DOCUMENTATION

for

PSYCHOPHYSIOLOGY PROTOCOL

in

MIDUS 2 BIOMARKER PROJECT (P4)

University of Wisconsin ♦ Institute on Aging
April 2024

INTRODUCTION

This document provides an overview of the psychophysiology experimental protocol (laboratory challenge study) included in the MIDUS 2 Biomarker Project (P4) protocol. It provides detailed information about the protocol and data processing procedures, as well as descriptions of variables created and basic guidance about their usage. Information is also included about construction and usage of administrative and computed variables.

Data users are also encouraged to review the "M2 P4 Biomarker Project Data File Notes". This document provides general information about naming conventions, as well as administrative and filter variables included in the data file. It also includes information about how we handled missing values and other issues that arose over the course of the study. For example, there are instances when variables were added or sections of an instrument were expanded for data entry purposes to accommodate additional information provided by the respondent.

This document will be periodically revised and updated as more information is gathered and as researchers continue to work with the MIDUS 2 Biomarker data. If there are suggestions or comments, please submit a message through the MIDUS HelpDesk (http://midus.wisc.edu/helpdesk.php).

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SECTION A

OVERVIEW OF DATA FILE AND COLLECTION PROTOCOLS

OVERVIEW OF DATA FILE AND COLLECTION PROTOCOLS

The Biomarker Project (P4) Psychophysiology protocol is conducted in the morning on the second day of the GCRC visit. The psychophysiology session is a standard, laboratory-based stress reactivity protocol and incorporates diverse measures from multiple sources as follows:

- Protocol Flowsheet (includes a Hand Usage Questionnaire)
- Salivary Samples for Cortisol assays
- Physiological measures of Stress Reactivity and Recovery
- Data Quality Filter variables

As described in the "M2 P4 Biomarker Project Data File Notes", the naming convention organizes variables according to the method used for data collection. We have followed this convention with respect to the psychophysiology data, thus analysts using saliva cortisol data in combination with flowsheet and/or stress reactivity and recovery data will need to pull variables from different sections of the data file as indicated below.

Revision in the 2024 Update Release

In the previous release, the MIDUS 2 high frequency (HF) heart rate variability measure used a 0.15-0.50 Hz band, while MIDUS Refresher and MIDUS 3 data used a narrower band (0.15-0.40 Hz). The 0.15-0.40 Hz band comparable with MR1 and M3 data is added in this update. The new variables are identified as HF (high freq HR variability) and LHF (natural log of HF-HRV) for each session period. The original, wider-band HF and LHF variables have been re-named to HF5 and LHF5. See example below:

Variable	Variable Label	Note
B4VB1HF	B1 HF-HRV, high freq HR variability, 0.15-0.40 Hz	added in the update release
B4VB1LHF	B1 natural log of HF-HRV, 0.15-0.40 Hz	added in the update release
B4VB1HF5	B1 HF-HRV, high freq HR variability, 0.15-0.50 Hz	renamed from B4VB1HF to B4VB1HF5
B4VB1LHF5	B1 natural log of HF-HRV, 0.15-0.50 Hz	renamed from B4VB1LHF to B4VB1LHF5

Protocol Flowsheet

The flowsheet variables appear in the data file immediately after the Actiwatch® data. Following the MIDUS naming convention, the variable names for the flowsheet data begin with the unique three characters set "B4V".

A copy of the flowsheet, with variable names added, can be found in Section B (below). Variable names generally appear to the right of the item they represent in brackets and bold capitals, however in some sections of the flowsheet they appear to the left of the item on the check line. See for example the second page of the flowsheet "Study start time **[B4VST]**" or the fourth page **[B4VS1T]** Collect Saliva Sample #1".

The first page of the flowsheet is a modification of the Edinburgh Handedness Inventory. This set of items was used to construct standardized indicators of laterality. Details about constructing laterality scores can be found in the "Documentation for Psychosocial Constructs and Composite Variables".

The second page of the flowsheet, contains questions about physical characteristics of the participant, and other factors that may influence experimental outcomes (e.g. consumption of caffeine, nicotine etc.), as well as a template providing an overview of the protocol order.

The remainder of the flowsheet is the detailed protocol followed by staff during the psychophysiology session. Saliva samples were collected at designated points in the protocol, along with stress ratings. Staff recorded the saliva collection times and the stress ratings in designated spaces in the flowsheet for subsequent data entry.

Salivary Cortisol

Saliva samples were collected for cortisol assay to provide a measure of neuroendocrine reactivity. Cortisol is a biomarker; thus, these data appear in the data file with the other biomarker data immediately following the Physical Exam data. Consistent with the naming convention for the biomarker data, the variable names for the saliva cortisol values begin with the unique 3-character set "B4B".

The samples were collected at four time points: 1) baseline (prior to attaching the ECG leads and other monitors); 2) immediately after the second cognitive stress task; 3) immediately after the orthostatic challenge; 4) 30 minutes after the orthostatic challenge. At the designated time respondents removed the cotton swab from the Salivette®, placed it in their mouth, chewed it until saturated, and then put the swab back in the tube and replaced the cap. At the end of the session, salivettes were stored in a -80°F freezer.

There are 3 sets of saliva cortisol variables. Each set contains 4 variables, one for each of the four samples collected. The saliva cortisol assay was run in duplicate for about half the Biomarker sample. We stopped running duplicates when it was determined that the cortisol assay provided high quality, reliable results. The three sets of variables therefore correspond to 1) values from the initial assay, 2) the duplicate assay for n=621 case, and 3) a final set of values corresponding to the 'average' cortisol value across the first two sets. The 'average' values were created for all cases to provide a single consistent variable for each sampling time that could be used in analysis. For cases that were not run in duplicate, the 'average' cortisol values are the same as those from the initial assay. The third set of values includes a fifth variable representing the average cortisol level across the 4 samples in this final set of "averaged" values.

For additional information about the saliva cortisol assay see the "M2 P4 Blood-Urine-Saliva Data Documentation" and the "M2 P4 Biomarker Project Data File Notes".

Psychophysiological Stress Reactivity and Recovery:

A detailed description of the psychophysiology protocol can be found in Section C. It provides a detailed outline of the protocol and descriptions of a subset of the measures and variables included in the data file, specifically, heart rate (HR), heart rate variability (HRV), and salivary cortisol. Details about the new variables comprising the expansion can be found in Section E (blood pressure (BP) and Section F (respiration) below.

These variables appear in the data file immediately after the Actiwatch® data. Data from flowsheet items, beginning with responses to the handedness questionnaire, are listed first, followed by variables specific to the psychophysiology protocol. The variable names for the reactivity data begin with the unique three characters set "B4V".

The section of the data specific to the protocol begins with two administrative variables:

- B4ZPPHYS – categorical variable indicating whether the psychophysiology session was completed or not, and if not the point in the period in which the session was terminated.

- B4ZPHYSD – categorical variable indicating whether the full set of physiological measures was obtained, and if not which measure is not available.

Heart Rate Variability (HRV) Filter Variables:

Details about these variables can be found in Section D below. Two sets of filter variables were created to facilitate analysis of cardiovascular reactivity data. The first set of variables indicates overall data quality for the session, while the second set indicates data quality for each period in the session.

These variables appear in the data file immediately after the above administrative variables (B4ZPPHYS, B4ZPHYSD).

Blood Pressure (BP) Data

The continuous blood pressure signal was used to compute standard measures of blood pressure (BP) and blood pressure variability (BPV). In addition, the data include standard measures of baroreflex sensitivity, which represent the modulation of BP through heart rate change. Details about the variables generated, including data quality flag variables, can be found in Section E below, along with details about data processing, variable naming and relevant citations.

Note, continuous blood pressure measurement was added to the Biomarker psychophysiology protocol after data collection began, thus this data is not available for all participants. The variable B4ZPHYSD can be used to identify cases for which no BP data is available. These variables appear in the data file immediately after the HRV variables.

Respiration (RSP) Data

Respiration was monitored continuously during the protocol by inductive plethysmography using the Portable Inductotrace system (Bio-logic Systems Corp.®, Mundelein, Illinois). This data set contains the mean respiration rate, in breaths per minute units, for each protocol period in the Psychophysiology protocol.

Heart rate variability in the high frequency range is influenced by respiration (Allen, Chambers, & Towers, 2007; Paul Grossman, Karemaker, & Wieling, 1991; Paul Grossman & Taylor, 2007; P. Grossman, Wilhelm, & Spoerle, 2004). In the psychophysiology literature, HF-HRV parameters are often adjusted for respiration rate prior to hypothesis testing analyses. Thus, users may want to compute respiration-adjusted values of HF-HRV. Details about computing respiration-adjusted values can be found in Section F along with details about how the respiration data were collected and processed.

SECTION B

PSYCHOPHYSIOLOGY PROTOCOL FLOWSHEET

APPENDIX: PSYCHOPHYSIOLOGY BLOOD PRESSURE TERMINATION CRITE

MIDUS PROJECT 4 PSYCHOPHYSIOLOGY PROTOCOL

Participant ID:_____

Date of Hand Usage Measure: ____/____/____
mm dd yyyy

NOTE: Please administer Hand Usage measure the night before the psychophysiology session.

Hand Usage Questionnaire:

Please indicate your hand usage preferences in the following activities. Put an X in the appropriate column. If with any activity you use ***both hands*** *confidently,* mark the "Either hand or both hands" column.

Some of the activities require both hands. In these cases, the part of the task or object for which hand preference is wanted is indicated in brackets. Try to answer all the questions, and only leave a blank if you have no experience at all with the object or activity.

	Strongly Left hand	Left hand	Either hand or Both hands	Right hand	Strongly Right hand
1. Writing **[B4VHAWR]**					
2. Drawing **[B4VHADW]**					
3. Throwing **[B4VHATH]**					
4. Scissors **[B4VHASC]**					
5. Toothbrush **[B4VHATO]**					
6. Knife (without fork) (e.g. cutting vegetables **[B4VHAKN]**					
7. Spoon **[B4VHASP]**					
8. Broom [upper hand] **[B4VHABR]**					
9. Striking Match [match] **[B4VHASM]**					
10. Opening box [lid] **[B4VHAOB]**					
	Strongly Left foot	Left foot	Either foot	Right foot	Strongly Right foot
i. Which foot do you prefer to kick with? **[B4VHAKI]**					
	Strongly Left eye	Left eye	Either eye	Right eye	Strongly Right eye
ii. Which eye do you use when using only one? (e.g. using a camera) **[B4VHAOE]**					

Participant ID:_____

Date of Psychophysiology session: ____/____/____
mm dd yyyy

Site ID:
UCLA 1
Wisconsin 2
Georgetown 3

Protocol performed in:
Participants' room alone 1
Participants' room with another present 2
Conference room alone 3
Other, Specify: 4

Missing Data Codes: use throughout flowsheet
Don't Know = 7, 97, 997 etc.
Refused/Missing = 8, 98, 998 etc.
Inapplicable = 9, 99, 999 etc.

Study Start time **[B4VST]** _____ :_____ a.m. p.m.

"What time did you last eat something?" **[B4VATEH]** _____ :_____ a.m. p.m.

Make sure participant had some calorie intake (juice/milk) before study. If not, provide snack to the participant

"What time did you last drink a caffeinated beverage?" **[B4VCAFH]** _____ :_____ a.m. p.m.

If a smoker, "What time was your last cigarette?" **[B4VCIGH]** _____ :_____ a.m. p.m.

Participant Measurements: Height(cm) Weight(kg)

Participant Age: _____yrs DOB___/___/___
m d y

Is Participant color blind? NO_ YES__ **[B4VCLB]** If Yes, blind to which colors? __**[B4VCLBT]**____

STAFF, next question is here in case of Finometer problems. May help understand a physiological reason for poor readings.
Does Participant have diagnosed Raynaud's Syndrome (circulatory disorder characterized by cold hands may affect Finometer BP data) or other diagnosed circulation problems? NO_____ YES_____**[B4VCIRC]**
If YES, describe:_____

GAcq Data Acquisition

STUDY TEMPLATES: c:\Program Files\Ledona Solutions\MIDUS 1.tpl or MIDUS 2.tpl **No. Of periods: 12**
Data acquisition: **C:\ DATA\MIDUS\PHYSDATA**
COM Ports: GAcq-to-Actor: COM1 **Acquistion PC to Finometer (finolink): COM_____**

Scheduler

Period Number	Period Name	File Prefix	Period Description	P'pant Activity	Duration (sec)
1	C1	42??????C1	Waveform Calibration		600
2	N1	42??????N1	NADA1		600
3	C2	42??????C2	Seated calibration		280
4	B1	42??????B1	Baseline 1		660
5	M1	42??????M1	MATHTurner*	MATHTurner	360
6	R1	42??????R1	Recovery 1		360
7	S1	42??????S1	Stroop*	Stroop	360
8	R2	42??????R2	Recovery 2		360
9	N2	42??????N2	Saliva Sample 2 (NADA2)		120
10	N3	42??????N3	Standing Transition (NADA3)		600
11	C3	42??????C3	Standing Calibration		280
12	U1	42??????U1	Standing (Upright)		360

* GAcq will automatically and randomly select order of presentation of PASAT and Stroop

Sampling Configuration: Summary

Signal	Amplifier	A/D Channel	**F_s (sampling rate)
ECG	ECG amplifier	0	500
BP	Finometer	1	500
Respiration (chest)	Inductotrace	4	20
Respiration (abdomen)	Inductotrace	5	20

Study Setup

Before participant arrives:

_____ Prepare room as needed (e.g. close blinds, remove pictures from wall, arrange chairs).

_____ Get MIDUS participant ID#

_____ Get saliva cortisol supplies

_____ Turn on all the computers and physiological monitors. Check that all cable connections are in place.

_____ Check X-keys Stick keypad on Stimulus PC. Run Macro Manager and confirm that the Stimulus PC "sees" the Stick Keys device and that the Associated Layout is: **C:\midus\Xkey\MIDUS_XKeyStick.xk8**

_____ Turn on the Finometer and start the Finolink software's Monitor function on Acq PC. Check that Finolink directory is set to **c:\data\midus\physdata**

_____ Be sure data folder **C:\data\midus\physdata** on Acquisition PC is **empty** (all files from prior sessions should have been moved to individual folders named with Participant ID number).

_____ Create new participant folder on Acquisition PC: In **C:\data\MIDUS\Archive** create a new folder with same Subject ID used for the Gacq output files: 42BCCCCC (B= site ID; C= MIDUS Subject ID)

After participant arrives:

When **P** arrives, interview him/her and fill in the demographic information on the first page of the protocol flowsheet. Inform **P** about the procedures and give instructions:

"In this part of the study, we are going to collect information on your heart rate, blood pressure and breathing while you rest quietly and during some challenging tasks. I am also going to place three electrocardiogram leads on you to measure your heart rate; two on your collarbones and one on your abdomen. Next, I am going to place stretch bands on your abdomen and your chest. These bands measure respiration. I will also place a blood pressure cuff on your upper arm and on your finger. During the lab session you will perform two challenging tasks and then you will move from the seated to the standing position. One task is a color-word matching task. The other is a simple arithmetic task. After you complete these two tasks, we'll ask you to get out of the chair and stand still for a few minutes. You'll be able to lean against the wall while standing."

We monitor heart rate, blood pressure and breathing rate during all the activities I told you about. Whether or not we move to the next activity in the session depends on the readings at the previous stage. If any of your readings reaches a standard cutoff level specified for this study during any of the activities, I'll tell you that we will stop the session now. Then I will ask you to relax for a few minutes.

This is a standard procedure, so please do not worry if we stop the session. The data we collect will be very useful regardless of when the procedure is stopped and will help us understand better how stress affects the way the heart works in many different kinds of people.

_____ Remind **P** that the session is about an hour and a half long, so if he/she needs to use the restroom, now is the best time.

_____ Ask **P** to change into hospital gown.

_____ Ask **P** to **turn off pager, cell phone, palm devices, and all other beeping devices**. Ask **P** to **remove wrist watch** and all jewelry from the arm from which you will collect blood pressure readings. Put **wristwatch out of view** so **P** will not be able to track clock time during the study.

"The first thing I would like to do while you are standing is collect a saliva sample. Then, while you remain standing, I will place three electrodes on your upper body to collect heart rate data. I will also place respiration bands around your chest and abdomen to record your breathing."

[B4VS1T] **Collect saliva sample #1 Time___ ___ : ___ ___ am=1 pm=2**

Saliva Collection Instructions:

a) Take cap off saliva collection tube (DO NOT Separate the two tubes), set aside
b) **"Put the swab in your mouth and chew it for at least one minute until it is saturated."**
c) Put saturated swab back in tube; with the smaller tube inside the larger, outer tube; replace cap.

_____ Attach ECG electrodes and Inductotrace bands while **P** is standing; use alcohol preps to clean area.

[B4VLC] Optimal Lead Configuration (use & **circle** whichever one gives best signal):
1. Upper Right and Upper Left 1
2. Upper Right and Lower Left (just above ground)..... 2
3. Other (specify) 3

Move the upper electrodes closer to each other on a horizontal line (toward center of chest) and slightly lower if you get a bad signal with the standard arrangement.

_____ Attach Inductotrace cables to the Inductotrace unit.
1. White leads for Chest band, Black for Abdominal
2. Bands go outside of gown, but shouldn't restrict ECG cables

_____ Seat **P** in chair; encourage her/him to find a comfortable position.

"Please sit down in a comfortable position. Keep in mind that you will be sitting in this position for quite some time and therefore it is important that you are reasonably comfortable. I understand that it will be slightly uncomfortable with all this stuff on."

"Now I am going to place a blood pressure cuff on your non-dominant arm and on your middle finger. Please let me know if anything feels too tight. The finger cuff will pulse throughout the session. Every now and then I will relax it to give you a break, but your finger might become a little numb. If it feels too uncomfortable, please let me know."

Finometer Set-up:

- Wrap the arm cuff air hoses with the small loop in the center of the Velcro strap.
- Place arm cuff on upper arm at heart level on same hand as finger cuff; the label "artery" should be placed just above the inside of the elbow.
- Strap the frontend box on the forearm facing the ceiling, on **TOP** of the wrist.
- Wrap the Velcro strap around mid-forearm to secure the frontend box, cables and air hoses in position.
- Attach finger cuff cable to the frontend box; match red dots on the frontend receptacle and cable connector, and insert as far as it will go.
- Carefully insert air hose in other receptacle on frontend box; ***plastic air hose is very fragile– handle with care!***
- Route the cable and air hose between two fingers to the frontend box.
- Wrap cuff on middle finger: point cable and tube toward wrist; center cuff between joints; cuff should cover both knuckles equally.
- Center LED (light emitting diode) and PC (photo cell), 2 dots on interior of cuff, symmetrically on sides of finger.
- Connect shoebox sensor to frontend box (a modular phone cord type outlet).
- Attach the pillbox height sensor at mid-armcuff or heart level.
- Attach the other square shaped sensor to the finger cuff.
- Place **P's** arm on the arm rest.

DEMONSTRATION AND INSTRUCTIONS

_____ Instruct **P** how respiration will be calibrated. Hand the respiration tube to **P**, then explain:

"Now we are going to practice calibrating the respiration monitor. You will be breathing in and out of this bag with your mouth six times. Make sure to breathe naturally and not forcefully, just enough to fill and empty the bag. First, inhale in a normal breath, then put your mouth tightly around the tube and exhale to fill the bag, then inhale to empty it. Keep your mouth around the tube and continue to breathe in and out for 6 full breaths. Be sure your lips are tight enough around the tube that no air escapes. Also, hold the tube at the top without touching the plastic bag. I will put this noseclip over your nose to make sure you breathe only through your mouth."

Before having **P** practice, demonstrate the calibration procedure using your own respiration bag **and noseclip**. When finished, place noseclip on **P** and ask them to begin the calibration breaths. Count the six breaths out loud for **P**. At the end of each breath (one full exhale-inhale sequence), say **ONE, TWO,** etc.

_____ **Give explicit instructions for remainder of protocol, with the following points:**

1. Recording will be done mostly during quiet rest with a math task, a color-word matching task, and standing up.
2. The order of the math and color-word matching tasks is random and no one knows which test the computer will present first.
3. **The tests are designed to be difficult** and everyone makes mistakes during the session but **participants** should just keep going. They may feel a bit frustrated or upset at times

"Periodically, during the session I will ask you for a stress rating, which will be on the scale of 1-10 (1 being not stressed at all and 10 being extremely stressed). I will ask: 'may I have a stress rating please.' Then you will give me a number from 1-10 indicating your stress level at that given moment. Just give me the number. Don't elaborate.

Also, it is extremely important during this session that you refrain from moving as much as possible. Movement creates noisy signals from the electrodes, and if they are too noisy, we may have to restart the session. In addition, it is equally important that you do not speak during any of the tasks or resting periods except when I ask for a stress rating. Speaking out loud changes your respiration data and if it changes too often then we may have to start over. Also make sure not to cross your legs during the session since it affects heart rate.

Of course, if AT ANY TIME you feel sick, have pain, or there is anything that needs immediate attention, please speak up and let me know right away.

Do you have any questions?"

"Now I am going to move on to the tasks and briefly explain each one. Feel free to interrupt me and ask for clarifications when needed. "

_____ Place keypad in comfortable position relative to the dominant hand.

"Have you ever used a keypad like this one before? It's similar to the keys on a computer or typewriter. Please familiarize yourself with the key pad. There are two sets of keys here that you will use, the colored keys on the right side, and the Yes-No keys near the middle. The other keys have no function – nothing happens if you press them."

PRACTICE TASKS

_____ **Set up practice for the MathTurner task**. Give instructions **before** starting task on the Stimulus PC.

"We'd like you to perform a simple arithmetic task. The computer will show you a series of addition and subtraction problems. After the problem appears, you will see the word "equals", then an answer to the problem will appear. Your task is to determine if the answer is correct or incorrect. If it is correct, you press "Yes" on the keypad. If it is incorrect, you press "No." When the answer appears, you have only about one second to press Yes for "correct" or No for "incorrect," then another problem will appear.

If you don't respond quickly enough, the computer will count your answer as wrong and will present another problem to you.

In this task, speed and accuracy are important. Concentrate on the problems and enter your answers as quickly as you can. Please do not speak at all during the task, and try to move as little as possible."

"Do you have any questions?"

Answer whatever questions the subject may have. Emphasize the importance of not speaking during task.

"Let's try a practice session now."

Click on **"Shortcut to MATHTurner practice"** on Stimulus computer. (Practice starts as soon as you run the Shortcut. There is no instructions screen as in the Stroop Practice.)

_____ **Practice MathTurner with keypad:** Have the P do a practice session, but **NO MORE THAN 3** times, as needed; during the first trial observe to see where they are having trouble.

After practice: **"This task is designed to challenge you, so don't be discouraged if you make mistakes. Please concentrate and try as best as you can. Do you have any questions about the math task?"**

Answer any questions the P may have. Emphasize importance of not speaking during task.

_____ **Set up practice for the Stroop task**. Click on **"Shortcut to Stroop practice"** on Stimulus computer.

"The second task is a color-word matching task. The computer screen will present you with color names, for example, the word red or blue. These names will appear in different colors, that is, the word "blue" may appear in yellow letters (cue card). Your task is to press the key on the keypad which corresponds to the color of the letters. For example, if the word "blue" appears in yellow letters, you would press the key corresponding to "yellow". There are four colors, as shown on the keypad: red, yellow, green and blue. Press the key that matches the color of the LETTERS in the word, not the color named by the word. During the task, the keyboard map of these colors will appear at the bottom of each screen.

In this task, the computer will score your responses for speed and accuracy. If you don't respond quickly enough, it will score your response as incorrect and present a new problem.

Let's try a practice session.

_____ **Practice STROOP task:** Start the practice session as shown on Stroop practice screen.
"Do you have any questions about the color-word matching task?"

Answer whatever questions the P may have. Emphasize to not speak and stay as still as possible during task. Also, emphasize that in this task, speed and accuracy are important.

_____ **Standing task explanation:** Explain that the final task simply is standing up for a few minutes. Explain that you (the researcher) will assist **P** in getting up out of the chair carefully. You will help **P** to lean against the wall, moving as little as possible. **Explain that they will be standing for about 10 minutes. Standing does not need to be practiced.**

SET UP PCs:

_____ **Stimulus PC: Set up ACTOR**.

1. Double click on the ACTOR shortcut on the desktop.
2. Check that the Path setting in the Actor screen is exactly this: **c:\Progra~1\Ledona~1**
3. Click on "Listen for Requests." Then click on "Blank Screen" which causes the screen to go blank. The screen will stay blank until the stimulus programs are called or ESC key is pressed.

_____ **Acquisition PC: GAcq**

1. Click on Shortcut to GACQ Template Toggler on desktop:
2. Enter SITE ID (UCLA = 1; Wisconsin = 2; Georgetown = 3)
3. Enter the SUBJECT ID

GAcq will begin collecting data in the C1 period as soon as you type in the Subject ID and press OK.

*****BEGIN DATA ACQUI ITION*****

C1 **600** **CALIBRATION 1: FINOMETER SET UP**

_____ 600 On FIN METER screen, press the **[Calibrate waveform]** tab card button until you see the square wave graph appear as shown in the figure.

_____ 540 Activate the [Finometer-Research] instrument using the **"red"** configuration; this will automatically terminate the square wave calibration and start the data recording screen.

_____ Enter participant data in the [Describe Subject] tab card. Use metric converter chart to put height in meters and weight in kilograms. **Remember to press [Describe Subject] button again or the data will not be saved!!**

ADV NCE TO NEXT PERIOD WHEN REA Y

N1 **600** **NADA 1**

_____ 600 **CHECK ECG and Respiration signals on Gacq screen.**
If the ECG and/or respiration signals are poor, then halt data acquisition and move the electrodes and/or bands around. Then restart NADA 1 period.

FIN METER ST RT UP:

_____ Prepare to start Finometer measurement. Warn the **P**:

"I'm starting the blood pressure monitor. You'll feel the finger cuff pulsing. Are you ready?"

Start a measurement by pressing on the **"start/stop"** key.

_____ Hold the shoebox and pillbox sensors at heart level and press the **"mark"** key to null height sensor, then place sensors in proper locations on finger and arm cuffs.

_____ **Check Blood Pressure signals:**

1. You should see a display of BP signals on the Finometer screen AND on the Gacq screen.
2. Pay attention to the time remaining in NADA1 to be sure you have enough time.
3. Make sure all the signals are clean before proceeding.
   a. If the ECG signal and/or respiration signal is poor, then move the electrodes and/or bands around.
4. If the blood pressure signal is poor, stop Finometer recording by pressing on the "start/stop" key and move the cuffs around.

_____ **ADVANCE TO NEX PERIOD WHEN READY: You should NOT restart the NADA1 period unless you are running out of time.**

C2 **280** **CALIBRATION 2 (SEATED)**

_____ 260 Inform the **P:** **Now I'm going to calibrate the blood pressure readings. The armcuff will now inflate and stay inflated for about 2 minutes. It will be slightly uncomfortable**. Also ask them to remain still and quiet during the calibration.

_____ 240 **Calibrate brachial arm pressure:** Press on the [Physiocal & RTF-cal] button. Look at the left side "Physiocal" column to be sure it is set "on" (by default it should be ON. If not, change setting). Use the right arrow to activate the "RTF-cal section" and then select the **"step"** inflation type by pressing the [Physiocal & RTF-cal] button.

_____ 110 **Calibrate Respitrace:** hand the **P** the respiration tube and place the nose clip on him/her. Instruct him/her to **"wait for the initial count before blowing in and out of the tube naturally"**. Return to Acquisition PC and begin counting.

As soon as you begin the first count:
1. PRESS AND RELEASE F1 : **WHEN SUBJECT BEGINS FILLING THE BAG WITH THE 1ST BREATH.**
2. PRESS AND RELEASE F1 : **AT END OF LAST BREATH.**

_____ 10 **TURN OFF PHYSIOCAL:** Press [Physiocal/RTF] tab card button. Use arrow keys to move to left section labeled Physiocal and change setting to OFF.

NOTE: When you press the [Physiocal/RTF] tab card button once, this may toggle the Physiocal between ON/OFF setting. You may not need to use the arrow keys to move to the Physiocal section.

After calibration, you cannot move the respiration bands from their position until the next calibration.

B1 **660** **BASELINE 1**

_____ 30 **TURN ON PHYSIOCAL:** Press [Physiocal/RTF] button. Use arrow keys to move to left section labeled Physiocal and change setting to ON.

_____ 25 **"May I have a stress rating please."**

RATE STRESS DURING BASELINE [B4VSRB1]

_____ 15 **TURN OFF PHYSIOCAL:** Press [Physiocal/RTF] button. Use arrow keys to move to left section labeled Physiocal and change setting to OFF.

_____ 10 **"Please Sit quietly and remember not to speak. The first task is about to begin."**

P1 or S1 **360** **TASK #1: Stroop or MATHTurner (circle one) [B4VTASK1] [B4VCS1]**

_____ 30 **TURN ON PHYSIOCAL:** Press [Physiocal/RTF] button. Use arrow keys to move to left section labeled Physiocal and change setting to ON.

_____ 25 **"May I have a stress rating please."**

RATE STRESS DURING TASK #1 [B4VSRCS1]

_____ 15 **TURN OFF PHYSIOCAL:** Press [Physiocal/RTF] button. Use arrow keys to move to left section labeled Physiocal and change setting to OFF.

_____ 10 **"Please sit quietly and try to relax." (Wait til task finished to say this !)**

R1 **360** **RECOVERY 1**

_____ 30 **TURN ON PHYSIOCAL:** Press [Physiocal/RTF] button. Use arrow keys to move to left section labeled Physiocal and change setting to ON.

_____ 25 **"May I have a stress rating please."**

RATE STRESS DURING RECOVERY #1 [B4VSRR1]

_____ 15 **TURN OFF PHYSIOCAL:** Press [Physiocal/RTF] button. Use arrow keys to move to left section labeled Physiocal and change setting to OFF.

_____ 10 **"Please sit quietly and remember not to speak. The next task is about to begin."**

P1 or S1 **360** **TASK #2: Stroop or MATHTurner (circle one) [B4VTASK2] [B4VCS2]**

_____ 30 **TURN ON PHYSIOCAL:** Press [Physiocal/RTF] button. Use arrow keys to move to left section labeled Physiocal and change setting to ON.

_____ 25 **"May I have a stress rating please."**

RATE STRESS DURING TASK # 2 [B4VSRCS2]

_____ 15 **TURN OFF PHYSIOCAL:** Press [Physiocal/RTF] button. Use arrow keys to move to left section labeled Physiocal and change setting to OFF.

_____ 10 **"Please sit quietly and try to relax."**

R2 **360** **RECOVERY 2**

_____ 30 **TURN ON PHYSIOCAL:** Press [Physiocal/RTF] button. Use arrow keys to move to left section labeled Physiocal and change setting to ON. *(**NOTE:** Physiocal will remain ON until the end of the Calibration 3 period.)*

_____ 25 **"May I have a stress rating please."**

RATE STRESS DURING RECOVERY #2 [B4VSRR2]

N2 **120** **NADA2**

[B4VS2T] **120** **COLLECT SALIVA SAMPLE #2 Time___ ___ : ___ ___ am=1 pm=2**

N3 **600** **NADA3: STANDING TRANSITION**

_____ **"Now please stand up and lean against the wall"**

Help the **P** get into the standing/leaning position, making sure that the connections to all the cables are maintained.

Set up an arm rest at Heart Height for **P** to rest the arm with Finometer cuffs attached. Adjust their arm so the HITE reading on Finometer is as close to 0 as possible (height difference between pillbox and shoebox sensors).

_____ **Check All Signals:**

1. You should see a display of BP signals on the Finometer screen AND on the Gacq screen.
2. Check quality of ECG, BP and Respiration signals on the Gacq screen.
3. If the ECG signal and/or respiration signal is poor then move the electrodes and/or bands around.
4. If the blood pressure signal is poor, stop Finometer recording by pressing on the "start/stop" key and move the cuffs around.
5. If you are running out of time restart the NADA3 period.

C3 **280** **CALIBRATION 3 (STANDING)**

_____ 260 Inform the **P:** **Now I'm going to calibrate the blood pressure readings again like I did when you were seated. The armcuff will now inflate and stay inflated for about 2 minutes. It will be slightly uncomfortable**. Also ask them to remain still and quiet during the calibration.

_____ 240 **Calibrate brachial arm pressure:** Press on the [Physiocal & RTF-cal] button. Check left "Physiocal" section to be sure it is still set "on." Use arrow to activate the right "RTF-cal" section and select the **"step"** inflation type by pressing the [Physiocal & RTF-cal] button.

_____ 110 **Calibrate Respitrace:** hand the **P** the respiration tube and place the nose clip on him/her. Instruct him/her to "**wait for the initial count before blowing in and out of the tube naturally**." Return to Acquisition PC and begin counting.

As soon as you begin the first count

1. **PRESS AND RELEASE F1: WHEN SUBJECT BEGINS FILLING THE BAG WITH THE 1ST BREATH.**
2. **PRESS AND RELEASE F1: AT END OF LAST BREATH.**

_____ 10 **TURN OFF PHYSIOCAL:** Press [Physiocal/RTF] tab card button. Use arrow keys to move to left section labeled Physiocal and change setting to OFF.

Once you complete calibration, you cannot move the respiration bands.

U1 **360** **STANDING TASK**

Participant ID:_____

_____ [If BP falls below criterion level, or P feels faint, dizzy, weak, nauseous, etc., help P to sit down in chair. If needed, have P lie down or bend and place head between legs from seated position. Proceed to **TERMINATION** period below.]

_____ **30** **"May I have a stress rating please."**

RATE STRESS DURING STANDING [B4VSRU1]

W1 (no time limit) **WAIT / PAUSE BETWEEN STANDING AND TERMINATION PERIODS**

After Standing task ends, Gacq advances to this period and COUNTS UP FROM ZERO indefinitely until you Halt Acquisition. This period is used to end a normal session and prevent Gacq from advancing automatically to the Termination period. The Termination period should not run unless you manually advance to it when needed. See below.

_____ **HALT Acquisition for a Regular Session:** If the session ran normally (no early Termination), end the GAcq session at any time during this WAIT period.

_____
1. Click the **Halt Acquisition** button in GAcq.
2. **Stop Finometer data collection:** **P**ress on the "**start/stop**" key (but leave finometer power on for data transfer later),
3. **Power off the ECG** machine.

_____ **Proceed to the last Saliva Samples section below (immediately after Termination period section of flowsheet).**

END OF REGULAR SESSION

GO TO NEXT SECTIONS OF FLOWSHEET FOR:

1. **Termination period (if needed)**
2. **Saliva Sample**
3. **Termination Debriefing (if applicable)**
3. **Disconnecting participant from equipment**
4. **Transfer Data**

T1 **TERMINATION: END SESSION DUE TO BP CRITERION OR OTHER PROBLEMS**

_____ If the BP goes **above** (usu. In Baseline or a Task period) or **below** (usu. During Standing) the criterion level, complete this section of Flowsheet. **Termination is a type of recovery period. The HPV technician must do several things in quick succession and often in parallel:**

1. Encourage P to sit quietly and relax. Goal is to see if BP returns to a range in the study criteria within 300 to 240 seconds on GAcq counter (1 to 2 mins) and to the P's near-baseline BP levels by end of the Termination period.
2. Determine if Participant is experiencing symptoms associated with high BP (or any other discomfort).
3. Monitor BP on Finometer. Use chart below to record BP every 30 sec or so.

_____ **When BP meets criteria for termination, note the info below, then get a stress rating.**

Above-criterion BP level: SBP_____DBP_____ GAcq period:_____ GAcq Counter:_____

"May I have a stress rating please."

RATE STRESS WHEN TERMINATION CRITERION REACHED. _____

_____ If BP criterion is reached during a **task**, inform the **P:** **"Thank you. You may stop responding to the task now. I am going to stop the task on your screen".** If criterion met during Baseline, proceed below.

_____ **ADVANCE GAcq to Termination period:** Click on Termination period in Gacq. This should halt whatever task is running on the Stimulus PC, if applicable.

_____ **360** Inform the P: **Thank you. You met the requirements for this part of the session. We are now starting the last phase of this session.**

_____ **360** **Finometer BP at beginning of Termination:** _____

_____ **350** **Symptom report:** Ask P how s/he feels, if s/he has any discomfort. If YES, probe for symptoms such as: dizzy, feel flushed, nauseous, any pain of any kind. To get symptom report, strike a balance – try not to alarm the P by prompting him/her too specifically about types of symptoms, but we need to know if the high BP reading is also accompanied by such symptoms.

Symptoms reported by P:_____

_____

Inform the P: **OK, please sit quietly now and try to relax. Keep your eyes open and do not let yourself doze.** You can better judge P's functional status with eyes open and awake. If they doze off, wake them gently and be sure they feel OK. If s/he can't seem to keep from dozing, ask a nurse or doctor to see the participant.

_____ **350** **Record BP reading** from Finometer every 30 seconds, as Gacq counts down. Don't worry if you don't get every reading or don't get them all exactly on time.

Counter: **330**	BP: _____	Counter: **150**	BP: _____
Counter: **300**	BP: _____	Counter: **120**	BP: _____
Counter: **270**	BP: _____	Counter: **90**	BP: _____
Counter: **240**	BP: _____	Counter: **60**	BP: _____
Counter: **210**	BP: _____	Counter: **30**	BP: _____
Counter: **180**	BP: _____	Counter: **0**	BP: _____

Continue monitoring BP until end of Termination in GAcq. **If BP does not recover to near-baseline levels by the end of the period, or if P reports symptoms that do not remit by end of the period (dizzy, feel flushed, nauseous) have a nurse or doctor see the participant.**

_____ **Did you call a doctor or nurse?**

No____ Yes_____ If yes, why, and what was the outcome? _____

_____

_____

_____ **0** If BP returns to a range in the study criteria within 300 to 240 seconds on GAcq counter (1 to 2 mins) and to the P's near-baseline BP levels by end of the Termination period, proceed with the next steps:

Ask for a stress rating.

"May I have a stress rating please."

RATE STRESS AT END OF TERMINATION PERIOD. _____

Inform P: **This part of the GCRC visit is complete. Thank you very much. You met the criteria for this visit. Now I'm going to ask you to do 2 more saliva samples.**

_____ **HALT Acquisition for a Terminated Session:**

1. Click the **Halt Acquisition** button in GAcq.
2. **Stop Finometer data collection:** **P**ress on the "**start/stop**" key (but leave finometer power on for data transfer later),
3. **Power off the ECG** machine.

_____ **Proceed to the last Saliva Samples section below**

END OF TERMINATION PERIOD

[B4VS3T] **COLLECT SALIVA SAMPLE #3** **Time___ ___ : ___ ___ am=1 pm=2**

_____ **Set "timer" for 30 minutes**

_____ **+30 MINUTES AFTER SAMPLE**

[B4VS4T] **COLLECT SALIVA SAMPLE #4** **Time___ ___ : ___ ___ am=1 pm=2**

TERMINATION DEBRIEFING [this section under review – not yet approved for use]

If session was terminated early, at this point give P more specific information about why. If the BP went too high or too low (during standing), explain what happened and tell them their BP value which pushed them over the criterion. Explain that this does not necessarily mean that they have a medical problem, but that we recommend that all participants who reach that level during the session be advised to see their own physician to have their BP and heart checked.

DISCONNECT PARTICIPANT

_____ **Power off** the Inductotrace and ECG.

_____ **Halt Finometer data collection**. Press the "start/stop" key on the Finometer, then press hard on both double arrow keys simultaneously to stop measurement and return to the start display. Do NOT yet power off the Finometer.

_____ Remove Finometer height sensors, finger and arm cuff.

_____ Disconnect finger cuff electrical and pneumatic connections.

_____ Remove frontend from wrist.

_____ Remove all ECG leads, tapes and bands from the participant.

_____ Disconnect Inductotrace OUTPUT cables from unit (**if you don't, the battery will run down!!**)

_____ Hit ESC key on Stimulus computer and tell Actor to Stop Listening.

TRANSFER DATA

_____ Move stress task output files to **archive folders** on the Stimulus PC, then **copy** task output files from **Stimulus to Acquisition Computer** into these folders:

Stroop (*.stroop): c:\data\archive\Stroopperfdata
MATHTurner (*.MathTurner): c:\data\archive\MATHperfdata
Both Stroop and MATH files: c:\data\archive\[SubID for this participant]

_____ **Transfer Finometer blood pressure files from Finolink.**

If the Finolink Monitor software was running during the session, the finolink file(s) should already be on the Acq PC in c:\data\midus\physdata. If you had to restart measurement on the finometer during the session, there will be more than one file.

If the Finolink Monitor software was NOT running during the session, move the file(s) now from Finometer to Acq PC (the order of these actions is important!) :

1. Start Finolink with shortcut on Acq PC's desktop. Choose **Download** option.
2. Select the Configure menu, then Directories. Be sure both directories are set to: ***C:\data\MIDUS\physdata***
3. Click **Connect** button on right. You should see a list of files stored on Finometer. Click on Date and/or Time headings to sort files so you see the most recent file at top. Click current session's file to select it.
4. Look at **Local Files** in left panel. It should display ***C:\data\MIDUS\physdata.*** If not, click button and browse to choose this folder.
5. Click on the **<** button in middle of screen to send file from Finometer list (right) to Acq PC (left).

_____ **Power Off Finometer:** Once Finolink file(s) is on the Acq PC, on the Finometer exit to the start display by pressing hard on both double arrow keys simultaneously. Switch OFF the Finometer with the switch at the rear.

At this point, ALL Gacq and Finometer files from this session should now be in ***C:\data\MIDUS\physdata.***

_____ **MOVE** all data files from ***C:\data\MIDUS\physdata*** to ***C:\data\Archive\[subID].*** The physdata folder should now be empty of files in preparation for next session.

_____ **COPY** all Stroop and MATHTurner data files from their C:\data\Archive subfolders into ***C:\data\Archive [subID].*** You will end up with a copy of the task output files both in the individual participant folder AND in their respective Archive subfolders.

_____ Backup *all* data from this session, all of ***C:\data\Archive [subID]*** to unique CD for this participant only.

_____ FTP *all* data from this session to Columbia server.

_____ Turn off the computers and the monitors.

NOTES AND COMMENTS ABOUT THE SESSION:

APPENDIX TO FLOWSHEET

MIDUS Biomarker Project
Revised Psychophysiology Blood Pressure Termination Criteria
December 13, 2005

The Finometer can produce brief artifactual values for one or two SBP-DBP cycles. These aberrant values, if they are really artifacts, should begin to correct to more normal levels within a few heartbeats/BP cycles. Thus, the criteria below include a 5-second duration at various points to allow staff to determine with greater confidence that they are "real" physiological values and the session should be terminated.

Termination Criteria for HIGH Blood Pressure

Baseline Exclusion Criteria:

Subjects will be excluded from participation if their baseline blood pressure is 180/100 (either systolic OR diastolic criterion is met) or greater. This will be based on 3 manual BP readings taken at least 5 minutes apart, with subject seated.

Session Termination Criteria:

Persistent "low" level increase – The session will be terminated if blood pressure rises above 200/110 (either systolic OR diastolic criterion is met) and persists at that level for 1 minute, or the respondent complains of chest pain, vision changes, and/or headache.

Immediate Termination – The session will be terminated **immediately** if blood systolic blood pressure rises above 210 and does not begin to fall within 5 seconds. That is, if ONLY systolic BP reaches 210, you terminate. If diastolic BP reaches greater than 110 but systolic stays below 200, the criteria specified at #1 above should be applied.

Termination Criteria for Low Blood Pressure

Immediate Termination Criteria:

The session will be terminated at any point during the protocol if either systolic or diastolic BP falls 20 mmHg compared to either average baseline levels or the average level in the preceding 5 minutes, AND remains at that lowered level for 5 seconds without ***beginning*** to rise again, while the subject's monitored finger is held at heart level.

Sitting to Standing Transition Termination Criteria:

The session will be terminated during the Sitting to Standing transition if the above criteria are met or:

The BP falls below 80/60 (both systolic and diastolic fall below this criterion), or

The participant appears distressed or complains of feeling lightheaded or faint or clammy and the Finometer blood pressure is falling steadily, or

There is a sudden slowing of the heart rate to below 60 beats per minute (displayed on Finometer device), and remains at that level for 5 seconds

SECTION C

DETAILED PSYCHOPHYSIOLOGY PROTOCOL DESCRIPTION

DETAILED PSYCHOPHYSIOLOGY PROTOCOL DESCRIPTION

The MIDUS Biomarker Project (P4) psychophysiology session is a standard, laboratory-based stress reactivity protocol. The data were collected at UCLA, Georgetown, and the University of Wisconsin and processed at the Columbia University Medical Center (CUMC) in the laboratory of Dr. Richard Sloan.

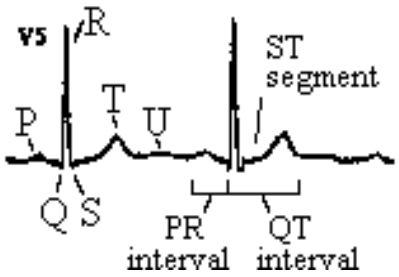
This section provides additional information about the protocol and variables included in the data file organized as follows: Overview of the protocol; description of the measures; detailed outline of the protocol and data processing; description of variables included in the data file, particularly the primary outcomes of interest (heart rate (HR), heart rate variability (HRV), and salivary cortisol); and naming conventions.

Overview of Protocol

A. Purpose. The psychophysiology protocol in Project 4 is a widely used laboratory based, experimental procedure designed to measure cardiovascular reactivity to and recovery from stress.

B. Procedure. During the protocol, participants' physiological outcomes are measured during a seated, resting baseline period followed by two cognitive/psychological stressor tasks, also in a seated position. The cognitive tasks are a mental arithmetic task (PASAT or MATH) and a Stroop color–word matching task. After each cognitive stress task, participants undergo another seated, resting period to assess physiological recovery to stress. The last period in the procedure is an orthostatic stressor. Participants move from a seated to standing position and remain standing for several minutes.

C. Physiological outcomes. Cardiovascular reactivity is assessed via continuous measurement of the electrocardiogram (ECG). The beat-to-beat ECG waveforms are then analyzed to calculate heart rate and several indices of heart rate variability (HRV). Heart rate variability is operationalized as variability in the series of intervals between consecutive R waves (the first upward deflection of the electrocardiogram following the Q-wave, arising from ventricular depolarization) (Figure 1). In addition, reactivity of the Hypothalamic Adrenal Pituitary (HPA) axis is measured via collection of saliva samples for cortisol assay.



D. Theory and method. Throughout this guide, relevant references are cited to provide investigators information about the methodology used in this protocol. We offer the following references, including one *in press* paper using Project 4 data, for an introduction and review of cardiac psychophysiology, and the types of questions that can be investigated with this type of protocol (Carney, Freedland, & Veith, 2005; Gorman & Sloan, 2000; Shcheslavskaya, Burg et al., in press (2009); Sloan, McCreath et al., 2007). A recent special issue of *Biological Psychology* (Allen & Chambers, 2007) on cardiac vagal control is a good resource. Investigators are encouraged to review the literature in more depth. Relevant key words for

literature searches include: heart rate reactivity, heart rate variability (also referred to as "RR interval variability" or as a related measure, "respiratory sinus arrhythmia"), stress reactivity, and stress recovery.

Measures

A. Physiological Measures

1. Acquisition and Processing of ECG Signals. Beat-to-beat analog ECG signals were collected then digitized at a sampling rate of 500 Hz by a 16-bit National Instruments analog-to-digital (A/D) board installed in a microcomputer. ECG waveforms were submitted to proprietary event detection software to identify R waves. Following established procedures, (Berntson, Quigley, Lang, & Boysen, 1990; Dykes, Ahmann et al., 1986), research staff visually reviewed all ECG waveforms to correct interactively any software errors in identifying normal R waves. The resulting series of normal RR intervals was used to calculate the cardiac variables heart rate (HR) and several standard indices of HRV.
2. Heart rate. Heart rate is calculated as an average of all valid RR intervals for a specified length of time. HR data in the MIDUS 2 data set have been converted from RR interval units (milliseconds) to beats per minute units.
3. Heart rate variability. Time domain indices of RR interval variability include the standard deviation of RR intervals (SDRR) and the root mean squared successive differences (rMSSD). Frequency domain measures include spectral power in the low (0.04-0.15 Hz (LF-HRV)) and high (0.15-0.50 Hz (HF-HRV)) frequency bands. The spectra of RR interval series were calculated using an interval method for computing Fourier transforms similar to that described by DeBoer, et al. (DeBoer, Karemaker, & Strackee,1984). Prior to computing Fourier transforms, the mean of the RR interval series is subtracted from each value in the series and the series then is filtered using a Hanning window (Harris, 1978) and the power, i.e., variance (in $msec^2$), over the LF and HF bands is summed. Estimates of spectral power are adjusted to account for attenuation produced by this filter (Harris, 1978).

B. Collection of Saliva Samples.

Saliva samples were collected at four time points: 1) baseline (prior to attaching the ECG leads and other monitors); 2) immediately after the second cognitive stress task; 3) immediately after the orthostatic challenge; 4) 30 minutes after the orthostatic challenge. At the designated time respondents removed the cotton swab from the Salivette®, placed it in their mouth, chewed it until saturated, and then put the swab back in the tube and replaced the cap. At the end of the session salivettes were stored in a -80°F freezer. Samples were sent to the Technical University of Dresden for cortisol assay by immunochemilluminescence.

C. Psychological Stressor Measures

1. Stroop Color-Word Task. In this modified version of the Stroop task, one of four color name words (blue, green, yellow or red) is presented on a computer screen in a font color that is either congruent or incongruent with the name. The color name stimulus appears on screen, and participants press one of four keys on a keypad corresponding to the color of the letters in the word, not the color name. To roughly standardize the stressfulness of the task, the rate of presentation of the stimuli varies as a function of task performance. Greater accuracy leads to a more rapid presentation rate. Poorer

accuracy leads to a slower rate. Overall, participants achieve an accuracy of about 67%. Response data for each trial, including the stimulus features, response latency, and response accuracy are stored in a file for later analysis.

2. Mental Arithmetic. The mental arithmetic task was changed from the PASAT to the MATH three months after Project 4 data collection began. This change was implemented to reduce respondent burden (administration time for the PASAT is 11 minutes compared to 6 minutes for the MATH) and to reduce participant confusion and frustration which at times resulted in refusal to respond to the task. Both tasks are described in detail below.

   a. *MATH.*

      The Morgan And Turner Hewitt (MATH) task is a computer-administered mental arithmetic task designed for use as a psychological stressor in laboratory studies of cardiovascular reactivity (Turner, Hewitt et al., 1986; Turner, Sims, Carroll, Morgan, & Hewitt, 1987). Task problems involve the addition or subtraction of two numbers. Problem difficulty can vary across five levels, ranging from problems of 1-digit ± 1-digit numbers (level 1) to 3-digit ± 3-digit numbers (level 5). The task always begins at level 3; difficulty level thereafter is determined at each trial by response accuracy on the previous trial. Correct responses were followed by one step up in difficulty, or if already at level 5, difficulty remains at level 5 until an incorrect response. Incorrect responses were followed by one step down in difficulty, or if already at level 1, difficulty remains at level 1 until a correct response.

      Each trial consists of three elements presented on screen in succession. First, one math problem is presented for 2.0 sec. Then, the word 'Equals' appears alone on screen for 1.5 sec, giving the participant more processing time. A solution to the problem then appears for up to 1.0 sec, during which the participant presses one of two keys on a keypad to indicate whether the presented solution to the problem is correct or not. The next trial is presented as soon as a response key was pressed. Failure to respond within the one-second solution screen is recorded as an incorrect response, with a response time of 1.0 sec, and the next trial is presented.

      Trials continued for the full duration of the mental arithmetic protocol period; total number of trials varies based on the participant's response times. The ratio of addition to subtraction problems is 3:7. The ratio of correct to incorrect problem solutions presented on screen is 1:1. Response data, including problem content, level, and response time and accuracy, are collected for each trial and stored in a file for later analysis. For MIDUS, the original task specifications by Turner et al. (Turner et al., 1986) were modified to extend the task length from 4 to 6 minutes.

   b. *PASAT.*

      For MIDUS 2 the PASAT (Paced Auditory Serial Addition Test) (Diehr, Heaton, Miller, & Grant, 1998) was administered by a proprietary computer program and completed by a total of 26 participants during the first three months of data collection. PASAT includes four blocks of 50 numbers, ranging from 0 to 9, presented in auditory format at fixed intervals. The task is to add two sequential numbers ($n_1 + n_2$) at a time and type the answer on a numeric keypad. While continually listening to the auditory list of numbers, one then continues by dropping the first number (n_1) from the prior trial to add the next two numbers ($n_2 + n_3$), and so on for all numbers in the block.

      The specific numbers presented in each block are standardized and fixed. The

interstimulus interval in each block of 50 numbers is fixed; however, the interval is reduced for each successive block, in this order: 3.0 sec, 2.4 sec, 2.0 sec, and 1.6 sec. Each block of 50 numbers was followed by a 15 second silent break. Failure to respond within the interstimulus interval is recorded as an incorrect response and given a response time equal to the interstimulus interval, then the next trial is presented.

Responses to each trial are stored in a file for later analysis. Data for each trial include: block number, trial number (presentation order), stimuli (2 numbers), correct response, participants' actual response, response latency, and response accuracy.

Psychophysiology Protocol Description

The following is a detailed description of the data collection protocol, including equipment setup, protocol order, and data processing.

A. Protocol Flowsheet:

MIDUS staff who conducted this protocol used a data collection form called the psychophysiology flowsheet. A copy of this form is in Section B (above)

The first two pages included questions about handedness, physical characteristics of the participant, and other factors that may influence experimental outcomes (e.g. consumption of caffeine, nicotine etc.), as well as a template of the protocol order. A more detailed version of this template appears in Table 1 below. The remainder of the flowsheet contains a more complete description of the protocol, instructions to research staff, instructions to participants, descriptions of the stress tasks, etc.
Throughout the protocol, staff were instructed to record information at designated locations on flowsheet. This information as well as responses to the items at the beginning of the flowsheet were data-entered and included in the MIDUS 2 Project 4 data file.

B. Monitoring Device Setup.

Electrocardiograph (ECG) electrodes were placed on the left and right shoulders, and in the left lower quadrant. Stretch bands were placed around the participant's chest and abdomen to measure respiration. A Finometer blood pressure cuff was placed on the middle finger of the non-dominant hand, and a Finometer blood pressure arm cuff was placed on the upper arm on the same side as the finger cuff. The participant was then seated and a numeric keypad, for responding to the stress tasks, was secured in a comfortable position relative to the dominant hand. The monitoring devices were then calibrated in the seated position.

C. Protocol Order.

The general protocol order was as follows (*details are in Table 1*): seated baseline (11 minutes); psychological stress task 1 (mental arithmetic or Stroop task - 6 minutes); recovery 1 (6 minutes); psychological stress task 2 (mental arithmetic or Stroop task - 6 minutes); recovery 2 (6 minutes); orthostatic stressor (standing/upright) (6 minutes). No recovery data were collected after exposure to the orthostatic stressor. Participants were instructed to remain silent throughout the procedures. After the second recovery period, participants were assisted in moving to a standing position. The monitoring devices were recalibrated, then the orthostatic stress period began.

Data Processing Criteria

The physiological monitoring equipment (ECG, Finometer, Inductotrace respirometer) ran continuously throughout the protocol and produced raw waveform data. These raw data were processed according to standardized algorithms (Task Force, 1996) to create variables (see Key Variables) that can be used in analyses. Analytic data are provided in MIDUS by ***period*** and by ***epoch*** within each period. The MIDUS 2 Biomarker (P4) data includes one set of data from the psychophysiology session, which uses 300-second epochs of data. This section defines these terms and describes the criteria used to select raw physiological waveform data for processing to generate key variables.

A. Periods.

1. The protocol was divided into periods based on experimental conditions and participants' activity. Physiological outcome variables are computed separately for each protocol period and are identified by Period, as specified in Table 1, in the data sets.
2. Periods in **BLUE** font in Table 1 represent data included in the MIDUS data set for analyses.
3. Other periods represent interim periods used for calibrating equipment and other purposes not relevant to hypothesis testing. Raw physiological waveform data from the interim periods are preserved at the CUMC site but are not analyzed.
4. Each period name as shown in Table 1 is part of the variable names for all data from that period.

B. Data Epochs for Analysis

Within each protocol period, data were analyzed in specified epochs of time, based on different criteria and different types of research questions.

C. Epoch Duration and Number of Epochs per Period

1. 300 sec epoch data set:
   a. First, data were analyzed with a specified 300 sec epoch duration.
   b. The analysis software was programmed such that, if unscorable data precluded a full 300 sec segment of analyzable data, epoch duration was decreased by 60 sec segments until a continuous data epoch could be analyzed.
   c. The minimum epoch length provided in this data set is 180 sec; epochs shorter than that were omitted from this data set. For all variables except the Low Frequency RRV variables, reasonable estimates can be obtained from epochs as short as 180 sec.
   d. For the 11 min baseline period, we attempt to provide 2 epochs of 300 sec each. Cases with unscorable intervals of data (due to noisy signal) include 1 or 2 epochs of 300, 240 and/or 180 sec.
   e. The stress tasks, recovery periods and upright stressor were all 6 min periods. For these, one epoch of data is included in the data set.
   f. Epochs for the PASAT math task: A special case. As noted above, the PASAT task was used as the math stressor for 26 cases in the beginning of P4 data collection. PASAT was run for 11 minutes to be able to complete the entire, standardized list of PASAT test items. For those same 26 respondents, the Stroop task also was run for 11 minutes to make the two stressor tasks the same length. Thus, two 300 second epochs were created from the PASAT and Stroop periods for these cases. Cases with unscorable intervals of data (due to noisy

signal) include 1 or 2 epochs of 300, 240 and/or 180 sec.

The CUMC group, in analyses thus far, has simply omitted the 26 respondents who received the PASAT math task and corresponding long version of the Stroop. Investigators who want to include the PASAT respondents are advised to explore differences in outcomes between those who had the PASAT versus the rest of the sample before deciding whether to retain the PASAT cases in the data set.

2. Salivary Cortisol Samples: Table 1 indicates the order and timing of the saliva samples. In the data set, saliva sample numbers (corresponding to numbers in Table 1) indicate the specific protocol context of the sample. For example, sample #3 was collected after the orthostatic stressor period. If sample #3 has a missing value in the data set, it means that participant does not have cortisol data related to orthostatic stress reactivity (period U1). Likely, it also indicates that the participant did not complete the U1 period in the protocol.

Key Variables and Naming Conventions

A. Key Variables.

The key cardiac variables from the psychophysiology session used by CUMC investigators are listed below. These output variables are somewhat standardized based on conventions for measuring heart rate and heart rate variability parameters:

HR: Average heart rate, beats per minute units

SDRR: Standard deviation of RR intervals, msec units

rMSSD: Root mean squared successive differences, msec units

LF_HRV: Low frequency RR interval variability, bandwidth 0.04-0.15 Hz, $msec^2$ units

HF-HRV: High frequency RR interval variability, bandwidth 0.15-0.40 Hz, $msec^2$ units

The data file includes both original and log transformed versions of all HRV variables (the last 4 variables listed above) for each period, and each epoch within a given period, along with variables indicating Epoch Duration (secs) and the Number of R-R intervals analyzed in each epoch.

Note: the CUMC team always uses log-transformed versions of the variables (natural logarithm), a standard practice in HRV research, due to reliable skew in their distributions.

B. Variable Naming Conventions.

SPSS Variable Labels and Value Labels are included in the data set. Per MIDUS naming conventions, the psychophysiology variable names are limited to 8 characters and have the following structure.

B4Va(a)bb(b)

Where:

B4 = MIDUS wave 2 (B), Project 4 (4), per MIDUS conventions

V = MIDUS Code letter assigned to Psychophysiology Session data

The remaining characters are determined by the data. Since a common set of variables is generated for each period, the following conventions are applied to the key cardiac variables.

a(a) = Period Name (e.g. B, R2) corresponding to the conditions and tasks presented during psychophysiology session (see column 2 in Table 1). Most periods are represented by one character in the variable name. There were 2 Recovery periods, so they are shown as R1 or R2 to indicate their sequence in the protocol.

(a) = Epoch Number. The Baseline and PASAT periods (and Stroop during PASAT sessions) were long enough to produce 2 epochs of physiological data. In these periods the second "a" character is used to indicate Epoch Number (1 or 2).

bb(b) = The final 2 or 3 characters identify the key outcome variables, described above, using the following abbreviations.

DU Epoch duration in seconds

BEG Begin/start time of epoch in elapsed seconds (from beginning of period)

END Stop time of epoch in elapsed seconds (from beginning of period)

NU Number of R-R intervals analyzed in epoch

HR HR, Avg heart rate, beats per minute

SD SDRR, standard deviation of R-R intervals, milliseconds

LSD natural log of SDRR

RM RMSSD, root mean square successive RR differences, milliseconds

LRM natural log of RMSSD

LF LF-HRV, low freq RR interval variability, bandwidth 0.04-0.15 Hz, $msec^2$

LLF natural log of LF-HRV

HF HF-HRV, high freq RR interval variability, bandwidth 0.15-0.40 Hz, $msec^2$

LHF natural log of HF-HRV

Example Variable Names:

[B4VB2HF] **=** Baseline period; Epoch 2; High Freq. HRV (not log transformed)

[B4VR1LRM] **=** 1st Recovery period (R1); Epoch 1 (only 1 epoch for recovery periods); log-transformed rMSSD (Root mean squared successive differences)

Table 1. Detailed outline of psychophysiology protocol.

Protocol Order[a]	Period	Period Description	Participant Activity	Duration (sec)	# Epochs
*		Saliva Sample #1 (Baseline)	Salivette		
		Setup and Instructions	Practice stressor tasks	varies	

	C1	**Calibration:** Finometer square wave & enter participant data.		≤ 600	
	N1	**Nada1:** check physio signals' quality; reposition sensors if needed.		≤ 600	
	C2	**Calibration, seated:** 1.Calibrate Finometer finger cuff to brachial artery (arm) BP. 2.Calibrate respiration volume.	1. Standard arm BP cuff inflates & deflates to auto-correct finger cuff BP readings. 2. 6 breaths into fixed volume 800ml plastic bag.	≤ 280	
1	**B**	**Baseline**	**Seated, quiet.**	**660**	**2**
2	**M (or P)**	**Cognitive stressor 1**	**MATHTurner[b] (or PASAT[c])**	**360[c]**	**1 (or 2[c])**
3	**R1**	**Recovery 1**		**360**	**1**
4	**S**	**Cognitive stressor 2**	**Stroop[a]**	**360**	**1 (or 2)**
5	**R2**	**Recovery 2**		**360**	**1**
*		**Saliva Sample #2 (After cognitive stressors & recovery)**	**Salivette**	≤ 120	
	N2	Nada2 period	Collecting saliva sample		
	N3	Nada3: Transition to standing position.		≤ 600	
	C3	**Calibration, standing:** 1. Calibrate Finometer finger cuff to brachial artery (arm) BP. 2. Calibrate respiration volume.	1. Standard arm BP cuff inflates & deflates to auto-correct finger cuff BP readings. 2. 6 breaths into fixed volume 800ml plastic bag.	≤ 280	
6	**U**	**Physical (orthostatic) stressor: Standing upright**		**360**	**1**
*		**Saliva Sample #3 (After orthostatic stressor)**	**Salivette**		
*		**Saliva Sample #4 (30 min post-protocol)**	**Salivette**		

Notes for Table 1:

a. The rows in Table 1 list the protocol activities in chronological order. The numbered items in the Protocol Order column represent physiological data included in the psychophysiology data set (B4V variable names) in order of occurrence. Physiological data collected during non-numbered protocol activities (e.g. calibration periods) are not included in the Project 4 data. Salivary cortisol values, indicated in the list with asterisks are provided as data in other sections of the Project 4 data set.

b. The order of the Math/PASAT and Stroop tasks was automatically and randomly selected at the time of data collection. Thus, each task was either in position 5 or 7 of the protocol for each session. Task presentation order data are in the psychophysiology flowsheet data set.

c. PASAT task (period label = P1) was run for 11 minutes (660 sec) to be able to complete the entire, standardized list of PASAT test items. In sessions when PASAT was the math stressor, the Stroop task also was run for 11 minutes to make the two stressor tasks the same length.

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SECTION D

HEART RATE VARIABILITY (HRV) FILTER VARIABLES

HEART RATE VARIABILITY (HRV) FILTER VARIABLES

Overview

The experimental psychophysiology protocol, conducted in the morning of the second day of the Project 4 (Biomarker) clinic visit, included assessments of beat-to-beat electrocardiogram (ECG), respiration, and beat-to-beat blood pressure. The larger P4 data file contains measures of heart rate (HR) and several indices of heart rate variability (HRV) for each period in the psychophysiology protocol. Details about these measures, as well as the protocol, can be found in the preceding section (Section C)

If you have not read Section C, please do so before continuing.

To facilitate analysis of the HRV data the Columbia group created two sets of quality control filter variables. This document describes these filter variables, which can be found in the data file just before the HRV indices.

Variables pertaining to the overall session are described first, followed by the period specific variables. Each set contains variables indicating the status of the session or period along with variables indicating the reason for that status designation. These variables can be used individually or in combination to select cases for inclusion in analyses.

In each section below, variable name(s) and label(s) appear first, then text descriptions of the variable(s), followed by a list of value labels and additional descriptive text about each label.

Filter Variables: Overall Session

Three variables are described in this section: pacemaker status, session status, and the session status reason.

B4VPACEM (RESP HAS PACEMAKER)

This variable indicates whether or not the participant has an implanted heart rate pacing device (i.e. pacemaker). These devices set an invariable heart rate that overrides any neural inputs to the heart. As a result, the heart rate and heart rate variability measures used as primary outcomes in this protocol, are invalid in these individuals. Pacemaker status was assessed by asking all participants “Do you have a pacemaker?” This variable has the following values:

0= NO PACEMAKER
1= HAS PACEMAKER

If B4VPACEM is 1, all cardiac outcome variables are missing values.

B4VTERM (Psych-Phys Session Termination Status)

This variable was created by P4 core staff to indicate whether the session was run and, if it was run, whether it was terminated early. This variable has the following values:

1= YES TERMINATED
2= NOT TERMINATED
3= SESSION NOT RUN

B4VPPSS (PSYCHOPHYS SESSION STATUS)

This variable indicates overall completeness of data ***collection*** during the psychophysiology protocol, including completeness of each protocol period and the 3 types of physiological signals that were collected (ECG, blood pressure, respiration). Even if data collection was complete, all or part of the data may have been invalid; thus, outcome data may be missing. The period-specific quality codes help identify why outcome data might be missing for each protocol period.

Value	SPSS Value Label	Description
1	COMPLETE	All protocol periods were conducted and, from the technician's perspective, all physiological signals were collected adequately.
2	INCOMPLETE: PHYS	Not all periods and/or physiological signals were collected. The general reason for this incomplete session was a ***physiological***, physical, or medical characteristic of the participant.
3	INCOMPLETE: TECH	Not all periods and/or physiological signals were collected. The general reason for this incomplete session was a technical problem with computers, signal monitoring devices or other aspects of the environment during the session.
4	NOT RUN	No session was run; no raw data were collected.

B4VPPSR (PSYCHOPHYS SESSION STATUS REASON)

These codes help explain why the session status code (B4VPPSS, above) was assigned.

Value	SPSS Value Label	Description
1	PP SUCCESSFUL	The psychophysiology (PP) session was successful and complete over all.
2	HI/LO BP	Participant met MIDUS study criteria for a high or low blood pressure reading; criteria call for either exclusion from this protocol or protocol termination during the session. See MIDUS 2 blood pressure exclusion & termination criteria in the Appendices to the Flowsheet in Section B above.
3	PHYS DISCOMFORT	Participant experienced some type of physical discomfort that affected data collection or completion of the session.
4	PHYS INCOMPETENCE	Unable to monitor physiological signals due to Participant's physical constraint or medical condition (e.g. obesity, injury, or disability) preventing collecting all or some physiological signals or completing certain protocol periods (e.g. Standing period omitted for wheelchair-bound participant).
5	MED CONDITION	Participant had a pre-existing or acute medical condition or illness that interfered with or prevented data collection.
6	EQUIP: ECG	Technical problems with the ECG monitor.
7	EQUIP: FINOMETER	Technical problems with the Finometer blood pressure monitor.
8	EQUIP: OTHER	Technical problems with equipment or computers other than the ECG or blood pressure monitors.
9	OTHER	Any reasons for interference with the session that does not fit in any other category.

Filter Variables: Period Specific

The beat-to-beat ECG waveform data for each period in the psychophysiology protocol were analyzed according to standard procedures, which are described elsewhere in this document. The quality i.e. fidelity of the ECG signal captured during data collection affects whether the data can be analyzed accurately. In addition, certain physiological anomalies (e.g. cardiac arrhythmias), represent non-sinus node neural input to the heart. R-R intervals that are not generated from the sinoatrial node are omitted from analysis. As a result of these various sources of error in the data, short or long sections of data in a "complete" session may show up as missing data in the final data set.

B4V_EQ (_____ ECG DATA QUALITY)
There are 7 period-specific ECQ data quality filters as follows:

Variable Name	SPSS Variable Label
B4VBEQ	BASELINE ECG DATA QUALITY
B4VMEQ	MATH TASK ECG DATA QUALITY
B4VPEQ	PASAT MATH ECG DATA QUALITY
B4VSEQ	STROOP TASK ECG DATA QUALITY
B4VR1EQ	RECOVERY 1 ECG DATA QUALITY
B4VR2EQ	RECOVERY 2 ECG DATA QUALITY
B4VUEQ	STANDUP TASK ECG DATA QUALITY

The above variables have the following values which indicate the overall quality of each period and can be used to help identify why outcome data may be missing for a given period.

Value	SPSS Value Label	Description
1	EXCELLENT	Great signal quality for entire period; should produce full 300 sec epoch of outcome data (or two 300sec epochs for Baseline and PASAT & Stroop sessions)
2	GOOD	Good signal quality, no designated "bad intervals" (i.e. invalid intervals) of data that had to be omitted from analysis.
3	SCOREABLE	Signals were of sufficient quality to be analyzed but "bad intervals" of invalid data may have been omitted from analysis. If bad intervals were specified, resulting outcome data will be for shorter than 300 sec (or two 300 sec, for Baseline and PASAT & Stroop sessions)
4	UNSCOREABLE	Entire period of data was invalid; thus all outcome data have missing values for this period.
5	NO DATA	No raw physiological signal data were collected; thus all outcome data have missing values.

B4V_EQR (_____ ECG DATA QUAL REASON)

There is a corresponding ECG Data Quality Reason variable (see below) for each period specific ECQ data quality filter variable listed above. These reason codes provide additional information about the reason why the quality code was assigned.

Variable Name	SPSS Variable Label
B4VBEQR	BASELINE ECG DATA QUAL REASON
B4VMEQR	MATH TASK ECG DATA QUAL REASON
B4VPEQR	PASAT MATH ECG DATA QUAL REASON
B4VSEQR	STROOP TASK ECG DATA QUAL REASON
B4VR1EQR	RECOVERY 1 ECG DATA QUAL REASON
B4VR2EQR	RECOVERY 2 ECG DATA QUAL REASON

The above variables have one of the following values which provide additional information about a given quality code was assigned.

Value	SPSS Value Label	Description
1	CLEAN/CLEAR SIGNAL	This code paired with ECG quality ratings of Excellent or Good.
2	NOISY BASELINE	Electrical or other source noise throughout the waveform file, making a “fuzzy” signal that is hard to analyze but often scoreable.
3	ABERRANT BEATS	Either a few non-sinus rhythm beats or systematic non-sinus pattern throughout the period. A few aberrant beats (< 20% of entire period) are usually interpolated to “impute” values and avoid missing data.
4	BAD INTERVALS	Some portion(s) of the period were unable to be scored due to random electrical noise, artifacts due to participant movement, coughing, etc.; thus, “bad intervals” were specified in the waveform analysis. Bad intervals are omitted from analysis, resulting in a shorter epoch of valid data (Duration variable will be < 300 sec)
5	NO DATA	No raw data available; thus no outcome data produced.
6	OTHER	Any conditions that affected the data quality that do not fit into any of the other reason codes. Text notes are provided to help explain the circumstances.

SECTION E

BLOOD PRESSURE VARIABILITY DATA

BLOOD PRESSURE, BLOOD PRESSURE VARIABILITY and BAROREFLEX SENSITIVITY

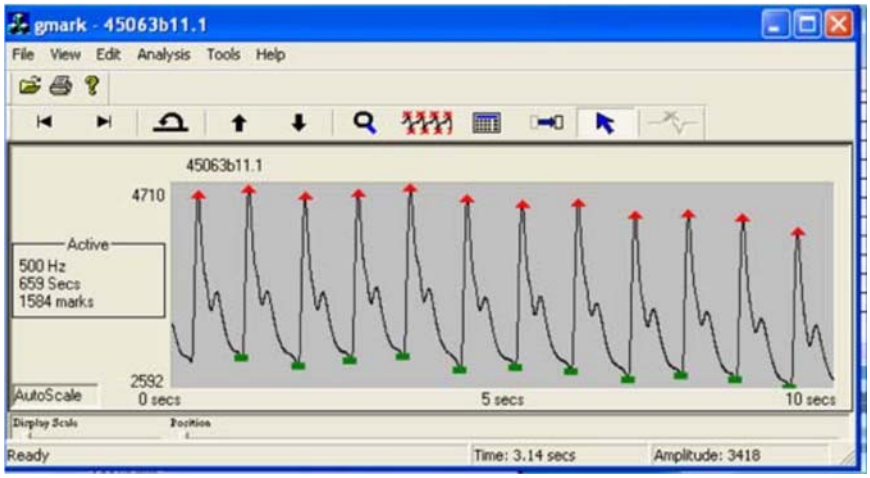
The Biomarker psychophysiology protocol assessed stress reactivity and recovery to psychological and orthostatic (body position) stressors. During this standardized protocol, while participants responded to the stressors presented, we measured three types of physiological signals continuously: electrocardiogram (ECG), blood pressure (BP) and respiration. The ECG data are described Sections C and D above, the Respiration data are described in Section F below. This section describes how the continuous blood pressure signal was used to compute standard measures of blood pressure (BP) and blood pressure variability (BPV), as well as standard measures of baroreflex sensitivity, which represent the modulation of BP through heart rate change. These variables appear in the data set after the HRV variables.

A. Blood Pressure (BP) and Blood Pressure Variability (BPV): Overview

The psychophysiology protocol collected noninvasive measures of beat-to-beat blood pressure (BP) and blood pressure variability (BPV). In humans, BPV measured in this way oscillates at the same frequencies as heart rate, i.e., between 0.003 – 0.50 Hz. Oscillations in the respiratory spectral range (0.15-0.50 Hz), termed “high frequency” (HF) are the mechanical product of respiration-induced intrathoracic pressure changes and, thus, are of little interest in psychophysiological research. BPV in the low frequency (LF) range (0.04-0.15 Hz), on the other hand, has been of considerable interest and may have physiologic significance, with evidence suggesting that it represents a central sympathetic oscillator, a resonance phenomenon, or the feedforward effects of heart rate variability (HRV) .

1. Scoring and Analysis of the BP Waveforms.

The beat-to-beat BP waveforms collected in this protocol go through an intensive process to identify physiologically valid data and use them to compute standard measures of BP and BPV. Systolic peaks and diastolic troughs are identified using custom-written software (see Figure below), resulting in 2-time series: the systolic and diastolic BP events. These time series are then visually reviewed by research staff trained to distinguish physiologically valid BP waveforms from artifact.



Non-valid signals are corrected if possible via an interpolation algorithm then submitted to Fourier-based spectral analysis similar to that described by DeBoer et al. (1984), yielding estimates of power in the low frequency (LF, 0.04-0.15 Hz) band. Prior to computing Fourier transforms, the mean of the BP series is subtracted from each value in the series. The series is filtered using a Hanning window and the power over the LF band is summed. Estimates of spectral power are adjusted to account for attenuation produced by this filter (Harris, 1978).

2. Variable Naming Conventions.

SPSS Variable Labels and Value Labels are included in the data set. Per MIDUS naming conventions the psychophysiology variable names are limited to 8 characters and have the following structure.

BP and BPV Root Variable Naming Scheme: B4 V b pp cc Where:
B4 = MIDUS wave 2 (B), Project 4 (4), per MIDUS conventions
V = MIDUS Code letter assigned to Psychophysiology Session data

The remaining characters are determined by the data type. Since a common set of variables is generated for all protocol periods, the following conventions are applied to all variables derived from the continuous BP waveforms measured during the protocol.

b = ***BP component***; 1 character, identifies from which component of the blood pressure waveform the variable is derived.
S = SYSTOLIC BP (peak of BP waveform)
D = DIASTOLIC BP (trough of BP waveform)

pp = ***Protocol Period and Data Epoch***; a one- or two-digit ***number*** indicates the protocol **period** and sequential data **epoch** within the period represented by the variable. See the key to the numbering scheme below.

cc = ***Construct*** being measured; 2 characters indicate the construct. These include the ***key variables***, as well as ***ancillary variables*** that describe several aspects of the data collected during each period. These 2 sets of variables are described in the next section.

The **Period and Epoch** designation is a combination of information. It indicates during which protocol period the data were obtained and within that period, an ordinal sequence in which the data occurred, called the "epoch". In Table 1 (see Detailed outline of psychophysiology protocol at the end of Section C or in the Protocol Flowsheet in Section B), column 2 shows the Period names used in the data set, using either 1 or 2 characters.

Each variable in the series represents information for one 300sec continuous epoch of recorded data. The number at the end of the variable name indicates either the SEQUENCE of repeated periods in the protocol (i.e. there were 2 different stress recovery periods, thus R1 was the first of the two recovery periods in order) or EPOCH number of data recorded during that PERIOD (i.e. whether the data are from the first or second contiguous, 300 sec series of blood pressure waveforms). The Baseline and PASAT periods (and Stroop period only during sessions that used PASAT task) were long enough to produce 2 epochs of physiological data.

*Key to numeric **Period** and **Epoch** indicators in variable names:*

B1 = BASELINE period, epoch1 (of usually 2 epochs) B2

= BASELINE period, epoch2 (of usually 2 epochs) M1 =

MATH period, epoch1 (of 1 epochs)

S1 = STROOP period, epoch1 (of usually 1 epoch, except when PASAT was math task)

R1 = first RECOVERY period (1 epoch)

R2 = second RECOVERY period (1 epoch)

U1 = UPRIGHT period (1 epoch)

P1 = PASAT period, epoch1 (of usually 2 epochs)

P2 = PASAT period, epoch2 (of usually 2 epochs)

S2 = STROOP period, epoch2 (of usually 2 epochs when PASAT was math task)

B. BP and BPV Variables

The data file contains three sets of variables in the following order: data quality codes, key and ancillary BP and BPV variables, and measures of BaroReflex Sensitivity (BRS). These sets of variables are described below beginning with the BP and BPV variables, then the data quality codes, and ending with BRS. Throughout the following, consistent with emerging nomenclature in experimental research, distinctions are made between key variables and ancillary variables. The key variables are the primary analytic variables derived from or computed using the physiological data. The ancillary variables include other descriptive or contextual data that users may want to consider when selecting variables for inclusion in analysis.

1. Key BP and BPV Variables.

a. The key parameters derived from the blood pressure waveforms during each period, separately, of the psychophysiology protocol are listed below. These output variables are computed based on conventions for these constructs.

b. Note that the data set includes ***both a Systolic BP and Diastolic BP value for all the key and ancillary variables*** listed below. That is, the systolic peak and diastolic trough of the BP waveforms are analyzed separately to produce 2 series of these key and ancillary variables.

c. The data file includes both untransformed and natural log transformed versions of the LF-BPV variables because these variables reliably demonstrate positively skewed distributions. It is standard practice in the psychophysiology literature to log-transform these variables and use the transformed values for data analysis.

Var Name component	Construct	Measurement units
BP	Blood pressure	mmHg[(a)]
BS	Standard Deviation of blood pressure	mmHg[(a)]
LV	Low frequency blood pressure variability (LF-BPV), in spectral bandwidth from 0.04-0.15 Hz	$msec^2$[(b)]
LL	Natural logarithm of LF-BPV value (transformation to correct for positively skewed distribution)	$msec^2$[(b)]

Notes: [(a)]millimeters of mercury; [(b)]milliseconds squared

2. BP and BPV Ancillary Descriptive Variables.

a. We provide these variables to give investigators descriptive information about the timing and duration of the physiological signals from which the computed key variables were derived.

b. All data included in the data set can be considered valid for most purposes. Data considered non-valid for use, based on the most common methods in the psychophysiology literature on blood pressure and BPV, already have been omitted from this data set.

c. Nevertheless, some investigators, depending on the research questions, may choose to omit some periods of data based on information in these descriptive variables.

Var Name component	Construct	Measurement units
DU	Epoch duration of valid data used to compute key variables for this epoch	sec[(a)]
ST	start time of data epoch	elapsed sec
ET	end time of data epoch,	elapsed sec
MT	total recorded time during the period;	sec
IT	Total # BP-BP intervals recorded in this period	count
IU	# BP-BP intervals in this period that are valid and used to compute key variables	count
IA	average length of BP-BP interval	sec

Notes: [(a)]seconds

In the data file all the diastolic variables are listed first followed by all the systolic variables. Per MIDUS convention, ancillary variables are listed first followed by the key variables for each period.

EXAMPLE:
An example of the complete set of variable names for ***one protocol period*** is shown below. This example shows the list of all key and ancillary variables derived from Diastolic BP data during the Math stressor task protocol period.

B4VDM1DU	Diastolic, Math Epoch1 duration, sec
B4VDM1ST	Diastolic, Math Epoch1 start time, elapsed sec
B4VDM1ET	Diastolic, Math Epoch1 end time, elapsed sec
B4VDM1MT	Diastolic, Math Epoch1 total recorded time, sec
B4VDM1IT	Diastolic, Math Epoch1 # B-B intervals total
B4VDM1IU	Diastolic, Math Epoch1 # B-B intervals used
B4VDM1IA	Diastolic, Math Epoch1 average length of B-B interval, sec
B4VDM1BS	Diastolic, Math Epoch1, std dev of DBP, mmhg
B4VDM1BP	Diastolic, Math Epoch1, DBP, mmhg
B4VDM1LV	Diastolic, Math Epoch1, low freq BP variability 0.04-0.15 Hz, msec squared
B4VDM1LL	Diastolic, Math Epoch1, natural log of LF BPV, msec squared

3. Data Quality Codes for BP and BPV Data.

We also provide with these data a set of variables describing the quality of the physiological data collected, whether non-valid data occurred that resulted in missing values for the BP and BPV outcome variables, and the nature of the non-valid data. These data quality variables are meant to help investigators understand why missing data might exist even though the stress reactivity protocol was administered to a participant. Depending on one's research questions, these quality codes may, thus, help make decisions on whether to include or omit certain cases from analyses. The data quality coding scheme was developed by Dr. Richard Sloan's team at Columbia University Medical Center.

One important point for understanding these quality codes is that we reviewed and corrected the BP waveform data in conjunction with the concurrent ECG waveform data. The reasoning behind this procedure is that BP is primarily determined by cardiac ventricular contraction. If the timing of the ventricular contractions i.e. the ECG R waves, or the shape of the ECG waveforms represents a cardiac arrhythmia that is not valid for computing HRV, for our purposes in this study the

corresponding BP waves also are not valid for use in computing BP or BPV. The valid computation of heart rate variability parameters depends on using ECG waves that, based on visual inspection, represent ***sinus rhythm*** of the R-R intervals i.e. contractions neurally generated via parasympathetic innervation of the sinoatrial (SA) node in the heart. For our interests in the MIDUS psychophysiological stress challenge protocol, we want to use corresponding blood pressure waves that are produced from normal sinus rhythm cardiac activity. Thus, anomalies in the ECG data are often used selectively to omit corresponding BP data.

Note that these ratings are made on the data quality of the overall BP waveforms for each protocol period. Unlike the computed BP and BPV variables, there is ***not*** a separate set of quality ratings for systolic and diastolic components of the waveforms.

Key Variables: BP Data Quality Codes for each Period:

Variable name component	Definition	Coded Values	Code definitions
WQ: Waveform quality	Physiological signal fidelity. If signal quality poor, valid signals cannot be identified for use in computing outcome parameters.	1=Clean signal	Period recorded clearly with no interference or noise.
		2=Noise	Period contains areas where signal is obscured by noise.
		3=Missing data.	Period recorded per physio protocol flowsheet but no valid data obtained; usually a technician error in which only the BP monitor's calibration waveform was recorded rather than participant data signal.
		4=Period not run.	Period not recorded due to early termination of protocol (determined by laboratory technician), or equipment malfunction; or entire session not run.
QR: Quality Reason	These codes help explain the reason for the Waveform Quality rating code.	1=Clean Signal	Waveform events are clearly visible; signal is consistently clean throughout file.
		2=Interference	Signal is obscured in some areas by electrical interference ("noise").
		3=PP movement	Signal morphology is contorted in some areas, likely due to participant movement.
		4=Loss of signal	Signal is lost in some areas, likely due to equipment malfunction or intentional termination of period (determined by laboratory technician).
		5=Missing data	Period recorded per physio protocol flowsheet but no valid data obtained; usually a technician error in which only the BP monitor's calibration waveform was recorded rather than participant data signal..
		6=Period not run	Period not recorded due to early termination of protocol (determined by laboratory technician), or equipment malfunction; or entire session not run.

PH: Physiology	Physiology of the signal based on visual review. If there were BP anomalies or arrhythmias associated with non-sinus rhythm in the ECG signal, what type were they?	1=Normal	Physiology does not contain any arrhythmias identifiable by visual scan.
		2=PVCs	Premature ventricular contractions (PVCs) are one commonly encountered kind of non-sinus cardiac rhythm. Visible concurrently in ECG and BP signals. ***Can*** be validly corrected via interpolation, but if PVCs are too frequent (>20% of a file), effect on BP pulse timing and magnitude make the BP signal non-valid for analysis.
		3=PACs	Premature atrial contractions (PACs) are one commonly encountered kind of non-sinus cardiac rhythm. Visible concurrently in ECG and BP signals. ***Cannot be corrected***, only omitted from period, and if too frequent may thus prevent there being enough usable continuous data to produce a long enough epoch from which to compute BP/BPV measures.
		4=Other Non-Sinus	Any arrhythmia not visually identifiable as PVC or PAC. A recurring interruption of pulse timing or magnitude making the BP signal non-valid for analysis.
		5=Missing data	Period recorded per physio protocol flowsheet but no valid data obtained; usually a technician error in which only the BP monitor's calibration waveform was recorded rather than participant data signal.
		6=Period not run	Period not recorded due to early termination of protocol (determined by laboratory technician), or equipment malfunction; or entire session not run.
BI: Bad Interval	Was there an unscoreable interval of data omitted from analysis? If so, how much of the period was affected?	1=None	No unscorable intervals in the period.
		2=Partial	Some unscorable intervals have been identified in the period and omitted from analysis.
		3=Whole	The whole period has been identified as unscorable and omitted from analysis.
		4=Missing data	Period recorded per physio protocol flowsheet but no valid data obtained; usually a technician error in which only the BP monitor's calibration waveform was recorded rather than participant data signal.
		5=Period not run	Period not recorded due to early termination of protocol (determined by laboratory technician), or equipment malfunction; or entire session not run.
NO: Notes	Data scorer's notes.		Text data format. No numeric codes.

EXAMPLE: Quality Codes Variables

An example of the complete set of quality code variable names for ***one protocol period*** is shown below. This example shows the variables for data quality during the Math stressor task period.

B4VM1BPWQ	Math, BP Waveform Quality
B4VM1BPQR	Math, BP Quality Reason
B4VM1BPPH	Math, BP Physiology
B4VM1BPBI	Math, BP Bad Interval
B4VM1BPNOT	Math, Scoring Notes

4. Baroreflex Sensitivity (BRS).

Blood pressure regulation – or dysregulation – is a crucial physiological function that can affect both acute and chronic health outcomes. Though blood pressure is regulated by several mechanisms, one of the most important is the baroreflex. The vascular system is equipped with stretch receptors called baroreceptors in the aortic arch and carotid arteries. BP changes on a beat-to-beat basis as blood is ejected from the heart, resulting in size fluctuations in arterial walls. The aortic and carotid baroreceptors signal these changes via the vagus nerve (cranial X) and carotid sinus nerve (to cranial IX) respectively. A homeostatic negative feedback reflex ensues, characterized by modulations of cardiac and vasomotor activity, which then result in changes in heart rate and vascular tone to offset changes in blood pressure (Levy & Pappano, 2007).

If the baroreflex is functioning properly, an increase in blood pressure results in a lengthening of the intervals between heartbeats i.e. R-wave to R-wave intervals (RRI). This RRI change allows BP to fall more between the next ventricular contractions than between shorter RRIs. Likewise, when BP decreases, baroreceptor feedback results in shorter RRIs.

In the MIDUS psychophysiology data, we can assess the cardiac arm of the baroreflex, as described above, because the aortic receptors signal via the vagus nerve, which also regulates heart rate variability.

This data set includes measures of baroreflex sensitivity, an index of how readily the heart responds to changes in BP. Reduced baroreflex sensitivity leads to increased transient changes in BP that may have acute or chronic ramifications.

a. BRS Indexes:

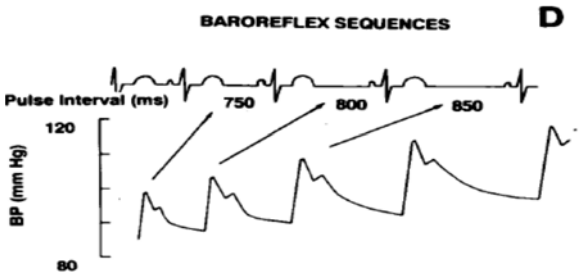
Traditionally, BRS has been measured as the RR interval (RRI) change corresponding to changes in BP produced by bolus injections of vasoactive drugs. Once regarded as the “gold standard,” most senior researchers in the field now believe that pharmacologic approaches are not free of problems and that noninvasive methods of BRS analysis are equally valid.

Accordingly, we use a sequence method approach. Series of ***3 or more increasing or decreasing systolic BP values*** constitute a “sequence” that likely represents engagement of the baroreflex. Such sequences are identified throughout each protocol period and used to compute BRS as described below.

b. **Sequence Method Calculation steps:** based on method described by Voss, et al. (1999).

1. Identify corresponding BP and ECG data from each protocol period.
2. Subtract 250ms from all BP times, to adjust for standard delay in output by the BP recording monitor used in this study, the Nexfin.
3. Remove Diastolic Records
4. Compute RR-Intervals (Time to next R-wave)
5. Remove Data occurring during Bad Intervals from both BPs and RRs

6. Detect Sequences of 3 or more consecutive BP increases or decreases
7. Match BPs of identified Sequences with corresponding RR-Intervals
8. Use linear Regression to Estimate the Slope of Each Identified Sequence
9. Filter out unwanted Sequences
   a. Those with 2 BPs within 1 RR Interval,
   b. Those with any RR Interval >2sec
   c. Others depending on variable being created)
10. Take mean slope (beta) of remaining Sequences



c. Baroreflex Sensitivity Root Variable Naming Scheme: B4 V pp ccc

B4 V = MIDUS conventions, as stated earlier

pp = ***Protocol Period***; two characters, using same characters as for the BP/BPV variable names. However, unlike for the BP/BPV variables, BRS values were ***not*** computed on epochs within protocol periods. Thus, there is a single set of BRS outcomes for each period. Investigators who want to compare periods with 2 epochs of BP/BPV outcomes with corresponding BRS outcomes can compute the mean of the 2 BP/BPV epochs.

ccc = ***Construct*** being measured; 3 characters indicate the construct. These include ***key and ancillary variables*** that describe several aspects of the data collected during each period. See tables below.

Key BRS Variables

As indicated by the last step in the sequence method calculation steps listed above, the primary indexes of BRS are computed as ***beta coefficients*** i.e. the mean slope of the regression line produced by all sequences in each protocol period.

Var Name component	Construct	Measurement units
TMB	Total Mean Beta for All Sequences	ms/mmHg
IMB	Mean Beta for All Sequences with Increasing BP	ms/mmHg
DMB	Mean Beta for All Sequences with Decreasing BP	ms/mmHg
MPS	Mean Beta for All Sequences with Positive Slopes	ms/mmHg
MSZ	Mean Beta for All Sequences with Slopes Significantly Different from Zero	ms/mmHg
MZP	Mean Beta for All Sequences with Positive Slopes Significantly Different from Zero	ms/mmHg

Ancillary BRS Variables.

Var Name component	Construct	Measurement units
TNS	Total Number of Sequences in the period	Count
INS	Total Number of Sequences with Increasing BP	Count
DNS	Total Number of Sequences with Decreasing BP	Count
NPS	Total Number of Sequences with Positive Slopes	Count
NSZ	Total Number of Sequences with Slopes Significantly Different from Zero	Count
NZP	Total Number of Sequences with Positive Slopes Significantly Different from Zero	Count

EXAMPLE: Baroreflex Sensitivity Variables (Note, the key and ancillary variables are listed separately above, but in the data file the Mean Beta for a given measure is listed first followed by the corresponding Total Number).

An example of the complete set of BRS variable names for ***one protocol period,*** the Math Stressor task is shown below.

B4VM1TMB	Math, Mean Beta for All Sequences, ms/mmHg
B4VM1TNS	Math, Total Number of Sequences
B4VM1IMB	Math, Mean Beta for All Sequences with Increasing BP, ms/mmHg
B4VM1INS	Math, Total Number of Sequences with Increasing BP
B4VM1DMB	Math, Mean Beta for All Sequences with Decreasing BP, ms/mmHg
B4VM1DNS	Math, Total Number of Sequences with Decreasing BP
B4VM1MPS	Math, Mean Beta for All Sequences with Positive Slopes, ms/mmHg
B4VM1NPS	Math, Total Number of Sequences with Positive Slopes
B4VM1MSZ	Math, Mean Beta for All Sequences with Slopes Significantly Different from Zero, ms/mmHg
B4VM1NSZ	Math, Total Number of Sequences with Slopes Significantly Different from Zero
B4VM1MZP	Math, Mean Beta for All Sequences with Positive Slopes Significantly Different from Zero, ms/mmHg
B4VM1NZP	Math, Total Number of Sequences with Positive Slopes Significantly Different from Zero

5. Missing Values.

Per MIDUS 2 coding guidelines, SPSS missing value codes have been applied to variables in this data set.

8, 98, 998, etc. = Missing; physiological data were recorded but the data were not valid for computing the resulting variable. Reasons for non-valid data include: technician error in which only a machine-generated calibration waveform was generated during the period, rather than BP signals

recorded from the participant; electrical interference noise that makes the valid waveforms unidentifiable for analysis.

9, 99, 999, etc. = Inapplicable; the protocol period (or entire session) was not run or no data were collected due to technical or other problems.

Suggested References:

These references provide a good overview on the computation and use of BP, BVP and BRS using the sequence method in psychosocial and psychophysiological research.

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SECTION F

RESPIRATION DATA

RESPIRATION DATA FROM THE PSYCHOPHSIOLOGY PROTOCOL

The respiration variables appear in the data set after the Baroreflex variables.

Respiration Monitoring and Computation of Respiration Rate

Respiration was monitored continuously during the protocol by inductive plethysmography using the Portable Inductotrace system (Bio-logic Systems Corp.®, Mundelein, Illinois). This device uses two stretch bands, one around the chest and abdomen, which measure volume excursions during the respiratory cycle. Respiratory volume was calibrated using an 800 ml plastic bag fitted with a mouthpiece tube (see psychophysiology protocol documentation for more detailed information about respiration monitoring procedures).

Analog signals from the two stretch bands were sampled at 20 Hz and digitized, then summed into a single waveform for analysis. Using proprietary event detection software, respiratory excursions were identified automatically then corrected based on visual inspection to produce a breath-by-breath time series.

Proprietary analysis software computed *respiration rate* in 60 sec epochs from the breath-by-breath time series. Criteria for retaining respiration events as valid breaths in computing respiration rate were: a minimum volume >= 100ml; and respiration rate of 6-30 breaths/minute. Missing values among the respiration variables in the 60 sec data set generally are due to movement artifacts or other sources of noisy physiological signals that prevented analysis of valid respiration signals during that minute of the protocol.

For each protocol period, as for the ECG and BP data, the respiration rate data are provided in the data set in 300 sec epochs. For the Baseline period, as for ECG data, minutes 1-5 were averaged to create one epoch, and minutes 6-10 comprise the second epoch. Thus, the respiration rate epochs generally parallel the epochs provided for the HR and HRV variables.

Epochs for the PASAT math task: A special case.

As explained in the Section C (above) for the ECG/HRV data from this protocol (see Table 1), the PASAT task was used as the math stressor for the first 26 participants in Project 4 in the MIDUS 2 protocol. PASAT was run for 11 minutes to be able to complete the entire, standardized list of PASAT test items. For those same 26 respondents, the Stroop task also was run for 11 minutes to make the two stressor tasks the same length. Thus, two 300 second epochs were created from the PASAT and Stroop periods for these cases. Cases with unscorable intervals of data (due to noisy signal) may include only 1 epoch of 300 sec.

We then changed to another type of math stress task (M1 period), which is detailed in documentation for the ECG data set.

Special Topic: Respiration Rate Adjustment Of HRV

This data set contains the mean respiration rate, in breaths per minute units, for each protocol period in the Psychophysiology protocol. However, heart rate variability in the high frequency range is influenced by respiration (Allen, Chambers, & Towers, 2007; Paul Grossman, Karemaker, & Wieling, 1991; Paul Grossman & Taylor, 2007; P. Grossman, Wilhelm, & Spoerle, 2004). In the psychophysiology literature HF-HRV parameters are often adjusted for respiration rate prior to hypothesis testing analyses.

That is, for any and all of the psychophysiology protocol periods used in one's analyses (e.g. Baseline, Math), one may want to compute respiration-adjusted values of HF-HRV for those periods.

How to compute respiration-adjusted HF-HRV values:

There is no single, standardized approach for adjusting HRV for respiratory rate. The references cited here offer descriptions of approaches that have been used.

One common method, described by Berntson (Berntson, Quigley, Jang, & Boysen, 1990)(p. 605), is a linear regression approach. Respiration rate is used to predict HF-HRV to produce unstandardized residual scores representing the variance in HRV that cannot be explained by the effect of respiratory rate. The residual scores are saved and used in hypothesis testing analyses, rather than using the unadjusted HF-HRV values. This is the approach typically used by Richard Sloan's laboratory at Columbia.

How to do this?

Conduct a univariate regression analysis using respiratory rate as a predictor of HF-HRV (Sloan et al., 2001) on a period-by-period basis. That is, run separate regression models on each protocol period. Save the residuals and predicted values from these regression models. You can explore using either the residuals or predicted values as the new values of HF-HRV. Use these regression adjusted values of HF-HRV in hypothesis testing analyses.

Note: Since in almost all analyses we suggest using log-transformed HRV parameters, we suggest to run the respiration adjustment regression models on the log-transformed form of the high frequency HRV variables.

Example SAS code to adjust HF-HRV from the Math Period (M1) stress task for respiration:

Run the regression of each period's HR-HRV variable on the corresponding period's respiration rate variable as in the example below.

```
proc reg data=[input-filename]  noprint;
model (B4VM1LHF) = (B4VM1RSP) ;
output out=[output-filename]  student=M1LHF_stud  residual= M1LHF_r predicted= M1LHF_p;
run;
```

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