**HBAT Data Processing and Codebook**

This file contains information about:

* Input files
  + RR Input
  + Parameters specified in GUI
  + Data Grid
  + Behavior Input
* Synchronization
* Algorithm
* Output files
  + RR Level
  + Event Level
  + Summary Level

**Input Variables:** The following variables will be input across four data sources (see sample files “Sample\_Behavior” “Sample\_DataGrid” “Sample\_RR”)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Data Source** | **Variable** | **Variable Type** | **Description** | **Categorical Values** |
| **RR Input** | n/a | Numeric | Input file is single column of RR intervals |  |
| **GUI** | LOOK\_LAG | Numeric | Duration of LOOK STOP needed to trigger new phase (ms) – default 150ms |  |
| MAX\_PHASE | Numeric | Maximum duration of |  |
| **Data Grid** | PARTICIPANT\_ID | String | Unique ID for each data file |  |
| USERVAR\_1 | Category (user-defined) | User-defined category for postprocessing summaries (e.g. diagnostic group, task, sex) | User-defined |
| USERVAR\_2 | Category (user-defined) | User-defined category for postprocessing summaries (e.g. diagnostic group, task, sex) | User-defined |
| RR\_PATH | String | File location of “Heart Rate Input” file |  |
| BEH\_PATH | String | File location of “Behavior Input” file |  |
| RR\_STARTTIME | Numeric | Time of first RR interval in “Heart Rate Input” file (seconds) |  |
| aRR\_SYNCTIME | Numeric | Time of “RR Input” file at time inputted for “BEH\_SYNCTIME” |  |
| aBEH\_SYNCTIME | Numeric | Time of “Behavior Input” file at time inputted for “RR\_SYNCTIME” |  |
| **Behavior Input** | aTIME | Numeric | Relative time of “Behavior Input” file, used as primary time metric |  |
| CODE\_TYPE | Category | Pre-defined variables needed to calculate heart-defined attention.  “Look” and “Task” are state events that have a temporal duration (e.g. participant looking at screen). “Trial” is a discrete | **Look**=participant physically attending to screen (State event)  **Task**=experiment is active (State event)  **Trial**=user-defined discrete event (Point event) |
| STATE\_TYPE (EVENT\_TYPE) | Category | Nature of event. | **Start**=beginning of state  **Stop**=end of state |
| EVENT\_NUM | Numeric | Event number (e.g. trial number; used for user to map sustained attention phase onto discrete experimental events) |  |

**Synchronization**

a The “SYNCTIME” variables are used to create new timestamps for the RR\_INPUT file that align with the BEH\_INPUT file. This adjustment relies on a user-defined “synchronization point” at which the user identifies the relative times in the RR file that corresponds to the relative time in the BEH file. For example, if the first RR occurs at 90s (RR\_STARTTIME=90), and the relative time of 30s in the behavior file (BEH\_SYNCTIME=30) corresponds to the relative time of 20 in the RR file (RR\_SYNCTIME=20), the algorithm will create new RR times that align with the BEH\_INPUT time scale. If timestamps in files are synchronized prior to processing, RR\_SYNCTIME and BEH\_SYNCTIME are both “0”

First, the algorithm will “fill in” the RR times by using the user-inputted RR\_STARTTIME. Next, the algorithm will identify the relative “shift” that must occur in the RR times to align with the times in the BEH\_INPUT file (“TIME”) by subtracting RR\_SYNCTIME from BEH\_SYNCTIME (e.g. 30-20) and adding the resulting value (e.g. 10) to the RR timestamps. The algorithm will then merge the Behavioral and RR input files by “TIME.”

**Algorithm** The following “rules” are used to assign codes to each RR and event:

|  |  |  |  |
| --- | --- | --- | --- |
| **Phase** | **Code** | **Onset** | **Offset** |
| MISSING | **.** | Pre and Post-Task RRs or codes | |
| INATTENTION | 0 | IBIs in periods of non-looking | LOOK START or TASK START (if LOOK START precedes task) |
| BASELINE | n/a | median IBI of 5 beats preceding LOOK START; reset after 1.5s inattention (or other duration input by user) | |
| ATTENTION ORIENTING | 1 | first IBI following LOOK START | onset of SUSTAINED ATTENTION or LOOK STOP |
| SUSTAINED ATTENTION | 2 | 1st IBI following 5 successive IBIs > BASELINE | 1st IBI following 5 successive IBIs < BASELINE or LOOK STOP |
| ATTENTION TERMINATION | 3 | offset of SUSTAINED ATTENTION | onset of SUSTAINED ATTENTION or LOOK STOP |

**Output Files** Ideally, the program will output three levels of data. Shaded rows are defined in the INPUT or ALGORITHM tables above

**Output File: RR-level data (“Sample\_Output.xlsx”):** includes all codes, events, times, RRs, baseline references, and assigned phases

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Variable Type** | **Description** | **Categorical Values** |
| PARTICIPANT\_ID |  |  |  |
| USERVAR\_1 |  |  |  |
| USERVAR\_2 |  |  |  |
| CODE\_TYPE |  |  |  |
| EVENT\_TYPE |  |  |  |
| TIME |  |  |  |
| RR |  |  |  |
| BASELINE | Numeric | Baseline value used to compare RR (RR datarows only) |  |
| PHASE | Categorical | PHASE assigned to each RR or event | {., 0, 1, 2, 3} |
| RR\_CHANGE | Numeric | RR difference from BASELINE (=RR-BASELINE) |  |

**Output Variables: Event Level:** includes the following variables, computed for each EVENT\_NUM (e.g. one row per EVENT\_NUM per PARTICIPANT\_ID)

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Variable Type** | **Description** | **Categorical Values** |
| PARTICIPANT\_ID |  |  |  |
| USERVAR\_1 |  |  |  |
| USERVAR\_2 |  |  |  |
| Event\_NUM |  |  |  |
| PHASE | Categorical | PHASE assigned to event | {., 0, 1, 2, 3} |
| RR\_CHANGE\_EVENT | Numeric | RR\_CHANGE assigned to event |  |

**Output Variables: Summary Level:** includes the following variables, computed for each PARTICIPANT\_ID (e.g. one row per PARTICIPANT\_ID)

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Variable Type** | **Description** | **Categorical Values** |
| PARTICIPANT\_ID |  |  |  |
| USERVAR\_1 |  |  |  |
| USERVAR\_2 |  |  |  |
| Duration\_Task | Numeric | Duration of Task (s) |  |
| Duration\_Looking | Numeric | Duration of Looking (s) |  |
| Duration\_0 | Numeric | Duration of Inattention (PHASE=0) (s) |  |
| Duration\_1 | Numeric | Duration of Orienting (PHASE=1) (s) |  |
| DURATION\_2 | Numeric | Duration of Sustained Attention (PHASE=2) (s) |  |
| DURATION\_3 | Numeric | Duration of Attention Termination (PHASE=3) (s) |  |
| PROPORTION\_0 | Numeric | Proportion Task in Inattention (PHASE=0) (s) |  |
| PROPORTION\_1 | Numeric | Proportion Task in Orienting (PHASE=1) (s) |  |
| PROPORTION\_2 | Numeric | Proportion Task in Sustained Attention (PHASE=2) (s) |  |
| PROPORTION\_3 | Numeric | Proportion Task in Attention Termination (PHASE=3) (s) |  |
| RR\_CHANGE\_1 | Numeric | Average RR Change from Baseline during PHASE=1 (s) |  |
| RR\_CHANGE\_2 | Numeric | Average RR Change from Baseline during PHASE=2 (s) |  |
| RR\_CHANGE\_3 | Numeric | Average RR Change from Baseline during PHASE=3 (s) |  |
| PHASES\_N\_0 | Numeric | Number Inattention Phases (PHASE=0) (s) |  |
| PHASES\_N\_1 | Numeric | Number Orienting Phases (PHASE=1) (s) |  |
| PHASES\_N\_2 | Numeric | Number Sustained Attention Phases (PHASE=2) (s) |  |
| PHASES\_N\_3 | Numeric | Number Attention Termination Phases (PHASE=3) (s) |  |
| PEAK\_DURATION\_TOTAL | Numeric | Total duration of longest look(s) |  |
| PEAK\_DURATION\_1 | Numeric | Duration of Orienting (PHASE=1) during Peak Look (s) |  |
| PEAK\_DURATION\_2 | Numeric | Duration of Sustained Attention (PHASE=2) during Peak Look (s) |  |
| PEAK\_DURATION\_3 | Numeric | Duration of Attention Termination (PHASE=3) during Peak Look (s) |  |
| PEAK\_PROPORTION\_1 | Numeric | Proportion Peak Look in Orienting (PHASE=1) (s) |  |
| PEAK\_PROPORTION\_2 | Numeric | Proportion Peak Look in Sustained Attention (PHASE=2) (s) |  |
| PEAK\_PROPROTION\_3 | Numeric | Proportion Peak Look in Attention Termination (PHASE=3) (s) |  |