The responses to sad and happy infant faces are negatively associated with Maternal Emotional Availability

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Abstract—The pervasive presence of technology, including digital devices, intelligent networks, and online platforms, has given rise to new forms of human interaction. Therefore, it becomes crucial to understand how technological development influences profound aspects of human relationships, such as communication and the formation of social bonds, and consequently how it can positively integrate into human interactions while preserving fundamental elements such as emotional components and empathy. In this context, it is important to carefully examine the caregiver-child relationship. Several studies on the quality of this relationship have emphasized that it may depend on adult responses to salient infant cues considered at different processing levels. However, there are few studies that have investigated the predictive validity of the association between responses to infant cues and the quality of real caregiving behaviours. The aim of this study was to explore the association between responses to different infant cues, evaluated at different levels, and the quality of the caregiver-child relationship, measured in terms of emotional availability. 25 mother-child dyads participated in the study. Preliminarily mothers (27-50 years) were administered two implicit and two explicit measures (SC-IATs and Semantic Differentials) adapted to assess their responses to sad and happy infant faces and then, after a week, they were observed interacting with their child (aged 20-68 months) during 10 minutes of free play. The results confirmed a low consistency between responses to different stimuli and showed that implicit responses to sad (not happy) infant faces were positively associated with greater emotional availability, r=.37, p<.05. This study confirms the importance of considering both the emotional valence of infant stimuli and the processing level to assess in a valid way adult caregiving propensity.

Index Terms—emotional availability, infant faces, caregiving, mother-child

I. INTRODUCTION

In the contemporary era, the rapid pace of technological advancement has brought about a profound transformation in the way individuals relate to each other and their surrounding environment [1]. This metamorphosis is evident in various aspects of daily life, particularly in the realms of communication and social connections. The pervasive integration of technology, including digital devices, intelligent networks, and online platforms, has given rise to new modes of human interaction [2].

Scientific inquiry in this field is essential for understanding how technological evolution not only influences the practical aspects of daily existence but also the more intimate facets of human relationships, including empathy, communication, and the formation of social bonds. Within this framework, scientific research endeavors not only to elucidate the tangible repercussions of technology but also to unveil the emerging challenges and opportunities in relational dynamics [3] The overarching goal is to achieve a deep understanding of how new technologies can be seamlessly integrated into human interactions while concurrently safeguarding fundamental elements of human relationships, such as emotional dimensions and empathy. This convergence between technological progress and human interactions has emerged as a central theme of interest for researchers poised to outline the trajectory of an increasingly interconnected and technologically advanced society [4]

In this context, it is of relevance to thoroughly examine the relationship between caregiver and child. The connection between technological evolution and caregiving dynamics becomes crucial, as it can open new perspectives for understanding human interactions in the digital era. Indeed, the quality of caregiving in the earliest years of life is among of the most important factors that influence the child development [5,6]. According to Bornstein [7], caregiver-child interaction constitutes the privileged context for child growth [8]. In particular, researchers have argued that the response to infant's emotional and physical needs during the early years of life, and the ability to provide models of cognitive and behavioural self-regulation have an important role in child development [9,10] and can be evaluated as caregivers' emotional availability [11,12].

The conceptualization of emotional availability results from the integration of various definitions of the construct from different theoretical perspectives [13-15]. Currently, emotional availability (EA) refers to the quality of emotional exchanges between caregiver and child, and it focuses on the mutual accessibility of dyad members and their ability to read and respond appropriately to each other's communication [11]. In addition, Biringern and Easterbrooks [16] defined it as the ability of a dyad to share an emotional connection and to rejoice in a healthy and mutually fulfilling relationship. Due to this conceptualization of emotional availability [11,16] and the validation of the Emotional Availability Scale (EAS) [17], the construct has been widely used in research on the quality of the caregiver-child relationship [18].

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The EAS is an observation coding system developed to assess caregiver-child interaction, by taking into consideration both the caregiver's emotional availability toward the child and the child's emotional availability toward the caregiver [16]. The emotionally available interactive exchange is thus be punctuated by positive emotions, expressed through face, gestures and voice, and by the ability of the caregiver to modulate any negative emotional signals expressed by the child, and to consider child's emotional signals as indices for regulating his/her behaviour. For example, in choosing how to structure a game with the child, the emotionally available caregiver repeats an action that elicits amusement, proposes something new in case of signals of boredom, or slows down the pace of her proposals in the case of the child's lack of response; in this way he/she can be non-intrusive toward the child. Another key feature of the concept of emotional availability is the variability of emotions that the caregiver accommodates and the importance of conflict negotiation skills. How the caregiver responds to these emotions, returning them in an empathetic manner, helps the child to adjust and build an internal image in which negative experiences are integrated with positive ones [19]. The emotionally available caregiver is also able to tolerate and resolve moments of conflict and can resume an effectively pleasant rhythm in exchanges, without reacting with avoidance or impatience and hostility [20].

As a summary, according to the literature, EA is a dyadic and relational construct, and although caregiver and child are differentiated, the general EA of both members of the dyad is also considered [21,22]. The dyadic nature of the construct reflects the bidirectional nature of the relationship; in this view, in a caregiver-child interaction not only the caregiver can be more or less emotionally available to the child, but also the child, who can exhibit a personal tendency to be more or less emotionally responsive and engaging to the caregiver. Therefore, to understand the degree of EA in a dyad, it is essential to consider the behaviour of both members.

As a result, several studies that have investigate how EA is associated with child development, have shown that it can have positive effects on child's cognitive function, sleep wake rhythm regulation, and on the child's acquisition of sophisticated play skills [20,23,24]; moreover, EA seems to be associated with child attachment [25], emotional expression and regulation [26,27], language development [28], and child social competence [29]. Studies have also highlighted that an infant who experiences EA interactions manifests curiosity and explores the environment; positive emotions foster processes of infant's imitation and identification, and emotional exchanges develop infants' empathy and pro-social inclinations [21]. In contrast, a lack of emotional availability may be associated with coarctation of experience, excessive emotions, such as rejection and emotion avoidance [30,31]. This can happen either because the caregiver has a previous experience of distress that prevents from relating adequately to the child, or because the child has adjustment difficulties (e.g., with food or sleep, frequent crying) that could impair the caregiver's ability to care for him/her, hindering their relationship [32]. This can cause difficulties in emotional exchanges between caregiver and child and in caregiver's ability of decoding the infant signals, resulting in tense situations [17]. Therefore, the assessment of EA is important in cases where there are alterations and difficulties on the part of the caregiver to contribute to the construction of the relationship with the child, and to perform appropriate caregiver behaviours, as occurs in cases of maltreatment, separation, and foster care [33].

If from a side in the literature has been pointed out that the quality of the caregiver-child relationship has an impact on the child's development [5,6], on another side, several researchers are investigating the factors that influence the quality of the caregiver-child relationship [34] to understand what are the processes explaining why not all caregivers respond the same way to infant's need, and why some caregivers are more or less available than others [35]. According to the literature [34], caregiving behaviours are influenced by a complex interaction between context, child, and adult characteristics. Given that has been shown that human infants are characterized by certain morphological features that may elicit caregiving in their caregivers [36], some researchers [37,38] have focused their attention on how adults respond to infant cues by using different infant stimuli, such as neutral infant faces, infant faces with emotional valence or infant cries. These studies led to the development of the Parental Brain Model (PBM) [39] that tried to define the factors that can determine the caregiver's response from infant cues perception. Specifically, according to PBM [39], the caregiving response associated with the perception of infant cues is an innate process that evolved to ensure the survival of the offspring. According to PBM, infant cues are processed at different levels (i.e., reflexive, emotional, and cognitive), and the results of these parallel elaborations determine caregiving behaviour. As a consequence, if one is interested in assessing the caregiving propensity in a valid way, both the reflexive and less conscious levels and the more controlled and conscious levels should be considered. Moreover, given that one could consider different infant cues, it would be interesting to verify the extent to which there is consistency between different cues considering different levels of processing.

Studies that have investigated the response to different infant cues (i.e., infant faces and cries) have shown that the consistency between levels of processing is moderated by the type of cue [40-43]. This suggests that the theoretical model of responses to infant cues should also consider differences between infant cues. Indeed, there are studies that have shown that beyond infants' facial morphology, facial expressions can also influence the quality of caregivers' response [44-45]. Smiling children seems to receive more positive responses than crying children [46] and elicit more caring behaviours from caregivers [47]. Other studies have found that faces perceived as cute elicit tenderness in the caregiver by influencing the quality of caregiver-child interactions [48]. For example, Badr and Abdallah [49] found that infants who are perceived to be physically cuter receive better quality of care. In addition, other studies have also found that infants' facial expressions influence the caregiver's judgment of the child's abilities, and that children perceived as prettier are considered more capable and competent. Furthermore, prettier children seem to activate more the brain areas related to the reward circuitry [50].

Despite the scientific evidence reported by theoretical models [37,38], to our knowledge the majority of studies aimed at understanding the processes involved in caregiving behaviour by observing the response to infant cues have not taken these aspects into account. For example, there are still few studies that have investigated in an integrated manner the responses to infant cues by considering the different levels of processing (i.e., explicit and implicit) [40-43], or that have considered the differential effect of the emotional valence of infant cues (i.e., happy and sad faces) considering the different levels of processing [40,42,43]; moreover there are no studies that have investigated the specific association between responses to different infant cues, considering different levels of processing, on real caregiving behaviour.

Given the abovementioned considerations, the aim of this study was to compare maternal responses to infant faces while taking into account different levels of processing and stimuli with different emotional expression (happy and sad infant faces), and to examine the extent to which implicit and explicit responses to infant cues (happy and sad faces) are associated to the quality of the caregiver-child relationship, evaluated in terms of emotional availability. This could provide valuable information on understanding the processes underlying the caregiver-child relationship, to develop interventions aimed at improving the quality of care.

II. METHOD

A. Participants

A sample including 25 mother-child dyads was selected by convenience sampling. To be included in the study, mothers had to be of age, while children had to be aged between 28 and 60 months and had to show no general behavioural problems and have adaptive behaviour in a normal range. No other inclusion or exclusion criteria were considered. The participating mothers showed a mean age of 35.1 years ($SD = 4.7$; range 27-48) and at least a high school or university education level. The study was carried out in conformity with the Declaration of Helsinki and the local Ethics Committee requirements. All participants signed a written informed consent before starting data collection that also specified that the procedure would include a videotaping phase.

B. Procedure

The experimental session was divided in two phases temporally spaced. The first phase was carried out at distance. By means of *PsyToolkit*, an online protocol was administered to each mother [47]. The protocol included a socio-demographic information questionnaire, two Single Category Implicit Association Test (SC-IAT) [51] and two semantic differentials (SD) [52], adapted to collect respectively implicit and explicit responses to infant faces with different emotional valence (happy and sad faces). Measures were administered in a randomized order. The sessions lasted about 25 minutes. The second phase was carried out about a week later and was conducted in-person at the participants' homes. Mothers were required to play with her child for 10 minutes, in the way they usually do, by using a set of standardized toys consisting of a toy train, a tea set, a doll, a cover, a book, a telephone, and a set of interlocking toy bottles. The interactive session was videotaped. At the end of the observation, participants were de-briefed about the study and thanked.

C. Measures

Sociodemographics. A socio-demographic questionnaire was administered to collect maternal information, such as: age (expressed in years), gender, and educational levels.

Single Category Implicit Association Test (SC-IAT). To measure the valence of adults' implicit associations to infant stimuli (happy and sad faces), two versions of the Single Category Implicit Association Test (SC-IAT) were adapted and administered [51] The SC-IAT is a two-stage classification task. In each phase, stimuli of a single target category, in this study infant happy or sad faces [53], in combination with stimuli of two attribute categories, positive and negative words, are presented, one item at a time, in random order. Participants are asked to classify each item into the correct category as quickly as possible. In case of error, a red "X" appears in the centre of the screen, while to emphasize the speed of response, a 1500 ms response window following the onset of the stimulus is applied for each stimulus. In the first phase, pleasant words, and the target stimuli are classified by using the same response key, while unpleasant words are classified using a different key (positive condition). In the second phase, unpleasant words, and the target stimuli are classified using the same response key, while pleasant words are classified using a different key (negative condition). The SC-IAT score is derived by comparing the latencies of responses in the two classification phases. If participants are faster in classifying stimuli in the positive condition than in the negative condition, they are considered to have an implicit positive association toward the target stimuli. If the opposite is true, a negative implicit association is attributed. For each test (sad faces and happy faces), the SC-IAT score was calculated by dividing the difference between the mean RTs of the two classification conditions by the standard deviation of the latencies of the two phases (positive and negative) [54]. Consequently, scores around 0 indicate no IAT effect; absolute values from 0.2 to 0.3 indicate a "slight" effect, values around 0.5 a "medium" effect, and values from 0.8 to infinity a "large" effect. The two tests showed adequate reliability (αs >.80).

Semantic Differential. To assess adults' explicit attitudes toward child cues (happy and sad faces), two semantic differentials (SD) [52] were adapted and administered to mothers. For each SD, participants rated the target stimuli, sad or happy infant faces (the same stimuli used in the SC-IAT), using six bipolar adjectives pairs (annoying-adorable; ugly-beautiful; hell-paradise; unpleasant-pleasant; joy-painful; happy- sad; gift-disaster; friend-enemy; hate-love). Responses were collected on a seven-point scale. A total mean score was computed for each SD, with higher values indicating a more positive evaluation of the target stimuli. The two SDs showed adequate reliability (αs >.80).

Emotion Availability Scale. The (EAS) [17] is an observational grid that can be applied to videotaped material to measure the emotion availability of a dyad. The scale is divided into six sub-scales, four related to the caregiver and two related to the child: (a) *sensitivity*, indicates the caregiver's ability to establish and preserve a positive, healthy emotional relationship with the child; (b) *structuring,* indicates the caregiver's ability to offer support, backing and stimulation in the child's exploration and activities, while respecting the child's autonomy and cues; (c) *non-intrusiveness*, that is related to the caregiver's ability to

be available without encroaching on the child's autonomy; (d) *non-hostility*, indicates the caregiver's ability to pose to the child in affectionate, warm, pleasant, and sensitive ways; (e) *responsiveness*, indicates the child's ability, desire, and emotional inclination to interact with his or her caregiver, following an explicit invitation; (f) *involvement*, indicates the child's ability to engage and seek out the caregiver in play and activity. For each sub-scale, the dimension is scored using a 7-point Likert from "1" (lowest score) to "7" (highest score). In this study, the entire play session was considered for coding the observed emotional availability [17], and for each dyad, both a score for each subscale and a total mean score were calculated. Two independent judges have completed the observation grids showing adequate inter-rater reliability for all scales (ICC > .80).

D. ANALYTIC PLAN

To analyse the results, descriptive statistics were calculated first and then two correlation analyses were performed. A first analysis was conducted investigating the association between the responses observed at the different processing levels (implicit and explicit) and related to the different type of stimuli considered (sad and happy faces), to evaluate their consistency. Subsequently, to verify the relationship between the responses to the infant stimuli and the quality of the mother-child interaction, the responses to the different infant stimuli, recorded in the different processing levels, and the EAS scale indices obtained from the analyses of the observations were correlated. An alpha value of .05 was set for all analyses.

III. RESULTS

Descriptive analysis showed that happy faces had more positive responses than sad faces, and this was observed regardless of the level of processing considered. In both cases, the difference was significant, $ts > 2.1$, $ps < .023$ (see Table 1).

TABLE I
DESCRIPTIVE STATISTICS OF VARIABLES

Measure	M	SD
SD Happy	6.0	1.1
SD Sad	3.1	1.0
SC-IAT Happy	0.08	0.64
SC-IAT Sad	-0.46	0.92
EAS Adult Sensitiviy	5.3	0.8
EAS Adult Structuring	5.2	0.9
EAS Adult Non-Intrusiveness	5.3	0.7
EAS Adult Non-Hostility	6.2	0.8
EAS Child Responsiveness	4.9	1.1
EAS Child Involvement	4.6	1.3
EAS Total Score	5.2	0.8

SC-IAT=Single Category Implicit Association Test; SD= Semantical Differential; Emotional Availability=Emotional Availability Scales; EAS Adult Sensitivity = Emotional Availability Scales (Adult Sensitivity Subscale); EAS Adult Structuring = Emotional Availability Scales (Adult Structuring Subscale); EAS Adult Non-Intrusiveness= Emotional Availability Scales (Adult Non Intrusiveness Subscale);EAS Adult Non-Hostility = Emotional Availability Scales (Adult Non Hostility Subscale); EAS Child Responsiveness= Emotional Availability Scales (Child Responsiveness Subscale); EAS Involvement= Emotional Availability Scales (Child Involvement Subscale)

Furthermore, the data showed a ceiling effect for explicit responses to happy faces (see Table 2). In the present study, our aim was to assess the consistency between explicit responses to sad and happy faces. The statistical procedure was applied using the Pearson correlation coefficient *(r)*, allowing us to evaluate the strength and direction of associations between the variables of interest. The correlation analysis investigating the consistency between the responses to infant cues showed that the explicit response to sad faces and happy faces correlated negatively and significantly, $r = -.40$, $p = .024$, and that the explicit and implicit response to sad faces correlated negatively and significantly, $r = -.34$, $p = 049$ (see Table 1). No other significant associations were observed, although, in the case of the two implicit responses, an association approximating to the significance was observed. These results provide a more detailed insight into the dynamics of responses to infant cues, highlighting the complexity of interactions between explicit and implicit responses to different emotional expressions. This opens the door to further reflections on the intricate nature of human responses to infant facial expressions.

TABLE II
PEARSON CORRELATION BETWEEN THE RESPONSES TO INFANT FACES AS A FUNCTION OF LEVELS OF PROCESSING AND TYPE OF STIMULUS

Measure	1	2	3
1. SD Happy	-		
2. SD Sad	-.40*	-	
3. SC-IAT Happy	-.08	.15	-
4. SC-IAT Sad	-.02	-.34*	-.32

SC-IAT=Single Category Implicit Association Test; SD= Semantical Differential.
*p<.05

Descriptive analyses have shown that, in general, dyads are characterized by a "moderate level" of emotional availability, i.e. good interaction patterns (see Table 1). The correlation analysis investigating the association between responses to infant cues and the quality of caregiving showed that only implicit responses to sad faces had a significant association with the observed emotional availability of the dyads. The statistical procedure was applied using the Pearson correlation coefficient *(r)*, allowing us to evaluate the strength and direction of associations between the variables of interest. In particular, the IAT score related to the sad faces showed a positive association with the caregiver's non-hostility score, $r = .39$, $p = .027$, and with the dyad total emotional availability score, $r = .37$, $p = .033$ (see Table 3). No other significant associations were observed, although, in the case of the implicit responses to sad faces, other associations approximated to the significance, i.e., the mother's sensitivity and the child's involvement. These results clearly indicate that implicit responses to sad faces are crucial for understanding the quality of caregiving in caregiver-child dynamics. This evidence underscores the importance of deepening the understanding of these associations to develop targeted strategies aimed at improving emotional interaction in infant care contexts.

TABLE III
Pearson correlation between the responses to emotional availability as a function of levels of processing and type of stimulus

	SD		SC-IAT	
EAS	Happy	Sad	Happy	Sad
Adult				
Sensitivity	.07	-.14	-.19	.33
Structuring	-.06	-.08	-.21	.27
Non-Intrusiveness	-.31	.09	.11	.22
Non-Hostility	.03	-.22	-.07	**.39***
Child				
Responsiveness	-24	.05	-.08	.28
Involvement	-.17	.06	-.18	.30
Total score	-.14	-.05	-.13	**.37***

SC-IAT=Single Category Implicit Association Test; SD= Semantical Differential; Emotional Availability=Emotional Availability Scales; EAS Adult Sensitivity = Emotional Availability Scales (Adult Sensitivity Subscale); EAS Adult Structuring = Emotional Availability Scales (Adult Structuring Subscale); EAS Adult Non-Intrusiveness= Emotional Availability Scales (Adult Non Intrusiveness Subscale);EAS Adult Non-Hostility = Emotional Availability Scales (Adult Non Hostility Subscale); EAS Child Responsiveness= Emotional Availability Scales (Child Responsiveness Subscale); EAS Involvement= Emotional Availability Scales (Child Involvement Subscale)

*p<.05

IV. Discussion

The aim of the present study was to investigate the ways in which mothers process different infant cues and to what extent the responses to infant cues were associated with caregiving behaviour, in terms of emotional availability. To this aim, maternal responses to infant cues characterized by different emotional expressions (happy and sad) and observed at different levels of processing (explicit and implicit) were considered. Subsequently, the predictive validity of these measures was tested by assessing emotional availability during mother-child interactions. The results confirmed that although both implicit and explicit responses towards infant happy faces are more positive than responses to sad faces [46-50], there is substantial independence between the responses, both when considering different stimuli and when considering different levels of processing [40-43]. Moreover, results showed, that only implicit responses to sad faces were significantly and positively associated with the quality of mother-child interaction, that is with the caregiver's "non-hostility" subscale and the total emotional availability score of the dyad. No positive associations were observed with either explicit or implicit responses to happy faces. This latter result could be explained by the fact that emotionally available mothers are more capable to tolerate, accept and respond with less avoidance, impatience, or hostility to negative infant signals [20], thus favouring the learning of emotional expression and regulation [26,27].

V. Conclusions

In summary, while these results are in line with the literature, confirming that different childhood stimuli lead to different adult responses [39], they also show for the first time that not all responses to different childhood stimuli, or at different levels of processing, are equivalent or show the same association with actual behavior.

Although this study has the merit of having (a) investigated the consistency between implicit and explicit responses to different infant cues (happy and sad faces), and (b) investigated if explicit and implicit responses to infant faces (happy and sad) and different level of processing (implicit and explicit) were associated with caregiving behavior evaluated in terms of emotional availability, there are also some limitations that

should be mentioned. First, the sample size is small, and this poses a threat to the statistical validity and generalisability of the results. Therefore, further studies are needed to verify the validity of these results by enlarging the sample. Second, the sample included only mothers and did not include fathers. Indeed, understanding the potential contribution of fathers represents a next step in the expansion of research on caregiving behaviour, as the quality of paternal involvement with children appears to be positively correlated with the developmental outcomes in children [54,55]. Data showed that the active involvement of fathers in interventions is particularly important for several benefits, including improving the quality of co-parenting and reducing parenting stress [56]. Future studies should replicate the study considering not only mothers but also the fathers. Finally, we must acknowledge that a substantial limitation of our investigation is the issue of low construct validity. This poses a significant challenge, and our study could benefit from future research efforts that delve more deeply into the complex nature of maternal responses to infant cues.

In conclusion, while recognizing these limitations, we believe that our analysis provides a foundation for further reflection and theoretical development. We are aware of the need to deepen the understanding of this complex phenomenon and hope that our work can serve as a stepping stone for future research that explores more comprehensively the relationship between maternal responses and the quality of caregiving in the context of mother-child interactions. In addition, the study highlights the importance of a multimodal approach in evaluating caregiving behavior. Based on the observed results, the assessment of adults' implicit associations to different infant cues, in addition to explicit measures, should be included in screening protocols to prevent negative outcomes and plan programs.

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