Infant temperament and anxious symptoms in school age children

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Abstract

A group of 164 children from different infant temperament categories were seen at 7 years of age for a laboratory battery that included behavioral and physiological measurements. The major results indicated that children who had been classified as high reactive infants at 4 months of age, compared with infants classified as low reactive, (a) were more vulnerable to the development of anxious symptoms at age 7 years, (b) were more subdued in their interactions with a female examiner, (c) made fewer errors on a task requiring inhibition of a reflex, and (d) were more reflective. Further, the high reactives who developed anxious symptoms differed from the high reactives without anxious symptoms with respect to fearful behavior in the second year and, at age 7 years, higher diastolic blood pressure, a narrower facial skeleton, and greater magnitude of cooling of the temperature of the fingertips to cognitive challenge. Finally, variation in magnitude of interference to fearful or aggressive pictures on a modified Stroop procedure failed to differentiate anxious from nonanxious or high from low reactive children.

There is a growing consensus among clinicians and scientists that the appearance of symptoms that presumably reflect states of anxiety or fear is most likely for those who inherit a temperamental diathesis (Crowe, Noyes, Pauls, & Slymen, 1983; Kendler, Neale, Kessler, Heath, & Eaves, 1992; Capps, Sigman, Sena, Henker, & Whalen, 1996). However attractive this hypothesis, it remains a presumption because of lack of impeccable empirical support. One useful research strategy is to study infants who possess particular temperamental qualities, using a longitudinal design, until they become old enough to display relevant symptoms.

Our laboratory has been studying a large group of healthy, Caucasian children from middle-class families who volunteered their children to be participants in a longitudinal study. All families had at least one parent who had graduated college and, for a majority of families, both parents were college graduates. The children were classified at 4 months of age into one of four temperamental groups—high reactive, low reactive, distressed, and aroused—based on the infant’s behavior to a standard battery of visual, auditory, and olfactory events (Kagan, 1994). The videotapes of each infant’s behaviors were coded reliably for the frequency of motor activity (movement of the limbs and arching of the back), fretting, and crying. Infants who showed a combination of frequent, vigorous motor activity combined with frequent fretting and crying were classified as high reactive (22% of the sample). Infants who showed the opposite profile of infrequent motor activity and infrequent fretting and crying were classified as low reactive (40% of the sample). Infants who showed infrequent motor activity but frequent fretting and crying were classified as distressed (25% of the sam-
ple) and infants who showed frequent motor activity but minimal distress were classified as aroused (10% of the sample). We assume, but have not proven, that these four groups of children inherit different profiles of limbic excitability which are based on different neurochemistries. We regard these four groups as categories rather than treating the motor and irritability scores as forming a continuum of reactivity because analyses based on a finite mixture model revealed that a categorical conception fits the data better than one that assumes continua of reactivity (Stern, Arcus, Kagan, Rubin, & Snidman, 1994).

These children were observed twice in the second year. Those who had been classified as high reactive were significantly more likely than the other three groups, and especially the low reactives, to show high levels of fear to unfamiliar situations, objects, and people in laboratory settings when they were 14 and 21 months old. Over one-half of the children who showed obvious fear to four or more unfamiliar events at both 14 and 21 months had been classified as high reactive infants, while only 10% of the fearful children had been low reactive. In addition, the children who had been high reactive infants more often showed indexes of sympathetic activity (for example, larger heart rate accelerations to challenge) (Kagan, 1994; Snidman, Kagan, Riordan, & Shannon, 1995). In addition, the high reactives had narrower facial skeletons than the low reactives (Arcus & Kagan, 1995). The association between a high reactive temperament and a narrower facial skeleton has some theoretical basis. The maxillary formation, which determines the width of the face, is a derivative of neural crest cells which are ectodermal in origin. Further, the homozygous mouse strains that show retardation in facial bone growth following the administration of glucocorticoids at birth are behaviorally more fearful to novelty than strains for whom glucocorticoid administration at birth does not slow the growth of facial bone (Thompson, 1953). These data imply a genetic basis for an association between the bony structure of the face and fearful behavior.

Fox, Calkins, and Bell (1994) and Calkins, Fox, and Marshall (1996) have verified, in an independent sample of middle-class children, that 1-year-olds who had been high reactive infants at 4 months were not only more fearful than others but also most likely to show desynchronization of alpha frequencies in the right, compared with the left, frontal area. This pattern of EEG activation is associated with states of anxiety and/or depression in adults (Fox, 1991; Davidson, 1994). Because children who had been high reactive infants are at risk for becoming fearful 2-year-olds and show right hemisphere activation, it is reasonable to assume that they should be at higher risk for the development of anxious symptoms when they attain school age. This report summarizes a study that evaluates this hypothesis.

Briefly, we used questionnaires and interviews with parents and teachers to select children from this longitudinal sample who might be at risk for signs of anxiety problems. These children and matched controls were evaluated between 6 and 8 years of age with a laboratory battery designed to answer two major questions: Were the children who had been high reactive infants different from low reactives on behavioral and physiological variables related to anxiety? Were high reactives with anxious symptoms different in behavior and/or physiology from high reactives who did not develop anxious symptoms?

Method

Subjects

The subjects were 164 middle-class, Caucasian children (85 girls and 79 boys), members of a longitudinal sample, who were assessed when they were between 6 and 8.5 years of age (mean age 7.3 years). All but six of the children had been classified at 4 months as belonging to one of the four infant temperamental groups described earlier. The six unclassified infants had incomplete protocols. Although a total of 560 children had been observed at 4 months, only 462 children were evaluated at 14 and 21 months. The remaining mothers were unwilling to participate in the study or had moved from the area. The 164 children in the current evaluation consisted of
51 children who had been high reactive infants, 60 who had been low reactive infants, and 53 children from the other temperamental groups.

Procedures for earlier assessments

14-Month assessment. Mother and child came to the laboratory for a battery that contained a series of unfamiliar events, procedures, and people. The unfamiliar events included placing EKG electrodes on the child’s body, a blood pressure cuff on the child’s arm, inviting the child to imitate unusual acts, requesting the child to accept liquid on the tongue, exposure to a rotating metal wheel containing plastic objects, an approaching woman wearing a gas mask, a pair of puppets speaking nonsense, a stranger requesting the child to approach a large metal robot, and a stranger wearing a black cloth over her head and shoulders inviting the child to approach her.

Between 3 and 6 weeks following the battery described above, each child returned with his or her parents for a play session that occurred in a different and larger room with two unfamiliar peers of the same age and sex along with their parents. The parent accompanying the child was the mother in all but five instances. The three children played with a set of age-appropriate toys for 25 min while coders behind a one way vision screen coded proximity to the mother, time talking, proximity to another child, and time staring at another child while not close to another child. At the end of 25 min, the mothers were asked to leave the room for 5 min. After the mothers returned, the examiner placed an attractive toy in the middle of the carpet and left it there for 3 min in order to see which child took possession of the toy. The examiner then returned to remove the attractive toy and several minutes later, an adult dressed in a gorilla costume carrying toys entered the room and after a minute invited the children to approach and to play with the toys. A coder studied the videotapes of the play sessions and placed each child into one of three categories based on behavior over the entire play session. One category reflected a sociable, spontaneous style characteristic of 51% of the children. A second category reflected a shy, timid style characteristic of 26% of the children and a third category was characteristic of those children who were neither clearly very shy nor very uninhibited (23% of the sample). An independent coder coded 24 randomly selected videotapes. The two coders agreed exactly on 75% of the classifications (κ = .61; See Kagan, Snidman, & Arcus, 1998 for details).

21-Month assessment. As at 14 months, parent and child came to the laboratory and the child was exposed to a series of unfamiliar events, procedures, and people, some of which were shown at 14 months. The new events included a room with five unfamiliar objects and an examiner who carried out a specific action with each object and invited the child to imitate her “exposure to a startle stimulus” request to the child to build block constructions, and a person dressed in a red clown costume and mask inviting the child to approach her.

Each of the episodes at 14 and 21 months was scored for the presence or absence of a fear reaction, where fear was defined as a fret or cry to an unfamiliar incentive or failure to approach one of the unfamiliar adults or robot or to imitate the examiner when requested. The intercoder reliability for the scoring of number of fears for each protocol from the videotapes was high ($r = .89$).

4.5-Year assessment. The parent and child once again came to a testing room and the child was administered a battery consisting of the recording of heart rate, blood pressure, exposure to film clips, request to implement actions, a modified Stroop interference procedure, a request to draw the self, puzzles, and a motor coordination task. A coder with no knowledge of the child’s prior behavior scored from videotapes the number of spontaneous comments and smiles made toward the examiner during the 60 min test battery. The intercoder reliability was .91 for comments and .92 for smiles.

Between 3 and 6 weeks following the battery described above, each child returned with his or her parents for a play session that occurred in a different and larger room with two unfamiliar peers of the same age and sex along with their parents. The parent accompanying the child was the mother in all but five instances. The three children played with a set of age-appropriate toys for 25 min while coders behind a one way vision screen coded proximity to the mother, time talking, proximity to another child, and time staring at another child while not close to another child. At the end of 25 min, the mothers were asked to leave the room for 5 min. After the mothers returned, the examiner placed an attractive toy in the middle of the carpet and left it there for 3 min in order to see which child took possession of the toy. The examiner then returned to remove the attractive toy and several minutes later, an adult dressed in a gorilla costume carrying toys entered the room and after a minute invited the children to approach and to play with the toys. A coder studied the videotapes of the play sessions and placed each child into one of three categories based on behavior over the entire play session. One category reflected a sociable, spontaneous style characteristic of 51% of the children. A second category reflected a shy, timid style characteristic of 26% of the children and a third category was characteristic of those children who were neither clearly very shy nor very uninhibited (23% of the sample). An independent coder coded 24 randomly selected videotapes. The two coders agreed exactly on 75% of the classifications ($κ = .61$; See Kagan, Snidman, & Arcus, 1998 for details).

Procedure at 7 years
When the children were between 5.0 and 7.5 years, a questionnaire was mailed to 438 of
Table 1. Questionnaire items that mothers checked as not true, sometimes true, or often true of their child

1. Becomes quiet, subdued in unfamiliar places
2. Refuses your requests or rules
3. Does not like to be away from you for very long
4. Laughs easily
5. Loses temper when reprimanded by adults
6. Shy with other children
7. Shy with unfamiliar adults
8. Shifts from one uncompleted activity to another
9. Is very sensitive to punishment or reprimand
10. Worries about the future
11. Acts before thinking
12. Reluctant to go to preschool or school
13. Loses temper when does not get own way
14. Plays happily with friends
15. Is easily distracted by things going on around him or her
16. Gets into arguments with other children
17. Likes to listen to music
18. Does not sustain attention in a play activity
19. Gets angry easily
20. Is afraid of lightning or thunder
21. Is afraid of animals
22. Is afraid of being away from home
23. Is afraid of strangers
24. Is afraid of loud noises
25. Likes to draw
26. Is kind to others: likes to share
27. Has difficulty remaining seated when required to do so
28. Enjoys vacation
29. Fidgets with hands or feet or squirms in seat
30. Does not seem to feel guilty after a misbehavior
31. Bosses other children
32. Has nightmares
33. Hits and pushes other children
34. Likes to go to playgrounds

The questionnaire was viewed as a screening instrument to determine which children might be at risk for signs of anxiety, either alone or in combination with conduct or attention deficit symptoms. However, because our primary interest was in anxious symptoms, most of the questions were devoted to this construct. The mother indicated for each question whether the behavior was not true, sometimes true, or often true of her child. The questionnaires were scored by assigning a value of one for sometimes true and a value of two for often true.

The questions used to decide if the child met an initial criterion for anxious symptoms were 1, 3, 6, 7, 9, 12, 20, 21, 22, 23, 24, and 32. If a child had a total score of 9 or more across these 12 questions (8 was the median), the child was regarded, potentially, as a member of the anxious group (43% had a score of 9 or more). We wished to evaluate children who might have signs of conduct disorder or ADHD without anxious symptoms; hence, we asked a few relevant questions. The three questions relevant to conduct problems were numbers 19, 31, and 33. A child whose total score was 3 or more (2 was the median) was regarded as potentially a child with conduct problems (31% had a score of 3 or more). The five questions related to attention deficit problems were 8, 15, 18, 27, and 29. If the child’s score was 6 or more (2 is the median), the child was regarded as a potential member of this group (15% of the children had a score of 6 or more).

If a child met the criterion for anxious symptoms, alone or in combination with other symptoms, or met the criterion for symptoms of conduct disorder or ADHD, the mother was telephoned by a member of the research team and asked to elaborate her answers by providing specific examples and detailed descriptions of the conditions under which her child displayed a particular behavior. This information was used to decide which children should remain as potential candidates of a symptom group. The telephone interview occasionally revealed that some mothers had exaggerated the seriousness of their child’s behavior, and these children were eliminated. For example, it was not uncommon for a mother to report on the questionnaire that her
child was shy with strangers, but when interviewed said that her child was quiet for a few seconds when he or she met a stranger but adapted very quickly. These children were omitted from the potentially anxious group.

The teachers of the children who remained as potential members of a symptom group provided the final source of information. The teachers were called on the telephone and interviewed about the child. The teachers had no knowledge of the child’s prior laboratory behavior or temperament nor the purpose of the research. Each teacher was first asked to describe the child, and then to rank the child with respect to all children of the same sex in that classroom on a set of relevant behaviors that included shyness, reluctance to talk, caution, and fearfulness.

All three sources of information—the maternal questionnaire and the subsequent interviews with the mother and teacher—were discussed by three of the investigators (J. K., N. S., & M. Z.). If a child met the criteria for any symptom group, based on the mother’s questionnaire and, in addition, both mother and teacher confirmed that classification in their interviews, the child was assigned to the symptom group. When the mother and teacher information was inconsistent, the investigators discussed all sources of information on these children until there was consensus as to whether the child did or did not meet criteria for the group. A total of 24 children had anxious symptoms only, and 19 children had anxious symptoms combined with conduct disorder or ADHD. All assignments to a symptom group were made before the child came to the laboratory for evaluation.

The final symptom group consisted of 43 children who met criteria for anxious symptoms. In addition, eight children without anxious symptoms met criteria for signs of conduct disorder, one child for signs of ADHD, and five children for a combination of conduct disorder and ADHD. None of these 14 children met criteria for anxious symptoms. We then selected 107 children, regarded as controls, who did not meet criteria for any symptom group based on the maternal questionnaire data. This control group contained equal proportions of girls and boys and similar proportions of each of the four original 4-month temperamental groups. Table 2 contains the distributions in each temperamental category for the symptom and control groups.

The sample evaluated in the laboratory at 7 years consisted of 51 children who had been high reactive; this represents about one half of the 112 infants who had been classified as high reactive at 4 months and, in addition, were observed in the laboratory at 14 and 21 months. Seventy-nine percent of this large group (n = 88) had returned the questionnaire. The 60 low reactive children seen in the laboratory represented about one-third of the 200 children who had been low reactive at 4 months and, in addition, were also evaluated at 14 and 21 months. Sixty-five percent of these parents (n = 130) had returned the questionnaire. The sample also contained 37 children who had been classified as distressed, 14 as aroused, and 2 children who had not been classified at 4 months. These 53 children represented one-fourth of the 250 children seen at 4, 14, and 21 months. Thirty-eight percent of these parents had returned the questionnaire.

Rationale for laboratory procedures

The procedures selected were intended to evaluate behavioral and physiological variables that had discriminated between inhibited and uninhibited children in the past or were in accord with theoretical expectations based on the work of other investigators. Prior research had revealed that high reactive infants who became fearful children in the second year were quiet and serious when they interacted with an unfamiliar adult (Kagan, Snidman, & Arcus, 1998; see also Asendorpf, 1994). Thus, we coded from the videotapes of the first half of the session number of spontaneous comments and smiles displayed by the child to the examiner during the first 30 min of the battery.

Research by other investigators (McNally, Kaspi, Riemann, & Zeitlin, 1990; McNally, Riemann, & Kim, 1990) had suggested that when a Stroop interference paradigm (Stroop, 1935) required patients and controls to name the color of printed words that were semanti-
Table 2. Number of children who met criteria for one or more of the diagnostic categories by their 4-month temperamental group and controls (n = 164)

<table>
<thead>
<tr>
<th>4-Month Category</th>
<th>Anxious Symptoms</th>
<th>ADHD or Conduct</th>
<th>Controls (No Symptoms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High reactive girls (n = 12)</td>
<td>12</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>High reactive boys (n = 12)</td>
<td>11</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Low reactive girls (n = 6)</td>
<td>5</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>Low reactive boys (n = 12)</td>
<td>4</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>Distress girls (n = 4)</td>
<td>4</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Distress boys (n = 3)</td>
<td>2</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Aroused girls (n = 2)</td>
<td>2</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Aroused boys (n = 4)</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Not classified girls = 0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Not classified boys = 2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Forty-five percent of the high reactives had anxious symptoms, 15% of the low reactives had anxious symptoms, and 21% of the remaining children had anxious symptoms.

cally related to a source of fear or anxiety, patients with anxious symptoms showed longer latencies to the threatening words than did controls. (See MacLeod, 1991, and Williams, Mathews, & McLeod, 1996 for reviews of this literature.) These data imply that interference to stimuli symbolic of threat might be more frequent for inhibited children. However, 7 year old children cannot read words proficiently. Hence, we constructed a Stroop interference procedure using pictures instead of words with the expectation that high reactive and/or anxious children would show greater interference to the pictures suggestive of fear than other children. There is precedent for the use of pictures in a Stroop paradigm. Women with eating disorders and controls were asked to name the colors of various body shapes, as well as the colors of neutral pictures. Both patients and controls showed interference to the pictures of body shapes, and the patients showed greater interference than the controls (Walker, Ben–Tovin, Paddick, & McNamara, 1995).

Earlier research had also suggested that inhibited children were cautious when faced with tasks containing uncertainty (Kagan, 1994). Hence, we administered an age appropriate version of the Matching Familiar Figures Test (Kagan, Rosman, Day, Albert, & Phillips, 1964), in which the child had to decide which one of six pictures was identical to a standard.

A third theoretically relevant variable was potentiated startle. Lang and his colleagues (Lang, Bradley, & Cuthbert, 1990; Bradley, Cuthbert, & Lang, 1996; and Vrana, Spence, & Lang, 1988) as well as Grillon and Davis (1997) have suggested that the magnitude of the eye blink reflex to a brief loud sound is enhanced when the subject is looking at a picture that is unpleasant in emotional valence or is threatening in some other way. Other research has shown that anticipation of a blast of air to the larynx potentiates the startle reflex in adolescents (Grillon et al., 1999). Hence, we assessed potentiated startle to the anticipation of a blast of air with the expectation that high reactives and/or anxious children would show greater potentiation of the blink reflex than other children when they were anticipating the unpleasant air blast.

We also evaluated several autonomic indexes that, in the past, had differentiated inhibited from uninhibited children. Specifically, we gathered sitting and standing heart rate and blood pressure values, with the expectation that the high reactives and anxious children would show larger increases in heart rate and blood pressure to orthostatic chal-
Temperament and anxiety

Earlier research had also indicated that inhibited children who had been high reactive infants showed larger temperature asymmetries on the forehead or fingertips than low reactive infants who became uninhibited children. Further, the former group tended to be cooler on the right than on the left side (Kagan, 1994; Kagan, Arcus, Snidman, & Rimm, 1995). The temperature of the skin surface is influenced primarily by the amount of blood in the underlying vessels which, in turn, is a function of sympathetic tone on the arterioles or the arteriovenous anastomoses that permit arterial and venous blood to mix (Drummond & Lance, 1987; Fox, Goldsmith, & Kidd, 1962; Johnson, 1978). Sympathetic innervation of these circulatory structures leads to constriction, through activation of alpha receptors, and, as a result, blood volume is decreased and the skin surface becomes cooler. When sympathetic activation is withdrawn, the skin becomes warmer (Sparks, 1978). The fingertips contain anastomoses and, as a result, display large temperature changes to incentives, typically differences of 0.3°C to 0.4°C (Hales, 1985).

We also assessed body build and facial skeleton because earlier research had revealed that high reactive infants had narrower facial skeletons than low reactives (Arcus & Kagan, 1995). As indicated earlier, this association finds support in the relation between the reaction of facial bone to the administration of glucocorticoids and vulnerability to fear to novelty in varied mouse strains.

Finally, we included two tasks that might be more characteristic of children with conduct or attention deficit problems than of those with anxious problems. Diamond, Prevar, Callendar, and Druin (1997) had suggested that an inability to inhibit behavior is characteristic of these two types and could be a function of a compromised frontal integrity (see also, Funahashi, Chafee, & Goldman-Rakic, 1993). We administered a task requiring children to inhibit a saccade to a sudden light onset. We also administered a test of memory for spatial locations, with the hypothesis that the conduct and/or attention deficit disorder children would perform less well on these tasks than the others (Cowan, 1997).

Description of the battery

The 12 laboratory procedures, in order of administration along with the variables that were coded, are described below:

1. The mother and child were first acclimated to the testing room by a female examiner who did not know the prior behavior of the child nor the symptom classification.

2. Sitting and standing systolic and diastolic blood pressure values were obtained using a child’s cuff.

3. Sitting and standing mean heart rates over 1 min were obtained.

4. The child was administered a modified Stroop procedure. A microphone embedded in a velcro band was placed around the child’s neck in order to record vocal response latency. Initially, a series of birds outlined in one of four colors appeared on a computer monitor and the child was to name the color of the bird as quickly as possible. The examiner, sitting beside the child, noted, for each picture, whether the child made a preliminary vocal sound (a grunt or “uh”) before naming the color or whether the child named the picture rather than the color. The latencies to these anomalous responses were eliminated from the final corpus. These anomalies made up less than 2% of all trials. Data were available on this procedure for 153 of the 164 children.
The 40 pictures, drawn especially for this study, had been assigned a priori to one of four categories. There were 10 pictures for each category and each category illustrated pictures in all four colors. The pictures from the neutral category were intended to have minimal emotional valence (plate, child reading a book, two people talking, child with a cup, adult sitting, child hopping, paper, person standing, ball, and an adult holding a cup of tea). The pictures called pleasant were intended to provoke associations of joy or fun (bowl of ice cream, birthday cake, ice cream cone, mother kissing a child, gift, two kittens, dog with a bone, puppy on a child’s lap, child patting a kitten, and a toy). The pictures called aggressive were intended to provoke associations of anger or hostility (child with arm raised as if to strike another, child with fists clenched, child hitting a dog, child throwing an object at another, child with a stick striking another, child kicking a cat, child hitting another child, a child breaking a plate, child with a hammer, and a person with a mean face). The pictures called fearful were intended to provoke associations of danger or harm (snake, witch, dagger, gun, mask, child falling from a roof, dog jumping on a child, boa constrictor, spider, and tiger). The pictures in the four categories were balanced for complexity; that is, we attempted to have equal proportions of pictures in each category that consisted of a single person or object or two people with or without an object. The variable of interest was the mean latency to name the color of each picture.

5. The child was then administered 12 items from the children’s version of the Matching Familiar Figures Test. Each item consisted of a picture of a familiar object on one page and six alternatives on a page below. Five of the six alternatives were very similar to the standard; only one was identical. The child selected the one picture from the six alternatives that was identical to the standard. The initial response latency to each item and the total number of errors were used to classify children as reflective or impulsive. A child whose average latency across all 12 items was above the mean but total errors below the mean was classified as reflective. The child whose average latency was below the mean but error score above the mean was classified as impulsive. The remaining children were classified as neither reflective or impulsive.

6. The child was administered a task intended to evaluate the ability to inhibit a reflex. The child’s head, supported by a chin rest, rested 150 mm in front of a panel that contained a focal point (a schematic face) and two LED (20 lumins), each placed 130 mm on either side of the focal point. The child was told that when one of the LEDs was lit, he or she was to inhibit the automatic tendency to look at the light, and to look at the unlit LED on the other side. After three practice items, 12 trials were administered. The examiner recorded the side to which the child looked.

7. The child was administered a test designed to measure recall memory for spatial locations. The child was shown a small design on a blank piece of 8 × 11 paper and told to remember it. The stimulus was removed, and the child was shown a page containing many small figures and was asked to name these figures. The purpose of this 20-s period of naming was to prevent the child from rehearsing the exact location of the design. The child was then shown a blank piece of paper and asked to point to the place on the page where the design had been seen originally. After two practice items, five items were administered and number correct was the variable of interest.

In addition to the variables noted above for these procedures, we also coded the number of spontaneous comments and smiles a child displayed over these first seven procedures, which took about 30 min, because the tendency to be quiet and to refrain from laughter and smiling with an unfamiliar adult are two salient charac-
teristics of inhibited children and shy adults (Cheek & Buss, 1981; Kagan, 1994). The intercoder reliability for these two variables, based on an independent coding of 30 children was $r = .90$ for comments and $r = .93$ for smiles.

8. The child was taken to another room where a potentiated startle procedure was administered. The child, who was told that he/she was going to be like an astronaut, was seated in a chair facing an array that simulated a spaceship with an embedded green light bulb 4 feet in front of the child’s face. Two electrodes were placed on the orbicularis oculi of the left eye to record the magnitude of the blink reflex and a plastic tube with a small opening was taped to the child’s throat near the larynx.

The child was given five acoustic probes (50-ms bursts of white noise—square wave with immediate rise time—at 95 dB) and told that he/she might experience this loud noise during the procedure that followed. The magnitudes of the blink reflex (in microvolts) to the five acoustic probes were treated as baseline values. The magnitudes of each startle reflex were coded in the following way. The digital signal was rectified and integrated using a 20-ms time constant. Peak amplitude of the blink reflex was determined in a 21 to 100 ms window following stimulus onset, relative to mean activity in the 10 ms following stimulus onset.

The child was then told that he/she would experience a brief blast of air coming from the tube. After this description, a 200-ms blast of air was delivered. Because this event is sudden and unfamiliar, most children show a large bodily startle to the stimulus.

The child was then told that when the green light bulb was off, he/she would definitely not be given the sudden blast of air. However, when the green light was on, he/she might experience the air blast. Actually, the air blast was never delivered again. The child was queried to make sure that he/she understood that when the light was off, the air blast would not be delivered. The child then experienced six acoustic probes which alternated between the light bulb being on and off (on, off; on, off; on, off). No air blast was ever delivered again. The child was then told that the lights in the room would be turned off. The investigator turned the lights off and delivered five additional acoustic probes in the dark room. Thus, 16 acoustic probes were delivered in all.

A total of 89 of the 164 children (54% of the sample) had adequate data on this procedure (60% of high reactives, 58% of low reactives, and 46% of the remaining children had adequate startle data). Technical difficulties and refusal to wear the electrodes were the major reasons for the loss of subjects. However, equal proportions of high and low reactives successfully completed the procedure.

9. The child was told that he/she would hear a noise through the earphones that would increase in loudness. We recorded the change in heart rate to the gradual increase in the loudness of the white noise. Heart rate was recorded during an initial baseline without noise followed by six phases, each 10 s long, during which white noise intensity increased, beginning at 60 dB and followed by 5-dB increments for five additional 10-s trials. An acceleration was coded if heart rate rose steadily across the first three trials and the increase was at least 4 bpm; a deceleration of heart rate was coded if heart rate fell steadily across the first three trials and the total decrease was at least 4 bpm. If neither of these occurred, then neither an acceleration nor a deceleration was coded.

10. We measured the temperature of the child’s ear drum (twice for each ear, alternating measurements between the right and left ear) using a digital thermometer gently inserted into the ear canal.

11. The child was then taken to a third laboratory containing a thermography scanner. The child placed his/her hands, palms up, on a board and the scanner was situated 6 inches above the pair of open hands. After
two baseline recordings of the temperature of the fingers, the child saw eight, 30-s video episodes that were either neutral in affective tone or symbolic of sadness, joy, or fear. The child was then asked to listen to a series of digits in order to recall them. The examiner read the digits at a rate of one per second (a series of three, four, five, or six digits in length) and a recording of the finger temperatures was made as the examiner read the next to the last digit. The computer program evaluated the temperature of the fingertips of the index, middle, and ring fingers of both hands for the two initial baseline images, the 24 images during each of the 8 video episodes, two baseline images prior to the digit recall series, and a single image for each of the six digit trials (34 images total). The coder placed a standard size rectangle on the fingertips of each finger and the program computed the mean temperature of the area of the rectangle. The variable of interest was the mean temperature for that area. The reliability of the placement of the rectangles on the fingertips was .93.

12. Finally, we measured the child’s height and weight and, using calipers, the width of the face at the bizygomatic and the length of the face. Two independent measures of width and length were made. The variable of interest was the ratio of width over length. The two measurements had to agree within 0.1 cm.

Because of the relatively long and varied battery, readers may wonder about the creation of a state of anxiety in some of the children. Unfortunately, it was not possible to evaluate that state. However, careful study of the videotapes of the battery suggested that most children became more, rather than less, relaxed as the session wore on.

Results

The presentation of results is organized around two central questions. The first is whether the children who had been high reactive infants differed from those who had been low reactive. The second question is whether the high reactives who were classified as having anxious symptoms differed from the high reactives who did not acquire anxious symptoms. Because the number of children with symptoms of ADHD or conduct disorder without signs of anxiety were small ($n = 14$), we shall not discuss this group.

High versus low reactives

Perhaps the most important result is that the children who had been high reactive at 4 months were more likely to be classified as possessing anxious symptoms than those who had been low reactive infants. Of the children seen at 7.5 years, 45% of the high reactives, 15% of the low reactives, and 21% of the remaining children were classified as having anxious symptoms. A comparison of high reactives, low reactives, and all remaining children yielded a $\chi^2(2 \text{ df})$ of 12.8, $p < .01$ (see Table 2). When the denominator was the number of children whose parents were sent questionnaires, 26% of the high reactives, 7% of the low reactives, and 11% of the remaining children had anxious symptoms.

Table 3 presents the values (means or percentages) on the major variables for the four infant temperamental groups (high reactive, low reactive, distressed, and aroused), independent of the child’s symptom status. A series of separate ANOVAs on each variable, with the four temperamental groups and sex as independent factors, revealed no significant $F$ for temperament for any variable, and only one significant sex difference—girls smiled more than boys, $F(1, 157) = 7.43, p < .01$. However, our primary theoretical interest was in the comparison between high and low reactives who made up 69% of the sample. These two groups did differ on several variables.

The high reactives differed from the low reactives (boys as well as girls) on several behaviors that implied a more subdued, cautious, reflective style for the former group. The high reactives displayed fewer spontaneous comments, $t(109) = 2.37, p < .01$, and fewer smiles with the examiner, $t(109) = 1.97, p = .05$, made fewer errors on the saccade inhibition task, $t(108) = 3.50, p < .01$, and were more...
Table 3. Means (standard deviations) for major variables by 4-month temperament categories

<table>
<thead>
<tr>
<th>Variable</th>
<th>High Reactive (n = 51)</th>
<th>Low Reactive (n = 60)</th>
<th>Distressed (n = 37)</th>
<th>Aroused (n = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments</td>
<td>19.6 (27.9)</td>
<td>32.8 (30.3)</td>
<td>21.6 (26.3)</td>
<td>19.9 (21.4)</td>
</tr>
<tr>
<td>Smiles</td>
<td>14.4 (18.2)</td>
<td>22.0 (21.5)</td>
<td>20.2 (22.5)</td>
<td>20.4 (16.4)</td>
</tr>
<tr>
<td>Systolic (mmHg)</td>
<td>108.4 (8.6)</td>
<td>107.4 (7.8)</td>
<td>107.6 (7.7)</td>
<td>102.3 (6.5)</td>
</tr>
<tr>
<td>Sit</td>
<td>112.5 (7.4)</td>
<td>110.8 (6.3)</td>
<td>111.5 (7.6)</td>
<td>108.4 (10.0)</td>
</tr>
<tr>
<td>Diastolic (mmHg)</td>
<td>58.8 (8.0)</td>
<td>56.1 (6.4)</td>
<td>57.0 (6.6)</td>
<td>57.2 (8.0)</td>
</tr>
<tr>
<td>Sit</td>
<td>61.3 (7.7)</td>
<td>59.7 (6.9)</td>
<td>63.0 (8.5)</td>
<td>62.0 (7.4)</td>
</tr>
<tr>
<td>Baseline H.R. (ms)</td>
<td>650 (76.4)</td>
<td>643 (58.1)</td>
<td>619 (48.1)</td>
<td>638 (63.8)</td>
</tr>
<tr>
<td>Sit</td>
<td>598 (86.0)</td>
<td>598 (70.3)</td>
<td>579 (47.5)</td>
<td>592 (76.1)</td>
</tr>
<tr>
<td>Stand</td>
<td>97.9 (1.0)</td>
<td>97.5 (0.98)</td>
<td>97.7 (0.98)</td>
<td>97.5 (0.71)</td>
</tr>
<tr>
<td>Right ear</td>
<td>97.7 (1.0)</td>
<td>97.4 (0.98)</td>
<td>97.6 (0.98)</td>
<td>97.5 (0.71)</td>
</tr>
<tr>
<td>Left ear</td>
<td>97.7 (0.99)</td>
<td>97.4 (1.0)</td>
<td>97.6 (0.88)</td>
<td>97.5 (0.73)</td>
</tr>
<tr>
<td>Difference</td>
<td>0.20 (.20)</td>
<td>0.60 (.60)</td>
<td>0.59 (.59)</td>
<td>0.60 (.60)</td>
</tr>
<tr>
<td>Right–left ear</td>
<td>0.80 (.71)</td>
<td>0.60 (.62)</td>
<td>0.59 (.67)</td>
<td>0.59 (.50)</td>
</tr>
<tr>
<td>Stroop, mean latency</td>
<td>974 (.97)</td>
<td>1059 (1.05)</td>
<td>1005 (1.05)</td>
<td>982 (1.04)</td>
</tr>
<tr>
<td>All pictures (ms)</td>
<td>974 (1.00)</td>
<td>1059 (1.05)</td>
<td>1005 (1.05)</td>
<td>982 (1.04)</td>
</tr>
<tr>
<td>Latency difference (ms)</td>
<td>72 (145)</td>
<td>98 (146)</td>
<td>48 (147)</td>
<td>55 (173)</td>
</tr>
<tr>
<td>Fear minus neutral</td>
<td>(145)</td>
<td>(146)</td>
<td>(147)</td>
<td>(173)</td>
</tr>
<tr>
<td>Agg minus neutral</td>
<td>−9 (147)</td>
<td>−33 (148)</td>
<td>−6 (130)</td>
<td>−28 (144)</td>
</tr>
<tr>
<td>Pos minus neutral</td>
<td>−17 (151)</td>
<td>−17 (138)</td>
<td>21 (138)</td>
<td>16 (118)</td>
</tr>
<tr>
<td>Saccade errors</td>
<td>1.8 (.23)</td>
<td>3.5 (2.8)</td>
<td>2.4 (2.8)</td>
<td>2.3 (1.8)</td>
</tr>
<tr>
<td>Memory errors</td>
<td>0.94 (1.3)</td>
<td>1.1 (1.1)</td>
<td>0.81 (.91)</td>
<td>0.42 (.75)</td>
</tr>
<tr>
<td>Matching familiar figures (%)</td>
<td>Impulsive</td>
<td>37 (0.51)</td>
<td>55 (0.70)</td>
<td>40 (0.45)</td>
</tr>
<tr>
<td>Reflective</td>
<td>37 (0.51)</td>
<td>18 (0.70)</td>
<td>35 (0.45)</td>
<td>35 (0.39)</td>
</tr>
<tr>
<td>Ectomorphy (height/cube root of weight)</td>
<td>12.9 (1.5)</td>
<td>12.9 (1.3)</td>
<td>12.9 (1.2)</td>
<td>12.9 (1.6)</td>
</tr>
<tr>
<td>Mean temperature asymmetry C: All films</td>
<td>0.40 (1.5)</td>
<td>0.25 (1.3)</td>
<td>0.26 (1.2)</td>
<td>0.96 (1.6)</td>
</tr>
<tr>
<td>Index finger</td>
<td>(1.5)</td>
<td>(1.3)</td>
<td>(1.2)</td>
<td>(1.6)</td>
</tr>
<tr>
<td>Middle finger</td>
<td>−0.03 (1.1)</td>
<td>0.10 (1.1)</td>
<td>−0.05 (0.95)</td>
<td>0.19 (1.1)</td>
</tr>
<tr>
<td>Ring finger</td>
<td>−0.06 (1.1)</td>
<td>−0.01 (0.80)</td>
<td>−0.12 (0.94)</td>
<td>0.26 (0.83)</td>
</tr>
<tr>
<td>Startle potentiate (%)</td>
<td>Large</td>
<td>24 (1.1)</td>
<td>43 (1.0)</td>
<td>0 (0.9)</td>
</tr>
<tr>
<td>Small</td>
<td>14 (1.1)</td>
<td>23 (1.0)</td>
<td>40 (0.9)</td>
<td>17 (0.9)</td>
</tr>
<tr>
<td>Not potentiate</td>
<td>31 (1.1)</td>
<td>31 (1.0)</td>
<td>54 (0.9)</td>
<td>40 (0.9)</td>
</tr>
<tr>
<td>Not blink (%)</td>
<td>33 (1.1)</td>
<td>3 (1.0)</td>
<td>6 (0.9)</td>
<td>10 (0.9)</td>
</tr>
</tbody>
</table>
often reflective on the Matching Familiar Figures Test, \( \chi^2(1) = 5.5, p < .01 \).

**Startle.** Comparison of the magnitude of the blink reflex (in microvolts) during the safe and threat conditions revealed that 50% of the children showed larger startles to the threat than to the safe condition. Thirty-seven percent showed either equivalent magnitudes or larger startles to the safe condition. Finally, 13% did not blink on at least nine of the 11 trials and the magnitude of any blink that did occur was less than 1.0 microvolts.

We asked if the children who showed potentiation to the threat condition (larger startle to threat than to safe condition) were different from those who did not. Group 1 displayed a potentiation of at least 1.0 microvolts (\( n = 23 \)); Group 2 showed a smaller potentiation of less than 1.0 microvolts (\( n = 21 \)); Group 3 showed no potentiation (\( n = 33 \)); and Group 4 consisted of the 12 children who did not blink to the acoustic probes. Nine of the 12 children who failed to blink had been high reactive infants; that is, 33% of the high reactives, compared with 5% of all remaining children, failed to blink (\( \chi^2(1) = 10.8, p < .01 \)). The children in the four startle groups were not significantly different in number of fears displayed in the second year, number of spontaneous comments or smiles with the examiner, or possession of anxious symptoms.

Further, 36% of the children (\( n = 32 \)) met criteria for potentiation when the acoustic probes were delivered while the child was sitting in the dark (difference of at least 1.0 microvolt between the mean of the last two startle reflexes and the largest startle to any of the five acoustic probes administered in the dark). Surprisingly, the children who showed potentiation in the dark were significantly less fearful in the second year, \( t(74) = 1.97, p = .05 \), and smiled more often to the examiner, \( t(74) = 2.19, p < .05 \), compared to those who did not potentiate. Moreover, 56% of those who potentiated in the dark had been low reactive infants, compared with 33% who did not potentiate. There were no differences between those who potentiated in the dark and those who did not with respect to the possession of anxious symptoms (19% vs. 20%). Thus, the display of the potentiated blink reflex was not especially characteristic of either inhibited or anxious children.

**Stroop interference.** As expected, most children showed the longest color naming latencies to the fearful pictures (See Table 3). A repeated measures MANOVA with picture type as the factor yielded an \( F(3, 147) = 18.1, p < .001 \). Of the 10 pictures that had the longest latencies, seven came from the fearful category (snake, boa constrictor, spider, dog jumping on a child, dagger, mask, tiger), and not one picture came from the pleasant category. However, despite the fact that fearful pictures were associated with long latencies, there were no significant differences between high and low reactives, nor between anxious and nonanxious children, in magnitude of interference to the fearful, or the aggressive, pictures (interference was defined as a continuous variable as the difference in mean latency between the fearful (or aggressive) pictures, on the one hand, and the neutral pictures, on the other). Nor was there any relation between spontaneous comments or smiles gathered contemporaneously or degree of fearful behavior in the second year and the magnitude of interference to the fearful or aggressive pictures.

**Anxious versus nonanxious high reactives**

The final analysis compared the 23 high reactives who met criteria for anxious symptoms with the 27 high reactives who were not classified as anxious. The two groups did not differ on most of the variables (e.g., spontaneous comments or smiles with the examiner, systolic blood pressure, heart rate, ear or finger temperature, errors on the saccade and memory tests, performance on the Matching Familiar Figures Test, potentiated startle, or Stroop interference).

However, the two groups did differ on three contemporary variables. First, more high reactive-anxious children had sitting diastolic blood pressures above the median value for their sex (67 vs. 55%, \( \chi^2 = 5.6, p < .05 \)). Second, fewer anxious children had very broad faces; 13% of the high reactive-anxious vs.
Temperament and anxiety

58% of the high reactive-nonanxious had face ratios in the top quartile (value = .62) of the distribution, \( \chi^2 = 3.8, p = .05 \).

Third, the magnitude of change in fingertip temperature to cognitive challenge distinguished the two groups. Most children showed a warming of the fingers across the eight brief film clips, and there was no difference between the anxious and nonanxious children with respect to average finger temperature or magnitude of asymmetry between the fingers of the right and left hand either during the first film clip or subsequent clips.

However, during the final episode, when the digit recall problems were administered, the high reactive-anxious children showed a greater magnitude of cooling across the six recall problems, even though they began the procedure with slightly cooler finger temperatures. We compared the mean temperature of the pair of index fingers when the first recall series was being read with the coolest temperature attained on any of the five succeeding trials. (Over 90% of the children attained their coolest temperature on either the fifth or final problem.) We chose the index fingers because temperature changes were greatest for those fingers. More of the high reactive-anxious children had a magnitude of cooling above the high reactives, those who had anxious symptoms at 7 years had a higher aggregate index of inhibition, where high scores indicated a subdued, shy profile. As might be expected, the children who had been high reactive had a significantly higher aggregate index of inhibition than those who had been low reactive, \( z = .62 \) versus \( z = -.28; t(95) = 4.98, p < .01 \). More important is the fact that, among the high reactives, those who had anxious symptoms at 7 years had a higher aggregate index than the high reactives who did not develop anxious symptoms, \( z = 2.04, p < .05 \).

Finally, the degree of fearful behavior to the unfamiliar episodes during the laboratory visit at 21 months discriminated the high reactive-anxious from the high reactive, nonanxious children. Sixty-five percent of those who were anxious, compared with 37% of those without anxious symptoms, had four or more fears to the unfamiliar events at 21 months (\( \chi^2(1) = 4.0, p < .05 \)). It should be noted, however, that the small number of children who had not been high reactive infants but, nonetheless, displayed four or more fears at 21 months, were not especially likely to develop anxious symptoms. It was the combination of a high reactive temperament at 4 months and high fear at 21 months that predicted the acquisition of anxious symptoms at 7 years.

The anxious and nonanxious high reactives were also different when they were evaluated in the laboratory at 4.5 years of age. Forty-two of the 51 high reactives and 58 of the 60 low reactives who were seen at 7 years had also been evaluated at 4.5 years. (The children who had been distressed or aroused infants at 4 months were not seen at 4.5 years.) It will be recalled that each child was seen first by a female examiner for a 1-hr test battery during which spontaneous comments and smiles were coded reliably from videotapes of the session. Several weeks later, each child played with two other unfamiliar children of the same sex and age in a large playroom and each child was classified reliably as inhibited, uninhibited, or neither based on their behavior during the session (Kagan, Snidman, & Arcus, 1998).

We created an average standard score across these three variables: spontaneous comments, smiles, and the three point rating of inhibition, where high scores indicated a subdued, shy profile. As might be expected, the children who had been high reactive had a significantly higher aggregate index of inhibition than those who had been low reactive, \( z = .41 \) versus \( z = -.28; t(95) = 4.98, p < .01 \). More important is the fact that, among the high reactives, those who had anxious symptoms at 7 years had a higher aggregate index than the high reactives who did not develop anxious symptoms, \( z = .62 \) vs. .25; \( t(40) = 2.04, p < .05 \).

Because degree of fearful behavior at 21 months and sitting diastolic blood pressure, facial ratio, and magnitude of cooling of the index fingers to the digit recall problems at 7.5 years separated the anxious from the nonanxious high reactives to a modest degree, we asked how many children in each of these two groups met criteria for all four variables. (We did not use the mean aggregate index at 4.5 years because some of the high reactives were not seen at that age.) The criterion for each of the four variables was a score above the mean value for that variable for that child’s gender. Seven of the 23 high reactive-anxious group, but only 1 of the 27 high reactive-nonanxious control children without symptoms (30% vs. 3%) met all four criteria, \( p < .05 \) by the Exact Test. By contrast, 12 of the 27 nonanxious-
high reactive children without symptoms, but only 3 of 23 anxious-high reactives (44% vs. 13%) met criteria for either none or only one of the four variables. (Six nonanxious-high reactives met none of the criteria; \(p < .05\) by the Exact Test.)

It is of interest that these seven high reactive-anxious children who met criteria for all four variables differed from the remaining group of 105 infants also classified as high reactive at 4 months of age. (Some of these infants were not seen at 14 or 21 months.) These seven, compared with the much larger group, had higher mean values for motor and distress scores and for heart rate as the 4-month battery began, and a larger decrease in heart rate to the unexpected onset of the first taped sentence spoken by a female voice. (Four of the seven infants cried to the onset of the voice.) No statistics were computed for this comparison because of the large difference in samples between the two groups (7 vs. 105 children). However, this evidence is suggestive of the conclusion that this small group of high reactive infants who developed anxious symptoms in later childhood—14% of the high reactivess seen at 7.5 years—were behaviorally and physiologically different from the majority of high reactive infants as early as 16 weeks of age.

**Discussion**

These data permit three reasonable generalizations. The most robust is that 7-year-old children who had been classified as high reactive at 4 months were more likely than those who had been classified as low reactive infants to develop anxious symptoms, to be subdued as they interacted with an unfamiliar female adult, and to be cautious on tasks with response uncertainty. This result implies that the 4-month temperamental category reflects a quality that is preserved to a modest degree.

Second, a few select physiological variables distinguished between the high reactives who developed anxious symptoms and those who did not. More of the former group showed high sitting diastolic blood pressure, a large magnitude of cooling of the surface temperature of the index fingers to cognitive challenge, and a narrow facial skeleton contemporaneously and, in addition, more fear to unfamiliar events 5.5 years earlier when they were 21 months old. These results suggest that this small group of high reactives who developed signs of anxiety by 7 years of age possessed a special diathesis that was detectable as early as the second year of life. These data add credibility to the belief, held by many, that the development of anxious symptoms in later childhood is influenced by a temperamental diathesis. However, less than 10% of the original group of high reactives developed a profile characterized by high fear in the second year, sympathetic lability, and anxious symptoms. But not one low reactive infant developed that profile.

Because 90% of high reactive infants did not develop the profile described above that reflected extreme inhibition, it is misleading to suggest that a high reactive temperament determines the development of a consistently inhibited and anxious profile. It is more accurate to conclude that a high reactive temperament constrains the probability of becoming a consistently fearless, uninhibited child. The difference between determine and constrain is not idle word play because the connotations surrounding the two words are different. The term “determine” implies a particular consequence; “constrain” implies a restriction on one or more members of an envelope of outcomes. It seems to be more correct to regard a temperamental bias as constraining the possibility of developing a particular profile than to suggest that a temperamental bias determines a certain personality trait.

The third result of interest, and one contrary to expectation, was that neither Stroop interference to fearful pictures nor magnitude of potentiated startle to a threatening incentive differentiated high from low reactive or anxious from nonanxious children. This result is also in accord with the fact that spider-phobic children did not show greater interference to spider words than normal children in a Stroop paradigm (Kindt, Bierman, & Brousschot, 1997).

The absence of a relation between Stroop interference to the fearful pictures and any
longitudinal or contemporaneous index of anxiety or fear is unlikely to be an artifact of using pictures rather than words because Stroop interference effects can occur with pictures (Walker, Ben–Tovin, Paddock, & McNamara, 1995). Moreover, interference can occur in the auditory mode. Adults are slower in naming the gender of a voice (male or female) if the male voice says the word “girl” and the female voice says the word “man,” compared with conditions in which the gender of the voice and the word are congruent (Green & Barber, 1991). The failure to confirm the expected relations for Stroop interference should motivate an examination of the validity of current assumptions regarding the meaning of this procedure. The lack of relation between potentiated startle and either high reactivity or inhibition is puzzling. On the one hand, it could be due to the loss of subjects for this procedure (46% did not have adequate data). On the other hand, this result could mean that the potentiation of the startle is not influenced by a child’s temperamental vulnerability to uncertainty.

The results of this study point to the utility of following longitudinal samples of children who vary in their behavioral and emotional profiles. It is unlikely that retrospective parental reports of the 7-year-olds that described their behavior at 4 months would have captured the categories of high and low reactivity nor led to the discovery of the relation between high reactivity at 4 months and high levels of fearfulness in the second year. There is much to be learned about the developmental course of childhood psychopathology. Hopefully, these data represent a small contribution to the more profound generalizations that future research will generate.

References


