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Prenatal Infant Stimulation Program

Chairat Panthuraamphorn, M.D.

ABSTRACT: A prenatal stimulation program designed to contribute to the quality of mother-child bonding and to enrich fetal life was created and administered to 12 pregnant women who were compared to 12 pregnant women in a control group. The program consisted of massage, breathing exercises, relaxation, visualization, sensory stimulation of the mother, and auditory, tactile, visual, and vestibular stimulation of the prenate. Head circumference 1 and 2 months after birth was significantly larger for infants in the stimulation program compared to the controls, and they tended to score better on gross and fine motor skills, personal-social development, and language skills than a representative sample of Bangkok infants.

ABOUT THIS PAPER: Bangkok obstetrician Chairat Panthuraamphorn has been an energetic and popular advocate of prenatal stimulation in Thailand, expressing his views in a parents' magazine column, radio and television interviews, and two books: Create a Better Intelligence before Birth *(7th ed., 1990) and* The Method of Enrichment for Your Unborn Child *(1993), both published in Bangkok. He is Head of the Prenatal Enrichment Unit, perhaps the only one of its kind anywhere in the world, in the Department of Obstetrics and Gynecology at Hua Chiew General Hospital.*

The outcome of his pilot study in prenatal stimulation with 12 experimental and 12 control group women and babies reprinted here (Panthuraamphorn, 1993) describes well the special emphasis in his prenatal curriculum on enrichment of the mother's environment and the large emphasis on the scope of fetal sensory experiences (rather than on word-related activities). Although small numbers are involved in this pilot study, significant differences were found, and the Denver Developmental Screening Test revealed that stimulated babies were significantly more advanced in smiling (happy babies!). A later experiment with 24 women focusing on auditory stimulation and comparing Denver Test findings with local norms (not a control group) confirmed earlier smiling, turning to voice, vocal calls, and imitation of speech sounds (Panthuraamphorn, Dookchitra & Sanmaneechai, 1995).

Our Journal also published Dr. Panthuraamphorn's excellent treatise, "How to maximize human potential at birth" (1994), which sets a new international standard for birth that is truly baby-friendly.

Editor's note: Reprinting this article from an older source discovered certain bibliographic discrepancies that could not be rectified at this late date.

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It seems to be an ongoing trend in developing as well as in industrialized countries to have fewer children, to live in a two- or even one-child family and to invest as early as possible more time, more emotion and more resources to provide the optimum health care, nutrition and sensory-cognitive stimulation for every child. This paper will consider the problem of how to maximize the potential of the newborn and the fetus with the aid of curricular stimulation. It will present a prenatal stimulation program that has been designed and applied with great success in Thailand and that can now serve as a guide to discovering new paths in pre- and neonatal care.

The First Part of the Program

It is known that during gestation brain tissue develops quite rapidly. The expectant mother should receive essential nutrition such as proteins, minerals and vitamins. These nutrients support the growth of fetal tissue, and many studies have shown a positive correlation between the quality of the mother's nutrition and the brain growth of her unborn child. The concentration of protein in fetal brain tissue will be deficient when the mother's nutrition is not adequate. Key factors affecting the quality of the unborn's life are the uterine and extauterine environments. The fetus receives all types of stimulation from various sources within and outside the womb. Throughout the second half of the pregnancy, the unborn child can hear, see, taste and move. He can also communicate with his mother and feel if she is happy or anxious. A highly anxious mother who is confronted with a lot of stress during pregnancy may get a hyperactive, irritable and anxious baby.[1,2] A relaxed mother who is expecting her baby with love and optimism supports positive bonding between the child and the family. Using prenatal stimulation we help create an adequate environment for the child in order to maximize his potential. In our program we encourage the mother to create positive feelings toward her unknown baby. With these positive emotions, endorphins will be released in the mother's limbic system which should promote the growth of the fetus and the development of his immune system. The mothers who considered their unborn children as persons early in their pregnancy are more likely to form good relationships with their children after birth and later on.[3] The fathers also influence their unborn children. Recent research has shown that fathers have a critical role in supporting the mothers in their attachment to their infants. Interac-

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tion and affiliation of both mother and father with the unborn have been shown to enhance mother-infant attachment.[5,6]

Furthermore, the quality of the mother-child interaction and the general environmental quality are the best predictors of the child's IQ, his language abilities and his emotional growth. Therefore, the focus of the first part of our prenatal infant stimulation program is:

1. to contribute to the establishment of a strong and loving bond between the unborn child and his parents.
2. to encourage positive feelings in the mother and in this way to support indirectly the emotional and intellectual growth of the unborn child. Our program consists of:

Interaction

Parents-to-be should spend time together as much as possible. The expectant mother especially needs love and care from her partner. Many studies have suggested that an early involvement of the father in pregnancy promotes father-infant attachment,[7] a bonding associated with significant emotional and cognitive advantages for the child.[8]

Massage

Tension affects the fetus in utero, producing chemical changes within his body. Abdominal massage gives the mother and the unborn pleasure and relaxation. Massage of other parts of the body can improve circulation and relieve tension. We recommend massage two to three times a week from the beginning of pregnancy until delivery.

Breathing

Exercises in breathing could be practiced for 5 minutes daily, from the first trimester until delivery.

Relaxation

During pregnancy real and imagined hazards, previous traumas, fears of ill or deformed children, personal immaturity, fears of lost beauty, etc. influence severely the physical and emotional growth of the unborn child. We provide six programs of relaxation to reduce anxiety, and we recommend mothers practice these programs for 5 minutes daily, from the first trimester until delivery.

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Visualization

Creative visualization helps to induce a state of complete mind and body relaxation. It not only reduces the fear of childbirth but also strengthens a positive view of birth, bonding and motherhood. The visualization class is conducted throughout the complete pregnancy period.

Sensory Stimulation of the Mother

We stimulate the mother's tactile, auditory, visual, gustatory, olfactory and vestibular pathways to induce the release of endorphins, which supports the physical and emotional growth of the unborn child. We suggest, for example, a sequence of bathing, sitting in a rocking chair, relaxing, looking at a beautiful picture and listening to classical Thai music.

The Second Part of the Program

The environment outside the womb may affect the fetus both positively and negatively. A pregnant woman exposed to loud noise may give birth to an irritable and restless child. On the other hand a sensory environment of familiar voices and harmonic music may contribute significantly to a better perspective for the child's physical and emotional development.

Reactions of the unborn child to external sensory stimuli can be measured through an increase in his heart rate, through changing patterns of his electromagnetic brain activity, [9,10] or through movement patterns.[11]

We have begun to set up a multisensory stimulation program consisting of stimulation of the auditory, tactile, visual and vestibular systems. This design follows from certain facts of fetal brain development. During gestation there are two phases of brain growth: hyperplasia and hypertrophy. Hyperplasia is the phase in which a number of brain cells is established. This phase begins during the 10th week of gestation and continues throughout the 18th week.[12] The second phase of brain growth, hypertrophy, refers to brain cell growth, to an increase in their weight and size. Brain growth by an increase of cell size occurs after the 18th week of gestation and continues until the postnatal age of 3 years. This period of brain growth is characterized by a high degree of plasticity, which means that environmental

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stimuli during this period might have a strong and long-lasting influence on further development. Therefore we recommend a program of sensory stimulation to be initiated as early as the 18th week and to be continued postnatally to achieve a stable enhancement of the sensory-cognitive development of the child and to promote bonding within the family.

Auditory Stimulation

Many studies demonstrate that the fetus can perceive auditory stimulation even in the first trimester of pregnancy,[10,13] and one can speculate that the nervous system would not develop normally without the perception of the sound of the mother's heartbeat or the familiar voices of the mother and father.

In a study by Murooka et al.,[14] a microphone was inserted into the pregnant uterus, and in this way all auditory stimuli within the uterine environment were recorded. The rhythmic pounding of the mother's heart was the dominant stimulus in this study, and it was shown that the newborn relaxed and calmed down when he heard the intrauterine recorded sound of the mother's heartbeat soon after birth. Other scientists did similar studies, not only of the heartbeat and its claming effects[15] but also of the discrimination of the mother's voice by the unborn child.[16]

Since the auditory pathway is responding at about the 20th week of gestation with regard to external stimuli, programs of prenatal auditory stimulation should be started at that gestational age.[17] Also, it was shown in 1984 that singing during pregnancy can promote the development of the child's intelligence.[18] Newborns who have been sung to in the womb appear calm and attentive, and they respond with high alertness to their new environment immediately after birth. Melodic voices and classical music are recommended therefore as adequate auditory stimuli; discordant noise and loud sounds like rock music should always be avoided. We began to record the voices of the mother and father when they were speaking or singing to their unborn child, and we have chosen as well natural sounds like the rhythmical sounds of the waves of the sea. This kind of prenatal auditory stimulation was applied once a day in the evening, and additionally we used a pregaphone to communicate with the unborn child. The experience I had with my second child is exemplary for our first results: I designed a prenatal tape with my wife's and my voices and played this tape daily for about 15 minutes to my unborn child, beginning in the 24th week of gestation. I found that immediately after birth our baby

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opened the eyes and responded with movements to the voices first perceived in utero. We recommend presenting prenatal auditory stimulation in the evening, when the unborn child is more alert and when other external stimuli are reduced in their intensity. Another alternative is to perform the prenatal auditory stimulation about one hour after the mother's meal when higher levels of glucose make the unborn more active. The prenatal tape should be played daily for about 20–30 minutes from the 20th week until birth. Beginning in the 28th week of gestation we completed the auditory stimulation with a communicative bell game: during a given stimulation we used a bell always when the child moved. In this way, the response of the child could be reinforced.[19,20]

Tactile Stimulation

Within the womb a gentle swirling action of the amniotic fluid occurs, providing some more stimulation for the child's sense of touch. When the mother turns, sits, walks or bends, the amniotic sack moves with her body, and tactile stimulation occurs when the fetus comes into contact with the uterine wall. In our program for prenatal tactile stimulation, we massage the mother's abdomen to stimulate the somatosensory system of the fetus. Touch has been shown to be the key element in introducing emotional security. It seems to be essential for the enhancement of positive bonding between the child and his parents. A gentle touch from the mother is also an excellent way to increase the child's endorphin level and beneficial for the strengthening of the immune system.[21–24]

In the Prenatal University Program of Rene and Kristin Van de Carr, a combined auditory and tactile prenatal stimulation has been applied with great success.[25,26] The children who took part in this program opened their eyes during birth, moved their heads and always tried to focus their eyes towards the mother and father soon after birth. They were happy to listen to music, showed a high degree of alertness, smiled early and always had a high apgar score. In our Prenatal Infant Stimulation Program we have used several types of tactile stimulation:

Effleurage

This is a light fingertip massage applied in a circular motion from the head to the bottom of the fetus. During effleurage, music and the mother's voice should be added. We recommend this practice 5–10 minutes daily in the evening from the 24th week until birth.

Kick game

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This is a game invented by the Van de Carrs.[25,26] It involves patting the abdomen when the fetus moves, and it is very similar to our bell game. Both games can be used from the 28th week of gestation until birth to induce some kinds of conditioned learning.

Rhythmic patting and singing

This involves gently, rhythmically patting the bottom of the child while singing in a traditional Thai style. We recommend practicing it 5–10 minutes daily in the evening from the 24th week of gestation until birth.

Warm and cold water treatment

The temperature outside the womb is lower than in utero. The baby needs to adjust his body temperature immediately following birth. For an adequate prenatal stimulation, we place warm and cold water bottles on the mother's abdomen near the back of the fetus so that he can perceive external differences in temperature and learn to adjust his body's temperature after birth. We recommend a half-minute treatment daily from the 24th week until birth.

Water massage

For another stimulation of the vestibular and somatosensory system we spray water from a shower nozzle on the mother's abdomen, a stimulation that induces a soft vibration for the unborn child, to be applied from the 24th week until birth.

Visual Stimulation

Towards the end of pregnancy the uterine and abdominal walls stretch and allow light to pass through. Therefore the fetus can be exposed to more intense light than daylight, and this may not only stimulate his visual system but also contribute to the reinforcement of his day-and-night cycle, so that he can fall asleep at night and wake up in daytime. One of our mothers who attended the prenatal stimulation class told us that she, during a longer period, had to wake up daily at 2:00 a.m. in order to work and pursue her research. After delivery she found that her son automatically woke up at 2:00 a.m., suggesting once more that external visual stimuli can influence pre- and postnatal behavior. A study from Tel-Aviv University[27] demonstrated that the fetal heart rate jumped immediately after the onset of a flashing light, and that the heart rate change occurred in accordance with the flashing light stimulation. Flashing a light is one of the visual stimulations applied in a prenatal stimulation program. The fetal brain first responds to external visual stimuli after the 27th week of gestation, and the eyes cannot maintain gaze on patterned

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stimuli before the 39th week. Since the fetus will always move towards the light stimulus, as seen with the ultrasonogram, prenatal visual stimulation enhances not only visual but also motor behavior.

As a suitable prenatal visual stimulation, we recommend moving a light source slowly left to right, up and down on the mother's abdominal surface. We started with this kind of stimulation in the 30th week of gestation and used white, green and red light in order to activate the immature sense for spectral differences as well.

Vestibular Stimulation

As the mother moves, she moves her unborn child and provides a very natural stimulation of the child's somatosensory and vestibular system. Studies on the effect of a vestibular stimulation in preterm babies have shown an enhancement of motor movements, visual orientation, and feeding and sleeping behavior.[28,29]

We recommend a program of prenatal vestibular stimulation that should be practiced by the mother in a rocking chair where she can move very harmoniously up and down and from left to right. These harmonic rocking movements soothe the child and promote motor and cognitive development in general.[30]

Outline of the Prenatal Infant Stimulation Program

The two parts of our Prenatal Infant Stimulation Program are described in the following tables.

Methods and Results

In order to test our Prenatal Infant Stimulation Program, 24 pregnant women were selected in the Bangkok area, and 12 of them took part in the program. The other 12 formed the control group. Before practicing the program, a questionnaire was provided to both groups to evaluate family relationships, the maternal character, economic and educational status, etc. Both groups were selected from a homogeneous population, as their scores with regard to age, education, economic status, gravidity (G), parity (P), type of delivery, apgar score, and status of amniotic fluid show in Table 3.

Both the experimental and the control groups received routine obstetric care, and the experimental group participated in the two parts of our program, starting in the 12th week g.a. with Part One and in

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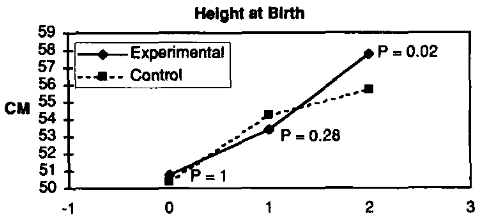
Figure 1

Significant Height Difference (p = 0.02) at 2 Months after Birth



the 20th week g.a. with Part Two. The experimental group was trained to practice the program in a 2-hour class, 4 times every month.

After finishing both parts of the program, every woman had to answer another questionnaire in order to check how often and how long they practiced. The effect of our program on growth and development of the children not only depends on the duration and procedure of prenatal stimulation but also on the maternal factors, the obstetric factors, medical complications and birth injuries. In our study we had no birth injuries or other medical complications in either group. Every woman had good family relationships. There was no serious anxiety during pregnancy, and the dosage of sedation used during labor was similar for both groups. No differences were found with regard to age, education, economic status, gravidity, parity, type of delivery or status of the amniotic fluid.

In Table 4, both groups are described with regard to maternal and obstetric factors. No significant differences could be determined.

In Table 5 and Figure 1, the height of the children at birth and 1 and 2 months after birth is evaluated. It is shown that both groups did not differ in height at birth or 1 month later. However, there was a significant difference (p = 0.02) 2 months after birth.

The weights of the experimental children measured at birth, 1 and 2 months after birth were 3130.8 g, 4339.2 g, and 5289.2 g respectively compared to 3080.0 g, 4185.8 g, and 5091.7 g for the control group. Although the weights seem to be heavier in the experimental group, this difference was not evaluated as statistically significant (p > 0.267).

The analysis of the head circumference showed no significant dif-

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Table 1
First Part: Create a Positive Feeling in the Mother and Father

Item	*Purpose*	*Practice*	*Time*
1. Interaction	stimulate the release of endorphin enhance father–mother bonding	spend time together as much as possible	prenatal period
2. Massage	give pleasure and relaxation enhance bonding release endorphin improve circulation prevent leg cramps relieve tension	massage step by step all parts of body	30 minutes 2–3 times a week from first trimester until birth
3. Breathing	help to relax oxygen metabolizes waste products oxygenation promotes fetal growth and intelligence	breathing exercises	5 minutes a day from first trimester until birth
4. Relaxation	diminish anxiety and stress alleviate aches and pains relieve tension	relaxation program	5 minutes a day from first trimester until birth

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Table 1
Continued

Item	*Purpose*	*Practice*	*Time*
5. Visualization	reduce fear of childbirth help to relax release endorphin enhance prenatal bonding	visualization class	5 minutes a day from first trimester until birth
6. Stimulate mother's 6 senses in a positive way	release endorphin to promote fetus's physical and emotional growth	looking at beautiful picture listening to a classical Thai song	5–10 minutes a day from first trimester until birth

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Table 2
Second Part: Create a Positive External Environment

Item	*Purpose*	*Practice*	*Time*
1. Prenatal auditory stimulation			
• Prenatal tape	stimulate auditory brain cells and pathway stimulate fetus's brain size and ultimate intelligence increase density of dendrites in auditory nerve pathway aid language development enhance fetus's physical and social growth musical expression of special love feelings and bonding improve mother–child attachment create positive emotion toward fetus release endorphin	mother's voice Thai traditional folk song	natural sounds (ocean, birds) played 15 minutes once a day in the evening. Begin at 20th week g.a.
• Mother's voice	as above	talk to fetus through pregaphone	occasionally begin at 20th week g.a.

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Table 2
Continued

Item	*Purpose*	*Practice*	*Time*
• Musical note	as above	record musical note in prenatal tape use xylophone	begin at 24th week g.a.
• Bell game	learn to respond to outside auditory stimuli	promote intelligence and emotional growth ring the bell when fetus moves	occasionally begin at 28th week g.a.
2. Prenatal tactile stimulation			
• Effleurage associated with mother's voice	release endorphin to promote fetal growth and development diminish aggressive behavior produce emotional security and calming effect reinforce positive emotional bonding in parent and child stimulate sensory brain cells and neural pathways increase density of dendrites in sensory neural pathway	light fingertip massage, circular from fetus's head to bottom	5 minutes a day in the evening, beginning at 20th week g.a.

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Table 2
Continued

Item	*Purpose*	*Practice*	*Time*
• Kick game	learn to respond to outside tactile stimuli improve intelligence and emotional growth	pat abdomen when fetus moves	occasionally begin at 28th week g.a.
• Rhythmic patting associated with singing voice	create calming effect in fetus diminish aggressive behavior give a positive emotional bonding stimulate sense of touch	gently pat fetus's bottom rhythmically, give a sing-song voice in a Thai traditional style	5 minutes a day in the evening beginning at the 28th week g.a.
• Cold–warm water	learn temperature differences and adjustment	place a warm and cold bottle on the mother's abdomen in the direction of fetus's back	one-half minute each, beginning at 24th week g.a.
• Water play	stimulate fetus's sense of touch and vestibular function	direct water from shower to abdomen during bath	begin at 28th week g.a.

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Table 2
Continued

Item	*Purpose*	*Practice*	*Time*
3. Prenatal visual stimulation			
• Search light	stimulate visual brain cells and visual pathway increase density of dendrites enhance fetus's physical growth and motor development	place a bright light on the lower part of abdomen in the direction of fetus's eyes	turn on and off 2 minutes a day in the evening, beginning at 28th week g.a.
• Green and red light	learn the difference in intensity of light	turn off and move	begin at 30th week g.a.
4. Prenatal vestibular stimulation			
• Rocking chair	stimulate vestibular neural pathway improve motor development and balance give a calming effect to fetus promote emotional growth and intelligence	sit on rocking chair, move forwards and backwards, left and right	10 minutes a day in the evening, beginning at 20th week g.a.

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Table 3
Sample Characteristics

Mother	*Age*	*Education**	*Economic status***	*G*	*P*	*Type of delivery†*	*Apgar score*	*Amniotic fluid††*
Experimental								
1	27	2	1	1	1	3	9 10	3
2	24	1	1	1	1	1	9 10	1
3	24	1	1	1	1	1	9 10	1
4	26	2	1	0	0	3	9 10	1
5	27	2	2	0	0	1	9 10	1
6	27	2	1	0	0	1	9 10	1
7	27	2	1	0	0	1	9 10	1
8	25	2	1	1	1	3	9 10	1
9	30	3	2	1	1	1	9 10	1
10	34	3	1	0	0	2	9 10	1
11	26	3	2	2	2	1	8 10	1
12	31	1	1	1	1	1	9 10	1

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Table 3
Continued

Mother	*Age*	*Education**	*Economic status***	*G*	*P*	*Type of delivery†*	*Apgar score*	*Amniotic fluid††*
Control								
1	29	1	2	0	0	2	8 10	1
2	32	2	1	0	0	3	7 9	1
3	30	1	1	1	0	3	8 10	2
4	30	3	2	2	2	1	9 10	1
5	29	3	1	0	0	3	9 10	2
6	32	1	1	0	0	1	9 10	1
7	32	1	2	1	1	1	8 10	2
8	22	1	1	0	0	1	9 10	1
9	24	2	1	0	0	1	9 10	1
10	31	2	1	1	1	1	9 10	1
11	25	1	1	1	1	1	9 10	1
12	27	2	1	0	0	1	9 10	1

*1 = university, 2 = diploma, 3 = high school.
**1 = >20,000B, 2 = 10,000–20,000B, 3 = 5,000–10,000B.
†1 = NL, 2 = V/E, F/E, 3 = C-sec.
††1 = clear, 2 = mild meconium, 3 = moderate meconium, 4 = thick meconium.

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Table 4
Maternal Character and Obstetric Factors

	Experimental (N = 12) mean ± SD	*Control (N = 12) mean ± SD*	*t*	*p*
Maternal age	27.3 ± 3.0	28.6 ± 3.4	0.96	0.34 (NS)
Education	2.0 ± 0.7	1.7 ± 0.8	1.08	0.29 (NS)
Economic status	1.3 ± 0.5	1.3 ± 0.5	0.00	1.00 (NS)
Gravid	0.7 ± 0.7	0.5 ± 0.7	0.61	0.50 (NS)
Parity	0.7 ± 0.7	0.4 ± 0.7	0.93	0.36 (NS)
Type of delivery	1.6 ± 0.9	1.6 ± 0.9	0.00	1.00 (NS)
Amniotic fluid	1.2 ± 0.6	1.3 ± 0.5	0.39	0.70 (NS)

Table 5
Height Measured at Birth, 1 and 2 Months after Birth

	Experimental (N = 12) mean ± SD	*Control (N = 12) mean ± SD*	*t*	*p*
Height at birth	50.8 ± 1.8	50.4 ± 1.7	0.0	1.00 (NS)
1st month	53.4 ± 1.2	54.2 ± 1.9	1.1	0.28 (NS)
2nd month	57.8 ± 1.7	55.7 ± 2.2	2.6	0.02 (S)

Table 6
Head Circumference Measured at Birth, 1 and 2 Months

Head circumference in cm	*Experimental (N = 12) mean ± SD*	*Control (N = 12) mean ± SD*	*t*	*p*
At birth	34.5 ± 1.1	33.9 ± 1.0	1.46	0.158 (NS)
1 month	37.0 ± 0.8	35.8 ± 1.2	2.93	0.008 (S)
2 months	38.7 ± 0.7	37.5 ± 1.2	2.91	0.008 (S)

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Table 7
Evaluation of Developmental Status, Denver Developmental Screening Test Items—Personal-Social Sector

	Experimental (N = 12) No. pass / No. test	*Control (N = 12) No. pass / No. test*	χ^2	*p*
Regards face				
Birth	12/12	12/12	—	—
Smiles responsively				
Birth	10/12	2/12	8.17	<0.001
Smiles spontaneously				
Birth	6/12	3/12	0.71	0.48
1 month	12/12	5/11	6.25	<0.001

Table 8
Evaluation of Developmental Status, Denver Developmental Screening Test Items—Language Sector

	Experimental (N = 12) No. pass / No. test	*Control (N = 12) No. pass / No. test*	χ^2	*p*
Responds to bell				
Birth	12/12	10/12	0.54	0.59
Laughs				
Birth	6/12	1/12	3.20	0.004
Squeals				
1 month	10/12	2/11	7.30	<0.001
Turns to voice				
Birth	4/12	0/12	2.70	0.01
1 month	9/12	0/12	11.3	<0.001

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Figure 2

Significant Differences in Head Circumference at 1 and 2 Months after Birth

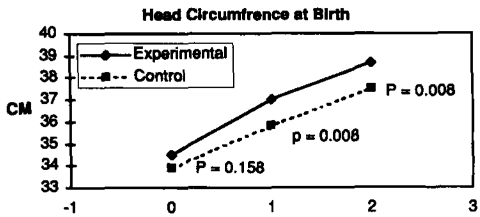

Table 9

Evaluation of Developmental Status, Denver Developmental Screening Test Items—Fine Motor Sector

	Experimental (N = 12) No. pass / No. test	*Control (N = 12) No. pass / No. test*	χ^2	*p*
Follows to midline				
Birth	9/12	5/12	1.54	0.14
Equals movement				
Birth	12/12	12/12	—	—
Follow post midline				
Birth	6/12	1/12	3.20	0.004
1 month	12/12	6/11	4.60	<0.001
Grasps rattle				
1 month	2/10	0/12	0.77	0.45
Regards rattle				
1 month	6/10	1/11	4.03	<0.001
Follows 180				
1 month	11/12	1/11	12.54	<0.001
Hands together				
1 month	8/12	2/11	3.69	0.001

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Table 10
Evaluation of Developmental Status, Denver Developmental Screening Test Items—Gross Motor Sector

	Experimental (N = 12) No. pass / No. test	*Control (N = 12) No. pass / No. test*	χ^2	*p*
Lifts head				
Birth	12/12	9/12	1.52	0.14
Head up 45				
Birth	9/12	0/12	11.37	<0.001
Head up 90				
1 month	11/12	0/11	15.8	<0.001
Chest up arm support				
1 month	9/12	0/11	10.5	<0.001
3 months	12/12	6/9	2.3	0.03
Sits head steady				
1 month	11/12	0/11	15.8	<0.001
Rolls over				
1 month	4/12	0/11	2.4	0.02
3 months	9/9	2/9	8.4	<0.001
Bears some weight on legs				
3 months	9/9	5/9	2.9	0.01
Pulls to sit, no head lag				
1 month	6/12	0/11	5.0	<0.001
3 months	8/9	2/9	5.6	<0.001

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Table 11
PROBIT Analysis of Developmental Status of Experimental and Control Groups and Sample Norms of Bangkok Children

	25%			50%			75%			90%		
	B	*Ex*	*C*	*B*	*Ex*	*C*	*B*	*Ex*	*C*	*B*	*Ex*	*C*
Personal-Social												
RF	—	0.9	1.2	3	1.6	1.9	12	2.8	3.0	54	4.7	4.5
RR	12	0.9	4.5	27	0.4	9.7	57	1.8	21.1	126	7.1	42.5
SS	30	1.9	6.5	54	4.2	27.0	99	9.0	112.0	168	18.0	401.0
Language												
RTB	3	0.9	1.2	6	1.6	2.2	30	2.8	4.4	102	4.7	7.9
L	39	1.9	9.5	63	3.8	15.8	141	7.3	26.1	255	13.3	41.1
S	39	6.4	40.0	75	15.9	54.0	144	39.6	74.0	255	89.6	97.0
TTV	57	3.8	83.0	96	11.6	88.0	165	34.9	93.0	267	94.2	98.9
Fine motor												
FTM	3	0.16	1.8	12	0.7	4.0	36	3.1	8.9	99	11.5	18.5
EM	—	0.9	1.3	—	1.6	2.0	—	2.8	3.0	—	4.7	4.5
FPM	24	0.8	11.2	45	2.6	21.6	75	8.4	41.7	150	23.9	75.3
GR	66	45.0	91.0	108	67.0	93.0	174	100.0	96.0	270	144	98.5
RR	60	23.0	43.4	96	30.0	57.8	159	39.0	77.0	246	49	99.7
F180	36	7.4	44.2	63	13.0	59.2	111	22.0	79.4	177	37	103.3
HT	51	12.0	40.6	78	20.0	54.8	153	33.0	74.0	159	51	97.0

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Table 11
Continued

	25%			50%			75%			90%		
	B	*Ex*	*C*	*B*	*Ex*	*C*	*B*	*Ex*	*C*	*B*	*Ex*	*C*
Gross motor												
LH	18	0.9	1.2	27	1.6	2.4	4.2	2.8	4.9	60	4.7	9.4
HU45	27	0.8	15.6	45	0.4	26.5	75	2.5	44.9	117	12.1	72.0
HU90	48	8.3	74.0	69	14.1	78.0	99	24.0	83.0	138	38.7	88.0
CUAS	75	16.3	90.0	86	23.5	93.0	123	33.9	96.0	156	47.2	99.0
SHS	60	6.2	85.0	93	10.5	88.0	150	17.8	92.0	228	28.6	95.0
RO	78	29.0	103.0	99	37.4	305.0	126	48.0	897.0	156	60.5	2371
BSWOL	111	33.4	84.0	150	35.8	91.0	192	38.4	99.0	255	40.9	106.0
PTSNHL	108	6.0	94.0	147	18.8	98.0	201	58.7	103.0	177	163.4	107.0

Age in days when given percentage of population passes items (sample norms of Bangkok children).
B = Bangkok sample norm.
Ex = Experimental group.
C = Control group.

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ferences between the experimental and control groups immediately after birth. However, the difference proved to be highly significant ($p = 0.008$) 1 month and 2 months after birth! The data are depicted in Table 6 and Figure 2.

The evaluation of apgar scores showed no significant differences between the experimental and control groups.

We then proceeded to evaluate the developmental status of the children in both groups. We differentiated four sectors of early child development using items from the Denver Developmental Screening Test, as follows (the abbreviations in parentheses refer to the ones used to display the data in the following tables):

1. Personal-social sector
   regards face (RF)
   smiles responsively (SR)
   smiles spontaneously (SS)
2. Language sector
   responds to bell (RTB)
   laughs (L)
   squeals (S)
   turns to voice (TTV)
3. Fine motor sector
   follows to midline (FTM)
   equals movement (EM)
   follows past midline (FPM)
   grasps rattle (GR)
   regards rattle (RR)
   follows 180 degrees (F180)
   hands together (HT)
4. Gross motor sector
   lifts head (LH)
   head up 45 degrees (HU 45)
   head up 90 degrees (HU 90)
   chest up, arm support (CUAS)
   sits, head steady (SHS)
   rolls over (RO)
   bears some weight on legs (BSWOL)
   pulls to sit, no head lag (PTSNHL)

Our results with regard to the developmental status of the children using the Denver Developmental Screening Test items are shown in tables 7, 8, 9 and 10.

In order to demonstrate the highly significant differences between

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both groups regarding developmental status as evaluated above, we converted the number of passes on all developmental sectors to the ages in which the children pass items (PROBIT analysis). Children in both groups are compared to sample norms of Bangkok children (B). These results are shown in Table 11.

Conclusion

A program of parent-fetal attachment like our Prenatal Infant Stimulation Program can enhance the physical, cognitive, emotional and social development of our children. And it can be shown to be effective especially with regard to developmental variables like height and head circumference; fine and gross motor performance; and speech and language acquisition.

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