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Natural versus Trained Maternal Expression in a Social Referencing Paradigm

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Abstract

Throughout the social referencing literature, mothers were used as emoters and trained to express prototypical expressions. The concern with using trained expressions is that this may not be how mothers naturally convey emotional information to their infants. Half of the mothers were trained to present prototypical vocal and emotional expressions of fear, happiness, and neutrality as they delivered a social referencing message to a toy and then allowed the infant time to interact with it. The other half were instructed to naturally convey these emotions to their infants. Untrained mothers used more affect and gestures when communicating compared to untrained mothers. Older infants touched the toy most when hearing happiness and least when hearing fear, while younger infants did the opposite. Maternal training did not have an effect on infant interaction with the toys, which suggests that training may not be a necessary component of social referencing paradigms.

Keywords: Social referencing; Mothers; FACS training

Introduction

Traditional social referencing studies train mothers in facial and vocal prototypical expressions in order to standardize delivery. A subset of new studies, some of which depart from typical paradigm set-up, have used untrained mothers as the signalers. This study sought to examine whether maternal emotional training was a necessary component in social referencing methodology.

Mothers have been consistently utilized as the emoters in social referencing research. To regulate the emotional signals made, all mothers in a given study were trained to produce the same facial expressions [1-6]. Mothers were taught standardized, prototypical, and universally recognized emotional expressions [7]. While descriptions of the training are not always provided in study methodologies, it appears that most researchers instruct parents using either Izard's [8,9] or Ekman et al. [7] systems. Vocalizations are standardized in a similar fashion, with a goal of making pitch and intonation similar across maternal participants [3,10]. Training mothers takes time and may impact the entire laboratory visit for the mothers and infants. Further, infants witnessing the training may change the results of the study itself. This raises the question of whether training is necessary or even beneficial for this research.

A concern with using trained expressions is that this may not be how mothers naturally convey emotional information to their infants and, therefore, may feel foreign to the infants watching their mothers. There are currently no reports comparing trained to untrained mothers. However, descriptions of untrained maternal communications suggest that their natural expressions are animated and succinct when communicating with their infants compared to prototypical expressions. In a study of display patterns in mother-infant play, Malatesta et al. [11] identified frequent changes in maternal facial expressions during a one- minute period. Mothers commonly display positive emotions, brow flashes, and encouragement to their infants. Additionally, mothers used more negative emotions with older infants. When used, negative emotions were placed in the context of playful mocking exaggerations. In another study, when asked to pretend to drink out of a play cup, mothers demonstrated more smiling and looking toward their infants, compared to mothers engaging in real drinking behavior [12]. In other words, when asked to pretend and improvise, mothers' expressions were more elaborate.

Having mothers convey emotional information naturally may work best in ambiguous, but not threating, situations. In research encouraging or discouraging newly walking infants to navigate sloped walkways, mothers were tasked to use their natural expressions to communicate to their infants [13,14]. The findings from these studies obscured the picture of what infants do when they socially reference. Adolph et al. [10] found that when positive maternal expression conflicted with the fear of slipping down a slope, infants relied on perceptual cues over the mothers' social signals to guide their behavior. Therefore, in designing a study that examines natural versus trained expressions, there should be no threats to the infants so that infants are not choosing between saving themselves from harm and socially referencing the mother.

One possible mitigating factor in infant response to trained versus untrained mothers might be the age of the infant. The ability to socially reference another person changes and develops with age. At approximately 12 months of age, infants learn that by looking to their mothers (and other caregivers), they can receive beneficial, interpretive information regarding unfamiliar and ambiguous occurrences. By using maternal appraisal of a situation, infants can generate a better understanding of that. situation. Infants then use the mothers' appraisals to align their own behavior in response to the unfamiliar occurrences in a process known as social referencing [15,16]. Collectively, this is a two-step process, which includes both the process of information gathering and behavior regulation. From previous studies, researchers concluded that infants develop a more

sophisticated social referencing skill set as they age [2,17-21]. Martin et al. [2] found that infants over 15 months of age could distinguish between emotions with the same valence and could regulate their behavior accordingly. This is referred to as affect specificity [22,23]. Therefore, around 12-months, infants may be able to collect relevant information and use it to regulate their behavior. Later, around 15 months of age, infants may have a greater understanding of various emotions which may lead them to differentiate between them.

The goal of the current study was to assess whether infants respond differently to trained versus untrained maternal signaling. There may be differences in social referencing study outcomes when mothers use trained expressions versus untrained, natural expressions. Therefore, we sought to determine if training mothers in social referencing studies is necessary, or if allowing mothers to convey emotional signals naturally would be just as effective. We addressed four questions in this study. First, how did maternal presentation differ between trained and untrained conditions? While this has not been explored thus far, there is indication that infants do respond negatively when they hear and see something different than their norm. Second, did infants reference one group of mothers more over the other? Third, were infants able to regulate their behavior based on the emotional signal delivered by trained versus untrained mothers? Finally, does infant referential behavior vary by age in regards to maternal delivery method? We predicted that infants would reference trained mothers more than untrained mothers because of a novelty in her behavior. We also assumed that the referential behavior in the older group of infants in this study would be more influenced by maternal signaling compared to younger infants, as other studies have demonstrated a stronger social referencing response in children over 14 months of age [2,19,22], regardless of training condition.

Method

Participants

Participants in this study were 20, 11-13 month-old infants (M=11.38 months; SD=0.25 months) and 20, 16-18 month-olds (M=16.10 months; SD=1.071 months) accompanied by their mothers. Of the total infant participants, 62% were male. Criterion for participation included infants being full term, healthy, and typically developing according to the Ages and Stages Questionnaire [23]. The mothers' ages ranged from 20 to 42 years (M=31.26 years, SD=1.071 years). Most of the mothers were married (85%), however 2.5% were separated, 5% were living together, and 7.5% were single. The median level of education for the mothers was a four-year college degree. Families were recruited from the local university area. Two families were excluded from the final sample and replaced; one due to excessive crying before the session started and one due to the mother not following the training protocol.

Experimental Conditions

Prior to arrival, families were randomly assigned to one of four experimental conditions (trained versus untrained mothers; happy or fear presented first). While all mothers presented a neutral baseline to their infants first, happy and fear presentation orders alternated depending on condition. Ten infants from each age group (11-13 months and 16-18 months) were placed in each condition. This divided the four different conditions into eight different groups. Each testing session included a toy presentation (information gathering) and a behavior regulation phase. All infants experienced a neutral, fear, and happy condition.

Toy presentation: Each mother took the first toy boat out of a bag and signaled the toy while saying: "Look at the boat. The boat is blue and floats on water. Look at the blue boat." The sentences used for each emotion (neutral, happy, and fear) were similar in content but varied by color (blue, green, and red) and by what activity the boat did (floats, moves, and goes fast). These sentences were chosen because they were descriptive, but not emotionally leading. Mothers were instructed to look alternately at the toy boat and the infant while also reading the sentences. The toy boats were kept in front of the mothers and out of the infants' reach until the mothers finished reading. The presentation phase averaged 16 s in length.

Behavior regulation phase: Mothers placed the toy boat in front of the infants, which allowed the infants to play with the boat for 30 s. While looking directly at the toy boat, mothers held their facial expressions as their infants played during the interaction period. At the end of the interaction period, mothers removed the toy boats from their infants' hands and began the next emotion presentation. This sequence was run three times so that infants experienced a neutral, happy, and fearful presentation from their mothers.

Procedure

Setting: The experiment was performed in a laboratory playroom that contained a long table and two chairs facing each other. Infants were secured into a high chair at one end of the table. Mothers and infants were placed next to each other so that infants could see their mothers' faces. The experimenter sat across from the mother, but turned his or her back while the testing took place.

Toy stimuli: Three plastic toy boats were used as stimuli objects for this experiment. Each boat was similar in size but varied in color and shape. These toys were chosen through pilot testing procedure in which infants were introduced to the three toy boats and allowed to interact/play with them during another study. Infant behavior indicated that they were neither excited by nor fearful of the toys. Further, mothers indicated that their infants had not interacted with these toys previously.

Training: Prior to arrival, mothers were randomly assigned to either the trained or untrained conditions. While the trained mothers were learning the facial and vocal systems, their infants played on the floor with an experimenter. In order to make the trained condition distinct from the untrained, we used a structured training hybrid of systems used in other social referencing studies [7,9]. Although this is a general description, for fear, mothers were trained to raise and draw together their brows, open their eyes wide, open their mouths, and pull back their cheeks and lips. For happiness, mothers were instructed to draw their lips out and up into a smile and raise their cheeks and brows slightly while they soften their eyes. For neutral, mothers were instructed to show no expression and to move facial features very little while delivering the message. Training on vocalizations was based on Scherer's et al. [24] descriptions and that have been used in other social referencing studies [3,10]. The neutral vocalization was spoken in a monotone, robotic tone with little to no inflections. For happiness, mothers were trained to speak smoothly, enthusiastically, and to turn their vocal pitch up at the start of each sentence. For fear, mothers were asked to gasp at the start of each sentence, corresponding with a held facial expression of fear. Vocalizations were kept at a tense, rapid pace, and were slightly higher in pitch than happiness. Both happiness and

fear were louder and more animated in sound compared to the neutral presentation. Facial and vocal expressions were rehearsed several times until mothers could hold a conversation while keeping the correct facial and vocal expressions.

A reliability check was performed on all mothers post- study to make sure that all trained mothers were able to hold the prescribed facial expression for 75% of the presentation. This check was then scored by a naïve rater who achieved reliability on MAX training [9]. Facial expressions met the criteria of having predicted components of neutral, fear, and happiness in two or three facial zones and not having components belonging to other emotions. All trained mothers met these criteria during the toy presentation and behavior regulation phases.

Untrained mothers: The other half of the mothers were pre-assigned to the untrained condition. These mothers were informed that they would be expressing neutral, fear, and happiness during their three trials. Mothers were only instructed to envision how they might regularly convey neutrality, fear, and happiness to their infants and asked to do so throughout their presentations. They were also instructed to hold their expressions during the behavior regulation period.

Training reliability check: In order to confirm that the trained mothers were doing something distinctly different from the untrained mothers, a naïve experimenter blindly coded all mothers' presentations. Coders were asked to rate how structured mothers' facial presentations appeared, how long they held or returned to each expression, and if vocalizations kept to a consistent tone, thereby indicating that the mother was trained. One mother-infant pair was excluded from the final sample because the mother did not follow the training when presenting and, therefore, appeared more like an untrained mother. This pair was replaced. All other mothers were blindly coded correctly into their respective training categories.

Coding

All behaviors by the mothers and infants were video recorded. Maternal and infant behaviors were coded independently. Further, infants were coded during the toy presentation and behavior regulation phases. The following measures were used in this study:

Measures of maternal behavior: Once mothers began to emote, the following variables were coded during the toy presentation period. All scores were calculated as proportion of time scores.

Maternal affect: Positive, negative, and neutral maternal vocal and facial affective expressions were coded separately. Positive affect was recorded for each second mothers' faces included smiles, general positive interest, and upbeat vocalizations. Negative affect was calculated for each second mothers' faces included worried expressions, fear expressions, and when their vocalizations included negative tones (e.g., whimpering, and gasps). Neutral affect was recorded for each second mothers' faces included no signs of affect, either positive or negative. This system was based on Stenberg's et al. [25] description.

Gestures: Any second in which mothers used their hands or body to signal their infants was coded. This included, but was not limited to, pointing, arm waving, shoulder shrugging, head nodding, leaning back, and touching face.

Measures of infant behavior: Infant behavior was measured in both the toy presentation and behavior regulation phases. All scores were calculated as proportion of time scores.

Infant referencing direction: Infant referencing direction was scored as the proportion of time infants looked either to their mothers, the experimenter, toy, or elsewhere in the room during the toy presentation and behavior regulation phases. All infants in the study referenced the mothers for at least 5 s during the toy presentation phase.

Object touch: Infant interaction with the toy boats was coded during the behavior regulation phase. Latency to touch measured how long, in seconds, it took for infants to touch the toy once the interaction period started. If infants never touched the toy, they were scored at 30 s, indicating that during the regulation phase, they chose not to interact with the toy. Infants were also measured for how much time they spent touching the toy. This was calculated as a proportion score. If infants never touched the toy, they received a proportion score of zero, as infants spent no time interacting with the toy. If the toy was dropped or thrown, this was also coded (as toy dropped) and the behavior regulation phase ended on the second the toy left the infant's hand.

Infant affect: Positive, negative, and neutral infant vocal and facial affective expressions were coded separately by using the same criteria as maternal affect. Infant affect was coded during the toy presentation and behavior regulation phases.

Reliability: To evaluate inter-rater reliability, 50 % of participants were coded for both the toy presentation and the behavior regulation phases by two separate coders, working independently of one another. Coders were blind to the age of the child, training of the mother, and emotion presented when coding. Further, coders only coded select behaviors, so they were limited to viewing only the segment in question. Reliability coefficients (Cohen's kappa) were averaged, and their mean values were calculated for each variable and ranged from, K=.79 to K=.94.

Results

To analyze infant response to trained versus naturally expressing mothers, we explored four areas of inquiry. Infant age, and specifically age group, was explored across areas as a possible mitigating factor stemming from development.

Maternal Presentation

Maternal presentations were evaluated using measures of maternal affect (positive, negative, and neutral) and maternal gestures. A 3x3x2x2 ANOVA was conducted with maternal affect score (neutral, positive, and negative), emotional conditions (neutral, fear, and happiness), training (trained or not trained), and age group (11-13m and 16-18m) of infants as the independent variables. This was used as a manipulation check to make sure mothers in both conditions were presenting the emotion correctly. Affect scores were significantly different $F(2,66)=11.777$, $p<0.001$. There was also an interaction between emotion and affect presented, $F(4, 132)=9.527$, $p<0.001$.

There was evidence that trained and untrained mothers behaved differently when presenting affective messages. When presenting happiness, untrained mothers used more vocal drama, $t(39)=2.221$, $p=0.032$, and more gestures compared to trained mothers, $t(39)=2.802$, $p=0.08$. When presenting fear, untrained mothers used

more negative affect compared to trained mothers, t (39)=4.730, p<0.00.

Infant referencing behavior

During the toy presentation phase, infants could look at their mothers, the experimenter (who had her/his back turned), a camera, the toy boat, or elsewhere in the room. The time spent looking at each location (expressed as proportion of total presentation time) was analyzed using a 5 (location) X 3 (emotion) X 2 (age group) X 2 (training condition) mixed ANOVA, with location and emotion as within subjects factors. Infant affect (positive, negative, and neutral) was also coded during this phase of the paradigm.

There was a main effect of location on proportion of time spent looking during the toy presentation, F (4, 148)=172.292, p<0.001. Infants spent the majority of their time looking at the toy, M=0.714, SD=0.033, followed by mothers, M=0.128, SD=0.022. There was also an interaction between emotion and the location of gaze, F (8,296)=2.535, p=0.011. To follow up this interaction, we estimated effect sizes for gaze location separately for each emotion condition. For the neutral, happy, and fearful conditions the effect sizes were η^2 neutral=0.596, η^2 happy=0.768, and η^2 fearful=0.980. As illustrated in Figure 1, a reasonable interpretation is that the emotional conditions resulted in a stronger bias toward looking at the toy.

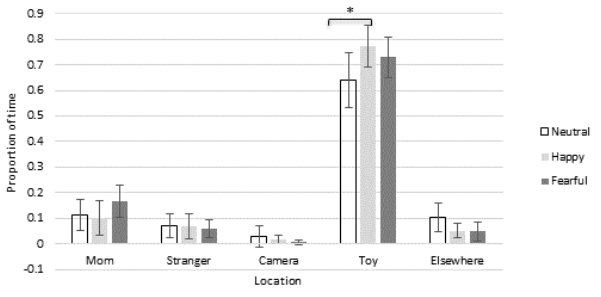

Figure 1: Infant looks to mother, experimenter (stranger), camera, toy, or elsewhere during maternal presentation of neutral, happy, and fearful signals. Error bars highlight 95% confidence intervals. *p=0.01.

Infant behavior regulation

Infants were given 30 s to interact with a toy at the conclusion of their mother's presentation. All infants experienced a neutral, happy, and fear condition. Measurements of infant behavior regulation included time touching the toy, latency to touch the toy, looking direction, and affective expression during each behavior regulation period. Each dependent variable was analyzed with a 3 (emotion) X 2 (age group) X 2 (training condition) mixed ANOVA with emotion as a within subjects factor.

There was a main effect of emotion on touching behavior in infants, F(2, 70)=6.443, p=0.003, and an interaction between emotion and age group on touching behavior, F(2, 70)=25.327 p<0.001. To follow up the interaction, contrasts (Bonferroni corrected α=0.025) indicated that the effect of fear relative to the neutral condition was greater for older than younger infants, F(1,35)=31.503, p <0.001, while the effect of happiness was not detectably different, F(1,35)=4.045, p=0.052. As illustrated in Figure 2, older infants touched the toy for a much shorter period of time in the fear condition relative to the neutral condition, while younger infants touched the toy longer in the fearful condition.

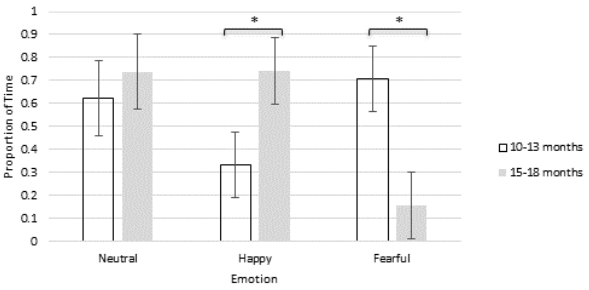

Figure 2: Proportion of time infants spent touching the toy by age in each emotional condition. Error bars highlight 95% confidence intervals. *p<0.001.

There was a main effect of emotion on latency to touch, F (2, 70)=5.256, p=0.007, and an interaction between emotion and age group, F (2, 70)=10.973, p<0.001. Contrasts were used to follow up the interaction, using Bonferroni corrected α=0.025. The effect of fear was larger for older infants than younger, F (1,35)=14.652, p=0.001, but the effect of happiness was not significantly different, F(1,35)=0.195, p=0.662. As indicated in Figure 3, fear significantly delayed older, but not younger, infants in interacting with the toy.

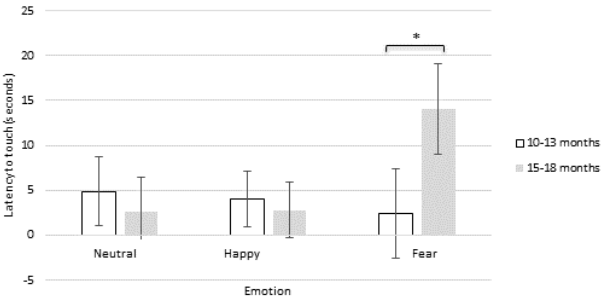

Figure 3: Latency to touch the toy in the neutral, happy, and fear conditions by infant age. Error bars highlight 95% confidence intervals. *p > 0.001.

There was a main effect of location of gaze on proportion of time spent looking during the behavior regulation phase, F (4, 148)=179.106, p <0 .001. Additionally, there was an interaction between emotional condition and age group, F(2, 74)=4.146, p=0.020. To follow up on this interaction, the effects of happiness and fear relative to neutral were contrasted between age groups. Neither the effect of happiness (F (1,37)=4.307, p=0.045) nor fear (F(1,37)=1.022, p=1.022) were significantly different between groups with Bonferroni corrected α=0.025. However, as illustrated in Figure 4, the interaction was a cross-over, indicating that in older children, happiness increased overall looking behavior and fear decreased it, while in younger infants the opposite occurred relative to the neutral condition.

Figure 4: Time infants looked at target object in neutral, happy, and fear conditions by age. Error bars highlight 95% confidence intervals. *p=0.02.

Discussion

As the majority of social referencing studies use trained maternal presentations of facial and vocal expressions, this analysis explored whether training made a difference in how infants responded when affectively signaled and whether age was a factor in infant response. While trained and untrained mothers differed in how they presented the affective messages to their infants, this did not appear to make a difference in how infants responded to these emotional signals. Infant response changed by age; older infants referenced and then reacted differently to the emotional signals compared to younger infants.

The standard methodology across social referencing studies involves training parents to present prototypical facial and vocal expressions. Training ensures that the presenter is signaling the appropriate emotion and ensures that infants can pick up the essential vocal and facial components necessary to interpret each emotion. However, trained expressions create an artificial situation as mothers do not typically convey emotional information to their infants with frozen expressions and mechanical vocalizations. Untrained mothers varied on how they conveyed emotions, as the blind coders were easily able to distinguish between the trained and untrained mothers.

Maternal behavior was used as a manipulation check to determine if mothers appropriately signaled the given emotions during their presentation. In the neutral presentation, mothers showed low amounts of positive and negative affect. Further, all mothers showed higher positive affect when presenting happiness and higher negative affect when presenting fear. Untrained mothers used more negative affect when presenting fear, positive affect when presenting happiness, and more gesturing when conveying happiness compared to trained mothers. This aligns with other research indicating that mothers behaving naturally use lots of body and hand movements when communicating with their infants [26]. While training changed the mothers' behavior in measurable and detectable ways, this did not translate into differences in infant behavior. Explanation of this data is limited in that this is an interpretation of a null results finding. It can be argued that infant behavior may differ in response to training in the parent if we had used a larger sample size. However, given the power of the significance, these findings would likely continue to demonstrate no differences in infant behavior in response to training in the mothers.

Our initial hypothesis was that infants experiencing the trained condition would reference the mothers more, because, while she was familiar, her behavior may seem foreign and curious. The results indicated that this was not the case and that both groups referenced the mothers equally. Although all infants referenced their mothers, they spent a majority of their time looking at the toy across training conditions. Mothers were presenting a novel toy as well as describing it, so it makes sense that the majority of the infants' looking time was spent focused on the toy.

Referential and looking behavior differed between the older and younger groups of infants. The 15-to-18-month-old infants delayed interaction with the toy boats when their mothers signaled fear. If these infants interacted with the toys at all, they touched the fear-signaled toys less compared to the neutral condition. Younger infants' latency to touch the toys and overall touching time was greater in the fear conditions compared to neutral. Although younger infants regulated their emotions differently in response to maternal fear and happy signals, their behavior contradicted the action tendencies expected [27]. Older infants were able to recognize the emotional signals from their mothers, regardless of training, and apply the signals to the new toys placed on the table. Evidence of older infants avoiding interaction with objects signaled with negative emotions is supported by other studies [2,28]. Although younger infants were able to socially reference in this study, they did not apply the emotional signals in expected ways. In the Martin et al. [2] study, all infants were presented with a distracter toy along with the toy targeted with the affective message, thereby allowing the infants to interact with a tempting toy while avoiding the one signaled with negative emotions. In the case of this study, there was no distractor. Perhaps the younger infants were enticed more by the toys than their mothers' signal of fear.

A final question stemming from this study is, why did mothers use more gesturing when signaling happiness compared to fear? There are a few reasons for this. Happiness signals infants to approach [29,30] and gestures may invite infants in, whereby fear signals a threat and something that should be monitored and avoided [22,31]. It may also be the case that gesturing is not needed when signaling fear because the face conveys enough information. The fact that the trained mothers used limited gesturing when presenting can be attributed to the training itself- mothers were instructed and rehearsed in facial and vocal signals and gesturing was never mentioned. It is likely that the mothers focused on perfecting vocal and facial expressions and neglected natural gesturing [32-34].

The goal of this study was to see if infants responded differently to trained mothers, which they did not. These results provide one piece of evidence that training may not be necessary for social referencing studies. Training takes time to standardize and these results suggest that this sample of infants did not respond differently to their mothers based on training. It may be the case that training helps infants distinguish numerous emotions or same-valenced emotions. For example, it may be harder for infants to distinguish between naturally conveyed fears versus surprise face, as they share similar components. Further inquiry into response to other emotions would be warranted.

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