

### APPENDIX 3

## MOVEMENT AND LEARNING PATTERNS OF THE UNBORN CHILD AND THE DEVELOPMENT OF THE SENSES

### ARM MOVEMENTS

Isolated arm movements first occur.	About 7 <sub>-</sub> to 8 <sub>-</sub> weeks after conception	de Vries (1982), p 311
Stretching an arm is frequently accompanied by extending the fingers.	From 10 <sup>th</sup> week after conception	de Vries (1982), p 307

### BREATHING MOVEMENTS

First seen.	8 <sup>th</sup> week after conception	Roodenburg, p 32
A single, large displacement of the diaphragm is sometimes similar to a sigh.	8 <sup>th</sup> week after conception	Nijhuis/de Vries, p 6
First seen.	8-9 <sub>-</sub> weeks after conception	Nijhuis/de Vries, p 5
Observed in 10 of 12 fetuses studied, with a median frequency of about 30 breathing movements per hour.	9 <sup>th</sup> week after conception	de Vries (1985), p 106
Observed in 12 of 12 fetuses studied, with a median frequency of about 60 breathing movements per hour.	11 <sup>th</sup> week after conception	de Vries (1985), p 106
The median breathing movement rate was 208 per hour in 12 fetuses studied.	17 <sup>th</sup> week after conception	de Vries (1985), p 105
The rate of breathing movements was much higher during the second hour after the mother's breakfast or lunch than during the third hour.	20 <sup>th</sup> – 22 <sup>nd</sup> weeks after conception	de Vries (1987), p 337
Breathing movements occurred most often right after the mother's meal at noon.	20 <sup>th</sup> – 22 <sup>nd</sup> weeks after conception	de Vries (1987), p 337

The frequency of breathing movements changes during the day. In a study of 10 fetuses, such movements increased from a median of 2% of the observation time in the morning to 13% in the afternoon, and then fell to 11% in the evening.	20 <sup>th</sup> – 22 <sup>nd</sup> weeks after conception	de Vries (1987), p 337
--	--	------------------------

A significant increase in fetal breathing occurred after giving glucose to the mother.	22 <sup>nd</sup> week after conception	Nijhuis/Visser, p 19
--	--	----------------------

**EMBRYOSCOPY**

Embryoscopy can directly visualize the embryo/fetus during the first trimester, paving the way to improved early prenatal diagnosis and treatment. Utilizing high-resolution fiberoptic endoscopy, testing can be done as early as 3 weeks after conception. The face can be visualized as early as 4 weeks. Numerous diagnoses have already been done but these just scratch the surface of the technology's potential.	3 <sup>rd</sup> – 4 <sup>th</sup> weeks after conception	Reece, pages p 775, 777, & 778
--	--	--------------------------------

**EYE MOVEMENTS**

Slow eye movements first occur.	14 <sup>th</sup> week after conception	Nijhuis/de Vries, p 5; Birnholz, p 679
---------------------------------	--	--

First seen.	About 14 <sup>th</sup> week conception	Inoue, p 172
-------------	--	--------------

First seen.	14 <sup>th</sup> – 16 <sup>th</sup> weeks after conception	Roodenburg, p 33
-------------	--	------------------

In 9 fetuses studied, the median number of eye movements at 18 weeks after conception were 25 per hour, increasing to 101 per hour at 34 weeks.	18 <sup>th</sup> - 34 <sup>th</sup> weeks after conception	Roodenburg, p 28
---	--	------------------

Rapid eye movements first occur.	21 <sup>st</sup> week after conception	Nijhuis/de Vries, p 5; Birnholz, p 679
----------------------------------	--	--

## **FINGER MOVEMENTS**

First occur.	10 <sup>th</sup> week after conception	Nijhuis/de Vries, p 5
Opening and closing one or more fingers can be seen.	10 <sup>th</sup> week after conception	Nijhuis/de Vries, p 6

## **GENERAL MOVEMENTS**

First occur.	6 <sup>th</sup> – 7 <sup>th</sup> weeks after conception	Roodenburg, p 31
First occur.	6 _ - 7 _ weeks after conception	Nijhuis/de Vries, p 5
In nine fetuses studied, there were a median of 57 general movements per hour, which were present during 24% of the observation time.	18 <sup>th</sup> week after conception	Roodenburg, p 23

## **HAND-TO-FACE CONTACTS**

Insertion of the fingers into the mouth has been observed.	8 <sup>th</sup> week after conception.	Nijhuis/de Vries, p 7
First occur.	8-10 _ weeks after conception	Nijhuis/de Vries, p 5
The hand touches the face slowly and the fingers often open and close.	8-10 _ weeks after conception	de Vries (1982), p 309 & p 311
Observed in 12 of 12 fetuses studied, with a median frequency of about 25 contacts per hour.	10 <sup>th</sup> week after conception	de Vries (1985), p 113
In a study of 9 fetuses, the median number of hand-to-face contacts was 95 per hour.	18 <sup>th</sup> week after conception	Roodenburg, p 33

## **HEAD MOVEMENTS (BACKWARD)**

First occur.	7 _ - 10 _ weeks after conception	Nijhuis/de Vries, p 5
--------------	-----------------------------------	-----------------------

## HEAD MOVEMENTS (FORWARD)

First occur.	8 _ - 12 _ weeks after conception	Nijhuis/de Vries, p 5
--------------	--------------------------------------	--------------------------

## HEAD ROTATIONS

First occur.	7 _ - 10 _ weeks after conception	Nijhuis/de Vries, p 5
--------------	--------------------------------------	--------------------------

Observed in 12 of 12 fetuses studied, with a median rate of about 5 head rotations per hour.	11 <sup>th</sup> week after conception	de Vries (1985), p 113
--	---	---------------------------

In a study of 9 fetuses, the median number of head rotations was 63 per hour.	18 <sup>th</sup> week after conception	Roodenburg, p 33
---	---	---------------------

## HEARING

“For at the moment the sound of your greeting reached my ears, the infant in my womb leaped for joy”.	Before birth	Luke 1: 44
---	--------------	------------

The fetus responds to sound.	10 <sup>th</sup> – 14 <sup>th</sup> weeks after conception	Nijhuis/Hep- per, p 133
------------------------------	---	----------------------------

“Blink-startle” responses to vibroacoustic stimulation have been observed.	22 <sup>nd</sup> & 23 <sup>rd</sup> weeks after conception	Birnholtz & Benacerraf, p 516
--	---	-------------------------------------

The fetus apparently hears some sounds <u>in utero</u> .	22 <sup>nd</sup> – 24 <sup>th</sup> weeks after fertilization	Williams, p 169
--	--	--------------------

Changes in fetal heart rate, eye blinks, and movements have occurred in response to sounds.	Not available	Nijhuis/Hep- per, p 137
---	---------------	----------------------------

Evidence is growing that the fetus can hear voices in the womb.	Not available	Fifer & Moon, p 430
---	---------------	------------------------

## HEART RATE

The heart is contracting at a rate of 40 to 80 beats per minute, as measured with an electrocardiogram.	6 <sup>th</sup> – 7 <sup>th</sup> weeks after conception	Rugh, p 53
---	---	------------

The fetal heart rate decreases overnight.	20 <sup>th</sup> – 22 <sup>nd</sup> weeks after conception	de Vries (1987), p 341
The daily pattern of changes in the fetal heart rate follows the changes in the maternal heart rate.	20 <sup>th</sup> -22 <sup>nd</sup> weeks after conception	de Vries (1987), p 345 & p 346

## HICCUPS

First occur.	6 <sup>th</sup> week after conception	Roodenburg, p 32
First occur.	6 _ - 8 _ weeks after conception	Nijhuis/de Vries, p 5
Observed in 12 of 12 fetuses studied, with a median frequency of about 50 hiccups per hour.	8 <sup>th</sup> week after conception	de Vries (1985), p 108
The frequency of hiccupping changes during the day. In a study of 10 fetuses, the median number of hiccups during 8 AM to 10 AM was 28 per hour, decreasing to 12 per hour during 1 PM to 3 PM.	20 <sup>th</sup> – 22 <sup>nd</sup> weeks after conception	de Vries (1987), p 338

## HUMAN LIFE

Includes the period from conception to birth.	From conception to birth	Nijhuis, p xix
---	--------------------------	----------------

## JAW OPENINGS

Jaw openings first occur.	8 _ - 10 _ weeks after conception	Nijhuis/de Vries, p 5
Jaw openings were observed in 10 of 12 fetuses studied with a median rate of about 18 per hour.	10 <sup>th</sup> week after conception	de Vries (1985), p 114
Jaw openings were observed in 12 of 12 fetuses studied with a median rate of about 30 per hour.	12 <sup>th</sup> week after conception	de Vries (1985), p 114

<p>Jaw movements include isolated jaw movements, sucking, swallowing, yawning, and tongue movements. In 9 fetuses studied, the median frequency of any kind of jaw movements was 142 per hour.</p>	<p>18<sup>th</sup> week after conception</p>	<p>Roodenburg, p 28 &amp; p 29</p>
--	--	------------------------------------

<p>The frequency of jaw openings changes during day. In a study of 10 fetuses, the median rate was 51 per hour during 8 AM to 10 AM, increasing to 97 per hour during 1 PM to 3 PM.</p>	<p>20<sup>th</sup> – 22<sup>nd</sup> weeks after conception</p>	<p>de Vries (1987), p 338</p>
---	---	-------------------------------

## LEARNING

<p>Newborns stopped crying and responded to songs played on shows that their mother watched while they were pregnant.</p>	<p>Immediately after birth</p>	<p>Nijhuis/Hep- per, p 144</p>
---	--------------------------------	------------------------------------

<p>Newborns prefer the sound of their mother's voice when it is adjusted to resemble what was heard in the womb.</p>	<p>Immediately after birth</p>	<p>Nijhuis/Hep- per, p 138</p>
--	--------------------------------	------------------------------------

<p>Newborns learned to change their pattern of sucking in order to hear their mother's voice instead of that of another woman. The preference appears to have been acquired before their birth.</p>	<p>Immediately after birth</p>	<p>Nijhuis/Hep- per, p 143;  DeCasper &amp; Fifer, p 1174; Fifer and Moon, p 430 &amp; 432</p>
---	--------------------------------	--

<p>Newborns changed their sucking pattern in order to hear a story that had been read to them before birth instead of an unfamiliar story.</p>	<p>Immediately after birth</p>	<p>Nijhuis/Hep- per, p 143</p>
--	--------------------------------	------------------------------------

<p>Mothers who kept the same diet before and after they gave birth were more successful in breast-feeding than mothers who changed to a less spicy diet. This may reflect the child's preference for food she ate while she was pregnant because the mother's milk contains clues about her diet.</p>	<p>Immediately after birth</p>	<p>Nijhuis/Hep- per, p 146</p>
---	--------------------------------	------------------------------------

## LEG MOVEMENTS

Isolated leg movements first occur.	About 7 _ - 10 _ weeks after conception	de Vries (1982), p 311
-------------------------------------	---	---------------------------

## MOVEMENTS

The technology of real-time ultrasonography can be used to detect movements such as breathing, cardiac contractions, and pulsations of the vessels.	Before birth	Williams, p 1023
---	--------------	---------------------

All fetal movements ever observed by the author are similar to those seen after birth and are easily recognizable to persons familiar with movements made by preterm and full-term infants. The pattern of yawns and stretches seen in the first trimester remains the same throughout life.	Before birth	Nijhuis/Pre- chtl, p 65 & p 66
--	--------------	--------------------------------------

Fetal movement patterns are coordinated from the start and are similar to those after birth.	Before birth	de Vries (1985), p 100
--	--------------	---------------------------

Heart activity can be measured with transvaginal ultrasonic scanning.	4 <sup>th</sup> week after fertilization	Williams, p 1027
---	---	---------------------

Spontaneous movements, such as twitching of the trunk and limbs, have been reported.	6 <sup>th</sup> week after fertilization	Moore, p 94
--	---	-------------

The earliest reflexes begin.	Day 42 after conception	Rugh, p 47
------------------------------	----------------------------	------------

The fetus normally moves spontaneously.	6 <sup>th</sup> -8 <sup>th</sup> weeks after conception	de Vries (1982), p 318
---	--	---------------------------

Neck and trunk muscles start contracting spontaneously.	7 <sup>th</sup> week after fertilization	England, p 206
---	---	-------------------

Purposeful limb movements first occur.	8 <sup>th</sup> week after fertilization	Moore, p 97
--	---	-------------

Limb movements first occur during the 8 <sup>th</sup> week. By the 14 <sup>th</sup> week, they become coordinated.	8 <sup>th</sup> -14 <sup>th</sup> weeks after fertilization	Moore, p 112
--	--	--------------

If the fetus is removed from the uterus, spontaneous movements may be observed. The most common movement patterns have emerged.	8 <sup>th</sup> week after fertilization 10 <sup>th</sup> week after conception	Williams, p 169 de Vries (1988), p 87
If the region near the mouth is stimulated, the fetus will open its mouth and suck a finger.	11 <sup>th</sup> week after fertilization	England, p 206
Reflex activity can be evoked in aborted fetuses, indicating muscular activity.	End of 3 <sup>rd</sup> month after fertilization	Sadler, p 114
Movements begin, but are usually not felt by the mother.	12 <sup>th</sup> week after fertilization	Sadler, p 116
The fetus responds to stimulation of the skin.	12 <sup>th</sup> week after fertilization	England, p 206
Stroking the lips causes the fetus to suck and stroking the eyelids results in a reflex response.	End of 12 <sup>th</sup> week after fertilization	Moore, 4 <sup>th</sup> edition, p 91
Slow eye movements occur.	14 <sup>th</sup> week after fertilization	Moore, p 112
The first day that movement is noticed by the pregnant woman is called “quickening”.	14 <sup>th</sup> – 18 <sup>th</sup> weeks after fertilization	Williams, p 23
In a study of 10 fetuses, the majority of movements occurred more frequently in the afternoon and evening than in the morning.	20 <sup>th</sup> – 22 <sup>nd</sup> weeks after conception	de Vries (1987), p 337
Signs of life (i.e. quickening) are felt by the mother.	18 <sup>th</sup> week after fertilization	Moore, p 109
Movement is usually recognized by the mother.	During the 5 <sup>th</sup> month after fertilization	Sadler, p 114
Rapid eye movements begin.	21 <sup>st</sup> week after fertilization	Moore, p 114
<b>QUIESCENCE</b>		
In a study of 12 fetuses, the longest median period of inactivity was 260 seconds.	6 <sup>th</sup> week after conception	de Vries (1985), p 102

## **PAIN**

The fetal heart rate increases in response to scalp blood sampling and after tactile stimulation during amniocentesis, indicating that the fetus responds to stimuli that may be painful.

Before birth

Nijhuis/Hep-  
per, p 135

The sudden burst of body movements that occurred during amniocentesis may have been caused by painful stimulation. In each patient, the needle either struck the fetus or the fetus moved against the needle.

3<sup>rd</sup> trimester

Hill, p 690

Pain pathways run from sensory receptors in the skin to those in the brain. Nerve endings that sense pain are at least as dense in the skin of a newborn as in an adult. Such receptors appear around the mouth in the 5<sup>th</sup> week after conception, and are present in the face, the palms, and the soles of the feet by the 9<sup>th</sup> week, spreading to the trunk, arms, and legs by the 13<sup>th</sup> week, and to all areas of the skin by the 18<sup>th</sup> week. The development of the neocortex, the largest part of the brain, begins at 6 weeks after conception, and by 18 weeks a full complement of nerve cells is present. The evidence thus suggests that by late in gestation the fetus has developed sufficiently to sense pain.

from 5<sup>th</sup> week  
after conception

Anand and  
Hickey,  
p 1322  
& p 1326

## **SMELL**

The olfactory lobe, which is related to the sense of smell, is present in the brain.

Day 35 after  
conception

Rugh, p 44

The foundation of the sense of smell is established when nerve fibers connect with the olfactory lobe in the brain.

Day 39 after  
conception

Rugh, p 47

## **SOMERSAULTS**

The fetus can accomplish a complete change in position, usually with a backwards somersault.

By 13<sup>th</sup> week  
after conception

de Vries  
(1982),  
p 301 & p 309

## **SQUINTING**

Local stimuli may evoke squinting.	8 <sup>th</sup> week after fertilization	Williams, p 169
------------------------------------	--	-----------------

## **STARTLES**

First occur.	6 – 7 _ weeks after conception	Nijhuis/de Vries, p 5
--------------	--------------------------------	-----------------------

First occur.	7 <sup>th</sup> week after conception	Roodenburg, p 33
--------------	---------------------------------------	------------------

Startles were observed in 12 of 12 fetuses studied, with a median number of about 42 per hour.	7 <sup>th</sup> week after conception	de Vries (1985), p 104
--	---------------------------------------	------------------------

## **STRETCHES**

First occur.	8 <sup>th</sup> week after conception	Roodenburg, p 33
--------------	---------------------------------------	------------------

First occur.	8 _ - 13 _ weeks after conception	Nijhuis/de Vries, p 5
--------------	-----------------------------------	-----------------------

In a study of 9 fetuses, the median number of stretches were 6 per hour.	18 <sup>th</sup> week after conception	Roodenburg, p 28
--	--	------------------

## **SUCKING**

First occurs.	10 _ - 12 _ weeks after conception	Nijhuis/de Vries, p 5
---------------	------------------------------------	-----------------------

## **SWALLOWING**

First occurs.	10 _ - 12 _ weeks after conception	Nijhuis/de Vries, p 5
---------------	------------------------------------	-----------------------

Swallowing is evident.	12 <sup>th</sup> – 14 <sup>th</sup> weeks after fertilization	Williams, p 169
------------------------	---	-----------------

## TASTE

The fetus has many more taste buds than a newborn. It probably has a sense of taste.	Nap	Rugh, p 34
Taste buds begin to form.	8 <sup>th</sup> week after conception	Rugh, p 53
Taste buds are evident.	3 <sup>rd</sup> lunar month	Williams, p 169
Taste buds are developing.	11 <sup>th</sup> – 13 <sup>th</sup> weeks after fertilization	Moore, p 234
A facial response occurs when the fetus is given bitter-tasting substances. Reflexes between the taste buds and facial muscles are in place.	26 <sup>th</sup> – 28 <sup>th</sup> weeks after fertilization	Moore, p 234
A fetus swallowed more amniotic fluid when it was sweetened. In contrast, the fetus responded to the injection of a noxious-tasting substance into the amniotic fluid by reducing its sucking movements, possibly indicating that it did not like the taste of the substance.	Before birth	Nijhuis/Hep- per, p 136

## TONGUE MOVEMENTS

First occur.	9 <sup>th</sup> week after conception	Nijhuis/de Vries, p 5
--------------	---------------------------------------	-----------------------

## YAWNING

Has been observed.	9 <sup>th</sup> week after conception	de Vries (1985), p 116
First occurs.	9 _ - 13 _ weeks after conception	Nijhuis/de Vries, p 5