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Infant Approach and Withdrawal in Response to a Goal Blockage: Its Antecedent Causes and Its Effect on Toddler Persistence

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Abstract

In two separate longitudinal studies, infants and their mothers were seen in three longitudinal visits. At two months, they were observed in free play where mothers' contingency toward their infants was obtained. At five months, a goal blockage response was produced when a previously learned contingent response became ineffective in producing an interesting event. Infants' emotional responses, in particular anger and sad facial expressions, were observed. At two years, toddlers' persistence at play was assessed by measuring children's responses to an interruption of their play. In both studies, the amount of toddlers' persistence was positively related to their anger response to the blocked goal at five months. Maternal contingency was not related either to infants' response to the blocked goal nor to their persistence at play. These findings provide evidence for the contribution to and the consequences of infants' response to a goal blockage and the role of anger as an approach emotion.

Keywords

Approach/Withdrawal; Anger; Persistence; Toddlers; Goal Blockage

Approach and withdrawal behavior to a blocked goal has long been the subject of considerable theoretical and empirical study (see Darwin, 1965; Schneirla, 1959). C. Harmon-Jones, Schmeichel, Mennitt, and E. Harmon-Jones (2011) have explored the similarities between approach behavior and emotion and found a strong association between the intensity of anger, in contrast to a positive emotion such as joy, and measures of determination. This work, together with other research on anger and left cortical activity has challenged the idea that approach motivation is associated only with positive affect (Harmon-Jones & Sigelman, 2001). Both Carver (2004) and Carver and Harmon-Jones (2009) reviewed the adult literature on anger and proposed that anger is an approach-related affect, associated with increased action. Their view supports Darwin's observation that anger leads to behaviors focused on overcoming obstacles to regain a goal while sadness is a

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withdrawal emotion as measured related to movement away from the goal. These differential action tendencies are supported by facial behaviors, body activity, and physiological responses such as heart rate and cortisol increases (Lewis, 2014).

While much of the reported data on this topic involves adult human subjects, there are a few studies observing anger as an approach response in infants and young children. Following Darwin's suggestion that anger is an approach emotion elicited as part of a response to overcome a learned response to a now-blocked goal, Lewis, Alessandri, & Sullivan (1990) observed infants' learning and response to frustration using pulling, they found that most infants from two to eight months of age readily learn to pull a ribbon to turn on a picture and sound, replicating similar learning procedures used by other investigators that also successfully demonstrated that infants can learn (Rovee-Collier & Capatides, 1979; Millar, 1972).

In a series of studies, Lewis et al. found that joy and interest faces were mostly seen during the learning task if the infant had learned the response, and once frustrated, anger and sadness faces predominated (Alessandri, Sullivan, & Lewis, 1990; Crossman, Sullivan, Hitchcock & Lewis, 2009; Lewis et al., 1990; Sullivan, Lewis, & Alessandri, 1992; Sullivan & Lewis, 2003). In each of these studies, both anger faces and significant increases in pulling occurred. Individual differences in the infants' response to the blocked goal were evident (Lewis, Sullivan, Ramsay, & Alessandri (1992). More than 85% of the infants showed anger and sad expressions, while approximately 15% of them showed just sad expressions. Anger expression to goal blockage was related to the prior expression of interest, whereas sad expression was not. Infant behavior during the learning of the task was unrelated to their behavior when the learned response did not result in the goal during the extinction phase of the pulling task. Instead work suggests that both emotional and pulling responses to the blocked goal are uniquely associated with the specific conditions of goal blockage (Lewis et al., 1992; Sullivan & Lewis, 2003). In subsequent studies of physiological responses, heart rate (HR) increases and heart rate variability (HRV) decreases were associated with anger faces, while this was less so for sad faces (Lewis, Hitchcock, & Sullivan, 2004; Lewis, Ramsay & Sullivan, 2006). Sad expression, conversely was associated with increases in cortisol level, while anger expression was not (Lewis & Ramsay, 2004, 2005). These findings support the view that anger and increased pulling to the blocked goal is associated with ANS activation and therefore an approach response (Harmon-Jones, Harmon-Jones, & Price, 2013).

These findings on the role of anger as part of an approach response have been reported by others using similar methods (He et al., 2010; He, Xu, & Degnan, 2012). Moreover, individual differences in anger expression appeared to be related to later individual differences in child surgency and attention at 4-years of age (He et al., 2013). Stability in anger expression to goal blockage also is evident early in life. Anger expressions were stable over both a 24-hour period and longitudinally in the 2- to 8-month period (Crossman et al., 2009; Sullivan, Lewis, & Alessandri, 1992). Such findings suggest a relationship between early differences in anger expressions to a blocked goal, a measure of early approach tendencies, and later instrumental persistence, also an approach response. Instrumental persistence is a hypothesized precursor of mastery motivation, typically observed in toddlers

and preschoolers (Dichter-Blancher, Busch-Rossnagel and Knauf-Jensen, 1997; Morgan & Yang, 1995). Theorists have proposed that instrumental persistence and positive affect upon task completion are entrained in the contingency experiences of infants younger than 9 months (MacTurk & Morgan, 1995). Yet, no research has examined the relations of anger expressions to goal blockage either to later instrumental persistence in mastery or autonomy-striving in social situations. Considered collectively, the studies of anger in response to a blocked goal, those of He et al. (2013), and the link of anger/approach emotion to subjective feelings of determination in adults (Harmon-Jones et al., 2011), support the idea that anger is an approach response to a blocked goal and that individual differences in anger may be a marker of later differences in instrumental persistence.

The relation of these individual differences in anger expression to maternal perceptions of temperament has not been explored extensively. Although temperament studies have found some individual stability in the first year of life, the temperament dimensions usually studied do not usually include differences in response to a goal blockage, but rather differences in general upset to any frustration (Bates, Goodnight, & Fite, 2008; Rothbart & Bates, 1998). Rothbart's (1986) distress to limitation scale on the Infant Behavior Questionnaire is closest to this as a measure. Thus, there might be a relationship between temperament measures and infants' affective response to a blocked goal which warrants further study.

Given learning of the contingency between pulling and access to the "picture/music" outcome, as well as the "blocked goal" aspect of the paradigm under discussion, the child's contingency experience with its mother may play an important role in how the infant learns, as well as how the infant responds when a learned goal is blocked. The contingency between an infant's behavior and the maternal response might explain individual differences in anger expression relative to sad. While this question has not been directly studied, there are at least three competing theoretical perspectives. The relation between maternal response to infant cry, first proposed by Bell and Ainsworth (1972), suggested that maternal contingency to the infant's cry results in less crying and more subsequent verbal communication. Extrapolating from this perspective it could be argued that contingent maternal behavior, by strengthening the infant's ego efficacy, would lead to greater approach behavior on the part of the child; thus the greater the contingency the more anger the child would express when the goal is blocked. Gewirtz and Boyd's (1977) learning theory conversely might argue that the more contingency the infant experiences, the more disruptive the infant's response becomes when the behavior toward the goal is blocked. Disruption in such a situation can be seen as a withdrawal response. Van Ijzendoorn and Hubbard's (2000) study of maternal responsivity and infant crying found that the less contingent the mother, the less likely infants cry in subsequent months and maternal contingency was unrelated to later attachment status. They concluded that "benign neglect" of infant fussing might promote infant's self-regulation of mild distress. Subsequent literature has not resolved the issue (see for example, Bornstein & Manian, 2013; Voorthuis et al., 2013). However, based on He et al's (2013) report of a relation between anger and subsequent approach behavior during play at four years, as well as the proposal that socialization must be considered across a range of domains in addition to attachment and security (Grusec & Davidov, 2010), we are led to propose that maternal contingent behavior will have relatively little effect on the infants' anger expression to the blocked goal at 5 months, and to their instrumental persistence in play at two years.

To examine these relations, we conducted two studies of early maternal contingent behavior and maternal perceptions of temperament to anger expressions to goal blockage at 5 months and to toddler instrumental persistence at self-selected goals. Study 1 explored these relations in a small sample, using maternal vocal contingency. Study 2 served as a replication trial with a larger sample and more comprehensive assessment of maternal contingency.

Study 1

Method

Participants—The sample consisted of 59 full-term infants (28 girls, 31 boys) seen at 2, 5, and 20 months of age. The participants were predominately White, European ancestry (85%) with 15% minority (largely African American and East Asian ancestry). The mothers were educated (54% had at least a college degree, with the remainder having completed high school). Mothers with infants in the well-baby nursery of a large teaching hospital were recruited for participation in this study during their postpartum hospital stay. At each of the assessments, the infants were healthy did not have any known developmental problems. Additional infants (20) were recruited but were excluded due to missed visits, incomplete data, or report of developmental problems.

Procedure and Measures—Maternal contingency and infant temperament were assessed at two months of age (M = 10.51 weeks, SD = 1.01). Infant emotional responses to goal blockage were assessed at five months (M = 17.59 weeks, SD = 1.24), and toddler persistence in response to interrupted play was assessed at 20 months (M = 85.36 weeks, SD = 2.14).

Maternal Contingency: At two months, mother-infant vocal interaction was video-recorded in the subjects' homes during a 5-minute *en face* playful interaction while infants were in their infant seats. Social interaction began when mothers judged their infant to be comfortable, alert, and playful. Mothers had been instructed to interact with their infants as they normally would. Previous use of this observation technique has yielded valid and reliable measures of maternal interactive behavior with young infants (Bendersky & Lewis, 1986; Malatesta & Haviland, 1982).

Mother-infant vocalizations were coded second-by-second from the videotapes. All noncry voiced sounds were considered infant vocalizations. Maternal vocalization occurring within 3 seconds of the onset of infant behavior was considered to be a contingent response (Lewis & Goldberg, 1969). This 3-second interval is regarded as within young infants' short-term memory for contingency perception (Lewis & Goldberg, 1969; Reeve, Reeve, & Poulson, 1993; Watson, 1985; 2001). The measure of maternal contingency was the proportion of infant vocalizations responded to by the mother within 3 seconds of their occurrence. On average, mothers responded contingently to 22% of their infants' vocalizations (M = .22, SD = .14).

Coding was done by three trained staff members who were unaware of the infant goal blockage and toddler data. To check reliability during the coding, multiple coders scored a

random selection of 25% of the tapes. Inter-rater agreement (κ) was .78 for infant behaviors and .87 for maternal behaviors.

Infant temperament: At two months, maternal ratings on the complete Rothbart (1986) Infant Behavior Questionnaire (IBQ) were obtained. The IBQ distress to limitations scale (M = 3.88, SD = .65) and the smiling/laughter scale (M = 4.87, SD = .66) were used to create a measure of negative versus positive temperament. These two dimensions were selected as they are among the most stable on the scale, and conceptually, they were the most likely to be related to anger and approach motivation. The temperament score was calculated as the difference between the z-score for the distress to limitations scale and the z-score for the smiling and laughter scale. The average score was .00 (SD = 1.45). A higher score reflected a more negative than positive temperament. Infant negative and positive temperament scales are typically unrelated to each other, as was the case here, $r = -.06$ (Ramsay & Lewis, 2001).

Infant emotional response to goal blockage: Infant approach and withdrawal characteristics were measured with anger and sadness responses. At five months, a contingency learning situation was used to assess infant anger and sadness response to a blockage of an expected goal. The task involved infants pulling on a string attached to their wrist. Pulls could activate a 3-second audio-visual display that consisted of a colorful slide and music. After 6 minutes of contingency and after Ss reached learning criterion – 1.15 times their individual base rate, see Rovee-Collier & Capatides (1979) for the selection of the criterion – a two-minute goal blockage period occurred. During this time pulling no longer produced the outcome. This procedure has been reported in greater detail elsewhere (Lewis et al., 1990; Lewis et al., 1992; Sullivan & Lewis, 2003).

Infant emotional expressions during the two minutes of goal blockage were coded from the videotapes using the Maximally Discriminative Facial Movement Coding System – MAX (Izard, 1995). Separate coding of the brows, eyes, and mouth regions was done from videotapes, second-by-second in slow motion with sound off. Since the two accepted major responses to the goal blockage are angry and sad expressions, and since these have been associated reliably with other behaviors (pulling) and stress hormones (Lewis et al., 1990; Lewis et al., 2006), anger and sad expressions were the focus of the study. Using the MAX coding system, the occurrence of facial expression components of anger, sadness, or neither were determined for successive 1-second intervals. Expressions were subsequently compiled across the three facial regions using a macro which assigned expression codes according to MAX formulae. Expressions analyzed were full or partial MAX anger (25-33-54/55; 25-33-00) and full or partial MAX sad (23-33-56; 23-33-00). Single movement codes were not counted. These data were summed over the two minutes to yield the frequency of occurrence of each of the two expressions during extinction (M = 7.20, SD = 7.58 for anger, M = 1.12, SD = 1.99 for sad). The amounts of expressions observed were comparable to that found in past work (Lewis et al., 1990; Lewis et al., 2006; Sullivan & Lewis, 2003). As in previous work, the amount of angry expression was the measure of approach while sad expression was the measure of withdrawal: the expression measures related to pulling have

been found to be the most reliable measures of approach and withdrawal (Lewis et al., 1992).

The measure of emotional response to the blockage was calculated as a *differential anger response.* Although anger responses are the modal expression to goal blockage, a differential anger score was used since infants can display both in the same context, which has been frequently reported in the literature. *Differential anger response* was defined as the difference between the *z*-score for angry expressions minus the *z*-score for sad expressions (i.e., Δ anger). A higher *differential anger response* reflects more anger expressions relative to sad expressions and is necessary due to the tendency of anger and sad expressions to co-occur in some individuals. The average differential anger score was .00 (*SD* = 1.30).

Two experienced coders who were unaware of the maternal behavior and toddler data coded the infant expressions. The coders had achieved inter-rater reliability with each other and with other coders in scoring tapes from previous studies. To check reliability during the coding for this study, both coders scored 25% of the tapes selected at random. Inter-rater agreement (κ) calculated for each region of the face was .70 or better. Past work using MAX has provided evidence for the reliability of the facial coding system in the contingency learning situation (Lewis et al., 1990; Sullivan & Lewis, 2003).

Toddler persistence: At 20 months, an interrupted play procedure was used to assess toddler responses to goal blockage. A standard set of interesting toys was placed in the center of the playroom floor. While the children were engaged in play, mothers were seated in a chair at one end of the room. They were instructed to remain seated, not to initiate or prolong any interaction with their child, but to respond passively if the child spoke or approached. After the child had been actively engaged in play for at least two minutes, on signal, the mother called her child to come sit on her lap. Each mother had been instructed to call her child three or four times saying “Come here! Come and sit on Mommy’s lap.” If the child did not respond after 1 minute, the mother was instructed to pick up the child and return to her chair without taking any toys, and to hold the child on her lap until the experimenter’s signal (1 minute). She then released the child, who could then return to the toys. Mothers had been instructed to respond to any child protests or requests to get down by saying “Not yet,” “Wait a little,” or “In a minute” while the children were on their mothers’ lap. After release from their mothers’ lap, the children were allowed to play with the toys for 5 minutes. After that point, this interruption procedure, as described, was repeated a second time in order to assess the stability of individual differences in toddler persistence.

Responses to interrupted play were coded by two experienced coders who were unaware of the maternal behavior to the infants at two months or the infant goal blockage data at five months. Latencies were determined from the time record on the videotapes of the play session. Also scored was frequency of protest or negative vocalization was also scored. To check reliability during the coding, both coders scored 33% of the tapes selected at random. Inter-rater agreement (κ) was .76 or better for protest on each of the trials. Agreement on latency approached 1.00. Persistence at play was indexed by the latency in seconds to leave their play and to go to their mothers’ lap following her request. A long latency was the measure of persistence at play. Persistence at play was the measure of instrumental

persistence. However, we wished to remove any effect of protest on the persistence score. To ensure that the toddlers' persistence was independent of any negativity measures such as protest or frustration, a regression analysis was performed to obtain a residual persistence measure that was independent of the other toddler negativity measures. The correlation of the residual persistence measure to protest or frustration was zero. This residual persistence measure yielded the same results as the unadjusted latency score. Thus, the latency score reflects only persistence independent of negative reactivity. Therefore, the mean latency score was used as the persistence measure. The mean time to stop play in response to maternal request was 24.83 sec (*SD* = 18.20) and 23.78 sec (*SD* = 17.27) on the first and second trials. Individual consistency in play persistence across trials was $r = .42$ ($p < .001$), and mean scores across the two trials were generated ($M = 24.31$, $SD = 16.37$).

Results

Preliminary Analyses—All study variables met the assumptions of multivariate normality and multicolinearity. The univariate distributions had a skew and kurtosis within acceptable range; i.e., < 3.0 and < 10.0, respectively (Kline, 2010). Mardia's coefficient of multivariate kurtosis was 23.33 ($p > .05$), indicating that data met assumptions of multivariate normality. The tolerance values (1/VIF) ranged from .91 to .98, which are close to 1, indicating no problem with multicolinearity.

We correlated all variables in the proposed model to test for discriminant validity across constructs by ensuring that correlation coefficients between variables were less than .70 (Tabachnick & Fidell, 2007). The bivariate correlation matrix is presented in Table 1. Bivariate correlation coefficients between all variables were all less than .70. A significant correlation was observed between toddler persistence and maternal contingency such that greater toddler persistence was related to less maternal contingent vocalizations to infant vocalizations. There was also a significant correlation between toddler persistence and infant goal blockage emotion such that more Δ anger to goal blockage was related to greater persistence at play. No other significant correlation was observed.

The existence of curvilinear relations between the outcome and the independent variables as well as between the outcome and the mediator variable was examined by looking at plots comparing toddler persistence and maternal responsivity, toddler persistence and infant goal blockage emotion, toddler persistence and infant temperament, and toddler persistence and infant temperament. No curvilinear associations were observed, suggesting no need for multiple group models.

Data Analytic Strategy—Structural path analysis was used to examine hypothesized associations between toddler persistence, maternal vocal contingency, infant temperament, and infant goal blockage emotion. We estimated a saturated path model (i.e., comparative fit index = 1.00, Root Mean Square Error of Approximation = .00) using Mplus (Muthén & Muthén, 1998–2010). Next, we tested the significance of the indirect effects of our proposed model, using a bootstrap method following the recommendations of Shrout and Bolger (2002). With 5,000 bootstrap samples, confidence intervals and standard errors for testing the significance of the indirect effect were generated. Unlike traditional methods of testing

mediation, the bootstrap procedure obtains a more precise standard error estimate (MacKinnon, Lockwood, & Williams, 2004). A saturated model was used; the power for detecting the main effect for each prediction with this sample size and our observed effect sizes as the basis of the population effect was checked for an α level = .05. A power calculator, G*Power (Faul, Erdfelder, Lang, & Buchner, 2009) indicated that we were able to detect moderate effects.

Structural Relations between Variables—Overall, the model accounted for 13 % of the variance in toddler persistence, and 9 % of the variance in infant Δ anger response to goal blockage. As shown in Figure 1, standardized path coefficients indicated that the two hypothesized direct paths in the model were significant: maternal responsivity was negatively related to infant Δ anger to goal blockage (β = −.26, p = .041; power = 58 %), such that less maternal contingent vocalizations to infant vocalizations predicted greater Δ anger. Infant Δ anger to goal blockage was positively related to toddler persistence (β = .30, p = .018; power = 76 %), such that greater Δ anger predicted longer persistence at play. The direct relation between maternal contingency and toddler persistence was not significant (β = −.14, p = .27), nor was the direct relation between infant temperament and toddler persistence. Maternal contingency became marginally significant when the hypothesized mediator was omitted from the model (β = −.22, p = .090). The direct relation between infant temperament and toddler persistence remained nonsignificant when the hypothesized mediator was omitted.

Mediation Effects—The indirect effect of maternal contingency through infant goal blockage emotion on toddler persistence was marginally significant (β = −.078, p = .056, 90% CI [−.146, −.011]). As recommended by Shrout and Bolger (2002), we computed the effect ratio by dividing the indirect effect by the total effect (i.e., −.078/−.214). The ratio for effect proportion mediated was .36, indicating that the path from maternal contingency to toddler persistence was partially mediated by infants' Δ anger to goal blockage.

Study 2

The results of Study 1 suggest that both early maternal contingency and greater infant anger than sad expression to goal blockage have differential effects on a toddler's tendency to persist at play when disrupted. Low maternal contingency was related to greater infant anger expression, but not directly to toddler persistence. Infant anger expression was related directly to greater toddler persistence. In contrast, infant negative temperament had no relation either to infant expression or to toddler behavior. This effect was in need of replication, and because the measure of maternal contingency was limited to maternal vocalizations to infant vocalization in Study 1 sample, we expanded our maternal measures to include maternal vocalizations to infant vocalizations (as before), maternal touch to infant vocalizations, maternal vocalizations to infant touch, and maternal touch to infant touch.

Method

Participants—The participants were recruited as in Study 1 and consisted of 166 full-term infants of healthy, uncomplicated pregnancies. Mothers with infants in the well-baby nursery of a large teaching hospital were recruited for participation in this study during their

postpartum hospital stay. Of these, 101 infants (51 girls; 50 boys) were included who learned the contingency between their pulling and slideshow onset, completed all three lab visits, as well as not having any known developmental problem. The mean age of the sample at each assessment was 11.40 weeks (*SD* = 1.04), 21.41 weeks (*SD* = .93), and 27.03 months (*SD* = 2.36). The sample was largely of White, European ancestry (70 %) with 16 % Hispanic, 6 % African American, and 8 % other ancestries. The mothers were educated (76 % had at least a college degree, with the remainder having completed high school).

Procedure and Measures—Maternal contingency and infant temperament were each assessed at 2.5 months. Infant emotional responses to goal blockage were assessed at five months, and toddler persistence in response to interrupted play was assessed at 24 months as in Study 1.

Maternal contingency: Mother-infant interaction was video-recorded in the home during a 3-minute *en face* playful interaction while infants were in their infant seats. The observer arrived at each home when mothers indicated the child would be waking shortly for a morning feed. If the infant fell asleep before the observer had completed recording, the observer returned on a later day that week. To assess maternal contingency, as in Study 1, maternal response occurring within 3 seconds of the onset of infant behavior was considered to be a contingent response (Lewis & Goldberg, 1969). To expand the results of Study 1, four measures of maternal contingent response were scored from the videotapes: 1) proportion of infant vocalizations responded to by maternal vocalizations; 2) proportion of infant vocalizations responded to by maternal touch; 3) proportion of infants' touching the mother responded to by maternal vocalizations; and 4) proportion of infants' touching the mother responded to by maternal touch. Reliability for mother and infant behavior coding by 2 independent coders blind to the study hypotheses was calculated across 20% of randomly selected tapes. Intraclass correlations between the two coders (ρ) were greater than .90 for infant and maternal vocalizations ($p_s < .001$). Intraclass correlation (ρ) for maternal touch was .75 and .84 for infant touch ($p_s < .01$). Inter-rater agreements (κ) for each of the maternal and infant behavior measures were significantly above chance ($p_s < .01$).

Proportional Measures of Maternal Vocal Contingency to Infant Vocalizations: The procedure for the proportional measure of maternal vocal contingency to infant vocalizations followed that of Study 1. Again, infant vocalizations were considered to be all non-cry voiced sounds. On average, mothers provided verbal responses contingent to 21% of their infants' vocalizations (*M* = .21, *SD* = .18), which is comparable to the findings of Study 1.

Proportional Measures of Maternal Touch to Infant Vocalizations: The proportion of infant vocalizations responded to by maternal touch within 3 seconds of their occurrence was scored. On average, mothers touched their infants contingently to 9 % of their infants' vocalizations (*M* = .09, *SD* = .16), which was comparable to the findings by Gros-Louis, West, Goldstein, and King (2006).

Proportional Measures of Maternal Vocal Contingency to Infant Touch: The proportion of infant touch responded to by maternal vocalizations within 3 seconds of its occurrence was scored. Infant touch was considered to be all discrete bodily contact made by infants to

their mothers. On average, mothers' verbal responses were contingent to 8 % of their infants' touches (*M* = .08, *SD* = .15).

Proportional Measures of Maternal Touch to Infant Touch: The proportion of infant touch responded to by maternal touch within 3 seconds of its occurrence was scored. On average, maternal touches were contingent to 5 % of their infants' touch (*M* = .05, *SD* = .14).

Infant temperament: The temperament was assessed as in Study 1, with the IBQ (Rothbart, 1986) distress to limitations scale (*M* = 3.76, *SD* = .75) and the smiling/laughter scale (*M* = 4.17, *SD* = 1.09). Again, two scales were unrelated to each other (*r* = −.14). The difference between the *z*-scores of the two scales was constructed (*M* = −.11, *SD* = 1.52), and a higher score reflected a relatively more negative than positive temperament.

Infant emotional response to goal blockage: The procedure for coding facial movements followed that of Study 1. The frequency of each of the two expressions during extinction (*M* = 5.19, *SD* = 9.95 for anger; *M* = 1.55, *SD* = 4.92 for sadness) was comparable to those observed in Study 1. As in Study 1, *differential anger response* was defined as the difference between the *z*-score for anger minus the *z*-score for sad expressions (i.e., Δ anger). The average score was −.13 (*SD* = 1.20). Intraclass correlation (ρ) of the facial coding system was .70 or better for 25% of the tapes selected at random.

Toddler persistence: Toddler persistence at play used the same play procedure as Study 1. Both latency and protest measures were obtained. Again to ensure that the toddler's persistence was independent of any negativity measures such as protest or frustration, the correlation of the residual persistence measure to protest or frustration was examined as in Study 1. There was no correlation between the negative behaviors and the latency measure. Persistence was indexed by infants' latency in seconds to stop play and to go to their mothers' lap following her request. The mean of the latencies on the first and second trials was used as the persistence measure (*M* = 19.19, *SD* = 23.18 for the first; *M* = 17.44, *SD* = 14.80 for the second). Individual consistency in toddler persistence across trials was *r* = .59 (*p* < .001), and the average score across the two trials was 22.85 (*SD* = 15.40). Intraclass correlation (ρ) for the persistence measure was .76 or better across 35 % of the tapes selected at random.

Results

Preliminary Analyses—Before conducting our primary analysis we examined the data for missing values. The missing data for measures of maternal responsivity to infant touch were ascribed to a number of infants who did not touch their mothers during the 3-minute *en face* interaction since maternal contingency was a proportional measure of maternal responses contingent to infant behaviors. To test whether the data were missing at random, we used Little's MCAR (Missing Completely At Random) test (Little, 1998), which indicated that the data were missing completely at random, χ^2 (49) = 52.20, *p* = .35. Further, the distribution of missing data for each variable was not different by the infants' sex and ethnicity, as well as the mothers' education (p_s > .10). Thus, missing at random was

assumed for all study variables, and missing data were handled with FIML (Full Information Maximum Likelihood) in Mplus (Muthén & Muthén, 1998–2010).

All study variables were checked for the assumptions of multivariate normality and multicolinearity. Many mothers exhibited a very small vocal response contingent to infant touch, and a small touch response contingent to both infant vocalizations and touch. These three proportional measures of maternal responsivity were log transformed to make the data distributions approximately normal; the means (*SD*) of the log transformed scores were −1.51 (.62), −1.41 (.56), and −1.59 (.49), respectively. Then, the univariate distributions had a skew and kurtosis within acceptable range; i.e., < 3.0 and < 10.0, respectively (Kline, 2010). Mardia's coefficient for each set of variables was 26.80 or less ($p_s > .05$), indicating that data met assumptions of multivariate normality. The tolerance values (1/VIF) ranged from .94 to 1.00, indicating no problem with multicolinearity.

The bivariate correlation matrix is presented in Table 2. Bivariate correlation coefficients between variables for each data analysis were all less than .70, ensuring discriminant validity across constructs (Tabachnick & Fidell, 2007). Some significant correlations were observed. The different types of maternal contingency were all correlated such that verbally responsive mothers were also more likely to respond with maternal touch to infant behaviors. The correlations also indicated that the more maternal contingency to her infant's vocalizations, the more anger than sad expressions the infant displayed during the goal blockage. More Δ anger to goal blockage in turn was related to greater persistence at play while greater persistence was related to less maternal contingent vocalizations to infant's touch. No curvilinear relationships between the outcome and the independent variables as well as between the outcome and the mediator variables were observed, suggesting no need for multiple group models by splitting a continuum into subgroups.

Data Analytic Strategy—As in Study 1, a saturated path model (i.e., comparative fit index = 1.00, Root Mean Square Error of Approximation = .00) examined the hypothesized associations between toddler persistence, maternal vocal contingency, infant temperament, and infant goal blockage emotion in order to see if the major findings in Study 1 were replicated. In addition, Study 2 examined whether other microanalytic measures of maternal responsivity to infant behaviors beside vocalizations were related to vocalizations, and to infant Δ anger and persistence. Power for each main effect was calculated as in Study 1, using G*Power (Faul, Erdfelder, Lang, & Buchner, 2009), and we found moderate to strong power for each main effect.

Structural Relations between Variables

Proportional Measures of Maternal Vocal Contingency to Infant Vocalizations —This model uses the same measure of maternal contingency as in Study 1. Overall, the model accounted for 16 % of the variance in toddler persistence (compared to 13% in Study 1), and 5% of the variance in infant Δ anger to goal blockage (compared to 9% in Study 1). As shown in Figure 2, standardized path coefficients indicated that the two hypothesized direct paths in the model were significant as before; but in contrast to Study 1, maternal vocal contingency to infant vocalizations was positively related to infant Δ anger to goal

blockage (β = .21, p = .046, power = .30), while infant greater Δ anger to goal blockage was again related to longer toddler persistence at play (β = .37, p = .012, power = .85). The direct relations between maternal responsivity and toddler persistence as well as between infant temperament and toddler persistence remained nonsignificant, even when the hypothesized mediator was omitted.

Mediation Effects: We also tested whether infant Δ anger to goal blockage mediated the relation between maternal contingency to infant vocalization and toddler persistence. The indirect effect of maternal vocal contingency to infant vocalizations through infant goal blockage emotion on toddler persistence was not significant (β = 0.64, p = .229, 90% CI [−3.133, 16.016]).

The findings from both Study 1 and Study 2 consistently show that infants' amount of anger as opposed to sad expression during the goal blockage predicts toddlers' persistence at play at two years of age. However, the two studies showed opposite impacts of maternal vocal responsivity to infant vocalizations on infant Δ anger to goal blockage. To more effectively gauge the effect of maternal vocal contingency to infant vocalizations on infant Δ anger emotion as well as toddler persistence, we maximized the power of our analyses by performing an additional analysis on the combined data of Study 1 and Study 2, a sample of 160 children (51 % boys). Maximizing the sample size in this way should allow a better chance of detecting more modest effects. SEM modeling suggests a ratio of sample size to the number of free parameter as 10 to 5 :1 (Bentler & Chou, 1987; Kline, 2010)., Using this metric our model needs a minimum sample size of 50 and a sample size of 100 or more is considered good. Sufficient power for weak effects was found by using G*Power (Faul, Erdfelder, Lang, & Buchner, 2009).

Structural Relations between Variables

As shown in Figure 3, the model accounted for 13 % of the variance in toddler persistence, but only 1 % of the variance in infant Δ *anger* to goal blockage. The standardized path coefficients again indicated that infant greater Δ anger to goal blockage was related to longer toddler persistence at play (β = .33, p < .001, power = 99 %). Maternal vocal contingency to infant vocalizations was not related to infant emotional response to goal blockage. The observed power to detect this effect actually decreased despite the increased sample size (power= 17 %.). Hence, we looked at the 95% confidence limit as recommended by Colegrave and Ruxton (2003), Hallahan and Rosenthal (1996), and O'Keefe (2007). For the confidence interval of [−.132, .205], the confidence limit of largest in magnitude gave us an estimate of the maximum effect size of .205 that was supported by our data. The direct relations between maternal contingency and toddler persistence as well as between infant temperament and toddler persistence also remained nonsignificant.

Other Maternal Contingency Measures—Table 3 presents the results of the structural equation models for the other maternal contingency measures. Across all the models, the direct path predicting toddler persistence from infant Δ anger was significant such that greater anger than sad expressions to goal blockage was related to longer persistence at play (β_s = .30 or larger, p_s < .05). However, maternal contingency differently predicted infant Δ

anger as well as toddler persistence. Maternal contingency (vocal and touch) was sometimes positively related to infant Δ anger (Study 2), and sometimes it was negatively related (as in Study 1). In the combined sample, there was no relation between maternal vocal contingency and infant anger expression to goal blockage. With regard to the relation of maternal behavior to toddler persistence, maternal contingency and toddler persistence was generally negative such that less maternal contingency was related to more persistence.

Discussion

Both studies assessed the potential influences and the consequences of individual differences in infant anger rather than sad expression to a blocked goal and the downstream relations of anger expression and toddlers' persistence at play. The consistent findings provide evidence that early individual differences in anger to a goal blockage are related to later persistence, a form of behavioral approach that was independent of any negative reactivity. These findings are consistent with the adult, child, and infant literature on approach action tendencies and instrumental persistence (Calkins & Johnson, 1998; Harmon-Jones et al., 2013; He et al., 2010; He et al., 2013; Putnam & Stifter, 2005). Anger appears to be an approach emotion associated with determination in adults (Harmon-Jones & Sigelman, 2001), with increased action to overcome a blocked goal (Sullivan & Lewis, 2003), and with increases in heart rate and changes in heart rate variability (Lewis et al., 2004). The downstream associations of infant anger to goal blockage in this study were reliably shown to be persistence in play with little association to negativity to distress. The literature has been relatively consistent in suggesting that children can be identified who are either high in approach tendencies or high in behavioral inhibition (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001). Moreover, previous work has also shown that early anger responses to goal blockage are not related to tantrum incidence or severity in toddlers (Sullivan & Lewis, 2012), also supporting that anger is not associated with negativity. Sadness and withdrawal also occur when goals are lost and cannot be regained (Carver, 2004). Lewis et al. (1990) showed that sadness to a blocked goal, in contrast to anger, was associated with lower pulling response (instrumental persistence), and infant cortisol increases as a measure of distress in infants who stopped pulling to try to get the learned goal. The same finding was found in infants who showed sadness when their mothers ceased interacting with them; the greater the sadness, the higher the increase in cortisol response (Lewis & Ramsay, 2004, 2005).

In addition, to furthering the data supporting anger as associated with approach, this study also helps to refine the construct of persistence in toddlers. Persistence appears to be a marker of approach motivation defined in two ways. One form is persistent goal-directed activity in mastery situations as opposed to withdrawal in the face of challenge or difficulty (Dweck, 1998; MacTurk & Morgan, 1995; Messer, 1993). In this literature, mastery motivation has been defined operationally as an impulse to persist at tasks that are somewhat cognitively challenging or effortful, and may include an affective component of enjoyment at successful completion that is thought to be a precursor of pride. The second form is assertiveness or the pursuit of one's agenda despite interruption or competing demands. In the present studies, this second form was measured as the toddler's persistence in play in the face of a maternal request to stop, and not negativity or protest to the disruption. In these studies, impulses to sustain ongoing activity were consistent from infancy to toddler period.

Persistence in the present and other studies is not a measure of negative, defiant behavior, since the findings show that toddlers' willful resistance to parental demands is linked to positive markers of development, including supportive maternal behavior, autonomy-granting, and low depressive symptoms; and that high-resistant toddlers initiated more positive interactions with mothers than did low-resistant toddlers (Dix, Stewart, Gershoff, & Day, 2007). Moreover, Dix et al. (2007) concluded that in toddlers, active resistance to parental demands reflects children's motivation to control events rather than poor parenting. This type of social interaction around issues of autonomy and self-efficacy reflects a socialization context distinct from both attachment and security (Grusec & Davidov, 2010). Historically, the personality dimension of "will" was used to refer to characteristics of this type of instrumental persistence (Jones, 1954).

The antecedents of these differences in response to a blocked goal were examined by looking at the role of relatively more negative temperament as defined by the difference between Rothbart's (1986) distress to limitation scale of the IBQ and the smiling/laughter scale. The scale scores were unrelated to each other, a finding previously reported by Ramsay and Lewis (2001). Neither scale, nor the difference between them was related to either the infants' response to the blocked goal at five months, or to their persistence at two years. These findings suggest that individual differences in response to goal blockage may not be related to the positive vs. negative temperament dimensions tapped by the IBQ. We believe this is, in part, because the response to the blockage of a learned response is not affectively the same as the general response to frustration. It is unlikely that temperament as measured by IBQ at two months changes by five months since the literature generally supports stability in the IBQ dimensions across this age range (Rothbart, 1986).

Measuring maternal contingency behavior allows for the assessment of its role on the infants' response to the goal blockage and to the toddlers' persistence at play. The role of maternal responsivity as measured in her contingent behavior has been considered central to the attachment relationship (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1969; Lewis & Goldberg, 1969). Yet, we observed no consistent effects, most likely because the interrupted play context does not tax the toddlers' need for security or reassurance. The contingency measures used here are consistent with other studies and have been shown to be a reliable method for assessing aspects of maternal responsivity (Watson, 2001).

As the results of Study 1 and 2 are contradictory in regard to the role of maternal contingency looking at maternal vocal response to infant vocalization, we examined the total sample from both studies to increase sample size to minimize random measurement error and to maximize power to detect more modest effects. The findings reveal little effect of maternal vocal contingency on infant Δ anger expressions to goal blockage, and the parsimonious interpretation is that maternal contingency to infant vocalization was unrelated to the child's instrumental response at either age.

Maternal contingency as measured by behavior other than vocalization in Study 2, likewise did not help to clarify the question. While there was some consistency within individuals across the various measures of maternal contingency, there were inconsistent findings regarding their relation to infant and toddler behavior. Thus, the question of the mothers'

influence on the infants' emotional response to goal blockage remains equivocal. While there may be some effect, the effect size is likely to be small relative to the continuity in the infants' own behavior. Other studies have indicated that not all individual differences in social-emotional behavior have the mother-child relationship as their cause. As both Lewis and Ramsay's (1999) findings in regard to infants' response to the stress of inoculation show, and as Van Ijzendoorn and Hubbard's (2000) review indicates, individual differences in some aspects of behavior, especially in the very young, may have more to do with neurobiological factors than social ones. This may apply as well to the infants' approach or withdrawal tendencies, particularly as they related to contingencies between the child and non-social objects.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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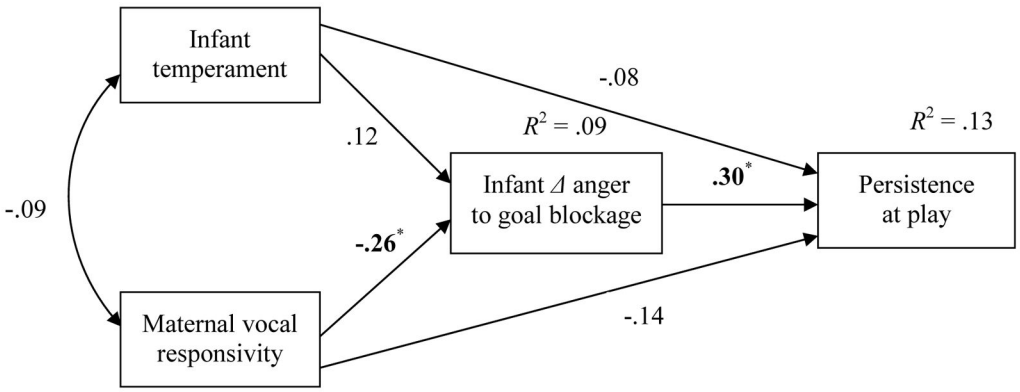

Figure 1.

Structural path model of Study 1 (N = 59). Values represent standardized path coefficients. *p < .05.

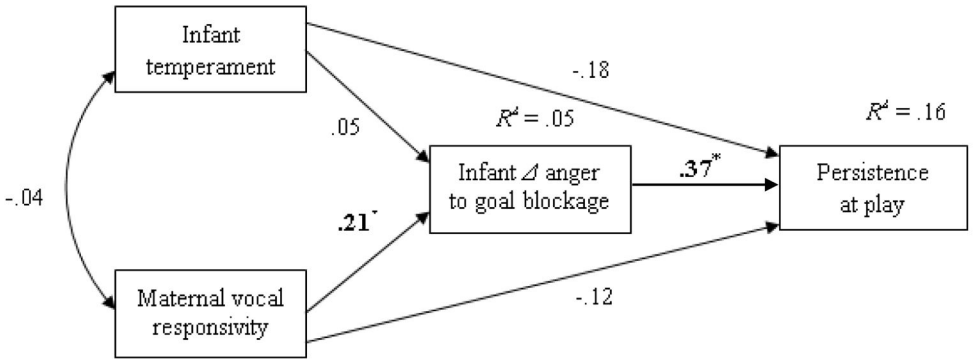

Figure 2.

Structural path model of Study 2 (N = 101). Values represent standardized path coefficients. *p < .05.

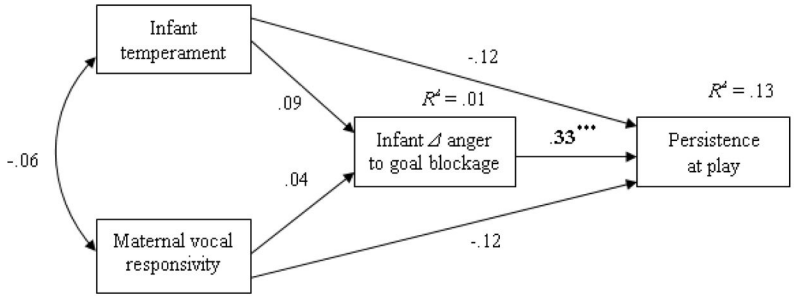

Figure 3.

Structural path model of the combined data of Study 1 and Study 2 (N = 160). Values represent standardized path coefficients.

***p < .001.

Table 1

Correlations among Variables of Study 1

Variable	1. Persistence at play	2. Infant Δ anger to goal blockage	3. Infant temperament	4. Maternal vocalizations to infant vocalizations
1				
2	.33*			
3	−.02	.15		
4	−.21	−.27*	−.09	

Note. $N = 59$.

* $p < .05$.

Table 2

Correlations among Variables of Study 2

	Variables in the model:			Maternal responsivity			
Variable	**1. Persistence at play**	**2. Infant Δ anger to goal blockage**	**3. Infant temperament**	**4. MV to IV**	**5. MT to IV[a]**	**6. MV to IT[a]**	**7. MT to IT[a]**
1							
2	.38^{+}						
3	−.13	.05					
4	.06	.21^{+}	−.04				
5	.07	.23*	−.12	.52***			
6	−.44^{+}	−.19	−.06	.33*	.28*		
7	−.25	−.05	−.02	.22^{+}	.23^{+}	.74***	

Note. N = 101. n range of variables was 30 to 99 (i.e., 30 for persistence, 83 for Δ anger to goal blockage, 99 for temperament, 97 for MV to IV, 97 for MT to IV, 60 for MV to IT, and 60 for MT to IT).

[a]Log transformed scores. MV = maternal vocalizations, MT = maternal touch, IV = infant vocalizations, and IT = infant touch.

$^{+}p < .10$,

$^{*}p < .05$,

$^{***}p < .001$.

Table 3

Results of Structural Equation Models by the Different Types of Maternal Responsivity to Infant Behaviors

	MV to IV		MT to IV		MV to IT		MT to IT	
Path	**β**	***p***	**β**	***p***	**β**	***p***	**β**	***p***
Infant temperament ↔ Maternal responsivity	−.04	.670	−.12	.247	−.06	.674	.01	.925
Infant temperament → Infant Δ anger to goal blockage	.05	.616	.08	.436	.05	.677	.05	.620
Maternal responsivity → Infant Δ anger to goal blockage	**.21**	.046	**.24**	.021	−.13	.371	−.02	.909
Infant Δ anger to goal blockage → Toddler persistence	**.37**	.012	**.35**	.016	**.30**	.025	**.37**	.005
Infant temperament → Persistence at play	−.18	.271	−.17	.312	−.22	.152	−.17	.274
Maternal responsivity → Persistence at play	−.12	.497	−.07	.742	**−.51**	.007	**−.41**	.057
R^2								
Infant Δ anger to goal blockage	.05		.06		.02		.00	
Persistence at play	.16		.14		.41		.33	

Note. *N* = 101. MV = maternal vocalizations, MT = maternal touch, IV = infant vocalizations, and IT = infant touch.