Family SES and maternal sensitivity predict infant patterns of regulatory behavior in Brazilian dyads

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ABSTRACT

Infant's patterns of regulatory behavior contribute to infant socioemotional development and attachment. These behavioral patterns affect and are affected by the quality of mother-infant interaction. In most studies with full-term infants, the Social-Positive Oriented pattern (i.e., the infant's ability to soothe his/her emotions in the context of reciprocal and positive interactions) is the most prevalent pattern, followed by the Distressed-Inconsolable and by the Self-Comfort Oriented patterns. However, these patterns are understudied in other populations beyond the US and European countries. The current research addresses this gap by studying the regulatory behavior patterns and their association with mother-infant interactions in Brazilian dyads and evaluating the association of these regulatory patterns with demographics. Analyses were based on data collected for 40 infants (20 boys, 20 girls) and their mothers. Infants' regulatory behavior patterns were evaluated in the Face-to-Face Still-Face paradigm and mother-infant interaction was evaluated during free play at 3 months age. Notably, our findings indicate that Distressed-Inconsolable was the most prevalent pattern in this sample; followed by the Social-Positive Oriented and the Self-Comfort Oriented patterns. Furthermore, we found that maternal sensitivity and family SES (social-economic status) predicted infant patterns of regulatory behavior.

1. Introduction

The concept of self-regulation entails children's ability to gain control of bodily functions and arousal, manage emotions (modify, inhibit, or maintain), and sustain focus and attention [1,2]. Young infants achieve self-regulation in the context of their interactions with the caregivers via mutual regulation or *co-regulation* [3]. During repeated everyday infant-caregiver social interactions, dyads learn to take turns in reciprocal interactions and to successfully repair interactive errors (mismatches) providing an opportunity for infants to develop interactive and self-regulatory skills (e.g., [4]).

Several studies observed individual differences in infant self-regulation using the Face to Face Still-Face Paradigm (FFSF, see [5] for a meta-analyses). This paradigm includes three successive two-minute episodes: i) a face-to-face play interaction (baseline) followed by ii) a perturbation in social interaction during which the caregiver is instructed to continue looking at the infant while holding an expressionless face and to refrain from talking or touching the infant (still-face), followed by iii) a resumption of playful interaction (reunion).

Typically, during the still-face episode, infants make active attempts to reengage with the adult by smiling, vocalizing, and gesturing (e.g., reaching with both hands). Confronted with the failure of these attempts, infant gazing and smiling at the caregiver's face decrease and negative affect increases, relative to the behavioral pattern observed during the baseline interaction [5].

Nevertheless, some infants fail in their ability in recovering from the stressful situation od still-face episode and in returning to baseline interaction in the reunion episode of FFSF. For instance, Montirosso et al. [6] used cluster analysis to identify different patterns of infant social engagement during the baseline episode of the FFSF. These patterns were then used as the basic unit of analysis from which to assess infants and mothers' behaviors during the subsequent still-face and reunion episodes. Montirosso and colleagues identified three patterns of infant regulatory behavior. Infants in the Socially Engaged pattern (33%) exhibited a high level of social engagement with the mother in the baseline, reacted to the still-face with increased levels of negative affect, and exhibited recovery during the reunion. Infants in the disengaged pattern (60%) exhibited a low level of social engagement in the

baseline, an increased level of negative affect during the still-face episode, and a strong increase of negativity in the reunion. Infants in the Negatively Engaged pattern (7%) displayed high negative emotionality and negative engagement with the mother during all three episodes of the FFSF.

Others studies [7] described three patterns of regulatory behaviors: (a) the *Social-Positive Oriented* pattern – infants predominantly display positive behaviors during high/moderate reciprocal interactions and interactive errors are easily repaired; infants tend to react to the still-face with positive behaviors (e.g., smiling) that progressively decrease during the episode and may be replaced by negative affect, followed by a clear recovery in the reunion episode; (b) the *Distressed-Inconsolable* pattern – infants display conspicuous negative behaviors when the dyadic reciprocity fails, and the repair of interactive mismatches becomes more challenging; infants immediately react to the still-face with the display of negative affect that persists or increases during the reunion episode, protesting or resisting adult attempts to reengage in the interaction; and (c) the *Self-Comfort Oriented* pattern - infants exhibit conspicuous avoidance of the adult in the first and the third episode (e.g., ignoring the adult's interactive initiatives, looking away, turning away) along with a predominance of self-comforting behaviors in all episodes.

US and European studies reported, in samples with low risk, that the *Positive Others Oriented* pattern is the most prevalent (e.g., [6,8,9]). In Portuguese studies with full-term infants, the Social-Positive Oriented pattern is the most prevalent (around 54% of the cases), followed by the Distressed-Inconsolable (around 35% of the cases) and by the Self-Comfort Oriented (around 11% of the cases) [10,11]. These patterns are relatively stable from 3 to 9 months of age [10] and are associated with infant-mother attachment [12,13], indicating their relevance for infant's socioemotional development.

Previous FFSF studies have investigated early social stress regulation, finding that maternal engagement and responsiveness moderate individual differences in infants' reactivity to and recovery from social stress (e.g., [4,6]). According to the Mutual Regulatory Model (MRM), infants signal their needs, emotions, and intentions to their caregivers [14]. In turn, maternal sensitivity enhances the infant's exploratory behaviors, facilitates emotional regulation in distressing situations, and helps infants develop a self-soothing repertoire [3,15]. Therefore, in the context of positive interchanges, the sensitive caregivers tend to provide prompt and adequate scaffolding during the process of dyadic mismatches, matches, and reparation that promote the development of infant's self-regulation abilities [16]. Parents-infant exchange is based on co-regulation, where both partners need to express their intentions, to acknowledge the intentions of the partner, and to scaffold the partner's actions so that each partner can achieve their goals. Supporting these hypotheses, several studies found a link between the quality of mother-infant interactions and infant strategies for emotional regulation (e.g., [4,17–19]).

1.1. Present study

This study aims to investigate: i) the prevalence of infant's patterns of regulatory behaviors and ii) these patterns associations with mother-infant interactive behavior and with demographic factors in Brazilian dyads. Brazil has high rates of infant mortality (12.4 per 1000 births) and poverty (about 27% of the population), as well as low levels of education (7% of the population has no formal education), and these worrying values are likely to raise in the current Pandemic scenario [20]. However, the literature about the impact of SES on infant self-regulatory strategies is scarce. Taking the social stratification (largely composed by low income families) of our sample, we hypothesized that the Social-Positive Oriented pattern is less prevalent in Brazilian dyads than in European or US studies and is associated with SES factors.

Table 1
Infant and family demographics.

	M	SD	Min–max
Gestational weeks at birth	39.08	0.97	37–41
Birthweight (g)	3362.20	402.59	2608–4380
Apgar at first minute	9.02	0.92	6–10
Apgar at fifth minute	9.65	0.48	9–10
Number of siblings	1.70	0.99	1–4
Maternal age	27.73	5.51	18–41
Maternal years of education	12.23	2.77	6–19

2. Method

2.1. Sample

Participants were 40 full-term (older than 37 weeks of gestation) healthy infant (20 girls, 20 boys), and their mothers. Based on The National Social Economic Raking (Critério de Classificação Econômica Brasil, CCEB) that includes literacy, family living conditions, and income, the participants were primarily Brazilian Caucasian from upper (25%), middle (32.5%) and low class socio-economic (SES) backgrounds (42.5%). About two thirds of the Brazilian population is from very low to low SES backgrounds. Our sample hardly represents the Brazilian society, but the inclusion of a large representation of low SES aims to represent this social prevalent group [29]. Twenty-two mothers were unemployed. All infants were healthy and clinically normal at delivery as determined by pediatric examination. Infants had no sensory or neuromotor disabilities, serious illnesses, or congenital anomalies. Parents had no mental health or drug/alcohol addiction problems. Descriptive statistics are provided in Table 1.

2.1.1. Recruitment

Over a three years, two research assistants contacted potential participants at S. Paulo Hospitals (the name of the Hospitals are blind) and explained the study's purpose and procedures. The exclusion criteria were: (a) maternal drug or alcohol abuse during pregnancy; (b) maternal age less than 18 years, (c) maternal mental or health problems, (d) infants born with less than 36 weeks of gestation and (d) infants whose primary caregiver was not the mother.

2.2. Procedures

The present study was conducted according to the ethical guidelines presented in the Declaration of Helsinki, with written informed consent obtained from all individual participants 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 Commission of Bauru School of Dentistry - University of São Paulo (CEP/FOB-USP).

At 3 months postpartum, mothers were contacted to schedule a follow-up visit to the laboratory. Mother-infant dyads were observed and videotaped during a free play interaction followed by the FFSF paradigm [21]. These procedures only took place when infants were fed, rested with changed diapers, and in a good mood.

2.2.1. Free play interactions

Mothers and infants were videotaped for 5 min during an unstructured free play session at the 3-month laboratory visit. A standard set of age-appropriate toys was arranged on a quilt on the floor of a laboratory playroom, and mothers were instructed to play with their infant as they usually do. No additional instructions regarding how to play were given.

2.2.2. Face-to-Face Still-Face paradigm (FFSF [21])

The FFSF paradigm includes three successive two-minute 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 them; and (c) a reunion episode, during which mothers were instructed to resume their normal play interaction with the infant. To mark the beginning and the end of each episode more clearly for scoring purposes, each episode was separated by a 15-second interval during which the mother was asked to turn away from their infant.

Dyads 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.

2.3. Measures

2.3.1. CARE-Index [22]

The CARE-Index scale was used to rate mother-infant free play interactions. The CARE-Index system focuses on seven aspects of the infant's and mother's interactive behavior: facial expression, verbal expression, position and body contact, affection, turn-taking contingencies, control, and choice of activity. Up to two points are assigned for each dimension, for a possible total score of 14. The points for each dimension are also added to yield seven scale scores, three adult independent scales, namely Sensitivity (warm, caring, reciprocal, contingent and developmentally appropriate), Control (hostile, over-caring, controlling, negatively/punitively contingent and too developmentally demanding), Unresponsiveness (inattentive, uncaring, passive, non-contingent and understimulating) and four independent infant scales, namely Cooperative (positive, responsive/reciprocal, comfortable and interested), Compliant-compulsive (compliant, obedient, worried, and fearful), Difficult (angry, incongruous, fussing and in high distress) and Passive (dull, inattentive, uninterested and expressionless).

Although the mother and infant are scored separately, the scale is considered to be dyadic because each behavior is considered in a dyadic context, according to the partner's behavior and perspective.

The videotaped free-play interactions were scored by two trained coders on the CARE-Index. Intercoder reliability was evaluated by computing the intraclass correlation coefficient (ICC) comparing the two coders' ratings [23]. The obtained average ICCs were consistently high for the CARE-Index maternal, infant, and dyadic scales (maternal scales: 0.92 for sensitivity, 87 for control, 0.84 for unresponsiveness; infant scales: 0.91 for cooperation, 0.81 for compulsive-compliance, 0.94 for difficulty, and 0.91 for passivity).

The *Coding System for Regulatory Patterns in the FFSF* [7] 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 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 system includes a behavioral description for *Social-Positive Oriented, Distressed-Inconsolable, and Self-Comfort Oriented* by episode (synthesis in Table 2). The coders must select the description that better describe each case.

The FFSF videotapes were coded by three trained, reliable coders. The intercoder agreement was calculated by Cohen's kappa coefficient.

Results indicated a very good agreement for all regulatory patterns ($\kappa = 0.92$). Following the assessment of intercoder reliability, discrepant classifications were discussed and resolved in conference.

2.4. 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 was obtained using univariate frequency analysis. Second, one-way analyses of variance (ANOVA) were used to determine whether there were differences in the mean scores of maternal and infant interactive behaviors among the three patterns of regulatory behavior in the FFSF at 3-months (Table 2). Tukey's post hoc test was used to test differences between specific groups (Table 2). Except for SES, none of the demographic variables were significantly associated with infant regulatory patterns, so demographic factors were not further considered as potential covariates. Stepwise regression analyses were used to investigate the determinants of infant patterns of regulatory behavior among variables associated with these patterns, namely: SES, maternal sensitivity, maternal control, infant cooperation, infant compulsive behavior, and infant difficulty.

3. Results

3.1. Distribution of patterns of infant regulatory behavior

In this sample, the Distressed-Inconsolable pattern was the most prevalent pattern of infant regulatory behavior (37.5%, 15 of 40), which is a noteworthy representation, followed by the Social-Positive Oriented pattern (32.5%, 13 of 40) and the Self-Comfort Oriented pattern (30%, 12 of 40).

3.2. Maternal and infant interactive behavior among infant patterns of regulatory behavior

According to Table 3, maternal sensitivity and infant cooperation are more likely in infants with a Social-Positive Oriented pattern of regulatory behavior, while maternal control and infant compulsive behavior are more likely in infants with a Self-Comfort Oriented pattern, and, at last, infant passivity is more likely in infants with a Distressed-Inconsolable pattern.

3.3. Demographic factors among infant patterns of regulatory behavior

We found no association between demographic factors (including mother's age [$F(2) = 0.082$; $p = .922$], maternal education [$F(2) = 0.116$; $p = .848$], infant birth weight [$F(2) = 0.893$; $p = .418$], number of siblings [$F(2) = 1.432$; $p = .254$], Apgar at first minute [$F(2) = 0.213$; $p = .809$], Apgar at fifth minute [$F(2) = 0.047$; $p = .954$], and infant patterns of regulatory behavior, except for one variable: the family SES). Compared with other regulatory patterns, SES was higher in infants with a Social-Positive Oriented pattern [$F(2) = 4.096$; $p < .05$].

3.4. Determinants of infant patterns of regulatory behavior

Using stepwise regression, we found that maternal sensitivity and family SES were, among all factors significantly associated in previews analyses, the determinants of infant patterns of regulatory behavior (results in Table 4).

4. Discussion

In the present study, the distribution of the three patterns of infant regulatory behavior (Social-Positive Oriented, Distressed-Inconsolable, Self-Comfort Oriented) observed at 3 months in the FFSF is distinct to

Table 2

Coding system for styles of infant's regulatory behavior in the FFSF [7].

Styles of regulatory behavior	Sub-styles of regulatory behavior
Social Positive Oriented - Predominance of positive social behaviors and recover after still-face	*Social-Positive1* – Infants exhibit prolonged positive behaviors in the context of reciprocal interaction in the first episode. There is a progressive decrease of positive affect during the still-face and a subsequent recovery in maximum of 30 s during the third episode
	Social-Positive 2 – Infants exhibit a predominance of positive behaviors (but less frequent or less intense than in *Social-Positive1*) in the context of a reciprocal interaction, but periods of dyadic lack of synchrony can also be observed in the first episode. There is a progressive decrease of positive affect during the still-face and a subsequent recovery in the third episode. The recovery takes maximum 60 s.
	Social-Positive 3 – Infants exhibit positive behaviors in a reciprocal interaction but there are more and longer periods of lack of synchrony in the first episode compared to *Social-Positive1* and *2*, in which infants alternate with a negative engagement and self-comforting.
	Resistant behavior can be observed during Still-Face.
	Signs of disturbance and withdrawal may persist during the third episode, but they gradually recover in 120 s maximum despite of some behavioral inconstancies.
Distressed-Inconsolable – Predominance of negative affect particularly in and after still-face, and failures in repairing interactive mismatches	*Distressed-Inconsolable 1* – Infants exhibit positive behavior during the first episode, but there are periods of disengagement or moderate negative affect.
	Infants react to the still-face with an increasing and persistent negative affect.
	Signs of disturbance and withdrawal persist in the third episode without recovering, although infants may present few or brief manifestations of interest.
	Distressed-Inconsolable2 – Infants' engagement in the first episode alternates among periods of interest/attention, withdrawal, and active resistance/protest.
	Infant react to the still-face with prompt evident negative affect that persists or increases in the third episode.
Self-Comfort Oriented - Conspicuous avoidance in first and third episode and predominance of self-comfort during all episodes	Infants predominantly avoid contact, including gaze aversion, muscular tension when touched, and general discomfort without exhibition of evident negative affect (e.g., masked and rigid facial expression, restrained vocalizations) during the first and third episodes.
	Predominance of self-comfort and exploring behaviors during the FFSF.
	Infants consistently use self-comforting behaviors across all episodes.

that reported in other studies conducted with infants at the same age. While in US and European studies (e.g., [6,8,10,24]) the Social-Positive Oriented pattern is the most prevalent pattern (ranging from 52% to 57%), in this sample it is the Distressed-Inconsolable. The Social-Positive Oriented pattern, an indicator of the infant ability to soothe his/her emotions in the context of reciprocal and positive interactions, was exhibited only by 32.5% of the sample while in most studies it is above 50%. Yet, 42% of the infants in our sample were from low SES backgrounds while in US and European studies this group represented less than 20% of their respective samples (e.g., [6,8,11,12]). In fact, we found that family SES predicted infant's self-regulation style. Infants with a Social-Positive Oriented pattern, compared with infants classified with other regulatory patterns, were more likely to come from higher SES backgrounds. The negative impact of low SES can be partially explained by the number of associated risk factors and by the interaction of these factors. SES is highly linked with a set of environmental risk factors among which are family support, stressful life events, maternal anxiety, parental representations, beliefs, and attitudes [25]. Yet, few studies have been conducted to evaluate the direct impact of SES variation on mother-infant relationships, so more research is necessary to fully understand why the Social-Positive Oriented pattern is more likely in families with higher SES. This is a worrying result taking into consideration that 13% of the Brazilian children are

raised in extremely poor households and, overall, 66% in low social households [20,26].

Moreover, in this study maternal sensitivity observed during free play was highly associated with a Social-Positive Oriented pattern and predicted infant regulatory patterns in the FFSF. These findings are consistent with those reported in prior work with infants born full-term [4,17,24,27]. In line with international research, our results suggest that mothers who were more sensitive in the free play (e.g., responsive behavior and positive engagement) exhibited greater ability to comfort their infant in the FFSF, while the infant responds with cooperative behavior. By contrast, when mothers showed more control-intrusiveness behavior (e.g., implicit hostility and interference with the activity of the infant, such as hyperstimulation) in the free play, the infant tended to exhibit a Self-Comfort Oriented pattern in the FFSF. The distressed-Inconsolable pattern was solely associated with infants' negative affect in the free play interaction. Overall, our results support the predictions of the MRM [14]. Infant repeated attempts to regulate emotions during and after stressful situations are based both on their own efforts and others' support in achieving co-regulation [3,28]. These exchanges gradually modulate infant's expectations to rely on self or others to regulate their own emotions, contributing to the consolidation of a specific style of emotional regulation. Taking in consideration that these styles are associated with specific attachment and socioemotional

Table 3

Means, standard deviations, and ANOVA results for maternal and infant interactive behavior, according to patterns of regulatory behavior.

3 months visit	Social-Positive Oriented M (SD)	Distressed-Inconsolable M (SD)	Self-Comfort Oriented M (SD)	F(2, 42)	p	Tukey HSD
Maternal sensitivity	9.92 (1.85)[a]	6.27 (1.34)[b]	6.83 (1.85)[c]	18.556	0.001	a > b; a > c
Maternal control	1.54 (2.30)[a]	3.47 (3.19)[b]	5.50 (2.58)[c]	6.518	0.004	c > a
Maternal unresponsivity	2.54 (1.90)[a]	4.27 (3.26)[b]	1.67 (1.97)[c]	3.777	0.032	b > c
Infant cooperation	9.85 (1.68)[a]	6.00 (1.20)[b]	6.92(2.40)[c]	18.978	0.001	a > b; a > c
Infant compulsive behavior	1.15 (2.04)[a]	1.47 (2.88)[b]	4.83 (3.46)[c]	6.949	0.004	c > a, c > b
Infant difficulty	1.38 (1.85)[a]	4.27 (3.09)[b]	1.17 (2.21)[c]	6.819	0.003	b > a, b > c
Infant passivity	1.54 (1.67)	2.33 (2.74)	1.00 (1.13)	1.481	0.241	

Note: Means sharing a common subscript are not statistically different at $p < .05$, Tukey HSD procedure.

Table 4
Summary of stepwise regression analyses predicting infant patterns of regulatory behavior.

Variables	Unstandardized coefficients		Standardized coefficients						95% CI
	B	SE_B	β	t	p	R	R^2	F	
First Step	0.190	0.047	0.547	4.029	0.001	0.547	0.299	16.23	0.285–0.094
Maternal sensitivity									
Second Step	0.168	0.046	0.484	3.671	0.001	0.620	0.385	11.58	0.261–75
Maternal sensitivity									
SES	0.295	0.130	0.299	2.269	0.029				0.031–558

developmental outcomes, our results reinforce that early intervention should be preventive, based on enhancing maternal and infant positive behavior and focused on promoting reciprocal, contingent, and positive mother-infant relationships, specially targeting families at social risk.

4.1. Implications for practices

Our results add to the body of knowledge which suggests that family SES and parenting styles affect infant development - in the case of this study - infant self-regulation. Presently, the COVID-19 pandemic constitutes an unprecedented challenge with very severe socio-economic consequences as is the case of Brazil. Therefore, early intervention practitioners should take a bioecological family systems perspective and attend to the degree to which parent's behavior affects infant development (supporting sensitive parenting), but also help parents to allocate resources and facilitate their access to social services so they can face the economic challenges. The lack of basic life resources, important for human survival, may jeopardize daily parental responsibilities and parents availability for sensitive caregiving.

4.2. Contribute and limitations

This study contributes to the body of knowledge about infant regulatory strategies across cultures. However, the results cannot be generalized given the reduced dimension of the sample, meaning that replication in a larger sample is required. Another limitation of this study is that there is no direct comparison with a non-Brazilian sample. In spite of these limitations, to our best knowledge this is the first Brazilian study to examine infant's patterns of regulatory behavior.

CRediT authorship contribution statement

Camila Ribeiro: Data collecting, Validation, Formal analysis, Data scoring, Data curation, Writing – review & edition, Visualization
Ana Teodoro: Data collecting, Validation, Formal analysis, Data scoring, Data curation, Visualization
Pedro Lopes dos Santos: Conceptualization, Methodology, Data curation
Dionisia Lamônica: Conceptualization, Methodology, Supervision, Project administration, Funding acquisition, Data curation, Writing – review & edition, Visualization
Marina Fuertes: Conceptualization, Methodology, Validation, Formal analysis, Data scoring, Data curation, Writing – original draft, Writing – review & edition.

Declaration of competing interest

The authors have no conflict of interests.

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