

Interoception Testing (v4) SOP

1 Equipment

1.1 Sensor

Heartbeats are detected using a Nonin OEM Development kit: Oximeter (sensor) and Xpod:

<http://www.nonin.com/documents/OEMOximetryDevelopmentKitOrderForm.pdf>. The Xpod has been out of stock for some time, so you may have to contact Nonin directly to source one. Our contact for this has been Joe Nagle (joe.nagle@nonin.com). The device driver for the Xpod should be included in your purchase. Alternatively, it can be located in the folder Interoception dropbox folder, under “NoninPulseOxDeviceDriver”.

In all cases, a ‘soft sensor’ pulse oximeter should be used in preference to a ‘finger clip sensor’. The finger clip sensor provides a very stable signal, as the emitter/collector is held more securely to the skin. However, the pressure of the clip facilitates the sensation of the pulse in the finger and additional sensory feedback on heart rate. The medium soft sensor is sufficient in most cases. Consider the demographics of your participants to determine whether the small and/or large sensors may be required.

The participants hand and arm should be positioned such that they are fully supported, e.g. with a cushion. Any small movements of the sensor may cause signal loss and the trial will fail. Put the index finger on the participants’ non-dominant hand in the sensor, with the cable on the top. Push the finger towards the end of the sensor such that the nail bed is directly underneath the transmitter. Careful fitting is central to achieving stable sensor readings. Their finger should rest lightly on the cushion, without pressing down.

During testing, emphasise that the participant must try to concentrate on ‘feeling’ their heartbeat by focussing attention on their heart beating, wherever they can feel it in their body (avoid drawing attention to any sensation in the finger attached to the sensor).

1.2 Computer

Ensure laptop audio is on and the screen is turned away from the participant. Plug in the Xpod and sensor.

1.3 Install Psychtoolbox & Gstreamer

Visit <http://psychtoolbox.org/download> and follow the instructions for installing Psychtoolbox and GStreamer.

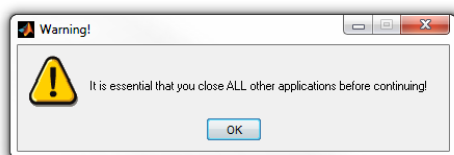
1.4 Visual analogue scale

After each trial on the heartbeat tracking, time tracking, and heartbeat discrimination tasks, the participant is required to provide an indication of their confidence in the accuracy of their answer using a visual analogue scale (VAS). You can use the pen and paper version, or give the participant the virtual version on a separate PC. After testing is complete, the confidence is measured against each trial and entered into the appropriate analysis.

2 Open the program

To run from Matlab command line, run the function: `>> InteroceptionTesting_v4.m`

When you start the program it will present a warning to shut down all other applications, This ensures the pulse oximeter signal is prioritised.

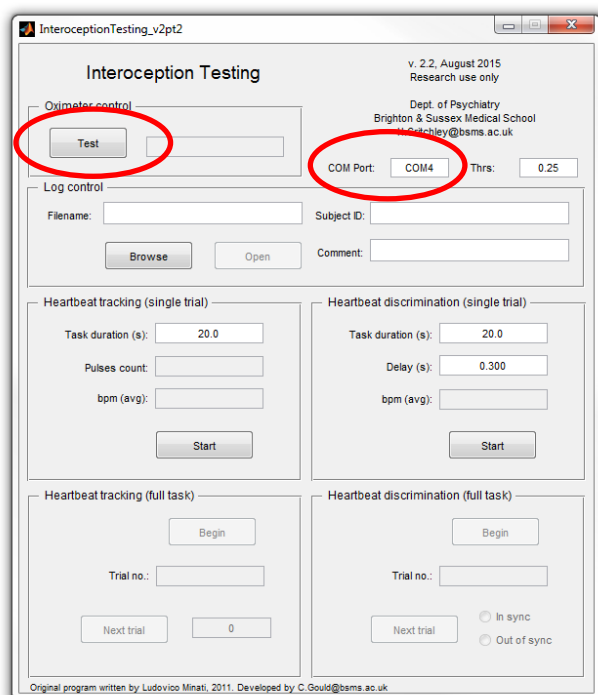


Close all other programs and press **OK** button.

3 Check connection to the pulse oximeter

Check that the correct COM port is entered for your system/computer (defaults to "COM3"). To check which COM port the pulse ox uses, open your Device Manager > COM (Ports & LPT).

Press **Test** to confirm sensor is being correctly detected.



If a COM has been entered which is not available, an error message will pop up and say which COMs are available on this computer.

If the test result displays **Check USB and COM#**, the system has timed out whilst trying to sync. This means either the XPod and sensor are not connected together, or they are not plugged into the COM port entered.

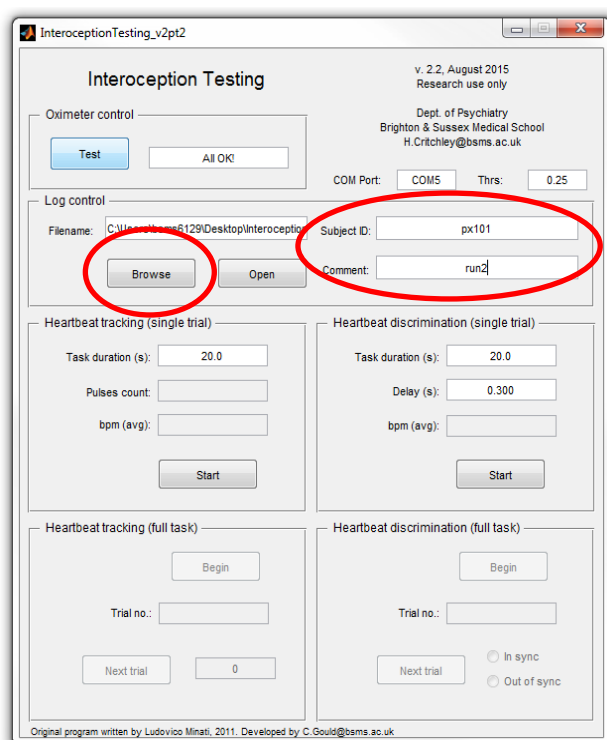
If the test result displays **Sensor Problem (unusable data)**, the system has been unable to sync. This is mostly likely caused by participant movement, poor finger positioning, participant having cold hands, or the pulse ox being dirty (clean with 70% alcohol wipes and let dry before use).

If the system is able to read from and sync with the sensor, the test results will report **All OK!**

If **All OK!**, continue to create a results file for the participant.

4 Create results file

Under **Log Control**, press **Browse** and navigate to the desired location to save your results file. Enter your participant ID and any comments as required.



5 Run practice trials if required

The **single trial** frames (middle of the display) give the participant a chance to practice the tasks before running them in full. Pressing **Start** will run a single example of the chosen task. Each task can be repeated until the participant feels comfortable with the task requirements.

It is important throughout these single blocks and the main tests to give no feedback to the participant regarding their accuracy. After each practice trial, the single block frames will give a beats per minute (bpm) score, which the participant may use to inform their answers in the main trial.

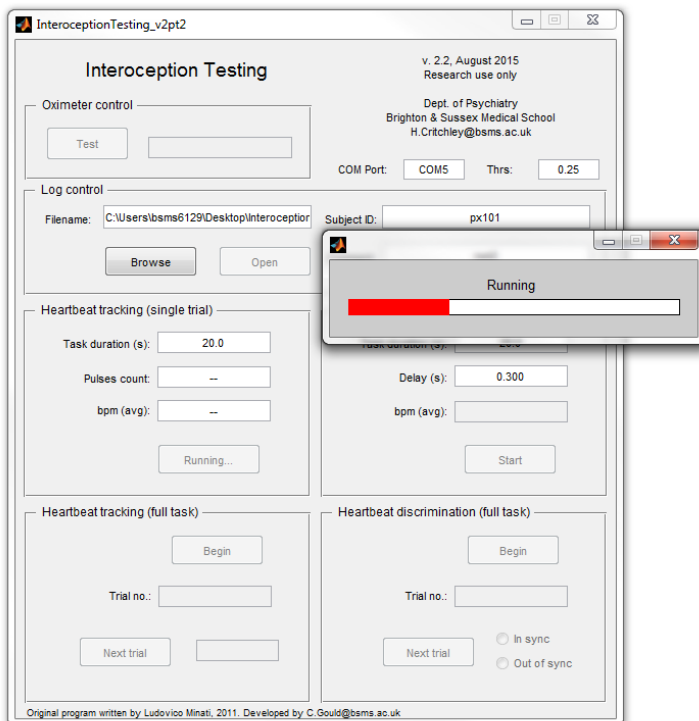
5.1 Heartbeat tracking

The participant is required to count number of heartbeats between a **Start** and **Stop verbal command**.

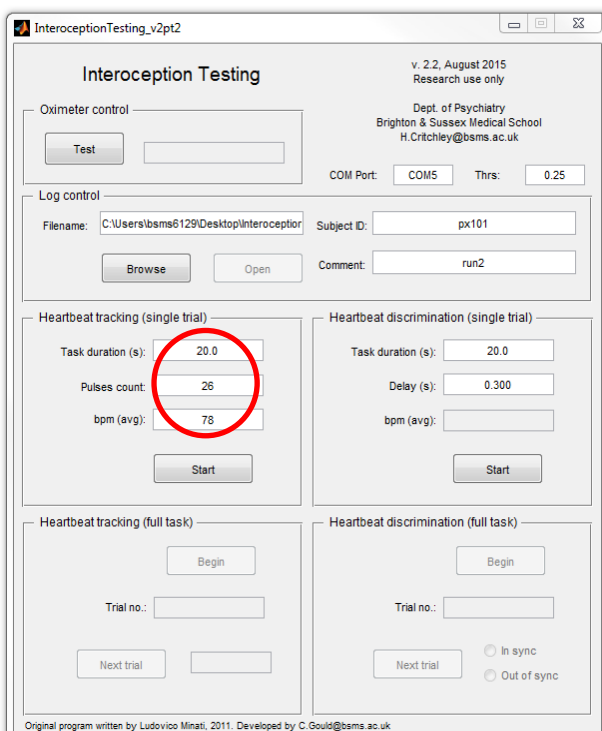
While the task is running, the participant counts how many heartbeats they feel between the start and stop instructions. When the task is finished, the participant should report how many they beats they counted. In

the full block, they are required to report their confidence in their accuracy on a paper visual analogue scale (VAS).

Press **Start** to run a single trial.

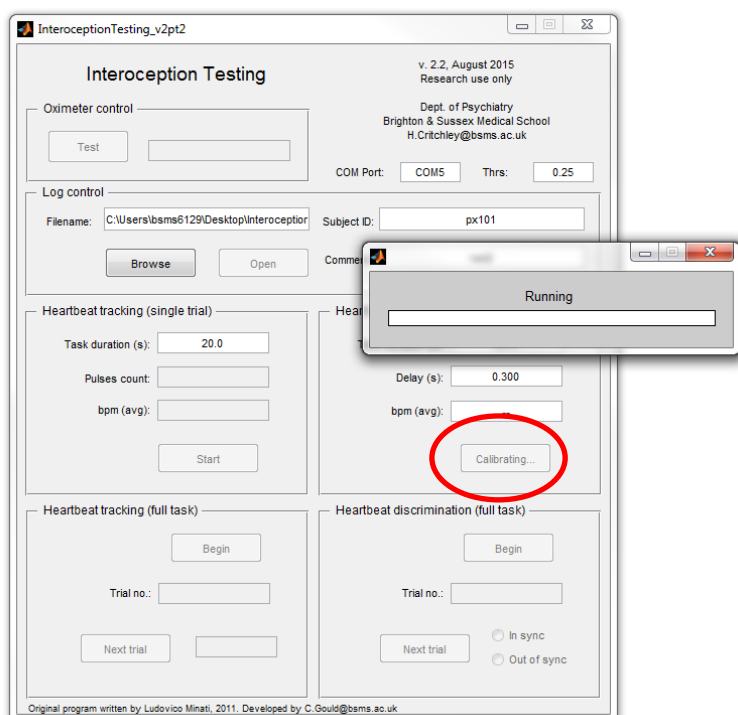


When the trial has finished (default duration is 20.0 seconds), the experimenter can compare the pulses counted to the beats reported.

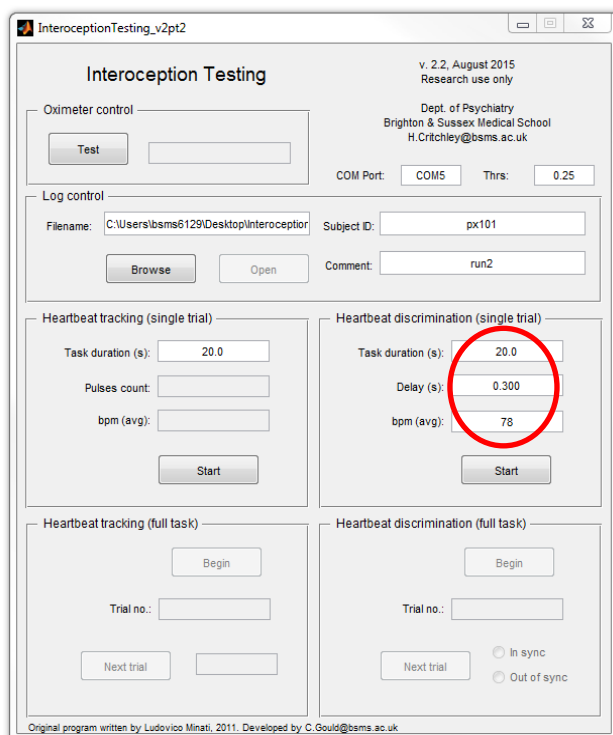


5.2 Heartbeat Discrimination

The participant is required to determine whether the audio tones are “in sync” or “out of sync” with their heartbeat. Press **Start** to run the task. The program will calibrate for a short period, and then tones will play.



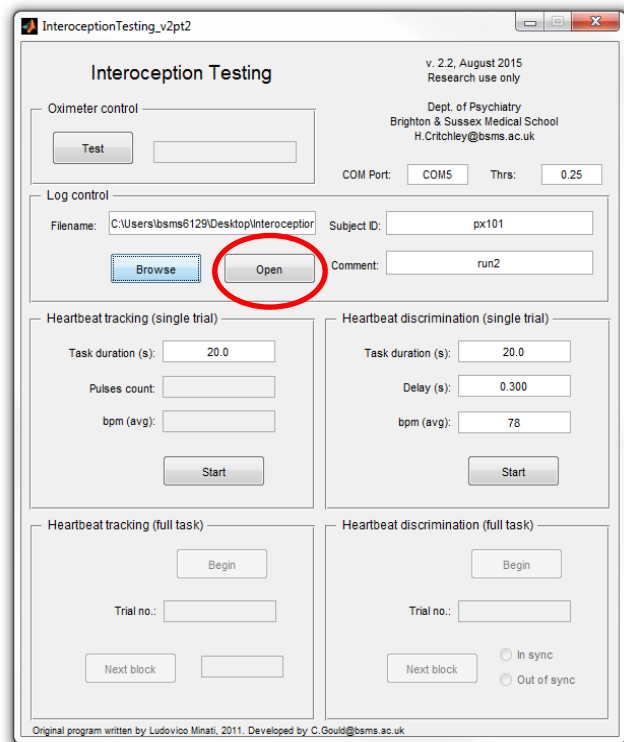
When the trial has finished (default duration is 20.0 seconds), the experimenter can compare the in/out sync report to the delay entered. The default delay of 0.30 seconds is equivalent to an ‘out of sync’ trial.



If it is intended that the participant completes both the tracking and discrimination tasks, the full tracking task should be run before the discrimination practice trials. This is to avoid giving the participant an indication of their heart rate (through the audio tone playback), which they may then use to inform their tracking answers.

6 Open the results file

Once the participant understands the tasks, click **Open** in the log control to write to begin writing to the results file.



7 Heartbeat tracking (full task)

Start the full **Heartbeat Tracking** task by pressing the **Begin** button in the **full task** frame.

The screenshot shows the 'InterceptionTesting_v2pt2' window. It includes sections for 'Oximeter control', 'Log control', and two task panels. The 'Heartbeat tracking (full task)' panel has a 'Begin' button circled in red. Other visible fields include 'Task duration (s): 20.0', 'Pulses count:', 'bpm (avg):', 'Trial no.:', and 'Next trial'.

There are 6 blocks of the heartbeat tracking task. After each block, enter the number of beats the participant counted, complete the VAS, then click **Next trial**.

This screenshot shows the same software interface after the first trial. The 'Heartbeat tracking (full task)' panel now shows 'Trial no.: 1' and the 'Next trial' button is circled in red. An 'Abort' button is also visible above the trial number field. The 'Heartbeat discrimination (full task)' panel remains unchanged with its 'Begin' button.

InterceptionTesting_v2pt2

v. 2.2, August 2015
Research use only

Dept. of Psychiatry
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Oximeter control

Test

COM Port: COM5 Thrs: 0.25

Log control

Filename: C:\Users\bsms6129\Desktop\Interceptor Subject ID: px101

Browse Close Comment: run2

Heartbeat tracking (single trial)

Task duration (s): 20.0

Pulses count:

bpm (avg):

Start

Heartbeat discrimination (single trial)

Task duration (s): 20.0

Delay (s): 0.300

bpm (avg): 78

Start

Heartbeat tracking (full task)

Abort

Trial no.: 6

Finish 28

Heartbeat discrimination (full task)

Begin

Trial no.:

Next trial

☐ In sync
☐ Out of sync

Original program written by Ludovico Minati, 2011. Developed by C.Gould@bsms.ac.uk

After five blocks have been recorded, click “**Finish**”.

8 Time tracking (full task)

Start the full **Time tracking** task by pressing the **Begin** button in the **full task** frame.

The screenshot shows a software interface with several sections. At the top, there are input fields for 'Filename:' (test.txt), 'Subject ID:', and 'Comment:'. Below these are 'Browse' and 'Close' buttons. The interface is divided into four main task sections: 'Heartbeat tracking (single trial)', 'Heartbeat discrimination (single trial)', 'Heartbeat tracking (full task)', and 'Heartbeat discrimination (full task)'. Each section has its own set of parameters and a 'Start' or 'Begin' button. The 'Time tracking (full task)' section is at the bottom left, and its 'Begin' button is circled in red. To the right of the task sections, there is a text block: 'Original program written by Ludovico Minati, 2011. Developed by C.Gould@bsms.ac.uk Edits v. 2.4. L.Quadt@bsms.ac.uk'.

There are 6 blocks of the heartbeat tracking task. After each block, enter the number of beats the participant counted, complete the VAS, then click **Next trial**.

This screenshot shows the same software interface as the previous one, but after the 'Time tracking (full task)' section. The 'Begin' button is no longer visible. Instead, there is an 'Abort' button and a 'Trial no.: 1' field. The 'Next trial' button is circled in red, and next to it is a text input field containing the number '45'. The text block on the right remains the same.

InteroceptionTraining_v2pt4

v. 2.4, January 2018
Research use only

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Interoception Testing

Oximeter control

Test All OK

COM Port: COM3 Thrs: 0.25

Log control

Filename: test.txt Subject ID: Comment:

Browse Close

Heartbeat tracking (single trial)

Task duration (s): 20.0

Pulses count: bom (avg):

Start

Heartbeat discrimination (single trial)

Task duration (s): 20.0

Delay (s): 0.300

bpm (avg):

Start

Heartbeat tracking (full task)

Begin

Trial no.: Next trial 0

Heartbeat discrimination (full task)

Begin

Trial no.: Next trial In sync Out of sync

Time tracking (full task)

Abort

Trial no.: 6

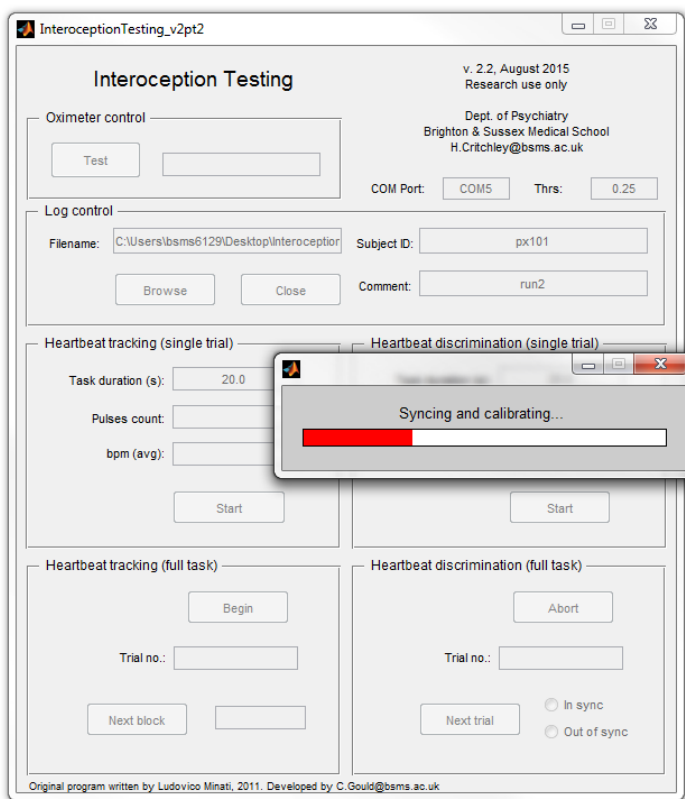
Finish 87

Original program written by Ludovico Minati, 2011.
Developed by C.Gould@bsms.ac.uk
Edits v. 2.4. L.Quadt@bsms.ac.uk

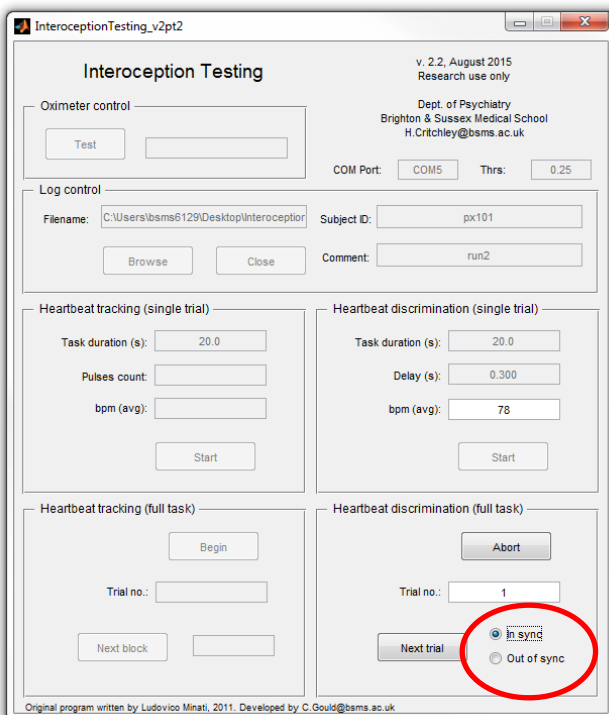
After five blocks have been recorded, click “**Finish**”.

9 Heartbeat discrimination (full task)

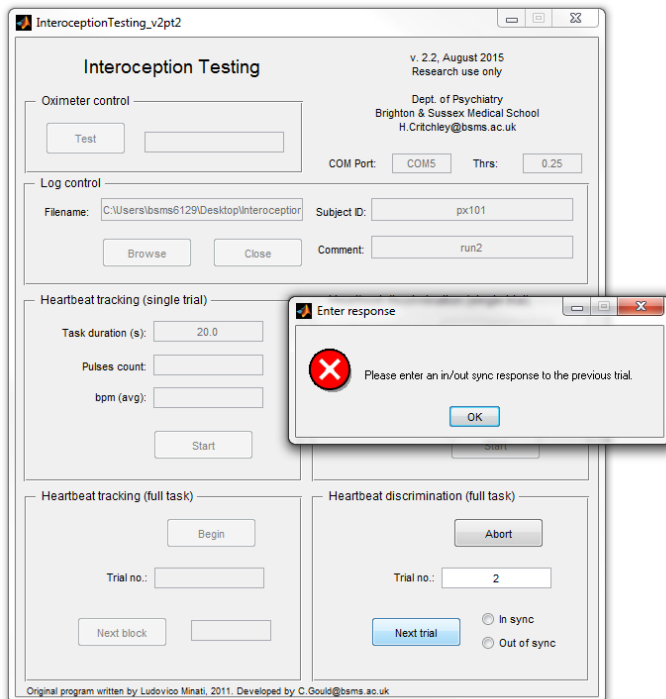
Start the full **Heartbeat discrimination** task by pressing the **Begin** button in the **full task** frame.



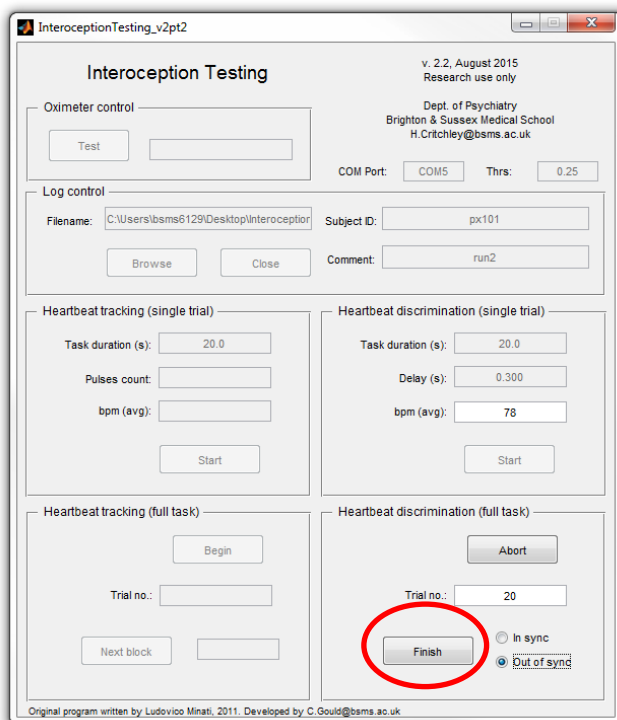
Each trial will present ten tones, all of which will be played on systole (in sync), or 0.3 seconds after systole (out of sync). After each trial, click the **radio button** for **in sync** or **out of sync**, based on the participants' response. Complete the VAS then click "**Next block**"



Both radio buttons will be reset to blank after the end of the tones. You will be prompted with an error if you attempt to proceed to the next trial without entering a response.



After twenty trials have been recorded, click **“Finish”**.



10 Close the results file

After both tasks have been completed, click **Close** in the log control to end writing to the results file.

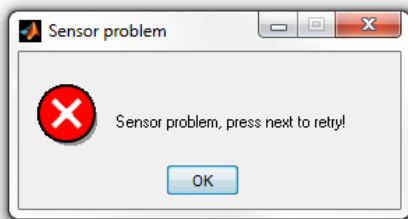
The screenshot shows the 'Interoception Testing' software window. The title bar reads 'InteroceptionTesting_v2pt2'. The main window has a header with 'v. 2.2, August 2015' and 'Research use only'. Below this, it lists the 'Dept. of Psychiatry, Brighton & Sussex Medical School' and the contact 'H.Critchley@bsms.ac.uk'. The interface is divided into several sections: 'Oximeter control' with a 'Test' button; 'Log control' with fields for 'Filename' (C:\Users\bsms6129\Desktop\Interoception), 'Subject ID' (px101), and 'Comment' (run2), and a 'Close' button circled in red; 'Heartbeat tracking (single trial)' with fields for 'Task duration (s)' (20.0), 'Pulses count', 'bpm (avg)', and a 'Start' button; 'Heartbeat discrimination (single trial)' with fields for 'Task duration (s)' (20.0), 'Delay (s)' (0.300), 'bpm (avg)' (78), and a 'Start' button; 'Heartbeat tracking (full task)' with a 'Begin' button, 'Trial no.' field, and 'Next block' button; and 'Heartbeat discrimination (full task)' with a 'Begin' button, 'Trial no.' field, 'Next block' button, and radio buttons for 'In sync' and 'Out of sync'. At the bottom, a small text line reads 'Original program written by Ludovico Minati, 2011. Developed by C.Gould@bsms.ac.uk'.

11 Error signals

The running of these tasks is highly dependent on the signal quality obtained by the finger sensor. As such, this program is very sensitive to movement and other factors which impeded signal quality, such as poor perfusion of the fingertips, nail varnish or false fingernails. These problems can be mitigated by:

- 1) Ensuring the participants' hand is fully supported and relaxed;
- 2) Ensuring the participants' hand is warm;
- 3) Removing nail varnish and false nails.

Despite the above, it is common to receive 'signal loss' errors during testing. Patience and persistence are advised in order to complete both tasks in full.



12 Analysis

Analysis is conducted as reported in:

Garfinkel, S. N., Seth, A. K., Barrett, A. B., Suzuki, K., & Critchley, H. D. (2014). Knowing your own heart: Distinguishing interoceptive accuracy from interoceptive awareness. *Biological Psychology*, 104, 65–74.

13 Task Instructions

13.1 Heart Beat Tracking Task

We are now going to test how well you can perceive your heart beat without manually taking your pulse.

We are going to do three different tasks that I will explain as we go along.

In the first task, the computer will say “Start” and “Stop”. I will ask you to count your heart beats in between that time. Some people find it helpful to focus inward and close their eyes, but you can do this however you want.

After the computer says “Stop”, please tell me the number of beats you counted. I will put your answer in the computer, so you don’t need to write it down. I cannot see the correct answer.

I will ask you to make a mark on this scale to show me how sure you are of your answer. This scale goes from “Total guess” to “Completely confident”. Please make a mark where you feel it shows best how sure you are that your answer is correct.

Do you have any questions about this? (Answer questions)

Then we can start and we are going to do this six times. Please remain as still as you can while we are doing this, because movements can disturb the sensor.

13.2 Time Tracking Task

The second task we are going to do is very similar to the first one.

Again the computer will say “Start” and “Stop”, but this time, I will ask you not to focus on your heart beat, but just to count seconds.

After the computer says stop, please tell me the number of seconds you counted and again make a mark on the sheet about how sure you are that your answer is correct.

Please stay still again, as we will still be measuring your pulse.

13.3 Heart Beat Discrimination Task

In the third task we are going to do, the computer will play your heart beat back to you in real time.

Whenever the computer detects a beat, it will play a tone. It either plays the tone at the same time as your heart beat, or it delays playing the tone, so that the tone is in between your heart beats.

Your task is to find out whether the ten beeps you hear are at the same time as your heart beat or not.

You can tell me the answer after the ten beeps are over and then again make a confidence judgment about how sure you are of your answer.

We are going to do this 26 times and the first set of beeps is going to take around 10 seconds to start.

If you don't have any questions, we can start.