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A self-comfort oriented pattern of regulatory behavior and avoidant attachment are more likely among infants born moderate-to-late preterm

Marina Fuertes[1,2] | **Joana L. Gonçalves**[2] | **Miguel Barbosa**[3] | **Rita Almeida**[4] | **Pedro Lopes-dos-Santos**[2] | **Marjorie Beeghly**[5]

[1]Instituto Politécnico de Lisboa, Escola Superior de Educação de Lisboa, Lisbon, Portugal

[2]Centro de Psicologia, University of Porto, Porto, Portugal

[3]Instituto de Saúde Ambiental, Faculdade de Medicina, Universidade de Lisboa, Lisbon, Portugal

[4]Faculdade de Psicologia, University of Lisbon, Lisbon, Portugal

[5]Department of Psychology, Wayne State University, Detroit, MI, USA

Correspondence
Marina Fuertes, Instituto Politécnico de Lisboa, Escola Superior de Educação de Lisboa, Lisbon, Portugal.
Email: marinaf@eselx.ipl.pt

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Abstract

Infants born preterm (<37 gestational weeks, GW) are at increased risk for regulatory difficulties and insecure attachment. However, the association between infants' regulatory behavior patterns and their later attachment organization is understudied in the preterm population. We addressed this gap by utilizing a Portuguese sample of 202 mother–infant dyads. Specifically, we compared the regulatory behavior patterns of 74 infants born moderate-to-late preterm (MLPT, 32–36 GW) to those of 128 infants born full-term (FT, 37–42 GW) and evaluated the associations of these regulatory patterns with later attachment. Infants' regulatory behavior patterns (Social-Positive Oriented, Distressed-Inconsolable, or Self-Comfort Oriented) were evaluated in the Face-to-Face-Still-Face paradigm at 3 months, and their attachment organization (secure, insecure-avoidant, or insecure-ambivalent) was evaluated in the Strange Situation at 12 months corrected age. In both samples, the Social-Positive-Oriented regulatory pattern was associated with secure attachment; the Distressed-Inconsolable pattern with insecure-ambivalent attachment; and the Self-Comfort-Oriented pattern with

insecure-avoidant attachment. However, compared to FT infants, infants born MLPT were more likely to exhibit a Self-Comfort-Oriented pattern and avoidant attachment. Most perinatal and demographic variables were not related to infant outcomes. However, infants with a higher 1-min Apgar were more likely to exhibit the Social-Positive-Oriented regulatory pattern and secure attachment.

1 | INTRODUCTION

Preterm (PT) birth (<37 gestational weeks, GW) is a growing public health concern, accounting for approximately 11% (range = 5%–18%) of live births worldwide (Blencowe et al., 2013). Although advances in medical care and technology have contributed to improved survival rates, PT birth continues to be a leading cause of infant morbidity and mortality globally, particularly among infants born at earlier gestational ages (i.e., very preterm, VPT, 28–31 GW, 10%; or extremely preterm, EPT, <28 GW, 30%), or among those born in regions with inadequate medical support (Blencowe et al., 2013).

However, most PT births (over 80%) occur between 32–36 gestational weeks (moderate-to-late preterm infants, MLPT), and until recently, infants born MLPT were thought to be at low risk for negative developmental sequelae. Indeed, findings from a recent geographical, prospective population-based study confirm that many infants born MLPT (67%) experience outcomes that are comparable to those of infants born full-term (FT) (Johnson et al., 2018). Nevertheless, a sizable percentage (26%) exhibit "non-optimal" developmental and behavioral profiles that are similar to those observed in higher-risk infants born VPT or EPT. For instance, recent research shows that infants born MLPT have compromised cognitive, behavioral, attentional, and emotion regulatory functioning, relative to that of infants born FT, both during infancy/early childhood (Arpi & Ferrari, 2013; Boyle et al., 2014; Cheong et al., 2017; Gerstein et al., 2017; Ketharanathan et al., 2011; Shah et al., 2013), and at school age (Chan & Quigley, 2014; Dilworth-Bart et al., 2018; Hornman et al., 2017; Quigley et al., 2012; Talge et al., 2010; van Baar et al., 2009).

This marked heterogeneity in the outcomes of infants born MLPT (and other infants born PT) cannot be explained by medical risks alone; caregiving and other environmental factors also likely play a significant role (Delonis et al., 2017). Because of their immaturity, infants' self-regulatory capacities are limited and emerge primarily in a relational context reflecting both self and parent–infant co-regulatory processes (Beebe et al., 2010; Beeghly et al., 2016). Infants born PT are often described as more challenging to parent effectively than infants born FT. This may be due to their regulatory behavior problems, their parents' stress levels, or the transaction between parental and infant risk factors (Braungart-Rieker et al., 2014; Gerstein & Poehlmann-Tyson, 2016; Poehlmann & Fiese, 2001; Poehlmann et al., 2011; Sameroff & Fiese, 2000). Although findings are inconsistent (Bilgin & Wolke, 2015), several researchers report that infant–mother dyads in the PT population are more likely to exhibit compromised patterns of social interaction, relative to their FT counterparts (Forcada-Guex et al., 2006, 2011; Minde, 2000; Thompson et al., 2003), and are more likely to form insecure attachment relationships (Korja et al., 2008; Wolke et al., 2013).

Other research suggests that positive parent–child relationships may be protective for infants born PT. In a longitudinal sample of infants born VPT and FT, Delonis et al. (2017) found that parent–toddler interactions characterized by mutual responsivity and shared positive affect attenuate the negative association between birth risk and children's cognitive and social emotional outcomes in early childhood. In contrast, Poehlmann et al. (2011) reported that infants born PT who are distress-prone are especially susceptible to the effects of negative parenting. Therefore, assessing individual differences in infants' early self-regulatory patterns is critical, and this assessment may be most effectively accomplished in a dyadic interactive context, such as the Face-to-Face Still-Face paradigm (FFSF, Tronick et al., 1978).

2 | EMERGENCE OF REGULATORY BEHAVIOR PATTERNS IN EARLY INFANCY

The ability to communicate and regulate emotions and behavior effectively during social interactions is crucial in accomplishing one's social goals and is a foundational component of social competence (Thompson, 1994). The success or failure of immature infants' attempts to regulate emotions and behavior during social exchanges derives not only from their own efforts and age-possible capacities but also from the quality of support that caregivers provide in achieving dyadic co-regulation (Beeghly et al., 2016; Bigelow & Power, 2014). Infants' regulatory patterns consist of co-occurring emotional expressions and behaviors (e.g., positive and negative affect, gaze directed at or away from the caregiver, self-soothing behaviors such as thumb-sucking, and altered postures such as distancing; Tronick et al., 2019). Infants use these regulatory patterns to achieve specific social goals such as re-engaging the caregiver in social interaction following an interruption, or down-regulating distress (Shapiro et al., 1998).

Infants' iterated experiences gradually modulate the style of their regulatory responses during caregiver-infant social interactions. Depending on their unique biopsychosocial characteristics (e.g., health, temperament, and consistency of caregiver responsiveness), different infants learn to use different regulatory patterns to best achieve their attachment and regulatory goals. Some infants learn to over-regulate their emotions during caregiver-infant interactions, whereas others learn to under-regulate them, as reflected in their relative tendency to engage in predominately positive or negative behaviors and to rely on self or others to regulate emotions during social exchanges (Tronick et al., 2019).

3 | EARLY REGULATORY PATTERNS OF INFANTS BORN PT OR FT IN THE FFSF

The FFSF is a well-described observational paradigm often used to evaluate variations in infants' regulatory behaviors before, during, and after an interactive stressor (maternal still-face) during which mothers temporarily adopt behavioral and affective unavailability (see Mesman et al., 2009, for a review). With a few exceptions (e.g., Jean & Stack, 2012), most studies comparing the regulatory behaviors of infants born FT and infants born PT in the FFSF have reported significant group differences (Feldman et al., 2010; Hsu & Jeng, 2008; Segal et al., 1995). However, specific findings vary. For example, Hsu and Jeng (2008) found that during the still-face episode of the FFSF, 2-month-old infants born PT (24–34 gestational weeks) became distressed faster and maintained a negative affective state longer than age-matched infants born FT, showing more

difficulty recovering after exposure to the maternal still-face. This suggests that infants born PT might be more susceptible to the stress of being exposed to a still-faced mother at 2 months of age. Similarly, in another study, 7-month-old infants born PT spent less time displaying big smiles to their mother during the first (baseline) episode of the FFSF and exhibited a less pronounced decrease in big smiles during the still-face episode, compared to age-comparable infants born FT (Segal et al., 1995). Results from these two studies describe infants born PT as fussier and as less engaged in positive social behavior than infants born FT during early to mid-infancy.

In an Italian sample, Montirosso et al. (2010) describe different patterns of infant regulatory behavior for PT and FT infants in the FFSF, at 6–9 months of age (corrected for gestational age in PT group). Specifically, they reported that infants born PT (26–36 weeks gestational age, with a high proportion of infants born MLPT) were more behaviorally and affectively restrained and were more likely to exhibit a self-comfort oriented style of coping during the FFSF than age-comparable infants born FT. The infants born PT in this sample exhibited more social withdrawal (e.g., distancing behaviors) and signaled their distress less often to their mother across all episodes of the FFSF. In this cross-sectional study, these infants also engaged in more social monitoring behaviors during the FFSF reunion compared to infants born FT.

Similar findings were reported by Fuertes et al. (2009) in a Portuguese sample of mostly MLPT infants (31–36 GW) evaluated at 3 months of age. In a study comparing three categories of infant regulatory behavior (positive other-oriented, negative other-oriented, and self-comforting behaviors), infants born PT exhibited a high prevalence of self-comforting behaviors (e.g., distancing behavior, looking away from the mother, oral behaviors such as thumb-sucking) across FFSF episodes Similarly, in an Israeli study by Yaari et al. (2018) comparing the behaviors of infants born very preterm (VPT, <32 GW), MLPT, and FT during the FFSF at 4 months of age, infants born MLPT exhibited more self-comforting behaviors, whereas infants born VPT exhibited more negative affect and gaze aversion than the other groups of infants.

Taken together, these findings suggest that infants born PT exhibit diverse patterns of regulatory behavior during the FFSF during the first year of life. Some infants born PT display increased negative affect and emotion regulation difficulties, compared to infants born FT, whereas others engage in social withdrawal and self-comforting regulatory behaviors. The reasons for these diverse reactions to the FFSF are not fully understood. These variations might be explained, at least in part, by methodological differences across studies, such as differences in the degree of prematurity (gestational age at delivery) among the infants born PT included in the sample, or differences in the post term age at which infants are evaluated in the FFSF. Alternatively, these findings may indicate that infants exhibit stable individual differences in early regulatory patterns that emerge in a relational context with their caregivers. Bowlby (1969) theorized that secure attachment relationships with caregivers develop gradually over time in relational contexts. However, whether infants' discrete regulatory behaviors or organized regulatory patterns during the FFSF presage variations in later attachment formation is relatively understudied.

4 | ASSOCIATION OF INFANT REGULATORY BEHAVIOR IN THE FFSF WITH ATTACHMENT

Only a few studies have investigated whether infants' discrete regulatory behaviors in the FFSF during the first year of life are associated with later attachment. Results of a meta-analytic review by Mesman et al., 2009, which included eight studies with FT infants, revealed that the display of more positive ($d = 0.23$) and less negative affect ($d = 0.24$) during the FFSF was associated with

attachment security at 12 months of age. The relatively small effect size for these associations suggests that the specific results from this small group of studies are somewhat inconsistent.

For example, several researchers found no significant associations between infant negative affect in the FFSF and later attachment (Braungart-Rieker et al., 2014; Ekas et al., 2013), whereas other studies reported that infants who exhibited less crying and negative affect during still-face and reunion episodes of the FFSF while presenting more positive social behaviors, were more likely to be securely attached in later infancy (e.g., Cohn et al., 1991; Kiser et al., 1986). Still other studies found that infants who were more alert, reactive, and had more difficulty in returning to baseline levels of behavior after exposure to the maternal still-face in the FFSF were more likely to be classified as being securely attached in later infancy (Koulomzin et al., 2002). In contrast, infants who tended to avoid eye contact with their mothers and displayed more self-comforting behaviors in the FFSF were more likely to be classified as having an avoidant attachment in later infancy (Koulomzin et al., 2002). Interestingly, Braungart-Rieker et al. (2001) found that infants' early emotion regulatory capacities may play an important role in these associations. Specifically, they found that infants who exhibited more affect regulation (e.g., less distress) during the FFSF were also more likely to show better emotion regulation during the Strange Situation in later infancy (i.e., to be classified as having an attachment pattern associated with lower arousal, such as an A1, A2, B1, or B2 classification), whereas infants who exhibited less affect regulation in the FFSF were more likely to be dysregulated and distressed during the Strange Situation (i.e., to be classified as having an attachment characterized by higher arousal, such as a B3, B4, C1, or C2 classification).

A growing literature also shows that infants may exhibit age-related changes in the strategies they utilize for regulating emotions and behavior during the FFSF. Work by Ekas et al. (2011, 2013) indicates that younger infants are more likely than older infants to use regulatory behaviors such as looking at parents and engaging in self-soothing (e.g., thumb-sucking) during social exchanges, whereas older infants are more likely to use distraction strategies such as object engagement. However, other research provides support for stable individual differences in infants' organized regulatory responses over time. For instance, in a longitudinal Portuguese study of FT infants, Barbosa et al. (2018) showed that infants' patterns of regulatory behavior observed in FFSF were relatively stable from 3 to 9 months of age.

These variations in findings across studies likely reflect methodological differences such as how infant regulatory behaviors are assessed. In a study of Portuguese FT infants, Fuertes and Lopes-dos-Santos (2009) evaluated infant regulatory patterns based on a typology that attends to the function of the infant behavior in context, for example, evaluating infants' goal to repair a disrupted interaction, to regain attention or to express negative affect, rather than assessing specific discrete behaviors. In that study and in a subsequent study of FT infants using a similar methodology, infants' early regulatory patterns were significantly associated with their attachment patterns in the Strange Situation at 12 months (Barbosa et al., 2020; Fuertes, Lopes-dos-Santos, et al., 2009). Specifically, infants who exhibited a Social-Positive Oriented regulatory pattern during the FFSF at 3 months of age were more likely to be classified as securely attached, whereas infants who exhibited a Distressed-Inconsolable pattern were more likely to be classified as insecure-ambivalent, and infants who engaged in Self-Comfort Oriented pattern were more likely to be classified as insecure-avoidant in the Strange Situation (Barbosa et al., 2020).

Similarly, in other longitudinal research with Portuguese infants born PT, Fuertes et al. (2006); Fuertes, Faria et al. (2009); Fuertes, Lopes-dos-Santos et al. (2009) found that infants who exhibited a pattern of positive social behavior with their mother across all episodes of the FFSF at 3 months were more likely to have a secure attachment in the Strange Situation at 12 months.

In contrast, infants who displayed negative behavior in the FFSF at 3 months were more likely to have an insecure-ambivalent attachment, and infants who engaged in more frequent self-comforting behavior in the FFSF were more likely to have an insecure-avoidant attachment.

However, none of these studies evaluated both PT and FT infants together in the same study. Further longitudinal studies comparing these associations in infants born PT and age and demographically similar groups of infants born FT are needed to better understand the impact of prematurity on the emerging relation between early self-regulatory strategies and attachment formation during the first year of life.

5 | THE PRESENT STUDY

To address this gap, we conducted a longitudinal study of infants born MLPT and infants born FT, and their mothers, to evaluate whether infants' regulatory behavior patterns in the FFSF at 3 months corrected age were associated with their attachment patterns at 12 months corrected age. A secondary aim was to assess whether infants' perinatal characteristics such as gestational age at delivery or birth weight, or demographic factors such as infant biological sex or maternal age and education were associated with infants' early regulatory patterns or later attachment.

6 | METHOD

6.1 | Sample characteristics and recruitment

Participants included 74 infants born MLPT (41 girls, 33 boys) and 128 infants born FT (61 girls, 67 boys), and their mothers who were followed longitudinally from the time of the infants' birth to 12 months postpartum (corrected for gestational age). Only infants born MLPT or infants born FT were evaluated in the current study due to the very low prevalence of infants born VPT or EPT at the time of recruitment. All participants in each group resided in the greater Lisbon and Porto metropolitan areas of Portugal. Most were Portuguese-Caucasian from urban, working-class and middle-class socioeconomic backgrounds.

Recruitment of the sample took place over a 2-year period. Two research assistants contacted potential participants in the maternity wards and NICUs of Lisbon and Porto metropolitan hospitals and explained the study's purpose and procedures to them. To be eligible to participate in the present study, infants and mothers had to meet the following inclusion criteria. Infants in the MLPT group had to have (a) a gestational age at delivery ranging from 32 to 36 weeks, and (b) a birth weight less than 2.500 g. Mothers in both the MLPT and FT groups had to be (a) at least 18 years old at the time of their infant's birth; (b) their infant's primary caregiver; and (c) free of any record of severe mental health or drug/alcohol addiction problems, as determined by medical record review and maternal self-report. Maternal postpartum depression was additionally assessed with the Portuguese Depression Scale, IACLIDE (Vaz-Serra, 1995). Five mothers from the MLPT sample and six from the FT sample had clinically significant levels of depression and were excluded from the present study (reducing our sample to 202 participants).

Descriptive statistics for the perinatal and demographic characteristics of participants in the FT and MLPT groups are provided in Table 1.

TABLE 1 Sample characteristics

	Full-Term			Moderate-to-Late Preterm				
	M	SD	Min–Max	M	SD	Min–Max	*t*	*p*
Gestational weeks at birth	39.53	1.07	37.00–41.57	34.25	1.75	31.9–36.50	26.66	.001
Birthweight (g)	3277.38	466.93	1390–4350	2285.55	605.63	1050–3900	12.96	.001
Apgar at first minute	9.12	0.57	5–10	8.01	1.42	2–10	7.72	.001
Apgar at fifth minute	9.97	0.18	9–10	9.35	0.79	7–10	8.47	.001
Maternal age	31.90	4.19	20–42	29.46	5.80	18–42	3.45	.001
Maternal years of education	14.64	3.44	6–23	12.42	5.10	3–23	3.67	.005

6.1.1 | Perinatal characteristics

All information regarding infants' pre- and perinatal characteristics in both groups was collected from hospital records. All infants in each group (MLPT and FT) were healthy and clinically normal at delivery as determined by pediatric examination. No infants had any sensory or neuromotor disabilities, serious illnesses, or congenital anomalies. As expected, infants in the MLPT and FT groups differed significantly on number of gestational weeks at delivery, birth weight, and Apgar scores evaluated at 1 and 5 min after delivery. In the MLPT group, infants' stay in the Neonatal Intensive Care Unit (NICU) ranged from 5 to 31 days (See Table 1).

6.1.2 | Demographic characteristics

Demographic information was obtained from mothers and medical record reviews at the time of recruitment. The two infant groups did not differ significantly on most demographic variables, including infant biological sex, parents' Portuguese nationality, marital status, parental employment status, or family size, including number of siblings. All infants in both groups lived with both parents in the same household.

However, the MLPT and FT groups differed significantly on two demographic variables. Mothers in the PT group were slightly younger and had fewer years of completed education than mothers in the FT group. Although these demographic differences are consistent with those reported in previous Portuguese samples of mothers of infants born PT and FT (Fuertes, Lopes-dos-Santos, et al., 2009; Rodrigues & Barros, 2007), we evaluated maternal age and education as possible covariates in the multivariate analyses.

6.2 | Procedures

All procedures in the present study were conducted according to the ethical guidelines presented in the Declaration of Helsinki, with written informed consent obtained from all individual participants or their legal guardians in the study before any assessment or data collection took place. All procedures were approved by the Ethics Committees of all Health Units and Hospitals involved, as well as by the Portuguese Data Protection Commission.

At 3 and 12 months postpartum (corrected age for the MLPT sample), mothers were contacted to schedule a follow-up visit to the laboratory. Mother–infant dyads were videotaped during two laboratory paradigms: (a) the FFSF paradigm (Tronick et al., 1978) when infants were 3 months old and (b) the Strange Situation procedure (Ainsworth et al., 1978) when infants were 12 months old.

Face-to-Face Still-Face paradigm (FFSF, Tronick et al., 1978). The FFSF paradigm includes three successive 3 min episodes: (a) a face-to-face baseline interaction during which mothers were instructed to play with their infants as they normally would at home without using toys or pacifiers; (b) a still-face perturbation, during which mothers were instructed to keep a "poker face" while looking at the infants, and to refrain from smiling, talking, or touching the infant; and (c) a reunion episode, during which mothers were instructed to resume their normal play interaction with the infant. To mark the beginning and end of each episode more clearly for scoring purposes, each episode was separated by a 15-s interval during which the mother was asked to turn away from the infant.

Mothers and infants were videotaped during the FFSF using two cameras, one focused on the mother's face and upper torso, and the other focused on the infant's face and body. Both cameras were connected to an image mixer software that generated a time-synchronized split-screen image of each partner on a single video record.

The *Strange situation* (Ainsworth et al., 1978) is a 21-min laboratory-based observational paradigm involving a sequence of eight brief (3-min) episodes (or less if the infant is distressed) of increasing stress for the infant, including being introduced to an unfamiliar playroom, interacting with an unfamiliar adult stranger, and two mother–infant separations and reunions.

6.3 | Measures

The *coding system for regulatory patterns in the FFSF* (Fuertes & Lopes-dos-Santos, 2009) was used to score infants' regulatory patterns from videotapes of the FFSF at 3 months. This coding system describes three patterns of infants' regulatory behavior: Social-Positive Oriented, Distressed-Inconsolable, and Self-Comfort Oriented, that were derived from four dimensions of infants' behavior and affective facial expressions across the three episodes of the FFSF paradigm: (a) behavior organization (e.g., the infant exhibits predominantly positive social behavior, distressed behavior, or self-comforting behavior, or a mixed-pattern behavior); (b) intensity of exhibited behavior (e.g., the infant displays prolonged and intense crying); (c) quality of behavior (e.g., the infant reacts by displaying signals denoting pleasure such as smiles, laughter, and reciprocal neutral or positive vocalizations); and (d) infants' ability to recover from negative affect during the reunion episode of the FFSF.

The FFSF videotapes were scored for infant regulatory patterns by three trained, reliable coders. The intercoder agreement was calculated using Cohen's kappa coefficient. Results indicated good agreement for all regulatory patterns ($M_{\kappa} = 0.81$). Following the assessment of intercoder reliability, discrepant classifications were discussed and resolved in conference.

Attachment classifications. Videotapes of infants' attachment behavior during the Strange Situation were scored by two trained, reliable coders following the procedures developed by Ainsworth et al. (1978). Infants were classified as either securely attached (B), insecure-avoidant (A), insecure-ambivalent (C), or insecure-disorganized (D). Cohen's kappa coefficients ($M\kappa = 91$) indicated excellent intercoder reliability.

6.4 | Analytic plan

Three sets of statistical analyses were conducted to address the goals of the current study. First, the distribution of patterns of regulatory behavior and patterns of attachment for the FT and MLPT groups were obtained using univariate frequency analysis. Second, cross-tabulations were performed for both samples to investigate the prevalence between the regulatory behavior patterns at 3 months and attachment patterns at 12 months. The chi-square test was used to determine group differences in prevalence. Additionally, the Bonferroni test correction was used as a measure of proportional reduction in error type I to predict patterns of attachment at 12 months based on patterns of regulatory behavior at 3 months. Cramer's V test was applied to test differences in our results considering the sample size. Finally, bivariate statistics were used to evaluate the association between perinatal and demographic variables and (a) the three infant regulatory

patterns at 3 months and (b) attachment classifications at 12 months. These analyses were conducted separately within each infant group.

7 | RESULTS

7.1 | Distribution of infant regulatory patterns and attachment classifications in the FT and MLPT groups

Table 2 summarizes the frequencies and percentages of infants in the FT and MLPT groups who were classified in the three infant regulatory patterns in the FFSF at 3 months postpartum.

In the FT group, the Social-Positive Oriented pattern was the most frequent (53.1%), followed by the Distressed-Inconsolable pattern (35.9%) and the Self-Comfort-oriented pattern (10.9%). In the MLPT sample, the Social-Positive Oriented was also the most frequent (54.1%); however, the prevalence of the other two regulatory patterns appeared in the reversed rank order. The Social-Positive Oriented pattern was followed by the Self-Comfort Oriented pattern (29.7%) and the Distressed-Inconsolable pattern (16.2%). Notably, the percentage of the Distressed-Inconsolable pattern was higher in the FT group than in the MLPT group, whereas the Self-Comfort Oriented pattern was more common in the MLPT group than in the FT group, χ^2 (2) = 15.651, $p < .001$. This difference was confirmed when the adjusted residual values were recalculated with the Bonferroni test correction. Results of Cramer's V provided no evidence for significant sample size effects, $\phi_C = 278$, $p < .001$.

Descriptive statistics regarding the distribution of attachment classifications in the FT and MPLT groups are provided in Table 3. At 12 months in the Strange Situation, secure attachment was the most frequent attachment pattern observed in both groups. However, the percentage

TABLE 2 Regulatory behavior patterns of infants born full-term and infants born moderate-to-late preterm in the Face-to-Face Still-Face paradigm at 3 months

Regulatory behavior patterns	Full-Term	Moderate-to-Late Preterm
Social-Positive Oriented (SPO)	68 (53.1% −0.1)[a]	40 (54.1% 0.1)[a]
Distressed-Inconsolable (DI)	46 (35.9% 3.0)[a]	12 (16.2% −3.0)[b]
Self-comfort oriented (SCO)	14 (10.9% −3.4)[a]	22 (29.7% 3.4)[b]

Note: Pearson's chi-square = 15.651, df = 2, $p < .001$; Each superscript letter denotes a subset of patterns of regulatory behavior at 3 months categories whose column proportions do not differ significantly from each other; $p < .05$ (column proportions test with Bonferroni adjustment).

TABLE 3 Attachment patterns of infants born full-term and moderate-to-late preterm in the Strange Situation at 12 months

Attachment Patterns	Full-Term	Moderate-to-Late Preterm
Avoidant (A)	15 (11.7% −4.0)[a]	26 (35.1% 4.0)[b]
Secure (B)	80 (62.5% 3.0)[a]	30 (40.5% −3.0)[b]
Ambivalent (C)	33 (25.8% 0.2)	18 (24.3% −0.2)

Note: Pearson's chi-square = 16.859, df = 2, $p < .001$; Each superscript letter denotes a subset of attachment at 12 months categories whose column proportions do not differ significantly from each other; $p < .05$ (column proportions test with Bonferroni adjustment). FT, full-term; MPT, moderate-to-late preterm.

of infants with secure attachment was higher in the FT group (62.5%) than in the MLPT group (40.5%). Moreover, the avoidant attachment pattern was more prevalent in the MLPT sample (35.1%) than in the FT sample (11.7%), χ^2 (2) = 16.859, $p < .001$. Results of Cramer's V provided no evidence for significant sample size effects, $\phi_{C =} 289$, $p < .001$.

7.2 | Association between patterns of regulatory behavior and patterns of attachment

The associations between infants' regulatory behavior patterns in the FFSF at 3 months and their attachment classifications in the Strange Situation at 12 months are summarized in Table 4 for the FT sample and in Table 5 for the MLPT sample.

In the FT sample, there was a moderate association between infants' regulatory behavior patterns at 3 months and their attachment classification at 12 months, χ^2 (2, n = 128) = 30.334, $p < .001$. Similar findings were observed in the MLPT sample, χ^2 (4, n = 74) = 55.926, $p < .001$. Specifically, in both samples, there was a significant association between (1) the Social-Positive Oriented pattern and secure attachment, (2) the Distressed-Inconsolable pattern and insecure-ambivalent attachment, and (3) the Self-Comfort Oriented pattern and insecure-avoidant attachment.

TABLE 4 Association between regulatory behavior patterns at 3 months and attachment patterns at 12 months in the Full-term (FT) group

		Attachment at 12 months			
FT group		**Avoidant**	**Secure**	**Ambivalent**	**Total**
Patterns of regulatory behavior at 3 months	SPO	2 (2.9% −3.3*)[a]	60 (88.4% 6.4*)[b]	6 (8.7% −4.7*)[a]	68
	DI	6 (14.6% 0.3)[a,b]	17 (35.4% −4.5*)[b]	23 (50% 4.7*)[a]	46
	SCO	7 (50% 4.7*)[a]	3 (21.4% −3.4*)[b]	4 (28.6% 0.3)[b]	14
Total		15	80	33	128

Note: Pearson's chi-square = 55.926, df = 4, $p < .001$; Each superscript letter denotes a subset of attachment at 12 months categories whose column proportions do not differ significantly from each other; $p < .01$ (column proportions test with Bonferroni adjustment). DI, distressed inconsolable; SCO, self-comfort oriented; SPO, social-positive oriented.

TABLE 5 Association of regulatory behavior patterns at 3 months and attachment patterns at 12 months in the Moderate-to-Late Preterm (MLPT) group

		Attachment at 12 months			
MLPT group		**Avoidant**	**Secure**	**Ambivalent**	**Total**
Patterns of regulatory behavior at 3 months	SPO	6 (15% −3.9)[a]	26 (65% 4.6)[b]	8 (20% −0.9)[a]	40
	DI	4 (33.3% −0.1)[a,b]	2 (16.7% −1.8)[b]	6 (50% 2.3)[a]	12
	SCO	16 (72.7% 4.4)[a]	2 (9.1% −3.6)[b]	4(18.2% −0.8)[b]	22
Total		26	30	18	74

Note: Pearson's chi-squar = 30.334, df = 4, $p < .001$; Each superscript letter denotes a subset of attachment at 12 months categories whose column proportions do not differ significantly from each other; $p < .05$ (column proportions test with Bonferroni adjustment). DI, distressed inconsolable; SCO, self-comfort oriented; SPO, social-positive oriented.

7.3 | Associations of perinatal and demographic characteristics with infants' regulatory patterns at 3 months and attachment at 12 months

7.3.1 | Perinatal characteristics and patterns of regulatory behavior

Results of one-way ANOVAs, provided in Table 6, showed that infants with higher 1-min APGAR scores at delivery in both groups were more likely to be classified as having a Social-Positive Oriented pattern of regulatory behavior at 3 months, than a Distressed-Inconsolable pattern or a Self-Comfort Oriented pattern. No other perinatal factors (i.e., 5-min Apgar scores, gestational age, or birth weight) or demographic factors (i.e., maternal age or maternal education) were associated with infant regulatory patterns.

7.3.2 | Perinatal characteristics and patterns of attachment

Results of one-way ANOVAs showed that, for infants in the FT group, higher birth weight was associated with secure and insecure-ambivalent attachment at 12 months Secure attached MLPT infants had higher of Apgar at first minute scores than infants with an insecure-avoidant or insecure-ambivalent attachment. These results are provided in Table 7.

7.3.3 | Demographic factors, regulatory patterns, and attachment

Cross-tabulation and chi-square analysis revealed no significant associations between the regulatory patterns or attachment patterns and demographic variables including infants' biological sex, maternal parity, maternal employment status, nationality, or family size.

8 | DISCUSSION

The primary goal of this longitudinal study was to compare the early patterns of regulatory behavior of infants born MLPT and infants born FT in the FFSF at 3 months (corrected age) and to evaluate their associations with infants' attachment organization assessed in the Strange Situation at 12 months. We also evaluated whether variations in perinatal or demographic characteristics were associated with the study variables in each group.

8.1 | Infant regulatory patterns in the FFSF at 3 months

As reported in past studies with Portuguese FT infants at 3 months of age (Barbosa et al., 2018), the most prevalent regulatory pattern displayed by infants in both groups in the current study was the Social-Positive Oriented pattern. However, significant differences in the prevalence of the other two regulatory patterns were observed within each group. A higher proportion of infants born FT exhibited the Distressed-Inconsolable pattern than a Self-Comfort Oriented pattern, whereas a higher proportion of infants born MLPT displayed a Self-Comfort-oriented pattern than the Distress-Inconsolable pattern.

TABLE 6 Means, standard deviations, and MANOVA results for perinatal factors and demographics, according to infant regulatory behavior patterns observed during FFSF at 3 months in the Full-term (FT) group and the Moderate-to-Late Preterm (MLPT) group

Demographics variables	Social-positive oriented (SPO) *M* (SD)	Distressed-inconsolable (DI) *M* (SD)	Self-comfort oriented (SCO) *M* (SD)	*F*	*p*
FT group					
Gestational weeks at birth	39.56 (1.15)	39.53 (1.01)	39.39 (0.89)	0.13	.88
Birthweight (g)	3259.85 (497.71)	3277.27 (389.11)	3362.86 (556.24)	0.28	.76
Apgar at first minute	9.28 (0.49)[a]	8.91 (0.70)[b]	9.00 (0.00)[b]	6.53*	.00
Apgar at fifth minute	9.99 (0.12)	9.93 (0.25)	10.00 (0.00)	1.43	.24
Maternal age	32.16 (3.81)	31.72 (4.92)	31.21 (3.49)	0.36	.70
Maternal years of education	14.56 (3.21)	14.83 (3.77)	14.43 (3.67)	0.11	.90
MLPT group					
Gestational weeks at birth	34.31 (1.61)	34.00 (2.41)	34.30 (1.64)	0.18	.83
Birthweight (g)	2912.74 (693.91)	3068.95 (649.03)	2656.78 (783.30)	0.26	.77
Apgar at first minute	8.36 (1.24)[a]	8.25 (1.03)[b]	7.38 (1.75)[b]	3.16*	.05
Apgar at fifth minute	9.64 (0.74)	9.40 (0.51)	9.10 (0.94)	1.94	.15
Maternal age	29.35 (5.72)	28.00 (7.12)	30.45 (5.17)	0.71	.50
Maternal years of education	11.62 (4.81)	14.50 (5.28)	12.71 (5.40)	1.54	.22

Note: Means with a different subscript are statistically different at $p < .05$, Tukey's HSD procedure. *$p < .05$.

TABLE 7 Means, standard deviations, and MANOVA results for perinatal factors and demographics, according to attachment patterns during the Strange Situation at 12 months in the Full-term (FT) group and in the Moderate-to-Late Preterm (MLPT) group.

Demographics variables	Avoidant *M* (SD)	Secure *M* (SD)	Ambivalent-resistant *M* (SD)	*F*	*p*
FT group					
Gestational weeks at birth	34.26 (1.74)	34.55 (1.87)	33.74 (1.51)	1.21	.30
Birthweight (g)	3052.14 (471.92)[a]	3286.14 (486.87)[b]	3353.28(390.60)[b]	3.09*	.05
Apgar at first minute	7.96 (1.57)	7.90 (1.54)	8.28 (0.96)	0.42	.66
Apgar at fifth minute	9.40 (0.71)	9.28 (.88)	9.39 (0.78)	0.20	.82
Maternal age	30.69 (5.32)	29.23 (5.50)	28.06 (6.88)	1.14	.33
Maternal years of education	13.24 (5.24)	12.31 (4.31)	11.44 (6.10)	0.65	.52
MLPT group					
Gestational weeks at birth	39.27 (0.79)	39.61 (1.11)	39.45 (1.08)	0.79	.46
Birthweight (g)	3052.14 (471.92)	3386.44 (486.87)	3353.28 (390.60)	2.10	.13
Apgar at first minute	9.00[a] (0.00)	9.23[b] (0.48)	8.91[a] (0.81)	4.12*	.02
Apgar at fifth minute	10.00 (0.00)	9.97 (0.16)	9.94 (0.24)	0.72	.49
Maternal age	31.07 (3.01)	32.34 (4.71)	31.21 (3.14)	1.18	.31
Maternal years of education	14.53 (3.70)	14.51 (3.42)	15.00 (3.46)	0.24	.79

Note: Means with a different subscript are statistically different at $p < .05$, Tukey's HSD procedure. *$p < .05$.

These results suggest that the effects of prematurity on early patterns of regulatory behavior may be observable as early as 3 months postpartum. Most importantly, it seems that, when assessed in stressful dyadic interactive contexts such as the FFSF, infants born MLPT have a greater tendency than age-comparable infants born FT to engage in self-comforting behaviors such as thumb-sucking and self-directed regulatory behaviors such as distancing behavior, as well as to exhibit more social monitoring and fewer smiles.

These results are consistent with prior findings by Fuertes, Lopes-dos-Santos, et al. (2009) in an independent Portuguese sample and by Montirosso et al. (2010) in an Italian sample. One possible explanation for these differences may reflect the developmental and neuromaturation specificities of infants born PT. Several studies report that infants' emotional regulation strategies change across the first year as they grow older, with important developmental transitions occurring at 1.5, 3, 4, 6, and 9 months (Ekas et al., 2013). For instance, self-comfort behaviors that are prevalent at earlier ages are replaced by more effective and sophisticated strategies such as attentional distraction (e.g., Ekas et al., 2013) or verbal cues (Yato et al., 2008) at later ages. In the current sample, it is possible that the infants born FT might have achieved these developmental shifts earlier than the infants born PT. Although age-corrected criteria were used for infants in the PT sample, we wonder whether the extensive use of social monitoring, the display of fewer smiles, and the production of more self-comforting behaviors observed for the infants born PT may reflect their delayed developmental and neuromaturation processes. Alternatively, these findings may indicate that, compared to infants born FT, the attempts of infants born PT to self-regulate may be more effortful and costly.

In the present study, infant regulatory behavior was evaluated only at 3 months postpartum. In future research, it will be important to evaluate possible age-related changes in the regulatory patterns of infants born MLPT and FT at multiple time points across the first year of life. This analysis could reveal important group differences in neuromaturation or parenting, as well as in age-related trajectories of infants' patterns of regulatory behavior across the first year.

Additionally, our findings expand the current knowledge concerning infants' early socio-emotional development by indicating that 3-month-old infants born MLPT are more likely than 3-month-old infants born FT to exhibit social withdrawal behaviors to cope with the social stressors of the FFSF (e.g., distancing behavior, social monitoring, and self-comforting behaviors). We speculate that a Self-Comfort Oriented pattern of regulatory behavior may emerge early in life for these infants, because PT birth (including MLPT birth) is often associated with challenging and stressful circumstances in early life, such as prolonged hospital stays, intrusive and painful medical procedures, and altered caregiving practices. For instance, in Portugal (e.g., Autunes et al., 2021), the NICU admission rate is five to ten times greater for infants born MLPT than for infants born FT. In a study comparing three categories of infant regulatory behavior (positive other-oriented, negative other-oriented, and self-comforting behaviors), Fuertes et al. (2014) reported that a higher number of days hospitalized in the NICU are associated with a higher frequency of self-comforting regulatory behaviors, such as thumb-sucking, gaze aversion, object orientation, and distancing, rather than positive other-oriented or negative other-oriented types of regulatory behaviors. In the current sample, infants born MLPT stayed in the NICU from 5 to 31 days.

In contrast, infants born FT in the current sample tended to exhibit a greater readiness to socially engage with caregivers during the FFSF. This suggests that, in relational contexts, infants born FT may learn how to contribute to the co-regulation and repair of social interactions and engage in prolonged reciprocal exchanges during the FFSF earlier than infants born PT, consistent with other reports (Banella & Tronick, 2019; Tronick & Beeghly, 2011). Therefore, prematurity may interfere with, or delay, these emergent transactional co-regulatory processes (Korja

et al., 2012). It may be that, instead of learning how to socially engage and relate with caregivers, infants born PT often need to learn to regulate their attention and emotional states and self-regulate based on their own "emotional resources" or coping mechanisms.

Moreover, mothers of infants born PT may experience a violation of their expectations regarding their infant, the transition to parenthood, and/or their maternal role and experiences (Fuertes et al., 2012; Gonçalves et al., 2020). Compared to mothers of infants born FT, mothers of infants born PT are more likely to be affected by differences in their PT infant's responses to them during social interactions (e.g., fewer alert states, less display of interest, less activity) and by the altered conditions of their maternity experience (e.g., being physically away from their newborn in the NICU and having to rely on health professionals to care for their baby; Muller-Nix et al., 2004). Such conditions may limit, alter, or delay the chances that each partner in the mother–infant dyad have to develop a mutually coordinated, synchronous relationship during early infancy, and to learn how to repair misattunements and return to mutually engaged social interactions. Perhaps infants born PT, therefore, are more likely to organize self-directed patterns of regulatory behavior during caregiver-infant social interactions, in order to cope with dyadic failure in repairing interactive mismatches (Beeghly et al., 2011; Tronick et al., 2020).

In the attachment literature comparing PT and FT birth, several studies report that insecure attachment is more prevalent among infants born PT (e.g., Korja et al., 2008). This association is especially likely when prematurity is associated with other social or health risk factors, including family socioeconomic disadvantage, lower parental education, inadequate social support (Fuertes et al., 2009; Gross et al., 2001), parents' mental health problems (Poehlmann & Fiese, 2001), or the presence of serious medical risks associated with PT birth, such as very low birthweight (less than 1500 g), gestational age less than 32 weeks, and co-morbid infant health problems/concomitant associated clinical-health conditions or medical complications (Coppola et al., 2007; Eriksson, & Pehrsson, 2002; Forcada-Guex et al., 2011; Schmucker et al., 2005). Nevertheless, our results also indicate that the incidence of insecure attachment is higher among infants born MLPT than in infants born FT. Specifically, infants born MLPT were more likely to be classified as having an insecure-avoidant attachment.

In the current study, we also found a moderate association between infants' early regulatory patterns in the FFSF at 3 months and their attachment classifications in the Strange Situation at 12 months. Notably, in both the FT and PT samples, there were significant associations between the Social-Positive Oriented pattern and secure attachment, the Distressed-Inconsolable pattern and insecure-ambivalent attachment, and the Self-Comfort Oriented pattern and insecure-avoidant attachment. These results corroborate similar findings with an independent Portuguese sample of infants born FT evaluated in the FFSF at 3 and 9 months of age and in the Strange Situation at 12 months of age (Barbosa et al., 2020). Taken together, this research suggests that infants' regulatory behavior during the FFSF, emerging as early as 3 months, predicts their later specific attachment patterns.

Few perinatal or demographic factors were associated with infants' regulatory patterns at 3 months or their attachment status at 12 months. There were several noteworthy exceptions. Among the perinatal factors evaluated, only infants' Apgar scores evaluated at the first minute after delivery were associated with their regulatory patterns at 3 months. Infants with a higher 1-min APGAR were more likely to be classified as having a Social-Positive Oriented pattern than a Distressed-Inconsolable pattern or a Self-Comfort Oriented pattern. This bivariate association was found in both the FT and MLPT groups in the current study. Past studies of Portuguese infants born FT report a similar association in studies about infant regulatory patterns (Barbosa et al., 2019; Seixas et al., 2017).

Similarly, only two perinatal factors were associated with infants' quality of attachment in the current study. However, the specific perinatal variables in question differed in the FT and MLPT groups. In contrast, for infants in the FT group, infants with a higher birthweight were more likely to be classified as having a secure or an insecure-ambivalent attachment.

For infants in the MLPT group, infants with a higher 1-min APGAR score were more likely to be classified as securely attached at 12 months.

Although findings across studies are somewhat inconsistent, these bivariate associations reinforce the idea that prematurity is a systemic developmental condition involving neuromaturation processes, prenatal, perinatal, and health factors (Boyle et al., 2014), as well as emerging social relationships with caregivers.

Similarly, the associations between infant regulatory patterns at 3 months and later attachment observed in the current study could not be explained by group differences in demographic characteristics. From a range of demographic factors evaluated, there were slight differences between the FT and MLPT groups on only two demographic variables: maternal age and education. Specifically, mothers in the MLPT group were slightly younger and had attained fewer years of education than mothers in the FT groups. However, these variables were not significantly associated with either infant regulatory patterns at 3 months or infant attachment classifications at 12 months.

As previous studies propose (e.g., Barbosa et al., 2020; Beebe et al., 2010; Braungart-Rieker et al., 2014; Fuertes, Lopes-dos-Santos, et al., 2009), the results of the current study support the hypothesis that organized patterns of regulatory behavior, assessed in dyadic contexts such as the FFSF, emerge early in development, and contribute to infants' later attachment organization. Infants develop the capacity for self-regulation gradually and primarily in relational contexts (Beeghly et al., 2016; Tronick et al., 2019). Their repeated attempts to regulate emotions and behavior during and after stressful social interactions and other situations are based both on their own efforts and others' support in achieving co-regulation (Beeghly et al., 2016; Bigelow & Power, 2014). Over time, these iterated experiences gradually modulate children's style of expressing emotions (i.e., learning to over- or under-regulate their emotions, using positive or negative behaviors, based on caregiver responsiveness, and to rely on self or others to regulate emotions). Based on the current findings, we speculate that infants, in their unique biopsychosocial contexts and during interactions with primary caregivers, attempt and learn how to use specific patterns of social and regulatory behavior to best achieve their attachment and regulatory goals.

8.2 | Study limitations and future directions

Our study has limitations that must be considered when evaluating the results. First, the participants in the MLPT and FT groups were recruited from two Portuguese cities. Most were Portuguese-Caucasian in race/ethnicity and from working to middle-class, urban backgrounds. Findings therefore may not generalize to mother–infant dyads in other geographical areas, ethnic/racial groups, or socioeconomic backgrounds. Another limitation is that the sample size of mother–infant dyads included in the FT and MLPT groups is not equal, due to slight differential attrition in the MLPT sample over time. However, results of Cramer V tests, calculating effect size in the two samples, indicated that this discrepancy did not affect the significance of our results.

Despite these limitations, we believe that the findings from the present longitudinal study contribute to a growing body of knowledge about individual differences in the early regulatory

strategies of infants born MLPT and infants born FT. In future research, it will be important to continue to explore the contextual, interactive, and biological factors that may affect these processes in the face of prematurity, including studying the regulatory behavior of infants varying in level of neonatal risk longitudinally during the first year postpartum.

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ORCID

Marina Fuertes https://orcid.org/0000-0001-7061-5092
Joana L. Gonçalves https://orcid.org/0000-0002-6174-3778
Miguel Barbosa https://orcid.org/0000-0002-0670-0425
Rita Almeida https://orcid.org/0000-0003-2777-5060
Pedro Lopes-dos-Santos https://orcid.org/0000-0002-0754-580X

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