.

MOTS CLÉS

dépression postpartum du père, reconnaissance faciale, interaction père-bébé

ZUSAMMENFASSUNG

Es wird geschätzt, dass bis zu 25% der Männer von einer postpartalen Depression betroffen sind. Trotz dieser hohen Prävalenz konzentriert sich die Mehrheit der Studien über postpartale Depression auf Mütter, und die Rolle der väterlichen Depression und ihre Auswirkungen auf die Säuglingsentwicklung wurden von Forschern und Klinikern übersehen. Die vorliegende Studie zielte darauf ab, diese Lücke zu schließen, indem sie die Auswirkungen der väterlichen postpartalen Depression auf die Interaktion zwischen Vater und Säugling untersucht. Zusätzlich untersuchten wir, ob Unterschiede in der Gesichtserkennung die Auswirkungen der väterlichen postpartalen Depression auf die Interaktion zwischen Vater und Säugling mediierten. 61 Vater-Säuglings-Dyaden (17 mit postpartaler Depression, 44 Kontrollen) nahmen an der Studie teil. Die Ergebnisse zeigten, dass Väter mit postpartaler Depression im Vergleich zur Kontrollgruppe ein schlechteres Interaktionsmuster mit ihren Säuglingen in Bezug auf die Responsivität, Stimmung und Sensitivität hatten; sie hatten auch größere Schwierigkeiten bei der Erkennung glücklicher Gesichter von Erwachsenen, während ihnen die Erkennung trauriger Gesichter von Erwachsenen leichter fiel. Depressive Väter schrieben traurigen Gesichtern von Erwachsenen und Säuglingen größere Intensitäten zu. Die Tendenz, traurigen Gesichtern von Erwachsenen eine größere Intensität zuzuschreiben, wurde als partieller Mediator der Auswirkungen der väterlichen postpartalen Depression auf die Responsivität des Vaters und als vollständiger Mediator der Auswirkungen der väterlichen Depression auf die Sensitivität des Vaters bestätigt. Klinische Implikationen und Vorschläge für weitere Studien werden diskutiert.

STICHWÖRTER

postpartale väterliche Depression, Gesichtserkennung, Vater-Säugling-Interaktion

抄録

産後うつ病は男性の最大25%に影響を及ぼす疾患と推定されている。男性の産後うつ病はこのように有病率が高いにもかかわらず、大半の研究は母親に焦点が当てられている。そのため男性のうつ病の役割とそれが乳児の発達に及ぼす影響は、研究者や臨床家に見過ごされてきた。本研究は、父親-乳児相互作用に対して父親の産後うつ病が及ぼす影響を調査しこの格差を埋めることを目的としている。それに加えて、私たちは顔認識の違いが父親-乳児相互作用に対する父親の産後うつ病の影響を仲立ちするかどうかについて検討した。父親と乳児の61組(産後うつ病群17、対象群44)が研究に参加した。結果は、対象群に比べ、産後うつ病の父親は、反応性、気分および感受性尺度において、乳児との相互作用のパターンが劣悪であった。さらに楽しい大人の顔を認識することは極めて困難であるが、悲しい大人の顔を認識することは極めて容易であった。うつ病の父親は悲しい大人と乳児の顔に極めて強い感度を示した。悲しい大人の顔に極めて強い感度を示す傾向は、父親の産後うつ病が父親の反応性に部分的な仲立ち、また父親の感受性に全面的な仲立ちとして影響していることが確認された。臨床的意義と今後の研究への示唆について考察した。

キーワード

父親の産後うつ病, 顔認識, 父親-乳児相互作用

摘要

據估計, 產後抑鬱症影響高達25%的男性。儘管如此普遍, 大多數關於產後抑鬱症的研究都集中在母親身上, 研究人員和臨床醫生忽視了父系抑鬱症的作用及其對嬰兒發育的影響。本研究旨在通過調查父親產後抑鬱對父嬰互動的影響來填補這一空白。此外, 我們檢查了面部識別的差異是否介導了父親產後抑鬱對父嬰互動的影響。 61個父嬰組合 (產後抑鬱症17個, 對照組44個) 參加這項研究。結果顯示, 與對照組相比, 產後抑鬱症的父親在測量反應性、情緒和敏感度方面與嬰兒的互動模式較差;他們在識別快樂的成人面孔方面也有較大的困難, 但在識別悲傷的成人面孔方面表現較好。抑鬱的父親對悲傷的成人和嬰兒臉孔反應較強。較大強化悲傷成人面孔的傾向, 被確認為父親產後抑鬱對父親反應影響的部分中介, 並且是父親抑鬱對父親敏感性影響的完全中介變數。作者討論研究結果的臨床意義和對進一步研究的建議。

關鍵詞

父親產後抑鬱症, 人臉識別, 父嬰互動

ملخص

تشير التقديرات إلى ان الاكتئاب بعد الولادة يؤثر علي ما يصل إلى 25 ٪ من الرجال. وعلي الرغم من هذا الانتشار المرتفع ، تركز معظم الدراسات المتعلقة باكتئاب ما بعد الولادة علي الأمهات ، وقد أغفل الباحثون والأطباء دور الاكتئاب الأبوي وأثاره علي نمو الرضع. تهدف الدراسة الحالية إلى سد هذه الفجوة عن طريق التحقيق في تاثير الاكتئاب الأبوي بعد الولادة علي تفاعلات الأب والرضيع. بالاضافه إلى ذلك ، درسنا ما إذا كانت الاختلافات في التعرف علي الوجوه توسطت آثار الاكتئاب الأبوي بعد الولادة علي تفاعلات الأب والرضيع. اشتملت عينة الدراسة على 61 من ثنائيات الأباء والرضع (17 من حالات الاكتئاب بعد الولادة ، 44 كمجموعة ضابطة). وكشفت النتائج انه ، مقارنه بالمجموعة الضابطة ، كان لدي الاباء المصابين باكتئاب ما بعد الولادة نمطا اسوأ من التفاعل مع أطفالهم الرضع على مقاييس الاستجابة والمزاج والحساسية ؛ كما كان لديهم أيضا صعوبة أكبر في التعرف على وجوه البالغين السعيدة ، ولكن سهولة أكثر في التعرف على وجوه الكبار الحزينة. وأبدى الاباء المكتئبون تركيزاً أكبر على وجوه البالغين والرضع الحزينة. وأكد الميل إلى التركيز الأكبرعلى وجوه البالغين الحزينه على وجود تأثير وسيط جزئي لاكتئاب الآباء بعد الولادة علي استجابه الأب وكوسيط كلي لآثار الاكتئاب الأبوي علي حساسية الأب. وتناقش الدراسة التطبيقات الإكلينيكية والاقتراحات لمزيد من الدراسات.

الكلمات الرئيسية

اكتئاب الأب بعد الولادة; التعرف علي الوجه; تفاعل الأب والرضيع

Most studies about postnatal depression have focused on mothers (e.g., Evans et al., 2012; Murray et al., 2011; O'Hara & McCabe, 2013; Stein et al., 2012) whereas paternal mental health and the changes experienced by men in the postpartum period have been repeatedly overlooked by researchers and clinicians. Results of a British cohort study by Ramchandani et al. (2008) showed that by 8 weeks' postpartum, the prevalence of fathers with postnatal depression (PND-F) varied between 2.5 and 3.6%. Another cohort study conducted in Australia by Matthey, Barnett, Ungerer, and Waters (2000) has reported a prevalence of PND-F between 2.8 and 5.3%. Recently, a meta-analysis conducted by Cameron et al. (2016) has reported an average prevalence rate of paternal pre- and postpartum depression of 8%; in some countries and samples, however, paternal postpartum depression prevalence may reach considerably higher rates (e.g., 25%: Soliday, McCluskey-Fawcett, & O'Brien, 1999; 17%: Suto et al., 2016), highlighting the need to assess and support fathers during the postnatal period.

A growing body of research has linked PND-F to an increased risk of children developing emotional, cognitive, and behavioral problems (Ballard, Davis, Cullen, Mohan, & Dean, 1994; Davé, Sherr, Senior, & Nazareth, 2008; Fletcher, Feeman, Garfield, & Vimpani, 2011; Matthey et al., 2000; Murray & Cooper, 1997; Narayanan, M. K., & Nærde, 2016; Natsuaki et al., 2014; Paulson, Bazemore, Prevalence, & Fac, 2010; Ramchandani, Stein, Evans, & O'Connor, 2005; Ramchandani et al., 2008; Schumacher, Zubaran, & White, 2008; Spector, 2006; Sweeney & MacBeth, 2016). A meta-analysis conducted by Gentile and Fusco (2017) investigated the effects of untreated paternal depression on offspring outcomes: namely, developmental difficulties, behavioral problems, and specific risks of psychopathology. A total of 23 studies were included; results revealed consistent findings, suggesting significant negative effects of paternal depression throughout children's development and, in particular, during infancy and the first years of childhood. Notably, these effects have been reported to be independent of the effects of maternal postnatal depression on the child, a result that may be especially significant since postnatal depression impacts children in a sensitive and critical period of their development (Ramchandani et al., 2011).

Research examining mediation effects, to understand the route whereby father depressive symptoms affect children's behavior and cognition, has revealed inconsistent findings concerning demographic mediators such as social class and education (Gentile & Fusco, 2017). Conversely, results on relational variables, such as impaired father–child interactions, have shown a more consistent pattern of findings, suggesting that there may be a stronger link between paternal depression and offspring impaired development (Wilson & Durbin, 2010). Indeed, a meta-analysis conducted by Sweeney and MacBeth (2016) included 21 studies; results indicated that the most common mediators of the effects of PND-F on offsprings' less optimal development were paternal hostility, low father involvement, and fathers' negative expressiveness. One of the first studies (Field, Hossain, & Malphurs, 1999) conducted on the topic assessed 80 couples and their children, and showed significant differences in the interactions of depressed fathers from nondepressed fathers and their infants regardless of whether the mother suffered from PND.

More recently, differences in specific paternal behaviors also have been examined in depressed and control fathers. Paternal speech was investigated in a study with 38 fathers (19 depressed); results revealed that PND-F fathers made more statements focused on themselves rather than on their children, and also made more negative and critical statements regarding their infants than did fathers not affected by PND-F (Sethna, Murray, & Ramchandani, 2012). In a larger observational study (192 fathers, 54 depressed) Sehtna et al. (2015) showed that paternal depression was related to greater withdrawn parental behavior in father–infant play interactions on a floor mat when the infant was 3 months old.

Data from studies on maternal postnatal depression have suggested that these patterns of impaired caregiver–infant interactions may be largely related to parental difficulties in recognizing infants' emotions. As such, recognition of facial expressions is considered a key mediator of the effect of maternal postnatal depression on the quality of caregiver–infant interaction (Arteche et al., 2011; Stein et al., 2010). Studies on depression and face recognition involve heterogeneous methods with varying exposure times and stimuli type. Time of stimulus exposure seems to be a key factor in the recognition of facial expressions, with 200 ms being considered sufficient to identify facial expressions (Schyns, Petro, & Smith, 2009). Accordingly, the unlimited exposure times or greater than 1-s exposures used in most studies do not mimic real life situations and may attenuate subtle differences between groups investigated (Vasconcellos, Salvador-Silva, Dias, Davóglio, & Gauer, 2014).

Despite methodological heterogeneity, results have tended to show that depression is associated with impairments in the ability to recognize emotional adult faces, with findings pointing to a bias toward sad faces (Gotlib, Krasnoperova, Joormann, & Yue, 2004; Joormann & Gotlib, 2007; Maniglio et al., 2014), and with depressed individuals even outperforming controls in recognition of sad faces (Gollan, McClosey, Hoxha, & Coccaro, 2010) and/or having difficulties in identifying happy faces (Isaac et al., 2014; Stein et al., 2010). However, few studies have examined these effects in samples of parents and using infant faces. Compared to healthy controls, women with postnatal depression have greater difficulty in identifying happy and fearful adult faces; when compared with depressed women outside the postpartum period, they have greater difficulty in identifying adult faces depicting disgust and anger (Flanagan, White, & Carter, 2011). Using

infant face stimuli, Pearson, Cooper, Penton-Voak, Lightman, and Evans (2010) assessed pregnant women and found that compared to nondepressed mothers, depressed participants found it easier to disengage from distressed infant faces—a finding that has a substantial impact on parent–child interaction. Furthermore, using infant faces as stimuli, mothers with postpartum depression were found to judge neutral faces as less neutral than were nondepressed mothers (Gil, Teissèdre, Chambres, & Droit-Volet, 2011).

Arteche et al. (2011), in a pioneer study conducted with 89 mothers (34 Generalized Anxiety Disorder, 21 Major Depressive Disorder, and 34 controls), used a "morphed infants" faces task when children were between 10 and 18 months, and showed that depressed mothers were less accurate than were controls in identifying happiness in infant faces, potentially leading to less positive responses to infant behaviors. Such processing, in a father–infant interaction, may be similarly associated with lower levels of responsiveness to the infant, with a negative impact on child development (Arteche et al., 2011; Murray, Marwick, & Arteche, 2010; Stein et al., 2010; Yarrow et al., 1984). Thus far, no study has investigated this hypothesis in a sample of PND-F.

Based on a comprehensive model on the effect of paternal postpartum depression on father–infant interactions, the present study therefore aimed to investigate whether recognition of facial expressions acts as a mediator of the effects of postpartum depression on father–infant interactions. A community sample of newborns was recruited in health centers and in a maternity ward in South Brazil. Parents were screened for depression, and fathers' ability to recognize emotional faces was assessed through a computerized task. Free-play father–infant interactions were recorded, as described later. We expected depressed fathers to show a poorer pattern of interaction with their infants when compared to controls. We also expected this effect to be partially mediated by paternal lower accuracy in recognition of happy and neutral adult and infant faces and by paternal attribution of greater intensity to sad adult and infant faces as well as attribution of lower intensity to happy adult and infant faces.

1 | METHOD

1.1 | Participants

Sixty-four couples with infants aged between 2 weeks and 4 months were recruited for the study. Inclusion criteria were (a) parents age >18 years and <60 years; (b) full-term infants (>37 weeks), with a minimum birth weight of 2.0 kg and without health problems; and (c) parents cohabiting. All fathers were screened using the Structured Clinical Interview for the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision* (*DSM-IV-TR*; American Psychiatric Association, 2000) Axis 1 Disorders (SCID; First, Gibbon, Spitzer, Williams, & Benjamin, 1997), the Beck Depression Inventory (BDI; Beck, Steer, & Brown, 1996), and the Edinburgh Postnatal Depression Scale (EPDS; Cox, Holden, & Sagovsky, 1987). Mothers were assessed using the BDI and the EPDS only. Inclusion criteria for PND-F included positive SCID and/or BDI (≥15 points) + EPDS (≥10 points). The same criteria (except for the SCID) were applied to mothers. Of the 64 triads (father–mother–infant) who met the inclusion criteria for participation in the study, 3 were lost. In two cases, it was not possible to record father–infant interactions, and in one case, the objective assessment was not performed. Therefore, the sample reported in the present article concerns 61 triads. A total of 17 men and 17 women (27.9%) met the diagnostic criteria for PND. In four cases, both the father and the mother met the diagnostic criteria for PND. Results presented in this article concern the 17 fathers with PND-F and the 44 control fathers and their infants.

Participants were recruited in health centers and on the local maternity ward. Parents with infants were invited to participate in the study. Data collection took part in the residence of the participants, with the first author conducting all home visits. The study was approved by the School—Clinic of Psychology of the Universidade Regional e Integrada do Alto Uruguai e das Missões and the Municipality of Frederico Westphalen—RS, Brazil as well as by the Research Ethics Committee of Pontifícia Universidade Católica do Rio Grande do Sul. All participants gave signed informed consent.

1.2 | Instruments

1.2.1 | Father mental state

The SCID–Depression Module; First et al., 1997)

The SCID is a semistructured interview for Axis I diagnoses. A high level of reliability and evidence of validity have been reported elsewhere (Basco et al., 2000; Zanarini et al., 2000). All SCIDs were conducted by the first author (a trained clinical psychologist) and supervised by the last author.

The EPDS (Cox et al., 1987)

This scale consists of 10 self-report items on a Likert scale of 0 () to 3 () according to the presence or to the intensity of symptoms concerning depressive symptoms commonly observed in the postnatal period. The scale has good internal consistency, Cronbach's $\alpha = 0.87$. The Brazilian version showed adequate sensitivity and specificity rates (Santos et al., 2007), and scores ≥10 (Santos, Martins, & Pasquali, 1999) are considered indicative of postnatal depression.

The Beck Depression Inventory II (BDI-II; Beck et al., 1996)

The BDI-II is a 21-item self-report measure of depression. It uses a scale ranging from 0 (least) to 3 (most) to assess severity of symptoms and has shown good internal consistency rates, Cronbach's $\alpha > 0.80$, in studies with Brazilian samples (Gorenstein & Andrade, 1996).

The Beck Anxiety Inventory–Brazilian version (BAI; Cunha, 2001)

The BAI consists of 21 questions. Each question has four possible answers (0 = *little* or none to 3 = *severely*) on how the individual felt during the past week, expressed in common anxiety symptoms, and has shown good internal consistency rates, Cronbach's $\alpha > 0.87$, in studies with Brazilian samples (Cunha, 2001).

1.2.2 | Facial recognition assessment

Facial affect recognition task

The adult facial affect stimuli used in this study (Facial Expression Recognition Brazilian Task) were developed by Vasconcellos et al. (2014). Vasconcellos et al. selected 26 facial expressions: happiness (four), anger (four), sadness (four), disgust (four), surprise (four), fear (four), and neutral (two), based on evidence for the universality of these emotions (Ekman & Friesen, 2003). To represent the multiracial Brazilian population, the authors used pictures from two male and two female professional actors of White, Mixed, and Black ethnicity. For the current study, just faces of happy, sad, and neutral emotions were analyzed. The 13 infant faces (five happy, five sad, and three neutral) used in this study were developed by Arteche, Vivian, Dalpiaz, and Salvador-Silva (2016) and depict infants from White, Mixed, and Black backgrounds representing Brazilian racial diversity.

Images of facial expressions were randomly presented in three separate blocks of trials, with durations of 200 ms, 500 ms, and 1,000 ms. Participants were first exposed to a block of infant faces, followed by a block of adult faces. After each face was displayed, participants were required to classify the emotion using a menu containing seven options (the six emotions + the neutral face option) by pressing the corresponding numeric key on a keyboard. Next, participants rated the level of intensity of the emotion on a scale of 1 (*very low intensity*) to 5 (*very high intensity*) also using the corresponding numeric key. We set no time limit for participants to emit a response. The task was conducted on a notebook with a 14.7-in. screen, placed approximately 50 cm away from the participant.

1.2.3 | Father–Infant Interaction Assessment

Father–Infant Interaction–Global Rating Scale for Mother–infant interaction (Gunning & Murray, 2002)

Father–infant interaction was assessed by direct observation. Infants were assessed along with their fathers, with the infant placed on an infant comfort seat, a cradle, the father's lap, or a couch. The father was allowed to select the child's position, as long as there was eye contact between father and infant. The father was told to interact with his child, being allowed to freely play and talk to the infant, with or without the aid of objects or toys, for 5 min (Murray, Fiori-Cowley, Hooper, & Cooper, 1996). Interactions were assessed every minute, according to the procedure of Murray, Cooper, Creswell, Schofield, and Sack (2007). The coding scheme comprises the following dimensions: caregiver (Factor 1: Responsiveness, Factor 2: Mood, and Factor 3: Sensitivity) for the infant (Factor 1: Attention to the Father, Factor 2: Mood), and finally, the dimension of the interaction of the pair, coded on a Likert scale of 0 (poor interaction) to 4 (very good interaction). A research assistant blind to father group carried out coding of father–infant interactions. The first author also coded 30% of the videos exclusively for establishing reliability. Kappas ranged between 0.50 and 0.70.

Parental Care Questionnaire (Tokumaru, Zortea, Howat-Rodrigues, & Andrade, 2011)

Father involvement on infant everyday caring was assessed via 16 Likert-type questions rated on a scale of 1 (*never involved*) to 7 (*always involved*). Mothers were requested to rate how much the father took part in activities such as changing nappies (diapers), bathing, changing clothes, taking to the doctor, putting to bed, playing, and so on.

1.3 | Data analysis

The effect of paternal education, sex of the infant, and parity, and the effect of PND-F on father–infant interactions were investigated using a series of multivariate analysis of variance (MANOVAs). The latter also were conducted taking into account demographics and maternal depression as covariates. For these sets of analysis, dimensions of the father, dimensions of the infant, and dimensions of the dyad were considered as dependent variables, and each demographic variable was entered separately as an independent factor. Next, a series of MANOVAS were performed to investigate the effect of demographic variables on the accuracy and intensity of face-processing, followed by a series of repeated measures analysis to investigate the effect of time of exposure and PND-F on the same outcomes. In both strategies, blocks of each emotion (happy, sad, and neutral) from each stimuli type (adult and infant faces) and rate (accuracy and intensity) on the three exposure times (200 ms, 500 ms, and 1,000 ms) were entered as dependent variables whereas demographics and father depression were separately considered independent factors. Subsequently, following Baron and Kenny (1986), a series of regression analyses investigated whether face recognition mediated the effect of PND-F on father–infant interaction. All indirect effects were estimated with bias-corrected bootstrapping (5,000 samples). The SPSS 17.0 statistical package was used for data analysis. Following Thiese, Ronna, and Ott (2016), a $P < .05$ threshold was applied for simple effects whereas a $P < .10$ was used for complex relationships (i.e., mediation tests and multiple comparison adjustments).

TABLE 1 Sample characteristics

	Control ($n = 44$)		PND-F ($n = 17$)		Statistics	
	M	*SD*	*M*	*SD*	$F(1, 59)$	*P*-value
Father Characteristics						
Age	31.82	(4.51)	35.12	(5.40)	5.88	.018
	n	%	*n*	%	$\chi^2(1)$	*P*-value
Education						
Secondary education	21	47.70	09	52.90	0.64	.544
Graduate or postgraduate	23	52.30	08	47.10		
Occupation						
Employed	44	100.0	16	94.10	2.63	.105
Not employed	00	0.0	01	5.90		
Past Depression Diagnosis						
Yes	04	9.10	16	94.10	46.19	.001
No	40	90.90	01	5.90		
Current Anxiety						
Moderate–severe	02	4.50	04	23.50	12.84	.001
Normal–mild	42	95.50	13	76.50		
Infant Characteristics						
Sex						
Male	22	50.0	14	82.40	5.30	.020
Female	22	50.0	03	17.60		
Age						
1–2 months	20	45.50	11	64.70	1.81	.178
3–4 months	24	54.50	06	35.30		
Only Child						
Yes	31	70.50	09	52.90	1.67	.197
No	13	29.50	08	47.10		

Note. PND-F = postnatal depression of the father.

2 | RESULTS

PND-F fathers were slightly older than were controls. The average income of the sample was 5.85 ($SD = 6.54$) times the minimum national wage, and there was no difference between PND-F and controls, $F(1, 59) = 0.30$, $P = .58$, $\eta^2 = .005$. Parental involvement in everyday caring for the baby was high in both groups, being described by their partners as "a lot" involved with daily caring for the child, $F\ (1, 59) = 0.01$, $P = .92$, $\eta^2 = .001$, PND-F $M = 5.29$ ($SD = 1.01$), control $M = 5.27$ ($SD = 0.86$). As shown in Table 1, there was no difference between groups concerning education and occupation. As expected, the majority of the PND-F group reported past depressive episodes on the SCID whereas only 9.1% of the controls had had such experience. In addition, postnatally depressed fathers were significantly more likely to show a moderate/severe score on the BAI than were controls. Most infants were the first child of both parents and were 1 to 2 months old, with no differences between groups. A significantly greater number of PND-F fathers had male children.

2.1 | Effect of demographic variables and PND-F on father–infant interaction

Distributions of father–infant interaction scores did not reveal outliers, with the exception of father responsiveness and infant mood. Significant effects of paternal age, $F(1, 59) = 7.06$, $P = .010$, $\eta^2 = .110$, and sex of the infant, $F(1, 57) = 5.94$, $P = .018$, $\eta^2 = .09$, were observed on the sensitivity factor, with younger fathers ($M = 3.85$, $SD = 0.54$) being more sensitive than were older ones ($M = 4.23$, $SD = 0.52$), and fathers of boys ($M = 3.91$, $SD = 0.46$) being more sensitive than were fathers of girls ($M = 3.33$, $SD = 0.55$). Regarding the effect of PND-F on father–infant interaction, significant effects were observed on all dimensions, with PND-F fathers being significantly less responsive and less sensitive, and displaying a more negative mood, as compared to controls (see Figure 1). Infants of fathers with PND-F also showed lower levels of attention to their fathers than did children of controls. These analyses were run again, taking into account father age, infant sex, and maternal depression (based on EPDS + BDI scores) as covariates, and all findings remained unaltered.

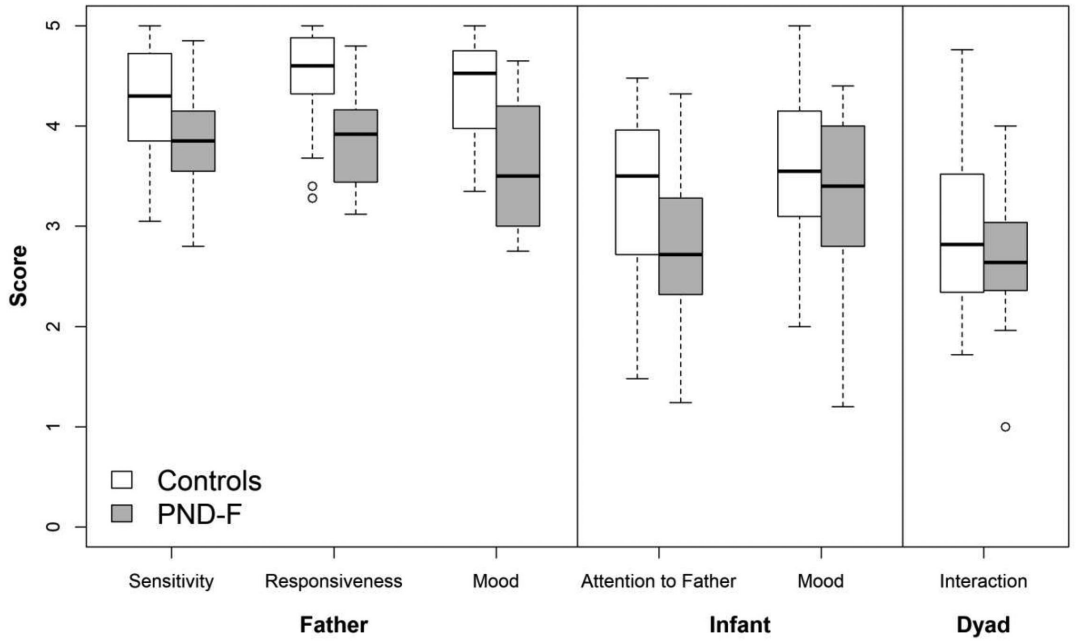

FIGURE 1 Mean and standard deviation of father–infant interactions for controls and fathers with postnatal depression (PND-F)

2.2 | Effect of demographic variables, time of exposure and PND-F on recognition of facial expressions

Regarding the effects of demographic variables on face recognition, fathers with higher education were better at recognizing sad infant faces at 500 ms, $F(1, 59) = 5.71$, $P = .020$, $\eta^2 = .088$. When compared to fathers of more than one child, fathers of only one child correctly identified a greater number of happy adult faces at 1,000 ms, $F(1, 59) = 2.11$, $P = .027$, $\eta^2 = .080$. Fathers of boys obtained a greater number of correct answers in relation to neutral infant faces at 500 ms, $F(1, 59) = 5.40$, $P = .024$, $\eta^2 = .084$, than did fathers of girls.

A significant time of exposure effect was observed on infant face accuracy. Overall, longer exposure times were related to poorer accuracy for happy infant faces, $F(2, 118) = 9.04$, $P < .001$, $\eta^2 = .130$, and a 500-ms exposure time was related to poorer accuracy for neutral infant faces, $F(2, 118) = 9.43$, $P = .001$, $\eta^2 = .138$. Significant exposure time effects also were observed on intensity ratings of adult faces. Lower intensities were attributed to happy adult faces at 200 ms, $F(2, 118) = 205.96$, $P < .0001$, $\eta^2 = .777$, and to sad, $F(2, 118) = 18.34$, $P < .0001$, $\eta^2 = .237$, and neutral, $F(2, 118) = 56.77$, $P = .001$, $\eta^2 = .49$, adult faces at 500 ms. A significant Time × PND-F effect was observed on intensity ratings of sad adult faces, $F(2, 118) = 16.26$, $P < .0001$, $\eta^2 = .216$, with PND-F fathers increasing their attribution of sadness at longer exposure times.

Regarding the effect of paternal postnatal depression, a significant main PND-F effect was observed on responses to happy adult faces, $F(1, 59) = 15.84$, $P < .0001$, $\eta^2 = 0.21$, and sad adult faces, $F(1, 59) = 9.70$, $P = .003$, $\eta^2 = 0.14$, with PND-F fathers showing lower accuracy rates than did controls for happy faces, but higher accuracy rates than did controls for sad faces. Results also revealed significant PND-F effects at specific exposure times. Compared to controls, PND-F fathers had more difficulty in recognizing happy faces at 200 ms and 500 ms, but were better in recognizing sad adult faces at 1,000 ms (see Table 2).

There was a significant main PND-F effect on responses to sad adult faces, $F(1, 59) = 29.13$, $P < .0001$, $\eta^2 = .331$, and sad infant faces, $F(1, 59) = 8.37$, $P = .005$, $\eta^2 = .124$, with postnatally depressed fathers attributing greater intensities as compared to controls. PND-F fathers also attributed significantly more sadness to adult faces at 1,000 ms, and less happiness at 1,000 ms and more sadness at 1,000 ms for infant faces (see Table 3).

2.3 | Mediators of the effect of PND-F on father–infant interaction

Having found a significant effect of PND-F on all paternal dimensions measured during father–infant interactions (i.e., Sensitivity, Responsiveness, Mood), mediation analyses were run to test whether this was explained by the effect paternal depression had on the recognition of facial expressions (both accuracy and intensity). In line with Step 3 of the classic Baron and Kenny (1986) method for mediation analysis, the effect of potential mediators on paternal interactive dimensions was tested, controlling for the influence of PND-F. Given the large number of parallel tests, to control family-wise error, the Benajamin–Hochberg correction was used, within sets of stimuli with the same time of exposure.

TABLE 2 PND-F effect on rates of correct responses of adult and infant faces

	M (*SD*)		Statistics		
	Control ($n = 44$)	PND-F ($n = 17$)	$F(1, 59)$	*P*-value	η^2
Happy Adult					
200	92.05 (11.78)	75.00 (17.68)	19.17	.000	.240
500	89.20 (14.66)	73.53 (20.67)	11.05	.002	.160
1,000	89.20 (14.66)	83.82 (23.24)	1.17	.284	.020
Sad Adult					
200	82.39 (19.12)	88,24 (12.86)	1.34	.250	.020
500	82.39 (18.35)	91.18 (12.31)	3.31	.074	.050
1,000	82.95 (20.72)	97.06 (8.30)	7.35	.009	.110
Neutral Adult					
200	72.73 (31.35)	88.24 (21.86)	3.48	.067	.050
500	80.68 (26.88)	76.47 (31.21)	0.27	.602	.005
1,000	79.55 (32.92)	79.41 (35.61)	0.001	.989	.000
Happy Infant					
200	93.64 (10.36)	88.24 (12.37)	2.98	.089	.050
500	93.30 (12.36)	96.50 (7.85)	1.68	.199	.030
1,000	86.36 (13.5)	83.53 (12.71)	0.56	.458	.009
Sad Infant					
200	90.91 (13.26)	89.41 (14.35)	0.14	.701	.003
500	91.36 (10.91)	95.29 (8.74)	1.76	.189	.020
1,000	95.00 (10.67)	96.47 (7.85)	0.26	.608	.004
Neutral Infant					
200	88.43 (17.80)	94.06 (17.76)	1.22	.273	.020
500	86.14 (19.71)	78.06 (20.47)	2.01	.161	.030
1,000	96.14 (10.91)	96.00 (11.29)	0.002	.966	.000

Note. PND-F = postnatal depression of the father; 200, 500, 1,000 = stimuli exposure time in milliseconds.

TABLE 3 PND-F effect on intensity ratings of adult and infant faces

	M (*SD*)		Statistics		
	Control ($n = 44$)	PND-F ($n = 17$)	$F(1, 59)$	*p*	η^2
Happy Adult					
200	2.61 (0.28)	2.54 (0.37)	0.71	.401	.012
500	3.97 (0.33)	3.99 (0.39)	0.21	.650	.004
1,000	3.54 (0.33)	3.44 (0.27)	1.31	.256	.022
Sad Adult					
200	3.22 (0.29)	3.35 (0.26)	2.41	.126	.039
500	2.93 (0.37)	3.02 (0.40)	0.70	.403	.012
1,000	2.99 (0.45)	3.80 (0.28)	48.81	.0001	.442
Neutral Adult					
200	3.35 (0.54)	3.29 (0.47)	0.15	.700	.003
500	1.92 (0.54)	2.20 (0.75)	2.74	.103	.044
1,000	2.64 (0.58)	2.70 (0.68)	0.11	.742	.002
Happy Infant					
200	3.30 (0.33)	3.38 (0.31)	0.78	.380	.013
500	3.35 (0.26)	3.29 (0.28)	0.71	.403	.012
1,000	3.74 (0.32)	3.54 (0.29)	5.15	.027	.080
Sad Infant					
200	3.92 (0.43)	4.16 (0.47)	3.46	.068	.055
500	4.10 (0.46)	4.30 (0.37)	2.50	.119	.041
1,000	4.02 (0.35)	4.27 (0.40)	5.43	.023	.084
Neutral Infant					
200	2.80 (0.39)	2.74 (0.32)	0.28	.593	.005
500	2.57 (0.28)	2.47 (0.37)	1.41	.239	.023
1,000	2.85 (0.33)	2.82 (0.39)	0.10	.746	.002

Note. PND-F = postnatal depression of the father. 200, 500, 1,000 = stimuli exposure time in milliseconds.

No facial recognition variable had a significant effect on paternal expressed mood during interaction, controlling for PND-F. The intensity that fathers attributed to sad adult faces at 1,000 ms, however, significantly and negatively affected responsiveness, b (*SE*) = −0.345 (0.137), $P = .014$, corrected $P = .087$. A significant indirect effect of PND-F on paternal responsiveness, through the intensity attributed to sad adult faces at 1,000 ms, was found, $b = -0.281$ (.0115) 95% BCa

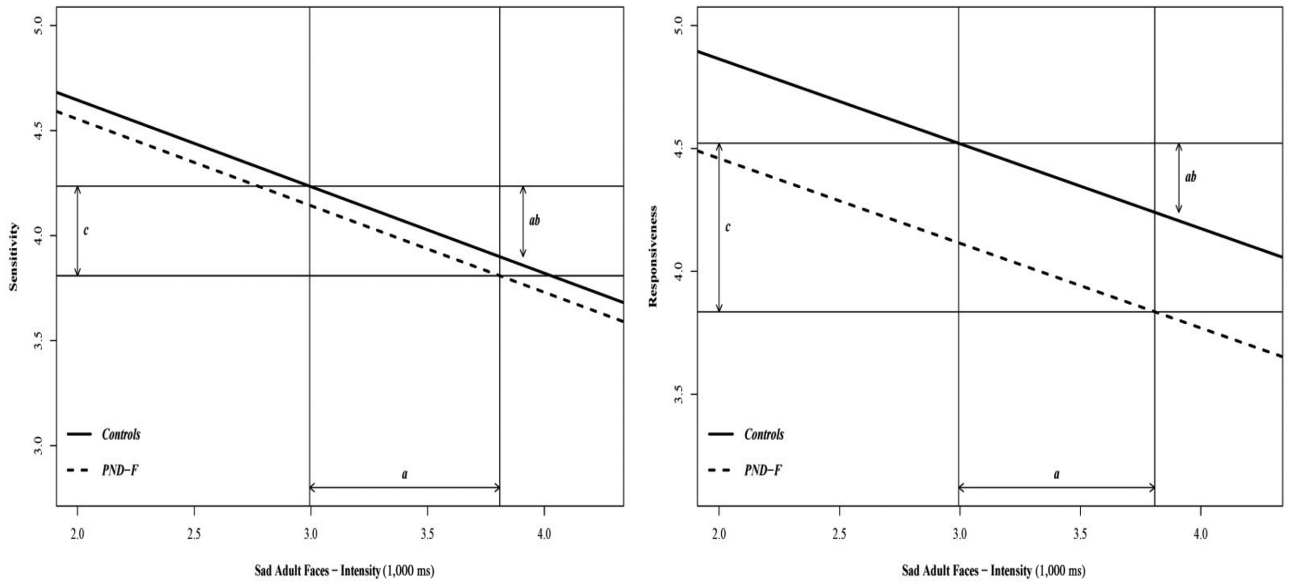

FIGURE 2 Mediator effect of adult sadness intensity on the relationship between postpartum depression and sensitivity and responsiveness dimensions. Note that *c* represents the direct effect of paternal depression on the dependent variable (responsiveness or sensitivity), *a* represents the effect of paternal depression on the mediator, and *ab* represents the portion of *c* that is mediated

CI [−0.519–−0.058], although this mediation was found to be partial, according to the Baron and Kenny (1986) criteria, as the effect of PND-F remained significant, *b* (*SE*) = −0.405 (0.167), *P* = .019, albeit reduced in magnitude by the inclusion of the mediator.

The intensity attributed to sad adult faces (1,000 ms) also was significantly and negatively associated with paternal sensitivity, *b* (*SE*) = −0.412 (0.155), *P* = .010, corrected *P* = .062. A full mediation of the effect of PND-F on the latter, through the former, was found, indirect effect, *b* = −0.336 (.0125) 95% BCa CI [−0.549–−0.050], with the effect of PND-F on paternal sensitivity made nonsignificant by the inclusion of the mediator. Figure 2 depicts our significant mediation models.

3 | DISCUSSION

This study aimed to explore whether recognition of facial expressions mediated the effects of paternal depression on father–infant interactions. Our results showed that the tendency to attribute greater intensity to sad adult faces was confirmed as a partial mediator of the effect of paternal postpartum depression on fathers' responsiveness, and as a full mediator of the effects of paternal depression on fathers' sensitivity. To our knowledge, this is the first study to investigate the routes whereby paternal postnatal depression affect father–infant interactions, assessing both face recognition and dyadic interactions in a male sample. A community sample of 61 father–infant dyads recruited in health centers and in a maternity ward of South Brazil took part in the study. In this sample, 17 fathers scored above the cutoff point for postnatal depression. The effect of PND-F on father–infant interaction in our sample was remarkably significant. Fathers diagnosed with PND-F showed difficulties in all dimensions of interaction with their infants.

Fathers with raised Beck anxiety scores postpartum were less responsive to the needs of the infants, less sensitive and less warm and affectionate toward their infants, and displayed a more negative mood in the responses to their infants as compared to nondepressed fathers. Such findings corroborate the results of Wilson and Durbin (2010), who examined dimensions of paternal interaction with offspring, and also corroborate studies on maternal postnatal depression that have revealed poorer interactions in dyads of postnatally depressed mothers and their infants (Field, 2010). These findings are of particular relevance given the importance of infancy interactions to later offspring mental health (Sweeney & MacBeth, 2016). Notably, our effects were independent of maternal mental health, pointing to a specific effect of paternal emotional state on parent–child interactions.

In our study, fathers with PND had more difficulty than did controls in recognizing happy adult faces at 200 ms and 500 ms, but were better in recognizing sad adult faces at 1,000 ms. PND-F fathers also attributed higher levels of sadness to adult and to infant faces at 1,000 ms and perceived happy faces at 1,000 ms as less happy than did controls. These results confirm those of previous literature showing impairments in recognition of happy stimuli (Isaac et al., 2014; Stein et al., 2010) and a bias toward sad stimuli (Gollan et al., 2010). Interestingly, our significant PND-F effects were observed at 200 ms and 500 ms, but mostly at 1,000 ms, suggesting that cognitive biases operate not only in terms of subtle processing

but also, and mainly, at more conscious levels. This pattern is key to understanding the impact that deficits in parents' emotional assessment of infants may have on child development, given that misinterpretation of offspring emotions may alter parents' pattern of interacting.

Due to difficulties in correctly assessing emotional faces, PND-F fathers may be less responsive and less sensitive to their infants, and therefore display an overall more negative pattern of interaction with their children. Accordingly, the clinical impact of paternal depression on the cognitive, social, and emotional development of children, especially male children, is a matter of concern. This hypothesis was corroborated in our mediation analysis. Our model confirmed responses concerning the intensity of sad faces at 1,000 ms as a mediator of the effects of PND-F on father–infant interaction, particularly on paternal responsiveness and sensitivity. Interestingly, our significant models comprised ratings of intensity (but not accuracy), in adult (but not infant) and in sad (but not happy) faces. In addition, a full mediation was confirmed for sensitivity whereas a partial mediation was confirmed for responsiveness. It could be argued that although significant group differences were observed in accuracy, rates of correct responses were still high in both groups (over 73% for all emotions at all exposure times). Therefore, it is possible that although postnatally depressed fathers did not perform as well as controls, they were still able to achieve minimum levels of accuracy.

Notably, our model was confirmed for intensity responses to sad, but not happy, faces, suggesting that overrating negative emotions has a stronger impact on father–infant interactions than do difficulties in correctly assessing happy emotions. Note that group effects were indeed stronger for sad faces, suggesting that PND-F fathers display a greater bias toward intensifying sad faces, which in turn compromises their interactions with their children. Our significant mediation models were observed for adult faces (not infant faces). The infant faces stimuli used in this study depicted infants' faces at high intensity, and deficits in face recognition with greater effect sizes may occur in expressions with lower intensities. This hypothesis is corroborated by the very high accuracy rates observed for our infant faces. Considering the three emotions and the three exposure times, the lowest average accuracy rate observed for infant faces was 83%.

This study provided evidence for a partial mediation model for responsiveness and a full mediation model for sensitivity. The responsiveness dimension assessed in this study comprises the paternal ability to be responsive and to actively capture and imitate infants´ cues as well as to respond to infants' expressions and vocalizations. It therefore includes not only the father's ability to decode infants' needs but also behavioral responses that may be learned and that are related not only to the interpretation of infant emotional expressions but also to broader experiences and culture. Conversely, the dimension of sensitivity comprises the ability to interpret subtle needs, being empathic, and not avoiding visual contact. This dimension is more closely related to empathy and subtle behaviors rather than to active behavior and imitative actions. Recognition of emotional faces has been related to theory of mind and emotional empathy in previous studies (Ávila, Morais, Bomfim, & Chagas, 2016; Bolat, Eyuboglu, Eyuboglu, Sargin, & Eliacik, 2017). It could be argued that attribution of intensity to emotional faces is of particular relevance to an empathic behavior and, in our study, fully explains the link between PND-F and paternal low sensitivity.

This study has some limitations. Our sample was relatively small. Thus, prevalence data should be interpreted with caution. The location of the research (an inner city area) can be considered another limiting factor since data from the capital of the state could have provided a more comprehensive picture of the target population than could data from the inner city, where the local population has a family income higher than the average income of families in the state capital. In addition, the first author conducted all SCIDs and also was responsible for establishing reliability on video ratings. Further studies are needed to include mothers and to perform analyses to control the effect of maternal PND on father–infant interactions, and also to use more than one blind rater for the observational data. Finally, the infant faces used in this study depicted emotions at high intensities; therefore, future research should include lower intensity stimuli. We also suggest that longitudinal studies are conducted including moderators such as socioeconomic level and parental schooling.

ACKNOWLEDGMENTS

The study was approved by the ethics committee of Pontificia Universidade Católica do Rio Grande do Sul and therefore has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All persons gave informed consent prior to their inclusion in the study.

CONFLICT OF INTEREST

All authors declare no conflicts of interest.

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