Section VIII: MEASUREMENT PROTOCOLS

A. Introduction

A variety of measurement protocols are included in the three-year (V7) in-person visit for both the child and adult. These measurements include anthropometry measures, weight, blood pressure, and cognitive testing. An overview of these protocols follows.

B. Child Measurement Protocols

1. Child Waist and Hip Circumferences

At Visit 7, the Research Assistant should measure the waist and hip circumference of enrolled Viva child participants. These measurements are taken using a Hoechstmass measuring tape (a blue, retractable measuring tape) and will help to determine the child's body mass index (BMI) and waist-to-hip ratio, intended for use in future analyses.

Before taking any measurements, the Research Assistant should first verify that a signed Diet-Asthma Consent Form has been obtained. If the participant has not yet decided to enroll her child in Project Viva, the Research Assistant should review the consent with the participant at the beginning of the visit. After completing a Toddler Enrollment Form (TEN), the Research Assistant should ask the participant if it would be a good time to measure the child.

a) Preparing for the Measurements

Before taking any measurements, the Research Assistant should wash her hands and remove all jewelry; including rings, watches and bracelets. The Research Assistant should be aware of any other sharp objects, such as pens, pencils, or sharp nails, when working with the child.

Good rapport with the child helps to secure a successful set of complete measurements. The Research Assistant should maintain a warm demeanor and work at the child's level, whenever possible. Additionally, the Research Assistant should stay attuned to the child's affective state. It is often helpful to recruit the mother for support and encouragement. If the child becomes significantly distressed, the Research Assistant should stop the measurement and turn to another part of the visit. While taking measurements in a standard order is preferred, the Research Assistant should use her judgment in determining when breaks and/or changes in measurement sequence are best.

Ideally, the waist circumference measurements should be taken directly on the skin. The hip circumference measurements should be taken directly on skin, over underwear, or over light clothing. The Research Assistant should *never* remove any of the child's articles of clothing without first receiving permission from the mother. Once permission is obtained, the Research Assistant should verify that she has all materials ready before the child is undressed. The Research Assistant should record whether each measurement was taken

b) Taking the Measurements

The ideal sequence for taking child circumference measurements is waist first, followed by hip. This acclimates the child to the measurement procedure before the Research Assistant performs the more intrusive hip circumference measurement, which may involve lowering the child's pants.

The child may cry or become agitated during the measurement procedures. It is important for the Research Assistant to tell the child what will occur during the measurement: *I'm going to measure your hips now with this measuring tape. I need you to stand as still as you can, like this. That's great.* Giving the child consistent positive reinforcement will often ease tension. The Research Assistant should work quickly, but not so fast that the accuracy of the measurement is called into question. If the Research Assistant is not confident that the measurement is accurate, and the child is upset, the measurement should be recorded on the form and the Research Assistant should also record her concerns in the comments section. Whenever possible, the measurement should be returned to at another time in the visit.

The Research Assistant should follow the protocol outlined below for each measurement:

i. Waist Circumference

- Position the child so that he/she is standing erect and still. The child should cross their arms in front of their chest (hold shirt up if necessary) and abdomen relaxed.
- Sit on the side of the participant.
- Identify the top of the iliac crest along the mid-axillary line on one side of the participant by palpating (with the pads of fingers) the pelvic bone. Mark just above the site with a self-adhesive sticker.
- Repeat the above instruction on the child's left side.
- Gently place the measuring tape over the two circles. If needed, ask the child to hold one side of the tape with a light pincer grasp. The mother can assist with this, as well.
- Adjust the tape so that it is in a level, horizontal plane.
- Tighten the tape, without pulling the skin.
- Re-check that the tape is in a level, horizontal plane.
- At the end of the child's natural exhalation, read the tape to the nearest tenth of a centimeter.
- Call the measurement out loud until it is recorded.
- Check the recorded measurement for accuracy and legibility.
- Release the tape, remove the stickers, and assist the child in getting dressed

ii. Hip Circumference

- Position the child so that he/she is standing erect, arms at their side and feet pressed together.
- Sit or squat to the side of the child, so that eyes are level with the child's hips.
- Place the measuring tape around the hips, anchored at the maximum protuberance of the buttocks.
- Adjust the tape so that it is in a horizontal plane.

- Tighten the tape, without pulling on the skin or clothing.
- Read the measurement to the nearest tenth of a centimeter.
- Call out the measurement repeatedly until it is recorded.
- Check the recorded measurement for accuracy and legibility.

c) Troubleshooting

The Hoechstmass measuring tape must be free of kinks or tears in order to obtain an accurate measurement. The Research Assistant should check the measuring tape prior to every visit. If any damage is present, the tape should be replaced.

2. Child Mid-Upper Arm Circumference, Triceps Skinfold, and Subscapular Skinfold

The child's mid-upper arm circumference (MUAC), Triceps skinfold, and back skinfold measurements are taken as a set because the measurement sites are physically proximal on the body. The MUAC measurement is taken using a child MUAC tape and the skinfold measurements are taken using the Holtain Caliper. MUAC tapes come in both child and adult sizes. The child tape is smaller and brightly colored. The data gathered from these anthropometrical measures assist with future analyses that focus on body mass index (BMI), growth, and development.

a) Preparing for the Measurements

As with the waist and hip circumference measurements, the Research Assistant should verify that a signed consent form has been obtained before beginning any measurement procedure. Likewise, she should wash her hands and remove any jewelry or sharp objects.

Children often shy away from the caliper measurements and it is in the Research Assistant's interest to spend a few minutes preparing the child for the visit. In addition to recruiting the mother's support, the Research Assistant should explain each measurement to the child. Suggested language is noted throughout the text below. Additionally, it is often helpful to let the child examine the caliper and to practice using it on her finger, or a stuffed animal. If the mother has participated in the adult measurement protocol, the Research Assistant can also remind the child that she is getting measured, "just like mom did."

Ideally, these measurements should be taken directly on the skin. The Research Assistant should *never* remove any of the child's clothing without first receiving permission from the mother. Once permission is obtained, the Research Assistant should prepare the child and gather all materials, before the necessary clothing is removed. Often times, it is sufficient to have the child remove her arm from her sleeve and to pull her shirt to the side. The Research Assistant should record whether each measurement was taken directly on skin or alternatively over clothing on the Child Anthropometry Form (CAT). Any complications or departures from standard protocol should be noted in the comments section.

b) Taking the Measurements

The standard sequence for taking this set of measurements is: MUAC, Triceps skinfold, and subscapular (back) skinfold. Before beginning the measurements, the Research Assistant should check to make sure that the caliper is calibrated. Proper calibration is reflected when the needle of the caliper is aligned with the zero on the face of the dial.

Per protocol, these measurements are taken on the **child's right side of the body**. If for any reason, the measurement cannot be taken on the right side, the Research Assistant should follow the same protocol and measure the child's left side. The Research Assistant should denote if she measured the child's left or right side, as indicated on the Child Anthropometry Form (CAT).

This set of measurements calls for precise positioning of the child's body. Each measurement requires the Research Assistant to follow a detailed set of instructions to ensure that the measurement data has integrity. The Research Assistant is challenged to maintain rapport with the child while also paying careful heed to these measurement protocols, drawing on her ability to multi-task but also focus attention. The Research Assistant should use clear, simple language when giving instructions to the child. She should also work quickly, but not so fast that the accuracy of the measurement is compromised. If the Research Assistant questions the measurement's accuracy, she should still record the measurement on the form, and note her concerns in the comments section. In this case, whenever possible, she should return to this measurement and attempt to obtain a more accurate reading later in the visit.

The Research Assistant should follow the protocol outlined below for each measurement:

i. Child Mid-Upper Arm Circumference (MUAC)

- Start by bending next to the child and explaining, *now I'm going to measure the distance around your arm (pointing to the area of measurement).*
- With the child standing, position her **right** arm so that it is flexed at a 90-degree angle at the elbow. The child's palm should be facing up and her fingertips pointing straight ahead.
- Move behind the child and stand at a 45-degree angle to the child's back. *I'm going to first find one of the bones in your shoulder and then I'll measure down to your elbow!*
- Locate the acromial process on the **right** shoulder by palpating firmly with the pads of the index and middle finger.
- Place and hold the zero end of the open MUAC tape on the acromial process with left thumb.
- Extend the tape down the midline of the back of the arm, past the tip of the olecranon process at the elbow (taking care not to bend the tape around the elbow).
- Measure the distance between the acromial process and the olecranon process to the nearest tenth of a centimeter. This is your length (L).
- Divide this number by two to obtain the vertical midpoint. (L/2= midpoint)
- Replace thumb (on acromial process) with index (or middle) finger and slide thumb down the length of the measuring tape and hold at the midpoint (olecranon process).
- Place a reinforcer **at the vertical midpoint.** *I'm going to put a little sticker in the middle of your arm and we'll take it off as soon as I'm done measuring.*

- Now, the reinforcer is at the vertical midpoint. Kneeling directly behind the child, move the reinforcer left or right so that it is also at the horizontal midpoint (the horizontal midpoint (The midpoint is determined using visual judgment, not direct measurement).
- Instruct the child to relax her arm (*Okay, you can let your arm hang loosely now)* and then position her arm so that it is extended down, and separated slightly from the side of her body.
- Standing to the right of the child, place a closed MUAC Tape (remember to use the small, colored tape designated for children) around the upper arm, perpendicular to the long axis of the arm at the marked point.
- The MUAC measurement is taken with the tape held gently against the skin surface. To ensure an accurate reading, the following steps (described below) should be taken: **Focus, Secure, Inspect, and Read.**

    - **Focus**: Hold the two ends of the tape with a pincer grasp (i.e., with index finger and thumb of each hand). Get a feel for the tension of the tape around the arm by tugging the tape a few times.
    - **Secure**: Hold the tape with the pincer grasp, using your right hand, only at the junction where the tape passes through the slot. The tape's tension around the arm is now fixed and will not move.
    - **Inspect:** Look at and feel the tension of the tape around the arm for any noticeable gaps or areas of constriction. If necessary, adjust the tension of the tape, re-secure and re-inspect.
    - **Read:** If you are using a single-slotted (child) insertion tape, you will need both hands to take the measurement. Use your left hand to lay the tab so that it is flush with the rest of the tape. Make sure not to pull the tape as you read the measurement.

- At eye-level, read the measurement from the side of the arm to the nearest millimeter.
- Call the measurement out loud repeatedly until it is recorded.
- Check the recorded measurement for accuracy and legibility.
- Loosen the tape and remove from the child's arm.
- Do not remove the reinforcement stickers from the child's arm as the midpoint placement is needed for the Triceps skinfold measurement.

ii. Child Triceps Skinfold

- Make sure the caliper is calibrated (i.e. needle is aligned with zero point on the dial)
- Identify the midpoint on the back of the child's arm (Note: The child Triceps skinfold requires identification of the midpoint on the back of the child's arm. This identification is made during the MUAC measurement and once identified the same landmark can continue to be used. If for some reason the MUAC measurement has not being taken, please reference the directions above (MUAC measurement) for locating the midpoint.
- Have the child stand upright with feet pressed together, shoulders relaxed, and arms hanging loosely by their side. (If necessary, the child may sit in a chair on the mother's lap for the triceps skinfold measurement as long as the child is upright with his/her right arm hanging loose). *Now I'm going to see how big your muscles are!*

- Standing behind the child, gently lift the Triceps skinfold with fingertips centered just above the midpoint, as marked by a sticker. Pick the skinfold up with the left thumb and index finger approximately 2 centimeters above the midpoint. Grasp firmly, about 1-2 centimeters into the skin, **making sure to separate fat from muscle.**
- Hold the skinfold parallel to the long axis of the upper arm.
- Place the caliper jaw perpendicular to the length of the fold and around the marked midpoint.
- While holding the skinfold, completely release grip on the caliper lever.
- Count 4 seconds (one-one thousand, two- one thousand,)
- Read the measurement, while the calipers are still on site, to the nearest 0.2 millimeter.
- Call the measurement out loud while gently removing the calipers.
- Release grasp on skinfold and rub spot to soothe the skin.
- Continuing calling the measurement out loud until recorded on the form.
- Check the recording for accuracy and legibility.
- Remove reinforcer.

iii. Child Subscapular (Back) Skinfold

- Position the child so that she is standing upright with her shoulders relaxed and arms hanging loosely at her sides. The child may sit on the mother's lap, facing mom, as long as the child is upright and the mother's arm is not interfering with the measure. Alternatively, the child may stand between the mother's legs, while facing the mother.
- Stand behind the child and gently palpate the lowermost tip of the scapula (shoulder blade) with pads of fingers, firmly so as not to tickle.
- The measurement site is 1-2 centimeters below the lower tip of the scapula.
- Gently lift the skinfold with the thumb and left index finger on a diagonal approximately 2 centimeters above and to the left of the measurement site.
- Place caliper jaws on the measurement site and perpendicular to the length of the skinfold.
- While holding the skinfold, completely release your grip on the caliper's lever.
- Count 4 seconds before reading the measurement (one-thousand one, one-thousand two…)
- Read the measurement to the nearest 0.2-millimeter while the calipers are still on the site.
- Call out the measurement while removing the calipers gently; depress and release the caliper level slowly. TAKE CARE NOT TO SNAP THE CALIPERS.
- Release grasp on skinfold, rub the spot a few times to soothe the skin.
- Continue to call out the measurement until recorded on the form.
- Check the recording for accuracy and legibility.

c) Troubleshooting

Both the Hoechstmass measuring tape and the Ross Insertion tape must be free of kinks or tears in order to obtain an accurate measurement. The Research Assistant should check the measuring tape prior to every visit. If any damage is present, the tape should be replaced. The Research

Assistant should confirm that the calipers are calibrated before taking each skinfold measurement. Proper calibration is reflected when the needle of the caliper is aligned with the zero on the face of the dial. If this is not the case, the Research Assistant should turn the dial so that the needle is aligned with the zero.

3. Child Weight, Standing Height and Sitting Height

The child's weight and height measurements are taken as a set because they both require the child to take off her shoes. Weight is measured using a SECA Scale. Height is measured using a Shorr Length Board. Acquiring both a standing and sitting height, allows for a measure of long bone growth in the child's legs. This measurement will be compared to child measurements from earlier Viva visits. Similar to the aforementioned measurements, the child's weight and height are also used as markers of BMI, growth, and development.

a) Preparing for the Measurements

If the child has not already done so, the Research Assistant should wash her hands and remove any jewelry or sharp objects from her being, after confirming that a signed consent has been obtained. The Research Assistant should carefully describe all measurements before working with the child. If it is necessary, the mother's help can be employed.

The equipment used for these measurements needs to be carefully handled and placed in the visit environment. If the Research Assistant is working in a Viva office, she should confirm that the equipment is assembled and stationed correctly. If attending a home visit, the Research Assistant should set up the equipment and then allow at least twenty minutes before taking any measurements. This delay assures that the scale has had sufficient time to "settle" and assures that the most accurate reading possible.

The scale should be placed on a hard, flat surface. Uneven and carpeted surfaces should be avoided. If the scale was carried to a visit, it should be allowed to rest for approximately twenty minutes. The Research Assistant should assure that the display is cleared and reset before taking any weight measurement. After assembling the Shorr Board, it should be placed firmly against a flat wall or door, and on top of a flat, hard surface. The Research Assistant should verify that the board is stable before taking any measurements. Whenever possible, avoid placing the board against any protrusions in the wall, such as molding. If placing the board against a door, the Research Assistant should take measures to assure that the door will not be opened. In the Viva offices a "Testing- Do Not Disturb" sign is available to hang. At home visits, the Research Assistant should recruit the mother's help in assuring the door will remain closed. When taking the sitting height, a stool or steady box, is placed directly under the Shorr Board and firmly against the wall. The stool or box should be sufficiently high so that the child's legs will hang freely. Whenever possible, the Child Anthropometry Form (CAT7) should be hung on a clipboard to the right of the Shorr Board for easy and quick recording of the measurements.

By this point in the visit the Research Assistant should have developed a good rapport with the child. These measurements are considerably "easier" to participate in from the child's

perspective and lend themselves well as a transitional phase of the visit. That said, the Research Assistant should still maintain fastidious attention to detail in obtaining the measures.

Ideally, the weight and height are taken while the child is wearing light clothing, no shoes, and no barrettes, other hair-ornaments, or hats. The Research Assistant should *never* remove any of the child's articles of clothing without first obtaining the mother's permission. Once permission is obtained, the Research Assistant should verify that she has all materials ready before the child is undressed. Optimally the child should be in the lightest clothing possible, so as not to interfere with the weight measurement. Bulky clothing should be avoided whenever possible, so as not to interfere with the height measurements. Additionally barrettes, or other hair ornaments, and ponytails, or braids should be removed whenever possible. An optimal height is taken when the measuring plate can rest flat against the top of the child's head. If the mother is unwilling or the child is unable to cooperate with the dress and hair requirements for any reason, the Research Assistant should still take the measurements, noting the discrepancy in the comments section. Regardless, the Research Assistant should record the type of clothing the child was wearing directly on the Child Anthropometry Form (CAT7).

b) Taking the Measurements

This set of measurements should be taken in the sequence indicated on the Child Anthropometry Form: Weight, Standing Height, Sitting Height.

The weight and height measurements are the least intrusive and are often well received. While not optimal, the child's weight can be taken while being held by the mother. Follow the modifications to the protocol listed below in this circumstance. At times, the measuring plate that is placed against the top of the child's head when taking a height measurement can generate some concern for the child. As such, the child should be allowed to look at and touch the plate before the height measurement is taken. As with all measurements, the Research Assistant should inform the child about each step before proceeding with the protocol.

The Research Assistant should follow the protocol outlined below for each measurement:

i. Child Weight

**If necessary, the child's weight can be taken while being held by the mother. In this case, please follow the italicized adjustments to the protocol indicated below. **

- Place the Child Anthropometry Form (CAT7) on a clipboard near the scale, for quick and easy recording.
- Step lightly on the scale until the digital display indicates that the scale has been activated.
- Make sure the scale is set to measure in kilograms. The bottom corner of the scale display will say either "kg" or "lb" to indicate if the measurement is occurring in kilograms or pounds. If the display indicates "lb," or pounds, press firmly on the button to the left of the display panel labeled "kg/lb." This button alternates the unit of

measurement. The display should read **"0.00 kg" before starting the weight measurement.**

- Stand or kneel at the side of the scale. Assist the child onto the center of the scale. Be sure that the child does not step on the display panel or "kg/lb" button.
- Ask the child to stand as still as possible with feet together and hands to her side. The child should be standing alone and without touching anything. Ask the child to look straight ahead.
- Wait until the display panel has settled on one reading.
- Read and call out the weight in a low, audible voice. Do not touch the child as you read the measurement. Continue to call out the weight as you guide the child off of the scale by the elbow.
- Write down the weight measurement, recorded in kilograms, to 2 decimal places on the Child Anthropometry form (CAT7). Record the type of clothing the child was wearing during this measurement on the form, as well.
- Check the recording for accuracy and legibility.

Weight- Child Held: Using the guidelines above, carefully measure the weight of the mother alone. Record the mother's weight measurement on the MAT7 if you have not already done sot. ***Ask the mother to remain standing on the scale.*** *Bend down and press the "Tare" button until the display panel reads "0.00 kg" again. While the mother is continuing to stand on the scale, lift her child up into her arms. Ask the mother to hold the child against her front, so that the mother and child are hugging each other. In this way, the weight is centered over the scale. Wait for the scale to settle on a new reading. This reading represents the weight of the child alone. Read the measurement and call aloud in a low, audible voice, until recorded on the Child Anthropometry Form (CAT7). Check the recording for accuracy and legibility. On occasion the scale may not tare properly. In this case, the kilogram reading will be far greater than the child's weight alone. The Research Assistant should use her judgment in verifying that the weight displayed represents the child only. If the result is ever questionable, the Research Assistant should retake the measurement.*

ii. Child Standing Height

- This measurement requires the assistance of the child's mother, or another adult. Before beginning the measurement, use the "One Minute Trainer" to instruct the assistant how to stabilize the child's legs during the height measurement.
- Guiding by the elbow, assist the child onto the board. The child's feet should be flat against the base of the board so that body weight is evenly distributed.
- Stand to the right of the Shorr Board at a 45-degree angle to the board.
- Position the child's feet and legs into one of the following three configurations:
    - **Both knees and feet together**
    - **Knees together and feet apart**
    - **Knees apart and feet together**

- Position the child's arms so that they are hanging freely by her sides, with the palms facing her thighs.

- Ask the child to stand up straight.
- Have the assistant press on the child's knees, with her left hand, and the child's ankles, with her right hand, as instructed above.
- Be sure that the child is standing up straight, not leaning or slouching. Using your palms, pat up the child's body from knees to shoulder, helping her straighten out if necessary.
- Firmly cup (with a rounded, not a "V" grasp) the child's chin with the left hand so that your hand goes around the child's ear but is not covering the child's ear, or the mouth. Your hand/arm should also not be touching the child's chest.
- Using the fingertips of your right hand, gently grasp the back of the child's head.
- **Place the child's head into the Frankfort Plane.** The Frankfort plane is determined by: Looking at the side of the child's head, draw an imaginary line from the bottom of the eye orbit to the child's ear hole. Position the head so that the imaginary line is parallel to the floor and perpendicular to the Shorr Board.
- Before removing left hand from the child's chin, re-check the positioning of the child's head while simultaneously picking up the headpiece with your right hand.
- Once the positioning of the head is confirmed, position the headpiece firmly on top of the child's head with sufficient pressure to compress the hair and make contact is made with the skull.
- Directly face the measuring index, when taking the reading. Measure the height in centimeters, to the nearest millimeter.
- Call the measurement out loud in a low, audible voice until recorded.
- Remove headpiece and release grasp of child's chin. Escort the child off of the board.
- Check the recording for accuracy and legibility. Record any braids, hair ornaments, or hats that the child was wearing when the measurement was taken.

iii. Child Sitting Height

- Place the Shorr Board on top of a sturdy stool or box and against a flat door or wall, making sure that the board is stable. The stool should be high enough that the child's legs dangle freely.
- Ask the child to sit on the stool. Position the child so that the buttocks are touching the back of the board.
- Ask the child to sit as erect as possible. The child's knees should be directed straight ahead.
- The child should keep both hands on her thighs or knees, with arms relaxed.
- Firmly cup (with a rounded, not a "V" grasp) the child's chin with the left hand so that your hand goes around the child's ear but is not covering the child's ear or mouth. Your hand should not be touching the child's chest.
- Using the fingertips of your right hand, gently grasp the back of the child's head.
- **Place the child's head into the Frankfort Plane.** The Frankfort plane is determined by: Looking at the side of the child's head, draw an imaginary line from the bottom of the eye orbit to the child's ear hole. Position the head so that the imaginary line is parallel to the floor and perpendicular to the Shorr Board.

- Before removing left hand from the child's chin, re-check the positioning of the child's head while simultaneously picking up the headpiece with your right hand.
- Once the positioning of the head is confirmed, position the headpiece firmly on top of the child's head with sufficient pressure to compress the hair and make contact with the skull.
- Directly face the measuring index, when taking the reading. Measure the height in centimeters, to the nearest millimeter.
- Call the measurement out loud in a low, audible voice until recorded.
- Remove headpiece and release grasp of child's chin.
- Check the recording for accuracy and legibility. Record whether the child was wearing a diaper or any braids, hair ornaments, or hats when the measurement was taken.
- Assist the child down from the stool or box.

c) Troubleshooting

It is imperative that the Research Assistant makes sure that the display on the scale reads "0.00 kg" before taking any measurements. If the display indicates an error, and no other scales are available, the Research Assistant should still take the measurement, indicating the exact error code that was displayed on the scale in the comments section. After the visit the Research Assistant should consult the user's manual for possible interventions. Each SECA Scale should be sent to SECA Corporation, 1352 Charwood Rd. Suite E, Hanover, MD 21076 for calibration bi-annually.

The Shorr Boards should be examined for any damage approximately once a month. These boards are made of wood and it is therefore especially important to check for any potential splintering. Any damaged Shorr Board should be sent to Irwin Shorr, Shorr Productions, 17802 Shotley Bridge Place, Olney, MD 20832 for repair, or replaced with a new board.

4. Child Blood Pressure

At Visit 7, the Research Assistant should obtain one set of 5 blood pressure measurements, each one-minute apart, from the child participant using the Dinamap Pro100 or Dinamap Pro200 automated blood pressure recorder. The Research Assistant should note the time of day, room temperature, pulse and activity state of the child at the time of measurement. Blood pressure varies from minute to minute, so it is necessary to take multiple readings. The readings will be averaged for data analysis.

Blood pressure is measured as systolic pressure/diastolic pressure. Systolic pressure indicates the pressure of the blood as it is pumped out of the heart and is the higher number displayed on the Dinamap monitor. Diastolic pressure indicates the pressure of the blood when the heart is relaxed, and is the lower number displayed on the monitor. While there is a single accepted normal range for blood pressure for adults, the range of normal varies in children based on a child's age, gender and height measurements.

Before taking any measurements, the Research Assistant should first verify that a signed Toddler Consent Form has been obtained. If the participant has not yet decided to enroll her child in Project Viva, the Research Assistant should review the consent with the participant at the beginning of the visit. After completing a Toddler Enrollment Form (TEN), the Research Assistant should ask the participant if it would be a good time to measure the child.

a) Preparing for the Measurements

Blood pressure measurements should be taken with the child sitting quietly and with her **right** arm extended in a manner that the **brachial artery is perpendicular to her heart.** This is easily accomplished by having the child sit in a chair with the arm, resting, and palm facing up, on a table or desk. The arm should be kept straight and prevented from moving during the measurements. Furthermore, the child should not speak during or between measurements. If the right arm is not available for taking the reading (e.g. a cast is present) the Research Assistant should attempt the measurement using the left arm. If this is unsuccessful, the Research Assistant may take a blood pressure reading on the child's calf. This attempt should begin with the right leg and then follow to the left, if needed..

The DinamapPro 100 and Pro 200 machines come with 2 sets of cords, a gray cord and a light blue cord. The gray cord, with the threaded connectors ("screw-in") and colored cuffs will be used for the three-year-old measurements. The Research Assistant should attach the cord to the Dinamap machine.

The colored Dinamap cuffs come in 6 different sizes: Infant, Child, Small Adult, Adult, Large Adult, and Thigh. It is critical that blood pressure measurements be taken with an appropriately sized cuff. A cuff that is too small can result in artificially high readings and a cuff that is too large can result in difficulty obtaining measurements. The Research Assistant should never assume that the child participant naturally fits into a child-sized cuff. Rather, **each child participant must be "fitted" for the appropriate size cuff.** To do this the Research Assistant should first locate the brachial artery on the inside of the right arm using two or three extended fingers. The thumb should not be used to locate the artery. The brachial artery is located on the inside of the elbow, just above the elbow crease between the elbow and shoulder and slightly medial to the center of the arm (toward the body when arm is held palm up). The cuff should then be placed on a bare arm. The Research Assistant should hold the arm steady with one hand, align the "artery" arrow on the cuff with the child's brachial artery, and wrap the cuff snugly around the arm with the other. If the straight white line on the outer edge of the cuff falls within the "size range" indicated on the inside of the cuff, than the fit is correct. If the line is very close to or over the edge of the "size range," the Research Assistant should choose a cuff that is smaller or larger, as indicated. The fitting procedure should be repeated until the Research Assistant finds a cuff that appropriately fits the child. It is important to note that larger cuffs may sometimes cover the child's elbow. This will not interfere with the measurement.

The Research Assistant should put the cuff on the child and then make sure the child is comfortable before beginning the blood pressure measurement. The Research Assistant may demonstrate for the child by gently squeezing over the cuff on the child's arm. Optimally, blood

pressure readings should be taken when the child is calm and relaxed. As such, the Research Assistant should take the time necessary to acclimate the child to the procedure.

b) Taking the Measurements

After the child has been sufficiently introduced to the procedure, the Research Assistant should connect the cuff to the threaded connector on the gray cord. The child can be sitting on the mother's lap if this is more comfortable. Importantly, the child should be sitting quietly and should be instructed not to speak during or between readings.

The blood pressure measurements should be obtained using the following protocol:

- Turn the machine on by pressing the power button.
- Verify that the cuff and the child are positioned correctly.
- Use the blue dial to set the machine. Turning the blue dial effectively "scrolls" through choices on the display screen and pushing the dial effectively "selects" a highlighted choice. Three important settings need to be established before taking the child's blood pressure: set point, time interval, and auto/manual. For children, the blood pressure set point is 140 mmHg. This means that the cuff will inflate with 140 mmHg of pressure before beginning to release pressure and take a reading. This set point is 30mmHg lower than adults and is intended to ease discomfort that children may experience when a higher amount of pressure is used. Next, set the machine to take readings at one-minute intervals. Finally, choose "auto," from the "auto/manual" option.
- Choosing "auto" will begin the measurement procedure.
- After each measurement, the machine will beep.
- At the time of the beep, the Research Assistant should record the state of the child, systolic pressure, diastolic pressure, and pulse on the Child Blood Pressure Form (CBP7).
- The machine will automatically resume the next reading in approximately one minute.
- When five complete readings have been obtained, the Research Assistant should press "stop," and take the cuff off of the child.
- It is important to note that a set of five, consecutive readings is required. **Obtaining a set of five consecutive readings (accurate blood pressure and pulse) will often take greater than five trials.**

The Child Blood Pressure Form allows for ten possible measurement trials, five on the first page and five on the second page. Additionally, at the top of each page, a field for the start time is indicated. Ten possible trials allow the Research Assistant to effectively obtain a complete set of readings. It is important to note that all measurements, including those with errors, should be recorded. If the machine displays an error code during one of the trials, the Research Assistant should record "-9" and the reason for the error in all applicable fields. The Research Assistant should similarly note the error, and any specific error codes displayed, in the comments section and continue with the measurements until five consecutive readings are obtained. Two examples follow:

E.g. 1: If three blood pressure measurements are obtained, an error code is displayed on the fourth trial, and then five successful measurements follow, the Research Assistant would code eight blood pressure readings in total. These readings would be recorded in order, in the first nine fields: the three initial readings (fields 1, 2and 3), the error trial "-9" (field 4) and the five consecutive readings (fields 5, 6, 7, 8 and 9). In this case, only one start time is needed and it would be indicated on the top of the first page.

E.g. 2: If three measurements are obtained and then the child becomes too upset to continue, the Research Assistant would discontinue the blood pressure protocol. She would attempt to return to the blood pressure measurements again at a later point in the visit. At this point, if five successful measurements were obtained, she would code eight blood pressure readings in total. These readings would be coded using all ten of the blood pressure fields, however: three initial readings (fields 1, 2, and 3), two blank fields (fields 4 and 5), and five consecutive readings (fields 6, 7, 8, 9, and 10). Importantly, two separate start times would be indicated, one on each page, reflecting the break from and return to measurement protocol.

- After visit completion, the Research Assistant should use the dial on the blood pressure machine to scroll through the measurements (which are automatically recorded) and to verify that the Child Blood Pressure Form has been accurately coded.

c) Troubleshooting

Any error code that the machine displays should be noted. The owner's manual should be referred to for possible interventions. Alternatively, the machine can be sent to GE Medical Services, 4502 Woodland Corp. Blvd, Tampa, FL 33614 for repairs. Each Dinamap machine is sent for calibration on a biannual basis.

C. Adult Measurement Protocols

1. Adult Waist Circumference

At Visit 7, the Research Assistant should measure the waist circumference of enrolled Viva mothers. This measurement is taken using a Hoechstmass measuring tape (a blue, retractable measuring tape) and will help to determine the mother's body mass index (BMI), intended for use in future analysis.

Before taking any measurements, the Research Assistant should first verify that a signed Maternal Consent Form has been obtained. After completing a Mother's Enrollment Form (MEN), the Research Assistant should ask the participant if it would be a good time to take her measurements.

a) Preparing for the Measurements

Before taking any measurements, the Research Assistant should wash her hands and remove all jewelry; including rings, watches and bracelets. The Research Assistant should be aware of any other sharp objects, such as pens, pencils, or sharp nails, when taking measurements.

Ideally, the waist circumference measurement should be taken directly on the skin. The Research Assistant should explain the importance of standard and accurate measurement protocols and then ask the mother to expose the pertinent areas for measurement. The Research Assistant should record whether the measurement was taken directly on the skin or alternatively over clothing on the Mother Anthropometry Form (MAT7).

b) Taking the Measurements

Participants may express some discomfort or embarrassment about the waist circumference measurement. The Research Assistant should remain mindful of the "intrusive" nature of this measurement by ensuring privacy, only asking the mother to undress or expose herself with minimal necessity, and maintaining a positive rapport. It is important for the Research Assistant to tell the mother what will occur during each step of the measurement. The Research Assistant should work quickly, but not so fast that the accuracy of the measurement is called into question. If the Research Assistant is not confident that the measurement is accurate, the Research Assistant should attempt to repeat the measurement. If this is not possible, any concerns should be recorded in the comments section.

The Research Assistant should follow the protocol outlined below for each measurement:

i. Waist Circumference

- Ask the participant to stand erect and still with her arms crossed in front of her chest (hold shirt up if necessary) and abdomen relaxed.
- Sit on the right side of the participant.
- Identify the top of the iliac crest along the mid-axillary line on one side of the participant by palpating (with the pads of fingers) the pelvic bone. Mark just above the site with a self-adhesive reinforcer.
- Repeat the above instruction on the mother's left side.
- Gently place the measuring tape over the two circles. Ask the mother to hold one side of the tape with a light pincer grasp.
- Adjust the tape so that it is in a level, horizontal plane.
- Tighten the tape, without pulling the skin.
- Re-check that the tape is in a level, horizontal plane.
- At the end of the mother's **natural exhalation**, read the tape to the nearest tenth of a centimeter.
- Call the measurement out loud until it is recorded.
- Check the recorded measurement for accuracy and legibility.
- Release the tape and remove the stickers.

c) Troubleshooting

The Hoechstmass measuring tape must be free of kinks or tears in order to obtain an accurate measurement. The Research Assistant should check the measuring tape prior to every visit. If any damage is present, the tape should be replaced.

2. Adult Mid-Upper Arm Circumference, Triceps Skinfold, and Subscapular Skinfold

The mother's mid-upper arm circumference (MUAC), triceps skinfold, and subscapular skinfold measurements are taken as a set because the measurement sites are physically proximal on the body. The MUAC measurement is taken using a Ross-Insertion tape, a white tape with three slots, and the skinfold measurements are taken using the Holtain or Harpenden calipers. If a participant is obese, the Holtain caliper may not be sufficient for taking the skinfold measurement. In this case the Harpenden caliper should be used. The data gathered from these anthropometrical measures will assist with future analyses that focus on body mass index (BMI), growth, and development.

a) Preparing for the Measurements

As with the waist circumference measurement, the Research Assistant should verify that a signed consent form has been obtained before beginning any measurement procedure. Likewise, she should wash her hands and remove any jewelry or sharp objects.

Research Assistants should be mindful of protecting the participant's privacy and being sensitive to any concerns about participating in the measurements. These protocols serve as a good opportunity to role model measurements for the child.

Ideally, these measurements should be taken directly on the skin. Often times, it is sufficient to have the mother remove her arm from her sleeve and to pull her shirt to the side, but sometimes the entire shirt will need to be removed. The Research Assistant should record whether each measurement was taken directly on skin or alternatively over clothing on the Mother Anthropometry Form (MAT7). Any departures from standard protocol should be noted in the comments section.

b) Taking the Measurements

The standard sequence for taking this set of measurements is: MUAC, triceps skinfold, and subscapular (back) skinfold. Before beginning the measurements, the Research Assistant should check to make sure that the caliper is calibrated. Proper calibration is reflected when the needle of the caliper is aligned with the zero on the face of the dial.

Per protocol, these measurements are taken on the **mother's right side of her body**. If for any reason, the measurement cannot be taken on her right side, the Research Assistant should follow the same protocol and measure the mother's left side. The Research Assistant should then note in the comments section of the Mother Anthropometry Form (MAT7) that she measured the mother's left side.

This set of measurements calls for precise positioning of the body and the Research Assistant will be coming in close contact with the participant. As such, the utmost respect and professionalism is called for. Each measurement requires the Research Assistant to follow a detailed set of instructions to ensure that the measurement data has integrity. She should work quickly, but no so fast that the accuracy of the measurement is compromised. If the Research Assistant questions the measurement's accuracy, she should repeat the measurement. If she is not able to repeat the measurement, she should still record the measurement on the form, noting her concerns in the comments section.

The Research Assistant should follow the protocol outlined below for each measurement:

i. Adult Mid-Upper Arm Circumference (MUAC)

- Position the participant so that her **right** arm is flexed at a 90-degree angle at the elbow. The participant's palm should be facing up and her fingertips pointing straight ahead.
- Move behind the participant and stand at a 45-degree angle to the participant's back.
- Locate the acromial process on the **right** shoulder by palpating firmly with the pads of the index and middle finger.
- Place and hold the zero end of the open Ross Insertion tape on the acromial process with left thumb.
- Extend the tape down the midline of the back of the arm, past the tip of the olecranon process at the elbow (taking care not to bend the tape around the elbow).
- Measure the distance between the acromial process and the olecranon process to the nearest tenth of a centimeter. This is your length (L)
- Divide this number by two to obtain the vertical midpoint. (L/2= midpoint)
- Replace thumb (on acromial process) with index finger and slide thumb down the length of the measuring tape and hold near the midpoint (olecranon process).
- Place a reinforcer **at the vertical midpoint.**
- Now, the reinforcer is at the vertical midpoint. Standing behind the participant, move the reinforcer left or right so that it is also at the horizontal midpoint (the horizontal midpoint is determined using visual judgment, not direct measurement).
- Instruct the participant to relax her arm and then position her arm so that it is extended down, and separated slightly from the side of her body.
- Standing to the right of the participant, place a closed Ross Insertion Tape (remember to use adult tape) around the upper arm, perpendicular to the long axis of the arm at the marked point.
- The MUAC measurement is taken with the tape held gently against the skin surface. To ensure an accurate reading, the following steps (described below) should be taken: **Focus, Secure, Inspect, and Read.**
    - **Focus**: Hold the two ends of the tape with a pincer grasp (i.e., with index finger and thumb of each hand). Get a feel for the tension of the tape around the arm by tugging the tape a few times.

- **Secure**: Hold the tape with the pincer grasp, using your right hand, only at the junction where the tape passes through the slot. The tape's tension around the arm is now fixed and will not move.
- **Inspect:** Look at and feel the tension of the tape around the arm for any noticeable gaps or areas of constriction. If necessary, adjust the tension of the tape, re-secure and re-inspect.
- **Read:** Make sure not to pull the tape as you read the measurement.

- At eye-level, read the measurement from the side of the arm to the nearest millimeter.
- Call the measurement out loud repeatedly until it is recorded.
- Check the recorded measurement for accuracy and legibility.
- Loosen the tape and remove from the child's arm.
- Do not remove the reinforcement stickers from the participant's arm as the midpoint placement is needed for the triceps skinfold measurement.

ii. Adult Triceps Skinfold

- Use judgment in choosing the appropriate size caliper and make sure that it is calibrated (i.e. needle is aligned with zero point on the dial)
- Identify the midpoint on the back of the participant's arm (Note: The participant's triceps skinfold requires identification of the midpoint on the back of the participant's arm. This identification is made during the MUAC measurement and once identified the same landmark can continue to be used. If for some reason the MUAC measurement has not being taken, please reference the directions above (MUAC measurement) for locating the midpoint.)
- Have the participant stand upright with her shoulders relaxed and arms hanging loosely by her side.
- Standing behind the participant, gently lift the triceps skinfold with fingertips centered just above the midpoint, as marked by a sticker. Pick the skinfold up with the left thumb and index finger approximately 2 centimeters above the midpoint. This may be particularly difficult with persons who are obese or very muscular and therefore have little fat at the site. If necessary, in the case of obese subjects, an assistant may pick up the fold with two hands. This will give a reading that is larger, however, than if one hand is used. Grasp firmly, about 1-2 centimeters into the skin, **making sure to separate fat from muscle.**
- Hold the skinfold parallel to the long axis of the upper arm.
- Place the caliper jaw perpendicular to the length of the fold and around the marked the midpoint.
- While holding the skinfold, completely release grip on the caliper lever.
- Count 4 seconds (one-one thousand, two- one thousand,)
- Read the measurement, while the calipers are still on site, to the nearest 0.2 millimeter.
- Call the measurement out loud while gently removing the calipers.
- Release grasp on skinfold and rub spot to soothe the skin.
- Continuing calling the measurement out loud until recorded on the form.

- Check the recording for accuracy and legibility.
- Remove reinforcer.

iii. Adult Subscapular (Back) Skinfold

- Position the participant so that she is standing upright with her shoulders relaxed and arms hanging loosely at her sides.
- Stand behind the participant and gently palpate the lowermost tip of the scapula (shoulder blade) with pads of fingers, firmly so as not to tickle.
- The measurement site is 1-2 centimeters below the lower tip of the scapula. For some subjects, especially the obese, gentle placement of the subject's arm behind the back aids in identifying the site.
- Gently lift the skinfold with the thumb and left index finger on a diagonal approximately 2 centimeters above and to the left of the measurement site.
- Place caliper jaws on the measurement site, perpendicular to the length of the skinfold.
- While holding the skinfold, completely release your grip on the caliper's lever.
- Count 4 seconds before reading the measurement: one thousand one, one thousand two…
- Read the measurement to the nearest 0.2-millimeter while the calipers are still on the site.
- Call out the measurement while removing the calipers gently; depress and release the caliper level slowly. TAKE CARE NOT TO SNAP THE CALIPERS.
- Release grasp on skinfold, rub the spot a few times to soothe the skin.
- Continue to call out the measurement until recorded on the form.
- Check the recording for accuracy and legibility.

c) Troubleshooting

Both the Hoechstmass measuring tape and the Ross Insertion tape must be free of kinks or tears in order to obtain an accurate measurement. The Research Assistant should check the measuring tape prior to every visit. If any damage is present, the tape should be replaced. The Research Assistant should confirm that the calipers are calibrated before taking each skinfold measurement. Proper calibration is reflected when the needle of the caliper is aligned with the zero on the face of the dial. If this is not the case, the Research Assistant should turn the dial so that the needle is aligned with zero.

3. Adult Weight and Standing Height

The participant's weight and height measurements are taken as a set because they both require the participant to take off her shoes. Weight is measured using a SECA Scale. Height is measured using a Shorr Length Board. These measurements will be compared to participant measurements from earlier Viva visits. Similar to the aforementioned measurements, the participant's weight and height are also used as markers of BMI and will help to determine patterns of weight change after pregnancy.

a) Preparing for the Measurements

If she has not already done so, the Research Assistant should wash her hands and remove any jewelry or sharp objects from her being, after confirming that a signed consent has been obtained. The Research Assistant should carefully describe all measurements before working with the participant.

The equipment used for these measurements needs to be carefully handled and placed in the visit environment. If the Research Assistant is working in a Viva office, she should confirm that the equipment is assembled and stationed correctly. If attending a home visit, the Research Assistant should set up the equipment and then allow at least twenty minutes before taking any measurements. This delay assures that the scale has had sufficient time to "settle" and assures that the most accurate reading possible.

The scale should be placed on a hard, flat surface. Uneven and carpeted surfaces should be avoided. If the scale was carried to a visit, it should be allowed to rest for approximately twenty minutes. The Research Assistant should assure that the display is cleared and reset before taking any weight measurement. After assembling the Shorr Board, it should be placed firmly against a flat wall or door, and on top of a flat, hard surface. The Research Assistant should verify that the board is stable before taking any measurements. Whenever possible avoid placing the board against any protrusions in the wall, such as molding. If placing the board against a door, the Research Assistant should take measures to assure that the door will not be opened. In the Viva offices a "Testing- Do Not Disturb" sign is available to hang. At home visits, the Research Assistant should recruit the participant's help in assuring that the door will remain closed. Whenever possible, the Mother's Anthropometry Form (MAT7) should be hung on a clipboard to the right of the Shorr Board for easy and quick recording of the measurements.

Optimally the participant should be in the lightest clothing possible, so as not to interfere with the weight measurement. Bulky clothing should be avoided whenever possible, as well, so as not to interfere with both the weight and height measurements. Additionally, barrettes or other hair ornaments, braids, or hats should be removed whenever possible. An optimal height is taken when the measuring plate can rest flat against the top of the participant's head. If the participant is unwilling or unable to cooperate with the dress and hair requirements for any reason, the Research Assistant should still take the measurements, noting the discrepancy in the comments section. Regardless, the Research Assistant should record the type of clothing the participant was wearing directly on the Mother Anthropometry Form (MAT7).

b) Taking the Measurements

This set of measurements should be taken in the sequence indicated on the Mother Anthropometry Form: Weight, then Standing Height. Standard protocol calls for the Research Assistant to work from the **right** side of the participant's body when reading measurements.

Though the weight and height measurements are the least intrusive, some participants will be reticent to have their weight taken. The Research Assistant should use her best judgment in this case. The SECA Scale measures a maximum weight of 400lbs. If the participant is concerned that her weight is above this threshold, the Research Assistant can suggest trying. If the participant is not willing, this should be coded on the form. If she is willing, and the weight is

indeed above threshold, this should be coded on the form as well. For other participants, the Research Assistant can offer to have the participant stand on the scale with her eyes closed, or alternatively, to step onto the scale backwards for this measurement. The importance of getting a complete set of measurement data should be stressed as the Research Assistant works to negotiate a comfortable compromise with the participant. As with all measurements, the Research Assistant should inform the participant about each step before proceeding with the protocol.

The Research Assistant should follow the protocol outlined below for each measurement:

i. Adult Weight

- Place the Mother Anthropometry Form (MAT7) on a clipboard near the scale, for quick and easy recording.
- Step lightly on the scale until the digital display indicates that the scale has been activated.
- Make sure the scale is set to measure in kilograms. The bottom corner of the scale display will say either "kg" or "lb" to indicate if the measurement is occurring in kilograms or pounds. If the display indicates "lb," or pounds, press firmly on the button to the left of the display panel labeled "kg/lb." This button alternates the unit of measurement and should generate a "kg" in the display panel. The display should read **"0.00 kg" before starting the weight measurement.**
- Stand or kneel at the side of the scale. Ask the participant to step onto the center of the scale. Be sure that the participant does not step on the display panel or "kg/lb" button.
- Ask the participant to stand as still as possible with feet together and hands to her side. The participant should not be touching anything and should look straight ahead.
- Wait until the display panel has settled on one reading.
- Read and call out the weight in a low, audible voice.
- Write down the weight measurement, recorded in kilograms, to 2 decimal places on the Mother Anthropometry form (MAT7). Record the type of clothing the child was wearing during this measurement on the form, as well.
- Check the recording for accuracy and legibility.

ii. Adult Standing Height

- Guiding by the elbow, assist the participant onto the board. The participant's feet should be flat against the base of the board so that her body weight is evenly distributed.
- Stand to the right of the Shorr Board at a 45-degree angle to the board.
- Ask the participant to position her feet and legs into one of the following configurations:
    - **Both knees and feet together**
    - **Knees together and feet apart**
    - **Knees apart and feet together**
    - **Knees and feet apart, thighs together**

- Position the participant's arms so that they are hanging freely by her sides, with the palms facing her thighs.
- After the legs and arms are positioned, move the feet so that the mid-axillary line is perpendicular to the floor.
- Ask the participant to stand up straight. At this point, the participant's feet, head or buttocks may or may not be touching the back of the board. Correct positioning does not always necessitate that all points come into contact with the back of the board. Although, one point must touch the back of the board. Similarly, the participant's feet may not be on the base of the board with correct positioning.
- Inform the participant that you are going to position her head. Firmly cup (with a rounded, not a "V" grasp) the participant's chin with the left hand so that your hand goes around the participant's ear but is not covering the participant's ear or mouth. Your hand should also not be touching the participant's chest.
- Using the fingertips of your right hand, gently grasp the back of the participant's head.
- **Place the participant's head into the Frankfort Plane.** The Frankfort plane is determined by: Looking at the side of the participant's head, drawing an imaginary line from the bottom of the eye orbit to the participant's ear hole and then positioning the head so that the imaginary line is parallel to the floor and perpendicular to the Shorr Board.
- Before removing left hand from the participant's chin, re-check the positioning of the participant's head while simultaneously picking up the headpiece with your right hand.
- Once the positioning of the head is confirmed, remove hand and ask participant to maintain the position. Then place the headpiece firmly on top of the participant's head with sufficient pressure to compress the hair and make contact with the skull.
- Directly face the measuring index, when taking the reading. Measure the height in centimeters, to the nearest millimeter.
- Call the measurement out loud in a low, audible voice until recorded.
- Check the recording for accuracy and legibility. Record the type of clothing and any braids, hair ornaments, or hats that the participant was wearing when the measurement was taken.

c) Troubleshooting

It is imperative that the Research Assistant makes sure that the display on the scale reads "0.00 kg" before taking any measurements. If the display indicates an error, and no other scales are available, the Research Assistant should still take the measurement, indicating the exact error code that was displayed on the scale in the comments section. After the visit the Research Assistant should consult the user's manual for possible interventions. Each SECA Scale should be sent to SECA for calibration bi-annually.

The Shorr Boards should be examined for any damage approximately once a month. These boards are made of wood and it is therefore especially important to check for any potential splintering. Any damaged Shorr Board should be sent to Irwin Shorr Corporation for repair, or replaced with a new board.

4. Adult Blood Pressure

At Visit 7, the Research Assistant should obtain one set of 5 blood pressure measurements, each one-minute apart, from the participant using the Dinamap Pro100 or Dinamap Pro200 automated blood pressure recorder. The Research Assistant should note the time of day, pulse and room temperature at the time of measurement. Blood pressure varies from minute to minute, so it is necessary to take multiple readings. The readings will be averaged for data analysis.

Blood pressure is measured as systolic pressure/diastolic pressure. Systolic pressure indicates the pressure of the blood as it is pumped out of the heart and is the higher number displayed on the Dinamap monitor. Diastolic pressure indicates the pressure of the blood when the heart is relaxed, and is the lower number displayed on the monitor. The average blood pressure of an adult is 120/80. The average adult pulse is 60-80 beats per minute.

Before taking any measurements, the Research Assistant should first verify that a signed Maternal Consent Form has been obtained. If the participant has not yet decided to enroll in Project Viva, the Research Assistant should review the consent with the participant at the beginning of the visit.

a) Preparing for the Measurements

Blood pressure measurements should be taken with the participant sitting quietly and with her **right** arm extended in a manner that the **brachial artery is perpendicular to her heart.** This is easily accomplished by having the child sit in a chair with her arm, resting and palm facing up, on a table or desk. The arm should be kept straight and prevented from moving during the measurements. Furthermore, the participant should not speak during or between measurements. If the right arm is not available for taking the reading, the Research Assistant should attempt the measurement using the left arm. If this is unsuccessful, the Research Assistant may take a blood pressure reading on the participant's leg using the Posterior Tibial Artery. This attempt should begin with the right leg and then follow to the left, if needed.

The Dinamap machines come with 2 sets of cords, a gray cord and a light blue cord. The gray cord, with the threaded connectors ("screw-in") and colored cuffs will be used for the adult measurements. The Research Assistant should attach the gray cord to the Dinamap machine.

The colored Dinamap cuffs come in 6 different sizes: Infant, Child, Small Adult, Adult, Large Adult, and Thigh. It is critical that blood pressure measurements be taken with an appropriately sized cuff. A cuff that is too small can result in artificially high readings and a cuff that is too large can result in difficulty obtaining measurements. The Research Assistant should never assume that the participant naturally fits into an adult-sized cuff. Rather, **each participant must be "fitted" for the appropriate size cuff.** To do this the Research Assistant should first locate the brachial artery on the inside of the right arm using two or three extended fingers. The thumb should not be used to locate the artery. The brachial artery is located on the inside of the elbow, just above the elbow crease between the elbow and shoulder and slightly medial to the center of the arm (toward the body when arm is held palm up). The cuff should then be placed on a bare arm. The Research Assistant should hold the arm steady with one hand, align the "artery" arrow

on the cuff with the participant's brachial artery, and wrap the cuff snugly around the arm with the other. If the straight white line on the outer edge of the cuff falls within the "size range" indicated on the inside of the cuff, than the fit is correct. If the line is very close to or over the edge of the "size range," the Research Assistant should choose a cuff that is smaller or larger, as indicated. The fitting procedure should be repeated until the Research Assistant finds a cuff that appropriately fits the participant.

b) Taking the Measurements

After securing the correct cuff size, the Research Assistant should connect the cuff to the threaded connector on the gray cord. Importantly, the participant should be sitting quietly and should be instructed not to speak during or between readings.

The blood pressure measurements should be obtained using the following protocol:

- Turn the machine on by pressing the power button.
- Verify that the cuff and the participant are positioned correctly.
- Use the dial to set the machine. Turning the dial, effectively, "scrolls" through choices on the display screen and pushing the dial effectively "selects" a highlighted choice. Three important settings need to be established before taking the participant's blood pressure: set point, time interval, and auto/manual. For adults, the blood pressure set point is 170 mmHg. This means that the cuff will inflate with 170 mmHg of pressure before beginning to release pressure and take a reading. Next, set the machine to take readings at one-minute intervals. Finally, choose "auto," from the "auto/manual" option.
- Choosing "auto" will begin the measurement procedure.
- After each measurement, the machine will beep.
- At the time of the beep, the Research Assistant should record the systolic pressure, diastolic pressure, and pulse on the Maternal Blood Pressure Form (MBP7).
- The machine will automatically resume the next reading in approximately one minute.
- When five complete readings have been obtained, the Research Assistant should press "stop," and take the cuff off of the participant.
- It is important to note that a set of five, consecutive readings is required. **Obtaining a set of five consecutive readings (accurate blood pressure and pulse) will often take greater than five trials.**

The Mother's Blood Pressure Form allows for ten possible measurement trials, five on the first page and five on the second page. Additionally, at the top of each page, a field for the start time is indicated. Ten possible trials allow the Research Assistant to effectively obtain a complete set of readings. It is important to note that all measurements, including those with errors, should be recorded. If the machine displays an error code during one of the trials, the Research Assistant should record "-9" and the reason for the error in all applicable fields. The Research Assistant should similarly note the error, and any specific error codes displayed, in the comments section and continue with the measurements until five consecutive readings are obtained. Two examples follow:

E.g. 1: If three blood pressure measurements are obtained, an error code is displayed on the fourth trial, and then five successful measurements follow, the Research Assistant would code eight blood pressure readings in total. These readings would be recorded in order, including the error, in the first nine fields: the three initial readings (fields 1, 2and 3), the error trial "-9" (field 4) and the five consecutive readings (fields 5, 6, 7, 8 and 9). In this case, only one start time is needed and it would be indicated on the top of the first page.

E.g. 2: If three measurements are obtained and then the participant needs to stop and help tend to her child, the Research Assistant would discontinue the blood pressure protocol. She would attempt to return to the blood pressure measurements again at a later point in the visit. At this point, if five successful measurements were obtained, she would code eight blood pressure readings in total. These readings would be coded using all ten of the blood pressure fields, however: three initial readings (fields 1, 2, and 3), two blank fields (fields 4 and 5), and five consecutive readings (fields 6, 7, 8, 9, and 10). Importantly, two separate start times would be indicated, one on each page, reflecting the break from and return to measurement protocol.

- After visit completion, the Research Assistant should use the dial on the blood pressure machine to scroll through the measurements (which are automatically recorded) and to verify that the Mother Blood Pressure Form has been accurately coded.

Per protocol, if a participant's blood pressure meets or exceeds the following values in any of the last three blood pressure readings, the Research Assistant is instructed to refer the participant to their clinician:

- If the blood pressure meets or exceeds 140/90, the RA requests that the participant see their clinician within 2 months.
- If the blood pressure meets or exceeds 160/100, the RA requests that the participant see their clinician within one month.
- If the blood pressure meets or exceeds 180/110, the RA requests that the participant see their clinician within one week.

c) Troubleshooting

Any error code that the machine displays should be noted. The owner's manual should be referred to for possible interventions. Alternatively, the machine can be sent to GE Medical Services, 4502 Woodland Corp. Blvd, Tampa, FL 33614 for repairs. Each Dinamap machine is sent for calibration on a biannual basis.

D. Child Cognitive Protocols

At Visit 7, the Research Assistant should administer the Peabody Picture Vocabulary Test (PPVT) to any enrolled child older than two years of age and the Wide Range Assessment of Visual Motor Abilities (WRAVMA) to any enrolled child at or above three years of age. These measures are used to assess the child's verbal, visual-motor, visual-spatial, and fine motor skills.

Infant cognition was initially measured during the Project Viva six-month visit using a Visual Recognition Memory (VRM) Paradigm **(see Project Viva MOO)**. The cognitive measures obtained at V7 will be compared to the six-month cognitive data, as well as, to information obtained about dietary and other biopsychosocial factors.

Whenever possible, these developmental assessments should be completed prior to any uncomfortable measurement procedures and with minimal amounts of distraction. Optimally, the Research Assistant should be alone in the room with the child during the cognitive protocols. If the visit is held at the Viva office, the mother can be escorted to another room near the office. The participant is allowed to observe the testing through a window. If the visit occurs at the participant's home, the Research Assistant should ask for a private space in which to work with the child.

As with any study protocol, the Research Assistant should verify that a signed consent form is in existence before administering the tests. If the participant has not yet been enrolled in the study, the Research Assistant should review the necessary consents (Diet-Asthma and/or Child Consent Addendum) with the mother at the beginning of the visit.

1. Peabody Picture Vocabulary Test

The Peabody Picture Vocabulary Test (PPVT) measures verbal skill and is standardized starting at two years of age. This protocol is relatively quick and has a simple format. When completing cognitive protocols, it is preferable to start with the PPVT for two reasons. First, the relative ease of the protocol helps to acclimate the child to the cognitive tasks at hand. More importantly, the PPVT obtains information that is related to a specific aim of the Diet-Asthma grant. If for any reason the cognitive protocols cannot be completed in full it is preferable, therefore, to have obtained PPVT data over WRVMA data.

Detailed instructions for administering the PPVT are included with the standardized testing materials. The following information should be used as a guide however the standard testing instructions should be referred to if clarification or further assistance is needed.

a) Preparing for Testing

In addition to being administered in a private, well-lit, and quiet space, the PPVT should also take place at a table. A child table is present in the Viva office. If a child table is not available at a home visit, the Research Assistant should modify the child's chair (e.g. booster seat) so that the child can work comfortably.

Test materials should be arranged in a standardized fashion. The Research Assistant should position the Peabody Stimuli Booklet in a standing position and so that training plate "A" is facing the child's seat. The Peabody Score Sheet should be placed on a clipboard and kept behind the booklet, out of the child's view. **The Research Assistant should verify that the Peabody Score Sheet number (IIIA or IIIB) matches the testing booklet (IIIA or IIIB) number.**

Before beginning the testing, the Research Assistant should confirm the child's date of birth with the mother. This birth date, along with the testing date, should be carefully recorded on the front of the Peabody Score Sheet. After the visit, these two dates will be used to calculate the child's chronological age.

At this time, the Research Assistant should request that the mother leave the testing room. The child's chairs should be positioned so that the Research Assistant is able to see both the pictures that the child points to on the front of the testing booklet, as well as, the test instructions on the back of the testing booklet. This position is often achieved if the tester and testee sit catty-corner from one another at the table. It is important to remember that the instructions and score sheet should be kept from the child's view.

b) Administering the Test

Many children enjoy participating in the cognitive tasks and the protocol flows quickly. For some, however, it is difficult to maintain focused attention on the required task. If warranted, small breaks can be incorporated into the testing. When this is done the Research Assistant should note the stop and start time alongside the relevant question on the score sheet. If a child is overly distraught by the mother's departure, it is permissible to administer the test with the mother in the room. In this case the mother should be instructed to abstain from talking and otherwise interacting with the child as much as possible. The Research Assistant should record that the mother was present on the score sheet, as well.

As a standardized test, it is imperative that the Research Assistant adheres to the to the guidelines indicated in the instructions. For an overview of these guidelines see **Appendix R: V7 Cognitive Protocol.** Additionally, while it is natural to want to use personal language to maintain rapport, the cognitive tasks demand the use of standardized language, as indicated in the instructions. The use of standardized language assures that individual results are comparable to other results in the cohort. As an example, a common mistake that may bias data collection is to add an article before a word when giving instructions. In other words, instead of the required instruction *Show me cat,* one might say, *Show me a cat.* Even this small modification jeopardizes the integrity of the test results as an article gives the child a natural "clue" (articles of speech only precede nouns). Some of the standardized language is indicated below. The Research Assistant should refer to the cognitive guidelines and the Peabody Picture Vocabulary Test instructions for further information.

The test is first introduced to the child using training plates in the following manner:

- Beginning with training plate "A" say *I have some pictures to show you*
- Point to all four pictures on training plate "A" using a circular motion with your index finger, being careful to point to all four pictures equally. At the same time say, *see all these pictures on this page? I will say something then I want you to put your finger on the picture I say. Let's try one. Put your finger on ball.*
- If the child correctly points to the ball in quadrant 2, say, *Good! Let's try another one. Put your finger on dog.* If the child answers incorrectly, pint to the correct picture and

repeat the name saying, *No, good try. But this is ball. Now you show me ball.* Have the child point to the correct picture on his/her own.

- **In order to begin the test, the child must answer correctly, without help, at least 2 consecutive training words on BOTH training plate "A" and "B".** Once the child has done so, turn the booklet to page 1.

The test is then administered in the following manner:

- Telling the child you are going to begin the game now, use a circular motion with your index finger to point to all four pictures on page 1 equally. **Beginning with number 1 of set 1 on the scoring sheet** say, *Show me bus.*
- Record the quadrant number that the child points to in the response space on the scoring sheet. If the response is wrong, circle "E" for error AND write the incorrect response in the response space.
- Continue administering the test until the child answers 8 or more incorrect items in a 12 item set. It is not necessary that these incorrect items be sequential. Importantly, any set that has been started should be finished. Test administration should never stop mid-set.
- When the child has reached the error threshold (8 or more incorrect responses in a 12 item set), record the number of errors for each set in the **"No. of Errors"** box at the end of each set on the score sheet.

c) Scoring the PPVT

After administering the PPVT, the Research Assistant is responsible for scoring the test. The following items should be scored:

Ceiling Item: the last item in the last completed set should be recorded in the space marked "ceiling item."

Total Errors: Record the number of total errors (each DK is scored as an error) in the "total errors" space.

Raw Score: [Ceiling Item] – [Total Errors] = Raw Score. Record this number in the "raw score" space. Similarly, record the raw score on the Child Cognitive Test Form (CCT).

In general, results for the PPVT are not given to parents **(See Appendix AA: Cognitive Q & A).** An exception is made if the child's standard score is worrisome. If the standard score is at or below 70, the mother is notified **(see Appendix T: Cognitive Concerns Letter)** and advised to speak with her pediatrician. Attached to the letter is a sheet of the cognitive scores that the mother can bring to the pediatrician **(see Appendix T: Cognitive Low Score Sheet).** A score of 70 or below will occur in approximately 2.3% of the population.

d) Troubleshooting

Detailed instructions accompany the Peabody Picture Vocabulary Testing materials. The Research Assistant should refer to this manual for any necessary administration or scoring

clarifications. If additional clarification is necessary, David Bellinger can be contacted at 300 Longwood Ave, Children's Hospital, Boston, MA 02115, 617-730-0618, email: david.bellinger@childrens.harvard.edu. In order to assure accuracy, all PPVT results are double-scored by another Research Assistant **(Appendix AA: Cognitive QC)**

2. Wide Range Assessment of Visual Motor Abilities

The Wide Range Assessment of Visual Motor Abilities (WRAVMA) assesses non-verbal skills and is standardized starting at three years of age. The WRAVMA consists of a drawing task that measures visual-motor skills, a matching task that measures visual-spatial, and a pegboard task that measures fine motor skills.

Detailed instructions for administering the WRAVMA are included with the standardized testing materials. The following information is intended for use as a guide however the standard instructions should be referred to if clarification or further assistance is needed.

a) Preparing for Testing

Like the PPVT, the WRAVMA should be administered at a table in a private, well lit, and quiet space. A child table is available in the Viva office. At a home visit, if a child table is not available, the Research Assistant should work at another table taking care to modify the child's chair (e.g. booster seat) to accommodate the child. The child's chair should be positioned next to the Research Assistant with plenty of workspace on the table.

All test materials should be readily available to the Research Assistant but out of the child's sight. Materials needed include: *WRAVMA Matching Booklet, WRAVMA Drawing Booklet, Pegboard, a thick sharpened pencil with no eraser, and a timer.* The WRAVMA Examiner Form should be place on a clipboard and to the side, out of the child's view.

Before beginning the testing, the Research Assistant should write the child's name and the visit date on the front of the Matching Booklet and the Drawing Booklet. Additionally, the Research Assistant should verify the child's date of birth with the mother. After doing so, the child's name, date of birth, and the visit date should be recorded on the front of the WRAVMA Examiner Form. The Research Assistant should next ask the mother to leave the testing room.

b) Administering the Test

Many children enjoy participating in the cognitive tasks and the protocol flows quickly. For some, however, it is difficult to maintain focused attention on the required task. If warranted, small breaks can be incorporated into the testing. When this is done the Research Assistant should note the stop and start time alongside the relevant question on the score sheet. If a child is overly distraught by the mother's departure, it is permissible to administer the test with the mother in the room. In this case the mother should be instructed to abstain from talking and interacting with the child as much as possible. The Research Assistant should record that the mother was present on the score sheet, as well.

As a standardized test, it is imperative that the Research Assistant adheres to the to the guidelines indicated in the instructions. For an overview of these guidelines, see **Appendix R: V7 Cognitive Protocol.** Additionally, while it is natural to want to use personal language to maintain rapport, the cognitive tasks demand the use of standardized language, as indicated in the instructions. The use of standardized language assures that individual results are comparable to other results in the cohort.

The WRAVMA should be administered in the following order: Drawing Task, Matching Task, and Pegboard Task.

i. Drawing Task

Allow the child to use whichever hand he or she naturally chooses to draw with. Note which hand the child chooses. It is this hand that you will direct the child to use for the Pegboard task. To administer the drawing task take the following steps:

- Start with page 1, item 1 and say: *We are going to do some drawing. This man has two balloons, and they need some strings. I'll make this one.* (Research Assistant draws a line from the gray balloon to the man's right hand).
- Pointing to the green balloon say, *now, you do this one.* It is important not to make a vertical motion but to only point to the balloon.
- Hand the child the pencil and encourage him/her to begin drawing.
  - If the child is successful, praise the efforts and go to the next item.
  - If the child is unsuccessful or seems confused, repeat the directions and illustrate the task again, retracing your previous 'string'.
  - If the child is still unsuccessful, show the child how the second balloon's string would be drawn and proceed to the next item.
- Turn the page to item 2. Take the pencil from the child, point to item 2 and say, *here is a train riding on a train track. We need to finish the track. I'll do this one.* (Research Assistant draws the **upper** unfinished track from the left endpoint to the right endpoint.)
- Point to the left endpoint of the **lower** track and return the pencil to the child saying, *there, now you draw this one.* It is important not to make a horizontal motion but to only point to the left endpoint.
  - If the child is successful, proceed to the next item.
  - If the child is unsuccessful or seems confused repeat the directions and illustrate the task again, retracing your previous 'track'.
  - If the child is still unsuccessful, show the child how the lower track would be drawn and proceed to the next item.
- Continue similarly for the remainder of the items, using the WRAVMA instructions for guidance with scripted instructions. As each page of items has been completed, turn to the next page. Directions may be abbreviated or omitted once the child fully understands the task.
- The Research Assistant should score each item as the test proceeds (see scoring instructions below) and then return for a more detailed scoring after the visit is over. **Discontinue after 3 consecutive failed drawings.** If unsure whether the child has

successfully drawn an item, the Research Assistant should continue the test until confident about 3 failed items.

- Once the test is completed, take the pencil back from the child, as it is not needed for the remaining tests.

It is important to encourage the child's efforts, not his/her drawing, throughout the test. If the child begins on the next picture or starts to draw elsewhere on the page, encourage him or her to complete the assigned item by saying, *finish the one you started.* Further encourage the child to draw the pictures roughly the same size as those shown in the booklet by saying, *Try to draw it about the same size as this one.* If the child is distracted by other pictures on the page it is okay to cover all but the assigned item with a piece of cardboard or paper.

It is the Research Assistant's responsibility to control the child's pace and provide support throughout testing. The child can turn the pages in between items as a way to maintain his/her interest. If after completing the test, the child wishes to continue drawing, allow him/her to do so if time permits. The completion of the Drawing Task is a natural break point if the child needs a few moments to stretch or walk around the room.

ii. Matching Task

To administer the Matching Task use the following steps:

- Using the Matching Booklet, point to the antlered deer in the left box (item 1) and say, *see this? Which one from down here* (point to the selections below with a rotating movement around the four figures) *goes best with this one?* (Point again to the antlered deer in item 1). Then say, *Point to the one* (pointing to the selections with a rotating movement) *that goes best with this one* (point to the standard).
  - If the child answers correctly, praise the child for his/her efforts and proceed to item 2.
  - If the child is tentative or seems confused, repeat the directions and encourage a response.
  - If the child answers incorrectly say, *No, that's not it. See, it's this one* (pointing to the antlered deer in the lower box) *that goes best with the one up here* (again point to the deer in the upper box). *Now you point to the one that goes best with this one* (pointing to item 1 again). The Research Assistant should avoid giving verbal explanations for why the match is correct.
- Proceed to item 2. Say, *Here's the next one. It's like a puzzle. See* (pointing) *a piece is missing. Which piece goes best with this one?* (Pointing to the spot where the piece is missing).
  - If the child answers correctly, praise the child for his/her efforts and proceed to item 3.
  - If the child is tentative or seems confused, repeat the directions and encourage a response.
  - If the child responds incorrectly, say, *No, that's not it. See, it is this one* (pointing to the correct alternative). *This one goes best with the one up here* (pointing to the

standard). *Now you point to the one that goes best with the one up here* (pointing to the standard). The Research Assistant should avoid giving verbal explanations for why the match is correct.

- Continue similarly for the remainder of the items, using the WRAVMA instructions for guidance with scripted instructions. As each page of items has been completed, turn to the next page. Directions may be abbreviated or omitted once the child fully understands the task.
- The Research Assistant should score each item as the test proceeds and then return for a more detailed scoring after the visit is completed. **Score the child's first choice only.**
- **Discontinue after 6 out of 8 items are incorrect.** If unsure about the correctness of an item, the Research Assistant should continue the test until confident about 6 failed items. It is better to do too many rather than too few items.

It is the Research Assistant's responsibility to control the child's pace and provide support throughout testing. The Research Assistant should cover all but the assigned item with a piece of cardboard or paper to minimize distractions. The child can turn the pages in between items as a way to maintain his/her interest.

It is important to encourage the child's efforts. It is permissible to tell the child that choices don't always "exactly match" and to encourage him or her to find the choice that *goes best with* the standard. If the child seems to be randomly choosing items, encourage him or her by saying, *Take your time and be sure to find the one that goes best with the one on top.* If the child still seems "stumped" encourage the child to make a *best guess* and then proceed to the next item. The completion of the Matching Task is a natural break point if the child needs a few moments to stretch or walk around the room.

iii. Pegboard Task

Before beginning the pegboard task, the Research Assistant should remove the lid from the pegboard storage bin. During the demonstration phase, the pegboard should remain close to the Research Assistant. However, once the testing begins the pegboard should be placed on the table with the peg bin oriented toward the child. During the pegboard task, the child should be directed to use his or her dominate hand, the hand he or she naturally chose to work with during the drawing and matching tasks.

To administer the pegboard task take the following steps:

- Start by demonstrating the pegboard task. Say, *Watch how I put some pegs in this board.* With the child watching, pick up one peg from the bin and place it accordingly:
  - If the child is **right-handed,** place the peg in the hole in the top left of the pegboard.
  - If the child is **left-handed,** place the peg in the hole in the top right hole of the pegboard.
- Place a second and then a third peg in the row, working sequentially and without skipping any spaces. From the perspective of a right-handed child, the pegs will be seen in a left-

to-right direction. From the perspective of a left-handed child, the pegs will be seen in a right-to-left direction. Leave these pegs in the pegboard.

- **Before beginning the practice phase** move the pegboard directly in front of the child and approximately 6-12" from the edge of the table. The peg bin should be closest to the child and the board should be positioned so that the child can comfortably work, taking the child's reach into consideration.
- **Do not allow the child to touch the pegs until the practice has begun.**
- Ask the child to place three pegs in the pegboard, as demonstrated by the Research Assistant. *Now it's your turn. This hand is going to work* (tap the child's dominate hand). *Your other hand* (tap the child's non-dominant hand) *is going to rest. You can put it in your lap or behind your back. For practice, put a few pegs in this row, one right after the other* (point to the 4th hole of the row started by the Research Assistant). *Pick up only one peg at a time and don't skip any holes.*
- The Research Assistant should be confident that the child understands the task before beginning the official testing phase. If needed, direct the child by saying: *use only one hand, just use one peg at a time, or please don't skip any holes.*
- **Before beginning the test phase,** remove all pegs from the board and return them to the bin.
- **Set the timer for 90 seconds.**
- Proceed to the following directions, which should be said with a noticeable pause after each component: *Good. Now when I say begin, see how many pegs you can put in until I say stop. Remember; only use this hand* (tapping the dominant hand). *Start here* (point to the first hole the Research Assistant started with) *and put pegs in the holes of this row* (motion along the row in the correct direction). *If you finish this row, go on to the next row* (pointing to the hole under the first peg and motioning along the second row in the same direction as the first). *Keep working like this* (motioning along the third and fourth rows in the same direction as the first and second) *until I say stop. Remember; work as quickly as you can. Don't skip any holes. Pick up only one peg at a time.*
- Ask, *Any questions?* If none, say, *Start.* **Begin timing when the child first touches a peg.**
- Allow 90 seconds and then say, *Stop.*

The Research Assistant should quickly correct the child whenever any aspect of the procedure is violated, in order to ensure the task is done properly. The Research Assistant should further encourage the child to move quickly without telling the child it is "a race." The Research Assistant should avoid pressuring the child.

Many young children will want to use both hands during the test. If the child is using one hand to place the peg in the other hand before placing the peg in the pegboard, that is acceptable as long as the child is consistently using the same hand to place the pegs into the board.

If the child selects only one color of pegs during the test, correct him or her by saying *Use all of the colors. Make a rainbow!* If a peg is dropped off the board during the test, the Research Assistant should quickly obtain it and hold onto it while encouraging the child to

use another peg and continue to work. If the child uses more than one peg at a time the Research Assistant should remind the child to use only one peg while guiding the child's hand back to the bin to deposit the extra pegs. If the child inadvertently knocks a peg that has already been placed out of the board, the Research Assistant should encourage the child to continue working. The Research Assistant should also replace the dislodged peg as soon as it is not disruptive to do so.

c) Scoring

i. Drawing Task

The Drawing Test-Scoring Guidelines provided by WRAVMA indicate specific criteria that must be met for each item in the drawing task. For each item, ALL criteria must be met for an item to be considered correct. If in doubt the child should be credited. The child should not be penalized for size discrepancy. The following steps should be taken when scoring each item:

- Score only the child's first attempt for each item.
- Check the space next to the criteria listed for each item when the child's drawing fulfills the description.
- If ALL criteria are not met, circle the item number. **This indicates a failed item.**
- Stop administering the test after the child fails 3 consecutive items.
- **1 point** is awarded for each correct item. Record the total number of correct items in the "Drawing Raw Score" space on the front of the WRAVMA Examiner Form.
- Using the Raw Score, look up the Standard Score in the WRAVMA Scoring Guide. Record the "Drawing Standard Score" in the space provided on the front page of the WRAVMA Examiner Form.
- Record the Raw and Standard Scores on the Child Cognitive Test Form (CCT).

ii. Matching Task

The correct responses for each item are indicated next to each item number on the Examiner's Score Sheet. If in doubt about a correct response the child should be credited. The following steps should be taken when scoring each item:

- **1 point** should be awarded for each correct answer.
- Indicate an incorrect response by circling the shaded area to the left of the item number.
- For ease of scoring, symbol sequences are repeated in blocks of eight. **6 incorrect responses out of 8 items presented** must be reached before ending the task.
- The **Raw Score** is calculated by adding the total number of correct responses. The Raw Score should be recorded in the space indicated, "Matching Raw Score," on the front of the Examiner's Score Booklet.
- Using the Raw Score, look up the **Standard Score** in the WRAVMA Scoring Guide. Record the "Matching Standard Score" in the space provided on the front page of the WRAVMA Examiner Form.
- Record the Matching Raw Score and the Matching Standard Score on the Child Cognitive Test Form (CCT).

iii. Pegboard Task

The following steps should be taken when scoring the pegboard task:

- Determine the total number of pegs inserted in 90 seconds. (For ease of counting, note that each row has ten holes).
- **1 point** is awarded for each peg.
- The **Dominant Hand Raw Score** is calculated by adding the total number of pegs and should be recorded on the front of the WRAVMA Examiner's Score Booklet in the space marked "Pegboard Raw Score."
- Using the Dominant Hand Raw Score, look up the **Standard Score** in the WRAVMA Scoring Guide. Record the "Pegboard Standard Score" in the space provided on the front page of the WRAVMA Examiner Form.
- Record the Pegboard Raw Score and the Pegboard Standard Score on the Child Cognitive Test Form (CCT).

d) Troubleshooting

Detailed instructions accompany the WRAVMA Testing materials. The Research Assistant should refer to this manual for any necessary administration or scoring clarifications. In order to assure accuracy, all WRAVMA results are double-scored by another Research Assistant **(Appendix AA: Cognitive QC).** If additional clarification is necessary, David Bellinger can be contacted at 300 Longwood Ave, Children's Hospital, Boston, MA 02115, 617-730-0618, email: david.bellinger@childrens.harvard.edu

E. Adult Cognitive Protocols

At Visit 7, the Research Assistant should administer the Peabody Picture Vocabulary Test (PPVT) to any enrolled mother. This test measures verbal skills and the results will be compared to child cognitive results to identify potential familial patterns.

Whenever possible, the PPVT should be completed prior to any uncomfortable measurement procedures and with minimal amounts of distraction. Optimally, the Research Assistant should administer the PPVT at a time that the mother can fully concentrate and that the child is quietly occupied (e.g. reading a book or coloring).

As with any study protocol, the Research Assistant should verify that a signed consent form is in existence before administering the test. If the participant has not yet been enrolled in the study, the Research Assistant should review the consent with the mother at the beginning of the visit.

1. Peabody Picture Vocabulary Test

The Peabody Picture Vocabulary Test (PPVT) measures verbal skill and is standardized starting at two years of age. This protocol is relatively quick and has a simple format. Detailed instructions for administering the PPVT are included with the standardized testing materials.

The following information should be used as a guide however the standard testing instructions should be referred to if clarification or further assistance is needed.

a) Preparing for Testing

In addition to being administered in a private, well-lit, and quiet space, the PPVT should also take place at a table. Likewise, test materials should be arranged in a standardized fashion. The Research Assistant should position the Peabody Stimuli Booklet in a standing position and so that training plate "C" is facing the participant's seat. The Peabody Score Sheet should be placed on a clipboard and kept behind the booklet, out of the participant's view. **The Research Assistant should verify that the Peabody Score Sheet number (IIIA or IIIB) matches the testing booklet (IIIA or IIIB) number.**

Before beginning the testing, the Research Assistant should confirm the participant's date of birth. This birth date, along with the testing date, should be carefully recorded on the front of the Peabody Score Sheet. After the visit, these two dates will be used to calculate the participant's chronological age.

The participant's chairs should be positioned so that the Research Assistant is able to see both the pictures that the participant points to on the front of the testing booklet, as well as, the test instructions on the back of the testing booklet. This position is often achieved if the tester and testee sit catty-corner from one another at the table. It is important to remember that the instructions and score sheet should be kept from the participant's view.

b) Administering the Test

Typically, the PPVT protocol flows quickly. If any interruption occurs (e.g. child needs attention), the Research Assistant should note the stop and start time alongside the relevant question on the score sheet. The Research Assistant should record any interruptions or distractions on the score sheet, as well.

As a standardized test, it is imperative that the Research Assistant adheres to the to the guidelines indicated in the instructions. For an overview of these guidelines see **Appendix R: V7 Cognitive Protocol**. Additionally, while it is natural to want to use personal language to maintain rapport, the cognitive tasks demand the use of standardized language, as indicated in the instructions. The use of standardized language assures that individual results are comparable to other results in the cohort. As an example, a common mistake that may bias data collection is to add an article before a word when giving instructions. In other words, instead of the required instruction *Show me cat,* one might say, *Show me a cat.* Even this small modification jeopardizes the integrity of the test results as an article gives the child a natural "clue" (articles of speech only precede nouns). Some of the standardized language is indicated below. The Research Assistant should refer to the guidelines and the Peabody Picture Test instructions for further information.

The test is first introduced to the participant, using a training plate, in the following manner:

- Beginning with training plate "C" say, *"We're going to do this in the same way as we did with your son/daughter. Let's try a couple of practice one's first".*
- Point to all four pictures on training plate "C" using a circular motion with your index finger, being careful to point to all four pictures equally. At the same time say, *"There are four pictures on this page. Each is numbered. I will say a word and then I want you to tell me the number of, or point to, the picture that best tells the meaning of the word. Let's try one. Which picture best describes parrot?"*
    - If the participant correctly points to the parrot in quadrant 2, say, *great! Let's try another one. Which number is scissors?*
    - If the participant answers incorrectly, point to the correct picture and repeat the name saying, *No, actually, this is parrot. Let's try again. What number is parrot?* Have the participant point to the correct picture on his/her own.
- **In order to begin the test, the participant must answer correctly, without help, at least 2 consecutive training words on BOTH training plate "C" and "D".**
- Turn the booklet to **set 13, item 145** (Note: The Research Assistant will need to flip the booklet around completely and use the other side of the booklet pages at this point).

The test is then administered in the following manner:

- Telling the participant that you are going to begin, use a circular motion with your index finger to point to all four pictures equally. **Beginning with number 145 of set 13 on the scoring sheet** say, *here are four pictures again. Which picture describes syringe?* Or *which picture is syringe?* Or *what number is syringe?*
- Record the quadrant number that the child points to in the response space on the scoring sheet. If the response is wrong, circle "E" for error AND write the incorrect response in the response space.
- Continue administering the test in this manner.
- **If the participant makes 2 or more errors in set 13**, the Research Assistant should go back to set 12 and continue administering the test from there. Continue backwards in sets until the participant makes 0 or 1 error(s) within a set. Move forward to set 14 only if the participant makes 0 or 1 error(s) in set 12. **If, however, the participant makes 8 or more errors in set 13**, the Research Assistant should not continue to set 14.
- Discontinue administration when the participant makes **8 or more errors in a 12-item set**. It is not necessary that these errors be sequential. Importantly, any set that has been started should be finished. Test administration should never stop mid-set.
- When the child has reached the error threshold (8 or more incorrect responses in a 12 item set), record the number of errors for each set in the **"No. of Errors"** box at the end of each set on the score sheet.

c) Scoring

After administering the PPVT, the Research Assistant is responsible for scoring the test. The following items should be scored:

Ceiling Item: the last item in the last completed set should be recorded in the space marked "ceiling item."

Total Errors: Record the number of total errors (each DK is scored as an error) in the "total errors" space.

Raw Score: [Ceiling Item] – [Total Errors] = Raw Score. Record this number in the "raw score" space. Similarly, record the raw score on the Mom Cognitive Test Form (MCT).

PPVT results are not given to participants **(See Appendix AA: Cognitive Q & A)**. It is important, therefore, to try and have the participant feel positive about her efforts. Making the experience a "human interaction" detracts attention from the score. Additionally, the Research Assistant can share the importance of the cognitive testing for Project Viva research, overall, without talking specifically about individual results.

d) Troubleshooting

Detailed instructions accompany the Peabody Picture Vocabulary Testing materials. The Research Assistant should refer to this manual for any necessary administration or scoring clarifications. If additional clarification is necessary, David Bellinger can be contacted at 300 Longwood Ave, Children's Hospital, Boston, MA 02115, 617-730-0618, email: david.bellinger@childrens.harvard.edu. In order to assure accuracy, all PPVT results are double-scored by another Research Assistant **(Appendix AA: Cognitive QC)**