Clinical depression affects approximately 1 in 10 mothers during the postpartum period (O’Hara, Neuhauser, & Zkoski, 1984), and is associated with disruptions in mother-infant interactions (Cohn, Campbell, Matias, & Hopkins, 1990). Relative to nondepressed mothers, depressed mothers exhibit more negative affect and are less likely to appropriately engage their infants, who, in turn, also show more negative affect and tend to become behaviorally withdrawn or avoidant. Children of depressed mothers are at elevated risk not only for insecure attachment (Teti, Gelfand, Messinger, & Isabella, 1995) and later psychopathology (Chorpita & Barlow, 1998), but also for problems in cognitive development. Relative to children of nondepressed mothers, for example, they have deficits in object constancy (Murray, 1992), lower scores on tests of cognitive-developmental milestones (Murray & Cooper, 1997), and lags in school readiness (NICHD Early Child Care Research Network, 1999). Although hereditary and gestational factors likely contribute to some of these risks, disruptions in caregiver behavior also play a significant role. In this report, we present evidence showing that infants of depressed mothers, although competent learners, fail to acquire associations in response to stimulation provided by their own mothers.

According to one hypothesis, poor infant learning can occur as a result of deficient motivational support and guidance of infant attention by withdrawn mothers (Field, 1984). Not only is there a relatively low contingency between infants’ behavior and the stimulation provided by depressed caregivers, but also the quality of that stimulation is poor. For instance, depressed caregivers tend to exhibit flat vocal affect (Betts, 1988). Vocal stimulation, particularly infant-directed (ID) speech, is an important source of stimulation for young infants. Relative to adult-directed (AD) speech, the ID speech style most prominently includes higher mean fundamental frequency (F₀) and exaggerated F₀ modulation (Fernald & Simon, 1984). Laboratory-based tests with infants have shown that ID speech is more effective than AD speech in eliciting infant responding (e.g., Cooper & Aslin, 1990).

However, ID speech produced by depressed mothers contains significantly less F₀ modulation than that produced by nondepressed mothers (Kaplan, Bachorowski, Smoski, & Zinser, 2001). ID speech produced by depressed mothers should, therefore, have weaker effects on infant learning than that produced by nondepressed mothers. This prediction was confirmed in a previous experiment (Kaplan, Bachorowski, & Zarlingo-Strouse, 1999) investigating the learning-promoting properties of ID speech produced by depressed and nondepressed mothers in a conditioned-attention paradigm. ID speech segments were recorded from 20 mothers who varied in symptoms of depression. These speech segments were used as signaling stimuli, or conditioned stimuli (CSs), with a smiling-face reinforcer (unconditioned stimulus, or US) in 20 independent groups of 4-month-old infants of nondepressed mothers. Infants who received pairings of an unfamiliar nondepressed mother’s ID speech and a face readily formed a voice-face association, whereas infants who received pairings of an unfamiliar depressed mother’s ID speech and a smiling face did not. Thus, acoustic differences in ID speech produced by depressed versus nondepressed mothers affected whether infants acquired a voice-face association.

Infants of nondepressed mothers were tested in that study to assess the learning-promoting properties of ID speech in infants without a history of disordered interaction with a depressed caregiver. However, the more direct question of how infants of depressed mothers respond to ID speech produced by their own mothers is important to test for several reasons. First, because of experience with a depressed primary caregiver, infants of depressed mothers might develop compensatory strategies or even be protected from learning deficits as the result of familiarity or prior associations. In this view, infants of depressed mothers should learn well in response to their own mothers’ ID speech. They could conceivably also learn well in response to an unfamiliar depressed mother’s speech because of generalization. Alternatively, because of either the low perceptual salience of their mothers’ speech or prior nonreinforced exposure (i.e., latent inhibition), infants of depressed mothers might fail to learn in response to their own mothers’ voices. More disturbingly, because of their experience with a depressed caregiver, infants of depressed mothers might exhibit a generalized diminished ability to acquire associations (Hay, 1997). As a result, they might show poor learning not only in response to their own mothers’ speech, but also in response to ID speech produced by an unfamiliar nondepressed mother. To assess these alternatives, we compared voice-face associative learning in infants of depressed and nondepressed mothers in response to their own mothers’ ID speech, as well as in response to ID speech produced by an unfamiliar nondepressed mother. To assess these alternatives, we compared voice-face associative learning in infants of depressed and nondepressed mothers in response to their own mothers’ ID speech, as well as in response to ID speech produced by an unfamiliar nondepressed mother.

METHOD

Subjects

Twelve depressed mothers and their 4-month-old infants, as well as 12 nondepressed control mothers and their 4-month-old infants, were recruited through birth announcements and advertisements in a

Address correspondence to Peter Kaplan, Department of Psychology, Campus Box 173, University of Colorado at Denver, P.O. Box 173364, Denver, CO 80217-3364.
parenting magazine. An additional 7 infants, 4 of nondepressed and 3 of depressed mothers, were tested but provided no data, because of excessive crying. All mothers were administered the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, & Erbaugh, 1961) and the Structured Clinical Interview for DSM-IV Axis I Disorders (First, Spitzer, Gibbon, & Williams, 1995). Mothers in the depressed group scored 16 or above on the BDI (M = 21.4, SD = 4.7), and also received an Axis I depression-spectrum diagnosis according to the criteria of the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV; American Psychiatric Association, 1994). Mothers in the nondepressed group had low scores on the BDI (M = 5.0, SD = 2.8) and did not meet criteria for any DSM-IV diagnosis. Interrater reliability ratings for a diagnosis of a DSM-IV Axis I depressive-spectrum disorder (American Psychiatric Association, 1994) yielded a kappa coefficient of .92. Final diagnoses were based on the primary rater. Mothers in the two diagnostic groups did not differ with respect to age, education, ethnicity, or number of children. Two of the depressed mothers were currently taking Prozac.

Apparatus

Each infant was placed in a car seat situated in front of a large flat-black board. A 4-in. × 4-in. translucent Plexiglas projection screen was embedded in the board at approximately eye level. A video camera filmed the infant through a small aperture located 1.9 cm to the infant’s left of the projection screen. Views of the infant’s face were watched by independent observers in separate rooms on 48.3-cm video monitors. Auditory stimuli were presented to the infant using a tape player. To make sure that looking at the projection screen was not an artifact of visual orienting toward the sound, we located the speaker 10 cm below and 33.5 cm behind the infant’s head. The distance from the infant’s head to the projection screen was, depending on the infant’s lean, approximately 42 cm. Visual stimuli, an achromatic slide of a smiling adult female face and an achromatic 4 × 4 checkerboard pattern (each check subtended 3° on a side), were presented using two slide projectors. A microcomputer controlled stimuli and the tabulation of observers’ responses.

Procedure

Speech segments were recorded from the mothers as they interacted with their 4-month-old infants. Each mother was handed a stuffed toy gorilla and asked to interest her infant using the phrase “pet the gorilla.” This phrase was selected to enhance the comparability of the current procedures to those used in our previous study (Kaplan et al., 1999). Each mother’s first two interrogative and first declarative “pet the gorilla” utterances (e.g., “Can you pet the gorilla? Do you want to pet the gorilla? Pet the gorilla.”) were edited out of an approximately 1-min stream of speech, repeated once, and combined into a 10-s speech segment. Two similar “pet the gorilla” speech stimuli served as control stimuli. One had been recorded previously from a depressed mother and had been shown not to promote learning in the conditioned-attention paradigm with infants of nondepressed mothers, whereas the other had been recorded from a nondepressed mother and had been shown to promote significant learning in infants of nondepressed mothers. All speech stimuli were matched for intensity level at an average of 68 dB (SPL), measured at a point near the infant’s head.

Speech segments were used as CSs for a smiling female face US in the conditioned-attention paradigm. Each infant was tested once in each of three separate sessions: one with his or her own mother’s voice, one with the unfamiliar nondepressed mother’s voice, and one with the unfamiliar depressed mother’s voice. The order of these three sessions was counterbalanced across infants. No less than 1 hr and no more than 24 hr separated one test from another. The amount of time between successive conditioning sessions was determined by the infant’s state and the mother’s schedule. There were no differences in the time between sessions as a function of the mother’s diagnosis.

For conditioning trials, each infant first heard a 10-s “pet the gorilla” speech segment while the projection screen was uniformly illuminated. Upon termination of the speech segment, the infant received a 10-s presentation of a smiling female face. A 10-s interstimulus interval (ISI), during which the projection screen was uniformly illuminated and only background noise was heard, immediately followed the termination of the face. Each infant received six pairings of the speech segment and face. The postconditioning test phase started 10 s after the sixth face presentation. For the test, the infant received four 10-s presentations of a 4 × 4 checkerboard pattern, separated by 10-s ISIs. The speech segment from the pairing phase was presented simultaneously with the first and fourth presentations of the checkerboard, whereas only background noise (measured near the infant’s head at 58 dB) accompanied the second and third presentations of the checkerboard.

Durations of looking at the projection screen during the 10-s speech, face, and checkerboard trials were recorded. Looking was signaled by an observer when the reflection of the visual stimulus was centered on the infant’s pupils. A second, independent observer was present on 75% of the tests. The mean interobserver correlation was r = .92 (SD = .06, range: .81–.99).

RESULTS AND DISCUSSION

As in previous conditioned-attention studies, and probably because the speech stimuli elicited moderate levels of looking even on Trial 1, there were no significant changes in responding to speech stimuli across the six voice-face pairings in any of the testing conditions. There also were no response differences as a function of the mother’s diagnosis. Therefore, we do not discuss pairing-phase data further.

Mean looking times during checkerboard-alone test trials did not differ as a function of maternal diagnosis, F(1, 22) = 0.61; testing condition, F(2, 44) = 1.02; or their interaction, F(2, 44) = 1.33, n.s. Figure 1 presents the mean difference scores for infants of depressed and nondepressed mothers as a function of the speech segment presented during the test phase. The difference score, a summary measure of conditioning, was calculated from the test-trial data by subtracting the average duration of looking during the two checkerboard-alone test trials from that during the two checkerboard-plus-speech-segment test trials. Values above zero indicate positive summation (i.e., speech segments increased looking at the checkerboard). Prior research showed that positive summation does not occur in this paradigm in random and backward control conditions (Kaplan, Jung, Ryther, & Zarlengo-Strouse, 1996).

As shown in Figure 1, infants of depressed mothers exhibited no evidence of associative learning in response to their own or an unfamiliar depressed mother’s speech, but learned readily in response to an unfamiliar nondepressed mother’s speech. In contrast, infants of nondepressed mothers exhibited significant learning in response to their own and an unfamiliar nondepressed mother’s speech, but not in response to an unfamiliar depressed mother’s speech. There was a sig-
significant interaction between mother’s diagnosis and testing condition, \( F(2, 44) = 3.97, p < .05 \). Analyses of simple main effects revealed higher difference scores for infants of nondepressed than depressed mothers in response to their own mothers’ speech, \( F(1, 62) = 4.96, p < .05 \). No other between-group differences were significant. Mean difference scores in response to the unfamiliar nondepressed mother’s speech were significantly above chance (.00) for infants of both depressed and nondepressed mothers, \( t(11) = 5.07, p < .01 \), and \( t(11) = 4.65, p < .01 \), respectively; mean difference scores in response to their own mother’s speech was significantly above chance for infants of nondepressed mothers only, \( t(11) = 2.79, p < .02 \).

The significant interaction effect was investigated further using residual analysis (Rosenthal & Rosnow, 1985). After removal of the main effects of maternal diagnosis and testing condition, mean residual difference scores for infants of depressed mothers were –0.68 s in the own-mother condition and 0.68 s in the unfamiliar, nondepressed-mother condition, and mean residual difference scores for infants of nondepressed mothers were 0.68 s in the own-mother condition and –0.68 s in the unfamiliar, nondepressed-mother condition. Thus, residual effects in the own-mother and unfamiliar, nondepressed-mother conditions were in opposite directions for infants of depressed versus nondepressed mothers.

Infants of clinically depressed mothers failed to learn that their own mothers’ ID speech signaled the presentation of a smiling face in the conditioned-attention paradigm. In contrast, infants of nondepressed mothers readily learned that their mothers’ ID speech signaled the face. Infants of depressed mothers exhibited no difficulty in learning that ID speech produced by an unfamiliar nondepressed mother signaled the face. These results demonstrate that infants of depressed mothers have the capacity to associate an ID speech segment with a face in the conditioned-attention paradigm, and suggest that exposure to a nondepressed caregiver may ameliorate some of the deficits observed in infants reared by depressed caregivers. However, probably because of the low perceptual salience of their mothers’ ID speech, or because of prior nonreinforcement, infants of depressed mothers failed to learn in response to their own mothers’ voices.

These findings represent the first demonstration of how a specific infant-learning process can be affected by maternal depression, and suggest a relatively well understood mechanism whereby depression can have an adverse impact on infant development. Parents normally use highly salient ID speech—as well as other sources of stimulation—to increase an infant’s state of arousal, induce positive affect, and highlight important environmental stimuli (Fernald, 1984). Infants learn about environmental stimuli and their interrelations better when experiencing transient changes in arousal and emotional state elicited by ID speech than they do when not aroused or when in a neutral or negative affective mood (Kaplan et al., 1996). Because depressed caregivers are often withdrawn and experiencing negative affect, they provide both a lower quantity of stimulation and less salient stimulation to their infants than nondepressed caregivers do. Consequently, their infants’ learning about environmental stimuli and their interrelations might be impaired. We hypothesize that after several months or even weeks of exposure to a depressed primary caregiver, infants who possess normal learning ability nonetheless might learn less about the world around them than they would have had the caregiver not been depressed. Such an effect may contribute to deficits in school readiness in older children of depressed mothers (NICHD Early Child Care Research Network, 1999).

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REFERENCES
agnosis and medication use in effects of maternal depression on infant-directed speech. Infancy, 2, 537–548.