



Social referencing in infants of mothers with symptoms of depression



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ABSTRACT

The present study examined the acquisition of social referencing skills in infants of mothers with symptoms of depression ($n=44$). We aimed to determine if a short discrimination training could facilitate infants' social referencing. Mothers were instructed to pose either joyful or fearful facial expressions to cue infants' approach/avoidance responses toward an ambiguous object. Maternal expressions were correlated with pleasant or unpleasant events occurring after the infant's response. The results showed that after the intervention, infants looked at their mothers more frequently and reached or avoided the ambiguous object based on the preceding maternal expression. The results suggest that discrimination training procedures can establish social referencing in infants of mothers with symptoms of depression.

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1. Introduction

Social referencing is the tendency of infants to use the vocal, and gestural expression of another person in order to evaluate ambiguous events and regulate his or her behavior accordingly (Pelaez, 2009). Social referencing is frequently established with the infant's parents and also with other individuals providing reliable information about the environment (Walden & Kim, 2005). There is limited evidence showing how social referencing is acquired and maintained. Some authors suggest that prewired emotional responses and perceptions are crucial for acquiring social referencing (e.g., Campos, 1983; Desrochers, Ricard, Décarie, & Allard, 1994). By contrast, the behavior-analytic approach defines social referencing as a sequence of environmental and behavioral events. Namely, during a referencing episode an ambiguous object signals the gaze shift of an infant toward another person, whose facial, vocal, and gestural cues may then signal a subsequent infant response (e.g., reaching for the object) (Pelaez, Virues-Ortega, & Gewirtz, 2012). For instance, Pelaez et al. (2012) used maternal joyful and fearful expressions as cues (discriminative stimuli) for subsequent positive or negative stimuli (e.g., crib music vs. blender noise) that would follow as consequences to specific responses of 3- and 4-month old infants (reaching for the object). Infant responses toward the ambiguous object were not cued by maternal facial expressions during baseline, which suggested that social referencing was not yet established in the infant's repertoire. The authors implemented a discrimination phase during which maternal joyful and fearful facial expressions were consistently correlated with the consequences of the subsequent infant response. During each training trial infants were confronted with a novel object followed by a joyful

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or fearful maternal expression. A reaching response after a joyful expression was followed by crib music, while reaching responses after a fearful expression were followed by an obnoxious noise. After the intervention, infants were more likely to reach for the novel object following a joyful face, while approaching behaviors became unlikely after the presentation of a fearful expression. On another example, [Brim, Townsend, DeQuinzio, and Poulson \(2009\)](#) successfully used an intervention based on the behavior-analytic approach to teach social referencing in older children diagnosed with autism.

1.1. *Infants of mothers with depression*

There is evidence to suggest that the acquisition of early social repertoires including social referencing is disrupted among infants of mothers with symptoms of depression as opposed to infants of non-depressed mothers. Infants of up to one year of age of mothers with depression have shown limited responsiveness to facial expressions and voices and limited play and exploratory behavior ([Field, Diego, & Hernandez-Reif, 2009](#); [Hart, Field, del Valle, & Pelaez-Nogueras, 1998](#)). Mothers with depression seem to respond less frequently to the vocal and gestural signs of their infants ([Field et al., 2009](#)), which may be detrimental to the development of mother–infant interaction. Communication between the infant and the caregiver at this early age may rely on responsiveness to subtle cues, which may explain why not only clinical depression but subclinical depressive symptoms have been associated with disrupted parent–infant interaction ([Tronick & Reck, 2009](#)).

Mothers with depression are likely to provide limited information when their infants reference them for cues in situations of uncertainty. For instance, [Stenberg \(2003\)](#) manipulated maternal attentiveness in a series of experimental conditions showing that infants of mothers that were instructed to be inattentive were less likely to refer their mothers in a social referencing paradigm. Similarly, [Pelaez-Nogueras, Field, Cigales, Gonzalez, and Clasky \(1994\)](#) observed 3-month-old infants interacting with either their mothers or their nursery school teachers. All mothers had significant symptoms of depression. Infants were non responsive when interacting with their mothers but showed frequent positive interactions toward their teachers. [Hart et al. \(1998\)](#) observed mothers with and without depression when interacting with their 1-year old infant during a toy play situation. They found that toddlers of mothers with depression showed lower engagement during free play and demonstrated more negative affect than those of non-depressed mothers. Moreover, mothers with depression reportedly show a withdrawn or intrusive parenting style when playing with their infants in a structured situation ([Hart et al., 1998](#); [Malphurs et al., 1996](#)). In spite of these findings, there is evidence suggesting that relatively simple modifications of maternal behavior may have a significant impact on the infant. For instance, [Pelaez-Nogueras, Field, Hossain, and Pickens \(1996\)](#) reported that providing maternal touch stimulation increased the positive affect and attention of infants of mothers with depression.

Social referencing and other early repertoires including play and exploratory behavior may be disrupted as a consequence of the parenting style of mothers with depression. [Field et al. \(2009\)](#) suggested that effective early interventions to support depressed mothers of young infants are instrumental to promote the social and emotional adjustment of the child. Meanwhile, behavioral intervention has been used successfully to establish social referencing in infants ([Pelaez et al., 2012](#)). However, no study has examined the effects of social referencing training in infants of mothers with depression. Given the potential challenges faced by this population in the development of mother–infant communication, testing effective maternal training procedures may have some clinical value.

While mothers with depression may provide less facial, vocal, and modeling cues to their infants during spontaneous interactions, scripted referencing trials delivered by the mothers could potentially increase the referencing responses of their infants. Namely, it may be possible to establish a functional relation between a scripted series of maternal cues (independent variable) and the infant's referencing responses (dependent variable). The present study examined the effects of a behavioral intervention protocol to increase social referencing responses in a group of infants of mothers with significant symptoms of depression.

2. **Material and methods**

2.1. *Participants*

Forty-four 8- to 12-month-old infants (mean age = 9.0 months, $SD = 0.7$) and their mothers with significant symptoms of depression (mean age = 18.5 years, $SD = 2.1$) participated in this study. One participant was 7 months old, nine were 8 months old, 24 were 9 months old, seven were 10 months old, and three were 11 months old. An a priori power analysis established that a sample of 32 infants would suffice to establish moderate to large effects ($\eta^2 \geq 0.10$) in a repeated measures ANOVA with one between-group factor ($\alpha = 0.05$; $\beta = 0.80$) ([Faul, Erdfelder, Buchner, & Lang, 2009](#)). Therefore our sample of mother–infant dyads with significant symptoms of maternal depression would be appropriate to establish moderate to large treatment effects.

All infants were of normal gestational age ($M = 39$ weeks) and birth weight, and had no history of medical conditions. Mothers were of medium socioeconomic status according to a self-reported 5-point scale ($Me = 3$; 1 = *low socioeconomic status*, 5 = *high socioeconomic status*). Mothers were black (59.1%), Hispanic (36.4%), or Caucasian (4.6%). The majority of mothers were single or lived alone (88.7%), while the rest were married or under a civil union (11.3%) ([Table 1](#)).

Mother–infant dyads were recruited from a day care center for adolescent mothers in Miami metropolitan area. Infants were attending a day care center for eight daily hours while their mothers completed their education. The day care center

Table 1
Demographics of mother–infant dyads.

	Control	Experimental
<i>Infants</i>		
Gender, male:female (total)	10:8 (18)	15:11 (26)
Age in months	9.0 (0.6)	9.0 (0.9)
Infant gestational age in weeks	38.3 (4.3)	39.0 (2.4)
<i>Mothers</i>		
Mother's age, years	18.0 (1.9)	19.0 (2.2)
Depressive symptoms (CES-D)	25.6 (8.1)	24.3 (6.9)
Married or civil union, %	0.0	19.2
Single or living alone, %	100.0	80.8
<i>Ethnicity (%)</i>		
Black	66.7	53.8
Hispanic	33.3	38.5
Caucasian	0.0	7.7

Notes: Unless otherwise specified, numbers refer to means and standard deviations in parentheses. All one-factor analyses of variance and non-parametric comparisons by group (experimental, control) were non-significant ($p > 0.05$). CES-D: Centre for Epidemiological Studies–Depression Scale.

function was to support mothers of a very young age. A few of the mothers were under treatment for depression and/or drug abuse. All mothers provided informed consent.

Symptoms of depression were assessed with the Center for Epidemiological Studies–Depression Scale (CES-D; Radloff, 1977). A CES-D score over the cut-off point for depression in the general population (≥ 16) was considered as evidence of potential/significant symptoms of depression. Mothers scoring below the cut-off point were not included in the study. To ensure group equivalence, infant–mother dyads were assigned to control ($n = 18$) or experimental groups ($n = 26$) according to a random stratification procedure. Infants of mothers with CES-D scores below the cut-off point were excluded a posteriori, making group size asymmetrical. However, sample size was kept constant across all experimental conditions for a given group, and no known outcome predictors were correlated with group assignment. Thus, the integrity of the analyses was not hampered by asymmetrical sample sizes (Myers & Well, 1995, p. 151). Non-parametric comparisons indicated that infants' age and gender, maternal age, marital status, socioeconomic status, and ethnicity did not differ significantly across groups (control, experimental) (Table 1).

2.2. Design

We used a factorial design with infants of mothers with depression ($\text{CES-D} \geq 16$) as participants, group (control, experimental) as between-subjects factor, and type of social referencing trial (positive, negative) and time of assessment (pre-test [T1], post-test [T2]) as within-subjects factors. Mother–infant dyads in the experimental group interacted spontaneously (uninstructed) with the infants during the pre-test assessment and were exposed to social referencing training during the post-test assessment. Mothers in the control group interacted spontaneously with their infants both during the pre-test and post-test assessments.

2.3. Procedure

We followed the social referencing protocol used by Gewirtz and Pelaez-Nogueras (1991) and updated by Pelaez et al. (2012). Training blocks were composed of positive and negative trials. The following sequence of events was present in a positive trial: (a) object presentation, (b) infant looking-at-the-mother response, (c) maternal joyful facial expression, (d) reaching response, and (e) reinforcing stimuli. If no reaching response occurred no consequence was presented and the trial finished. The following sequence of events was in place during negative trials: (a) object presentation, (b) infant looking-at-the-mother response, (c) maternal fearful facial expression, (d) reaching response, and (e) aversive stimuli. Again, if no reaching response occurred the aversive consequence was not administered and the trial finished.

During both pre-test and post-test phases, training blocks were composed of a series of six positive trials and four negative trials alternated at random. We used different numbers of positive and negative trials to maximize discriminative learning. Specifically, there is evidence to suggest that less training of the stimulus associated with nonreinforcement relative to the stimulus correlated with reinforcement maximizes the discriminative control of either stimuli in a simultaneous discrimination paradigm (Biederman, 1967, 1968; Deutsch & Biederman, 1965). A complete social referencing episode was composed of either of these two series of events. Therefore, positive and negative trials provided the operational definition of social referencing used here. We used the term social referencing or *referencing* to refer to these behavior sequences on occasions when the infants successfully used their mother's facial cues in order to regulate their own behavior (i.e., reaching during positive trials, response omission during negative trials).

Depending on the preceding maternal facial expression, reaching responses were followed by stimuli likely to be aversive or reinforcing. During the discrimination training (post-test assessment in the experimental group), infant reaching

responses preceded by a joyful maternal expression (positive trials) were followed by reinforcing consequences, while reaching responses preceded by a fearful expression (negative trials) were followed by potentially aversive stimuli. Reinforcing consequences for reaching included 3 s of baby music coupled with slight movements of the ambiguous object. Aversive consequences consisted of a 2 s warning-harsh sound (e.g., food blender, door buzzer, or whistle). Sounds never exceeded 85 dB (equivalent to busy city traffic) and 2 s in duration.

In order to establish the ambiguity of the social referencing episode, objects were covered with a white cloth when presented and remained covered until the reaching response occurred. This arrangement strengthened the salience of maternal facial expressions as discriminative stimuli. (If the object would have not been covered, infants may have become distracted.) Once the infant reached for the object, the experimenter removed the cloth and administered the consequence appropriate to that trial.

Infants were seated in a booster chair attached to a table facing a puppet theater for stimulus presentation. Mothers seated two feet to the infant's side. Mothers gaze naturally alternated between the object and the infant during all sessions; however, we did not monitor this response. Sessions took place in the central area of a 12 × 12 ft room. Sessions were videotaped with two wide-angle camcorders. One camcorder captured the infant's responses while the other camera recorded the mother's facial cues and the puppet theater. The experimenter randomly presented a set of unfamiliar objects through the puppet theater on each of the two phases of the experiment (pre-test, post-test). Mothers confirmed that the infants were unfamiliar with the objects used as stimuli. At the beginning of each trial the experimenter told the mother what was the appropriate facial expression.

Pre-test assessment (T1). During the pre-test, 10 objects were presented randomly to the infant across 10 successive 15-s trials. Objects were covered during the social referencing trials. Therefore, they never acquired discriminative properties for the reaching or avoidance responses. Before each trial, the experimenter informed the mother about the nature of the upcoming trial (positive or negative). Mothers were asked to interact with their infants as they normally would at home. No attempt was made to influence maternal expressions in any way. Positive and negative consequences followed reaching responses based on the type of trial in effect. This phase was identical for both the control and the experimental groups.

Post-test assessment (T2). This phase was composed of 10 successive 15-s trials. The post-test was identical to the preceding phase for the individuals in the control group. Mothers in the experimental group, however, were instructed to pose a joyful facial expression during positive trials and a fearful facial expression during negative trials. The experimenter informed the mothers about the nature of each upcoming trial (positive or negative).

2.4. Behavioral responses

Looking-at-the-mother, reaching-toward-the-object, and avoidance were recorded as dependent variables. Reaching responses are expected to be high during positive trials (joyful expression followed by reward in the event of a reaching response), while avoidance is expected to be relatively high during negative trials (fearful expression followed by aversive stimulation in the event of a reaching response). Looking responses are expected to be relatively high across positive and negative trials. All three dependent variables were computed as the average percentage of trials with the response present. For procedural integrity purposes we also coded the infant's looking-at-the-object response and the mother's joyful and fearful facial expressions. Target responses were defined as follows. Finally, we recorded the infants' fear responses in order to discard interim emotional processes as a significant factor for differential responding at post-test.

Looking-at-the-object was defined as the infant orienting his or her head toward the ambiguous object within 5 s of its presentation. The infant would continue to stare at the object for a continuous period of 1 s or more.

Looking-at-the-mother was defined as the infant orienting his or her head toward the mother's face ($\sim 90^\circ$ turn) within 10 s of the presentation of the ambiguous object. The infant would continue to stare at his or her mother's face for a continuous period of 1 s or more.

Reaching was defined as the infant emitting gross motor movements of the upper body including the extension of one or two arms toward the ambiguous object.

Avoidance was defined as the infant emitting gross motor movements of the upper body away from the ambiguous object.

Fear was defined as startling responses, crying, fussing, grimacing and/or extended response inhibition (>5 s) after the presentation of novel stimuli.

Mothers were given the opportunity to practice joyful and fearful expressions before the session started. Research assistants modeled the expressions and made sure that mothers were able to perform them correctly and comfortably, according to our operational definitions. Training typically took a few minutes. Joyful and fearful expressions were defined following the descriptions of expressions of happiness and fear by Ekman (1975). A joyful expression was composed of: (a) corners of the lips drawn back and up, (b) mouth open with teeth exposed, (c) naso-labial folds running down from the lower sides of the nose to the outer sides of the lips, (d) raised cheeks, and (e) wrinkles below the lower eyelid (Ekman, 1975, Figure 50A, p. 112). A fearful expression required (a) eyebrows raised and drawn together, (b) eyes open and lower lid tensed, and (c) both lips stretched back (Ekman, 1975, Figure 22B, p. 50). During the post-assessment sessions, we asked that mothers use a neutral facial expression at times when joyful or fearful expression were not required. We defined a neutral expression as: (a) eyes open with orbital area relaxed and (b) mouth closed with cheeks and lips still and relaxed. Mothers were asked to refrain from talking to their infants during the post-test assessment.

Table 2
Summary of procedural integrity.

	Control		Experimental	
	Pre-test (T1)	Post-test (T2)	Pre-test (T1)	Post-test (T2)
<i>Looking-at-the-object</i>				
Positive trials	97.1 ± 0.0	100.0 ± 0.0	99.3 ± 3.4	99.7 ± 1.9
Negative trials	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0
<i>Joyful face</i>				
Positive trials	29.5 ± 34.7	36.4 ± 38.8	33.2 ± 35.7	99.3 ± 4.0
Negative trials	24.0 ± 33.5	18.1 ± 29.6	16.2 ± 25.3	2.8 ± 8.4
<i>Fearful face</i>				
Positive trials	0.0 ± 0.0	0.5 ± 2.8	0.3 ± 2.2	0.0 ± 0.0
Negative trials	0.7 ± 4.2	6.2 ± 19.3	8.3 ± 22.0	93.5 ± 13.9

Notes: Average percentage and standard deviation of trials with the target responses.

2.5. Interobserver agreement and procedural integrity

We collected interobserver agreement for all outcome variables. Agreement per participant was calculated as the number of trials in which primary and secondary observers agreed on the occurrence of a given response divided by the total number of trials for that participant and converting that ratio into a percentage. Interobserver agreement data was available for 43% of participants ($n = 19$). The average percentage of agreement across individuals was as follows: looking-at-the-mother, 97% (range 73–100); reaching-the-object, 98% (84–100); and avoiding-the-object, 99% (75–100).

Given that the success of the procedure was to a great extent dependent on the presence of specific infant prerequisite responses (looking-at-the-object) and the ability of the mothers to pose specific facial expressions at the right moments, we documented procedural integrity (Gresham, Gansle, & Noell, 1993; Wolery, 1994). We selected three crucial components of the procedure to establish procedural integrity: (a) looking-at-the-object, (b) maternal joyful expression, and (c) maternal fearful expression. The presence of these responses was recorded for all participants as the average percentage of trials across individuals with the target response present. Looking-at-the-object, which was a prerequisite for a referencing episode to occur, was consistently high across groups, trial types and study phases (97–100%). By contrast, joyful facial expressions were present in almost every trial (99.3%) only during the post-test positive trials of the experimental group. Similarly, fearful expressions were distinctively high (93.5%) solely for the experimental group during the post-test negative trials (Table 2).

2.6. Analysis

We conducted two-way repeated measures analyses of variance (ANOVA) to examine the main and interaction effects of all two-term combinations of study factors (group, trial type, time of assessment) among infants of mothers with significant symptoms of depression. Independent infant responses considered essential for a referencing episode to occur (looking-at-the-mother, reaching or avoiding the object) were used as separate dependent variables. Low correlation of target dependent variables at pre-test advised against using multivariate models. We computed partial eta square (η^2) effect sizes for all ANOVA effects (0.01–0.05 = small, 0.06–0.13 = medium, ≥ 0.14 = large; Cohen, 1988, p. 283). A 0.05 level of significance was used throughout. All analyses were conducted with STATA version 11 (STATA Corporation, College Station, TX).

3. Results

Looking-at-the-mother is the initial infant response in a referencing episode. As expected, there was no evidence of differential responding by trial—looking-at-the-mother responses are equally distinctive of referencing episodes during both positive and negative trials, $F(1, 25) = 0.72$, $p > 0.1$ (Table 3, Fig. 1). Comparisons by group showed that individuals in the experimental group had higher levels of looking responses, $F(1, 42) = 9.01$, $p = 0.005$, $\eta^2 = 0.71$ (Table 3, Fig. 1). The interaction between group and type of trial was not significant. Comparisons by time of assessment within the experimental group indicated that infants increased significantly their looking responses in the post-test assessment both during positive and negative trials, $F(1, 25) = 20.57$, $p < 0.001$, $\eta^2 = 0.67$.

Appropriate reaching and avoidance responses increased as a result of the intervention. In particular, the infants in the experimental group reached toward the ambiguous object after the mother posed a joyful expression more frequently than when she posed a fearful expression. There was a main effect of trial type for the individuals in the control group, $F(1, 25) = 10.06$, $p = 0.004$, $\eta^2 = 0.28$ (Table 4, Fig. 1). Although, reaching responses only increased significantly during the positive trials of the experimental group at the post-test assessment, $F(1, 25) = 6.90$, $p = 0.014$, $\eta^2 = 0.22$ (Table 4). There was also a significant interaction between trial and group during the post-test, $F(1, 42) = 4.72$, $p = 0.013$, $\eta^2 = 0.11$, which again suggests that differential responding across positive and negative trials increased as a function of the intervention. A post-hoc analysis indicated that infant reaching responses during T2 positive trials were significantly higher than in T2 negative trials, $F(1, 25) = 10.27$, $p = 0.004$, $\eta^2 = 0.29$.

Finally, avoidance responses showed a main effect of trial across the experimental and control groups, $F(1, 42) = 7.06$, $p = 0.011$, $\eta^2 = 0.14$ (Table 5, Fig. 1), and an interaction effect between trial and group, $F(1, 42) = 4.26$, $p = 0.045$, $\eta^2 = 0.09$. Subsequent analyses showed that these effects were driven by differential avoidance responding in the experimental group. No main or interaction effects of group and trial were established for the control group. There was a main effect of trial in the experimental group, $F(1, 25) = 9.59$, $p = 0.005$, $\eta^2 = 0.26$, and an interaction effect between time and trial, $F(1, 25) = 7.19$, $p = 0.013$, $\eta^2 = 0.22$. These results suggest that avoidance was differentially higher during post-test negative trials only for the individuals in the experimental group (Table 5, Fig. 1). A post hoc analysis showed that infants presented avoidance responses more often during negative trials after the intervention,

Table 3
Repeated-measure ANOVAs of looking-at-the-mother responses.

	T1 M (SD)	T2 M (SD)	Factor difference				
			Source	F	d.f.	p	Partial η^2
<i>Experimental (Exp)</i>							
Positive trial	42.3 (33.9)	61.0 (35.8)	Trial	0.72	1, 25	–	–
Negative trial	42.4 (34.8)	67.7 (36.6)	Time	20.57	1, 25	<0.001	0.67
			Trial × Time	0.27	1, 25	–	–
<i>Control (Ctrl)</i>							
Positive trial	36.1 (31.3)	35.3 (36.3)	Trial	0.09	1, 17	–	–
Negative trial	39.0 (37.7)	35.5 (37.4)	Time	0.94	1, 17	–	–
			Trial × Time	0.26	1, 17	–	–
<i>Group (T1)</i>							
Exp: positive trial	42.3 (33.9)		Group	0.01	1, 42	–	–
Exp: negative trial	42.4 (34.8)		Trial	0.03	1, 42	–	–
Ctrl: positive trial	36.1 (31.3)		Trial × Group	0.05	1, 42	–	–
Ctrl: negative trial	39.0 (37.7)						
<i>Group (T2)</i>							
Exp: positive trial		61.0 (35.8)	Group	9.01	1, 42	0.005	0.71
Exp: negative trial		67.7 (36.6)	Trial	0.08	1, 42	–	–
Ctrl: positive trial		35.3 (36.3)	Trial × Group	1.61	1, 42	–	–
Ctrl: negative trial		35.5 (37.4)					

Note: p values and partial η^2 of non-significant tests have been omitted.

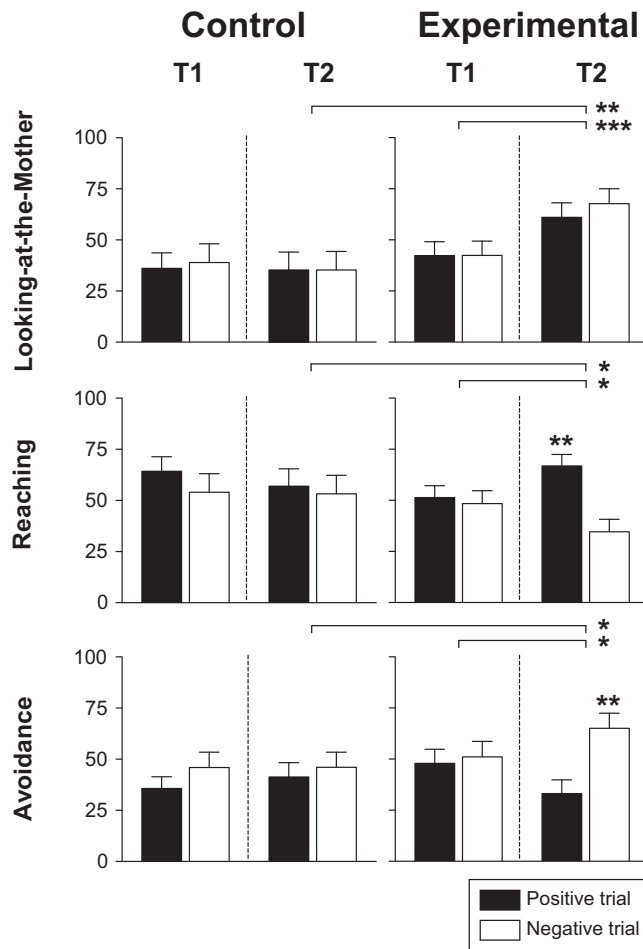


Fig. 1. Mean percentages and standard errors of infant responses (depressed mothers) during social referencing episodes. Asterisks highlight the effect of group at pre-test (T1) and post-test (T2), the Trial × Time interaction in the control and experimental groups, and the effect of trial within each group and time of assessment. **p* < 0.05, ***p* < 0.01, ****p* < 0.001.

Table 4
Repeated-measure ANOVAs of reaching responses toward the ambiguous object.

	T1	T2	Factor difference				
	M (SD)	M (SD)	Source	F	d.f.	p	Partial η^2
<i>Experimental (Exp)</i>							
Positive trial	51.4 (29.0)	66.8 (28.4)	Trial	10.06	1, 25	0.004	0.28
Negative trial	48.4 (31.5)	34.6 (30.8)	Time	0.01	1, 25	–	–
			Trial \times Time	6.90	1, 25	0.014	0.22
<i>Control (Ctrl)</i>							
Positive trial	64.3 (29.1)	57.0 (35.0)	Trial	1.78	1, 17	–	–
Negative trial	54.0 (37.5)	53.3 (37.3)	Time	1.34	1, 17	–	–
			Trial \times Time	0.94	1, 17	–	–
<i>Group (T1)</i>							
Exp: positive trial	51.4 (29.0)		Group	0.03	1, 42	–	–
Exp: negative trial	48.4 (31.5)		Trial	2.98	1, 42	.009	0.06
Ctrl: positive trial	64.3 (29.1)		Trial \times Group	1.29	1, 42	–	–
Ctrl: negative trial	54.0 (37.5)						
<i>Group (T2)</i>							
Exp: positive trial		66.8 (28.4)	Group	0.42	1, 42	–	–
Exp: negative trial		34.6 (30.8)	Trial	6.69	1, 42	0.013	0.14
Ctrl: positive trial		57.0 (35.0)	Trial \times Group	4.72	1, 42	0.035	0.10
Ctrl: negative trial		53.3 (37.3)					

Note: *p* values and partial η^2 of non-significant tests have been omitted.

Table 5
Repeated-measure ANOVAs of avoidance responses.

	T1	T2	Factor difference				
	M (SD)	M (SD)	Source	F	d.f.	p	Partial η^2
<i>Experimental (Exp)</i>							
Positive trial	47.9 (29.1)	33.2 (28.4)	Trial	9.59	1, 25	0.005	0.26
Negative trial	51.1 (32.2)	65.1 (31.3)	Time	0.01	1, 25	–	–
			Trial \times Time	7.19	1, 25	0.013	0.22
<i>Control (Ctrl)</i>							
Positive trial	35.7 (29.1)	41.3 (35.6)	Trial	2.04	1, 17	–	–
Negative trial	46.0 (37.5)	46.1 (37.3)	Time	0.77	1, 17	–	–
			Trial \times Time	0.67	1, 17	–	–
<i>Group (T1)</i>							
Exp: positive trial	47.9 (29.1)		Group	0.02	1, 42	–	–
Exp: negative trial	51.1 (32.2)		Trial	2.60	1, 42	–	–
Ctrl: positive trial	35.7 (29.1)		Trial \times Group	1.50	1, 42	–	–
Ctrl: negative trial	46.0 (37.5)						
<i>Group (T2)</i>							
Exp: positive trial		33.2 (28.4)	Group	0.19	1, 42	–	–
Exp: negative trial		65.1 (31.3)	Trial	7.06	1, 42	.011	0.14
Ctrl: positive trial		41.3 (35.6)	Trial \times Group	4.26	1, 42	.045	0.09
Ctrl: negative trial		46.1 (37.3)					

Note: *p* values and partial η^2 of non-significant tests have been omitted.

$F(1, 25) = 10.27$, $p = 0.004$, $\eta^2 = 0.29$. Finally, infants' fear responses in the experimental group did not change significantly as a function of assessment time ($p > 0.05$). Post hoc analyses showed a small effect of trial type in the experimental group during the pre-test, $F(1, 17) = 8.28$, $p = 0.001$, $\eta^2 = 0.03$, and a comparable trend during the post-test, $F(1, 25) = 3.39$, $p = 0.077$, $\eta^2 = 0.03$.

4. Discussion

There is evidence to suggest that the acquisition of early social repertoires is disrupted among infants of mothers with symptoms of depression as opposed to infants of non-depressed mothers. For instance, infants of mothers with depression seem to have limited responses to facial expressions and voices, limited play and exploratory behavior, and low responsiveness according to the Brazelton Neonatal Behavioral Assessment Scale (Field, 1998; Field et al., 2009; Hart et al., 1998). There is a scarcity of empirical studies exploring the reversibility of these challenges to the development of early social repertoires. The behavior-analytic approach to early social development, and to social referencing in particular, suggests that social responses of infants may be a function of a history of interactions with their caregivers (Pelaez et al., 2012). Therefore, social referencing responses could be firmly established in infants of mothers with depression under the appropriate

set of contingencies. Our results showed that behavioral procedures including discrimination training and reinforcement could increase social referencing responses in children of mothers with significant symptoms of depression. These infants increased their ability to turn to their mothers for information shortly after the presentation of an ambiguous object, and, more importantly, they increased the number of discriminated reaching and avoidance responses (i.e., reaching during positive trials, avoiding during negative trials). Interestingly, baseline responding for all three outcomes was relatively high but with no evidence of differential responding across positive and negative trials. Undifferentiated responding by trial continued at post-test for the control group. The intervention effect sizes were large for the within-subject comparisons in the experimental group, while between-group comparisons were within the range of moderate to large effect sizes. The consistency and size of our findings were substantial for a relatively brief intervention. In summary, our results suggest that, with appropriate instruction, mothers with significant symptoms of depression are able to improve the quality of the emotional cues presented to their infants in contexts of ambiguity. By doing so, mothers were able to strengthen, at least temporarily, the social referencing repertoire of their infants.

There are several potential limitations of the present study that ought to be described. First, our study provides an experimental demonstration of the effects of a brief behavioral procedure on discriminated responding in a social referencing paradigm. However, the level of generalization and maintenance of treatment gains cannot be established on the basis of our findings. Nonetheless, the effect sizes obtained in such a brief intervention suggest that maintenance and generalization may be possible with adequate programming (see for instance Hayne, Barr, & Herbert, 2003). Also, while our study offers a model of the potential sequence of behavioral and environmental events required for the acquisition of social referencing, we provided no evidence of the ecological validity of this model in terms of the processes responsible for the acquisition of social referencing in the natural environment.

Second, Pauli-Pott (2008) showed that depressed mothers tend to be more responsive toward their child in laboratory as opposed to home settings, which might suggest that our findings could be spurious. Nevertheless, the intervention gains in the present study cannot be attributed to location, but rather to the behavioral procedure ensuring that mothers delivered informative cues to their infants when appropriate. Interestingly, Pauli-Pott (2008) reported that increased familiarity with the laboratory setting caused cross-setting inconsistency to drop. By contrast, our control group did not show a decrease in maternal responding at post-test, which would have been predicted by the increased familiarity with the laboratory setting.

Third, mothers with significant symptoms of depression did not undergo a formal diagnostic evaluation for major depression. Therefore, we cannot state on the basis of the present analysis that infants of clinically depressed mothers are likely to benefit from social referencing training. Nevertheless, the continuous nature of depressive symptoms, ranging from mild preclinical symptoms to major depression (Hankin, Fraley, Lahey, & Waldman, 2005; Wood, Taylor, & Joseph, 2010), lends some support to the potential generalizability of our findings to clinically depressed mothers and their infants.

Forth, emotional factors could have played a role that is difficult to evaluate on the basis of the current analysis. Increased reaching and avoidance responses could have been a function of the differential exposure to joyful and fearful faces, respectively. Specifically, infants could have become more active as a function of joyful expressions, and more passive as a function of fearful expressions; possibly due to the interplay of interim emotional responses. However, in the event that the exposure to joyful expressions alone could have increased reaching (by way of interim emotional responses), we would have observed an overall increase in responding over the course of positive post-test trials and not only increases in item-related behavior (reaching). By contrast, reaching responses during positive post-test trials increased, avoidance responses dropped, and looking-at-the-mother responses were similar across positive and negative trials. Also, higher levels of response omission would have been expected during post-test negative trials had infants become more passive. This was not observed. By contrast, active avoidance responses increased during post-test negative trials (Fig. 1). Moreover, our data showed that fear responses were not distinctively higher during negative post-test trials suggesting that interim fear responses were unlikely to play a role. Moreover, a recent study using this procedure with younger infants showed that reaching was only established when the availability of reinforcement was correlated with joyful faces, which were equally distributed across baseline and training sessions. In other words, the potential eliciting effects of the exposure to joyful faces alone did not induce higher reaching responses during baseline, even though joyful faces were present in every positive trial (Pelaez et al., 2012).

Fifth, it could be argued that higher looking-at-the-mother responses during the post-test (experimental group) may simply indicate that the infants were mirroring the increase in either the quality or the quantity of maternal attention. However, mothers were seated two feet away from the infants without any distracting activities throughout the experiment (other than the presentation of the novel objects). Therefore, maternal attention was continuously available, albeit its quality varied in accordance to the study procedures (“natural” interaction vs. “scripted” interaction). It is unclear if the quality of maternal attention was more or less valuable to the infant during post-test trials as opposed to pre-test trials. For instance, the nature of the attention provided during post-test trials was restricted to joyful, fearful, and neutral faces, while we observed more varied interactions during pre-test trials (e.g., vocalizations, gross motor movements, touch). Moreover, even if the increase in looking-at-the-mother responses was a function of increase maternal attention, maternal expressions were the only cue that infants could use to acquire the differential reaching and avoidance responses observed during the post-test.

In summary, social referencing responses have been successfully established in infants and individuals with developmental disabilities using reinforcement-based interventions (Brim et al., 2009; Gewirtz & Pelaez-Nogueras, 1992; Pelaez et al., 2012). Our results suggest that these methods could be equally effective among infants of mothers with significant symptoms of depression.

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References

- Biederman, G. B. (1967). The overlearning reversal effect: A function of the non-monotonicity of the negativity of S-during discriminative training. *Psychonomic Science*, 7, (11), 385–386.
- Biederman, G. B. (1968). Stimulus function in simultaneous discrimination. *Journal of the Experimental Analysis of Behavior*, 11., 459–463. <http://dx.doi.org/10.1901/jeab.1968.11-459>
- Brim, D., Townsend, D. B., DeQuinzio, J. A., & Poulson, C. L. (2009). Analysis of social referencing skills among children with autism. *Research in Autism Spectrum Disorders*, 3, 942–958. <http://dx.doi.org/10.1016/j.rasd.2009.04.004>
- Campos, J. J. (1983). The importance of affective communication in social referencing: A commentary on Feinman. *Merrill-Palmer Quarterly*, 29., (1), 83–87.
- Cohen, J. (1988). *Statistical power analysis for the behavior sciences* (2nd edn., pp.). New York: Routledge Academic.
- Desrochers, S., Ricard, M., Décarie, T. G., & Allard, L. (1994). Developmental synchrony between social referencing and Piagetian sensorimotor causality. *Infant Behavior and Development*, 17., 303–309. [http://dx.doi.org/10.1016/0163\(94\)90010-8](http://dx.doi.org/10.1016/0163(94)90010-8)
- Deutsch, J. A., & Biederman, G. B. (1965). The monotonicity of the negative stimulus during learning. *Psychonomic Science*, 3., (9), 391–392.
- Ekman, P. (1975). *Unmasking the face*. Englewood Cliffs, NJ: Prentice Hall.
- Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, 41., 1149–1160. <http://dx.doi.org/10.3758/BRM.41.4.1149>
- Field, T. (1998). Early interventions for infants of depressed mothers. *Pediatrics*, 102., 1305–1310. <http://dx.doi.org/10.1006/pmed.1998.0293>
- Field, T., Diego, M., & Hernandez-Reif, M. (2009). Depressed mothers' infants are less responsive to faces and voices. *Infant Behavior and Development*, 32., 239–244. <http://dx.doi.org/10.1016/j.infbeh.2009.03.005>
- Gewirtz, J. L., & Pelaez-Nogueras, M. (1991). The attachment metaphor and the conditioning of infant separation protests. In J. L. Gewirtz, & W. M. Kurtines (Eds.), *Intersections with attachment* (pp. 123–144). Hillsdale, NJ: Erlbaum.
- Gewirtz, J. L., & Pelaez-Nogueras, M. (1992). Social referencing as a learned process. In S. Feinman (Ed.), *Social referencing and the social construction of reality in infancy* (pp. 151–173). New York: Plenum.
- Gresham, F. M., Ganste, K. A., & Noetl, G. H. (1993). Treatment integrity in applied behavior analysis with children. *Journal of Applied Behavior Analysis*, 26., 257–263. <http://dx.doi.org/10.1901/jaba.1993.26-257>
- Hankin, B. L., Fraley, R. C., Lahey, B. B., & Waldman, I. D. (2005). Is depression best viewed as a continuum or discrete category? A taxometric analysis of childhood and adolescent depression in a population-based sample. *Journal of Abnormal Psychology*, 114., 96–110. <http://dx.doi.org/10.1037/0021-843X.114.1.96>
- Hart, S., Field, T., del Valle, C., & Pelaez-Nogueras, M. (1998). Depressed mothers' interactions with their one-year-old infants. *Infant Behavior and Development*, 21., 519–525. [http://dx.doi.org/10.1016/S0163-6383\(98\)90024-8](http://dx.doi.org/10.1016/S0163-6383(98)90024-8)
- Hayne, H., Barr, R., & Herbert, J. (2003). The effect of prior practice on memory reactivation and generalization. *Child Development*, 74., 1615–1627. <http://dx.doi.org/10.1046/j.1467-8624.2003.00627.x>
- Malphurs, J., Field, T., Larrain, C. M., Pickens, J., Pelaez-Nogueras, M., Yando, R., & Bendell, D. (1996). Altering withdrawn and intrusive interaction behaviors of depressed mothers. *Infant Mental Health Journal*, 17., 152–160. [http://dx.doi.org/10.1002/\(SICI\)1097-0355\(199622\)17:2<152::AID-IMHJ5>3.0.CO;2-S](http://dx.doi.org/10.1002/(SICI)1097-0355(199622)17:2<152::AID-IMHJ5>3.0.CO;2-S)
- Myers, J. L., & Well, A. D. (1995). *Research design and statistical analysis*. Hillsdale, NJ: Lawrence Erlbaum.
- Pauli-Pott, U. (2008). Mothers with depressive symptoms: Cross-situational consistency and temporal stability of their parenting behavior. *Infant Behavior and Development*, 31., 679–687. <http://dx.doi.org/10.1016/j.infbeh.2008.04.010>
- Pelaez, M. (2009). Joint attention and social referencing in infancy as precursors of derived relational responding. In R. A. Rehfeldt, & Y. Barnes-Holmes (Eds.), *Derived relational responding: Applications for learners with autism and other developmental disabilities* (pp. 63–78). Oakland, CA: New Harbinger.
- Pelaez, M., Virues-Ortega, J., & Gewirtz, J. L. (2012). Acquisition of social referencing via discrimination training in infants. *Journal of Applied Behavior Analysis*, 45., 23–35. <http://dx.doi.org/10.1901/jaba.2012.45-23>
- Pelaez-Nogueras, M., Field, T., Cigales, M., Gonzalez, A., & Clasky, S. (1994). Infants of depressed mothers show less depressed behavior with their nursery teachers. *Infant Mental Health Journal*, 15., 358–367. [http://dx.doi.org/10.1002/1097-0355\(199424\)15:4<358::AID-IMHJ2280150405>3.0.CO;2-U](http://dx.doi.org/10.1002/1097-0355(199424)15:4<358::AID-IMHJ2280150405>3.0.CO;2-U)
- Pelaez-Nogueras, M., Field, T., Hossain, Z., & Pickens, J. (1996). Depressed mothers' touch increases infant positive affect and attention in still-face interactions. *Child Development*, 67., 1780–1792. <http://dx.doi.org/10.2307/1131731>
- Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, 1., 385–401. <http://dx.doi.org/10.1177/014662167700100306>
- Stenberg, G. (2003). Effects of maternal inattentiveness on infant social referencing. *Infant and Child Development*, 12., 399–419. <http://dx.doi.org/10.1002/icd.321>
- Tronick, E., & Reck, C. (2009). Infants of depressed mothers. *Harvard Review of Psychiatry*, 17., 147–156. <http://dx.doi.org/10.1080/10673220902899714>
- Walden, T. A., & Kim, G. (2005). Infants' social looking toward mothers and strangers. *International Journal of Behavioral Development*, 29., (5), 356–360. DOI: 1080/01650250500166824.
- Wolery, M. (1994). Procedural integrity: A reminder of its functions. *Journal of Behavioral Education*, 4., (4), 381–386.
- Wood, A. M., Taylor, P. J., & Joseph, S. (2010). Does the CES-D measure a continuum from depression to happiness? Comparing substantive and artifactual models. *Psychiatry Research*, 177., 120–123. <http://dx.doi.org/10.1016/j.psychres.2010.02.003>