

ERTS Psychometric Test Battery

Review of Part 11 compliance

Version 1.0 from 08.09.2002
Author: Dr. Jörg Beringer

Copyright 2002 by BeriSoft Cooperation

Components of psychometric test battery	2
<i>Hardware</i>	<i>2</i>
<i>Software.....</i>	<i>2</i>
<i>Psychometric Tests</i>	<i>2</i>
<i>Data Records.....</i>	<i>2</i>
<i>Persistency of Data Records</i>	<i>3</i>
Part 11.....	3
Classification	3
§11.10a: Validation of system	3
<i>Accuracy, reliability, consistent intended performance.....</i>	<i>3</i>
General software platform	3
ERTSCODE data processing tool for generating case report.....	4
ERTS session launcher for automated session coding.....	5
Individual test applications (tailored to individual study).....	5
<i>Intended performance of test paradigms.....</i>	<i>5</i>
<i>Intended performance of subjects.....</i>	<i>6</i>
<i>Ability to discern invalid and altered records.....</i>	<i>7</i>
§11.10b: Accurate and complete copies of records	7
<i>Completeness.....</i>	<i>7</i>
<i>Inspection and Readability.....</i>	<i>7</i>
§11.10c: Protection of records.....	7
<i>Persistency and flow of data records</i>	<i>8</i>
<i>Protection of data records.....</i>	<i>8</i>
§11.10d: Limiting system access	9
§11.10e: Time-stamped audit trails	9
§11.10f: System checks	9
§11.10g: Authority checks.....	10
§11.10h: Device checks.....	10
§11.10i: Training and education.....	10
§11.10j: Accountability and responsibility.....	10
§11.10k: System documentation.....	10

Components of psychometric test battery

Hardware

EXKEY

Microprocessor logic that transfers external key presses to computer via parallel port using asynchronous communication protocol.

Test Station

Standard PC or Laptop running in stand-alone mode (no network connection). Visual presentation is done via standard VGA card and monitor. Auditory presentation is done via SoundBlaster compatible sound card.

Consolidation Engine

Standard PC or Laptop running stand alone or in network with user password protected accounts.

Software

DOS or Win9x

Real-mode operating system ensuring real-time capabilities.

ERTS

Standard run-time kernel for controlling event timing and response registration in milliseconds.

ERTSCODE

Reporting tool for generating case reports out of raw data files

WINZIP

Data compression

Psychometric Tests

Test application

A single test or scale consisting of several presentation of stimuli and response registrations.

Test Battery

A series of individual test applications that can be launched as one test session.

Data Records

Raw data file

Original trial by trial data from test applications. Files include full coding of session, subject, and psychometric treatment.

Case Reports

Printable ASCII file that contain tables with descriptive statistics from each test for one session.

Biometric Export Files

ASCII file that contains test parameters for one test application aggregated from raw data files for every subject and session.

Persistency of Data Records

Test Station

Standard PC or Laptop running DOS or Win9x real-mode operating system in stand-alone mode (no network connection). For each session and sub-test one raw-data file is generated and stored on the computer's hard disk. At the end of each session, new data are copied to subject disk.

Subject Disk

Standard floppy disk initialized with subject code and initials. The disk is used to auto-start next scheduled session on the test stations depending on what data already exists. The disk stores all data from one subject. Each subject has a different disk.

Consolidation Engine

Standard PC or Laptop that is used to collect data from all subjects and for printing case reports. Raw data from all disks are copied to this machine. The lab manager selects sessions and generates printable case report files that are print on a printer connected to the consolidation engine.

Part 11

Classification

The ERTS Psychometric Test System is considered to fall under Part 11.10 "Electronic Records".

- the system produces and stores data, records, or documents used in FDA submissions
- the system is a closed system in that stand-alone computers with limited access to certified employees is guaranteed. No signatures are used.

The following sections review the efforts and actions being related to Part 11 compliance. The sections also list gaps that have been identified and potentially could be improved in future studies.

§11.10a: Validation of system

Accuracy, reliability, consistent intended performance

General software platform

The general software platform for controlling stimulus presentation and response registration relies on the ERTS runtime kernel that has been validated several times

Beringer, J. (1992). Timing accuracy of mouse response registration on the IBM microcomputer family. *Behavior Research Methods, Instruments, & Computers*, 24 (3), 486-490.

Beringer, J. (1993). Entwurf einer Anwendersprache zur Steuerung psychologischer Reaktionszeitexperimente. European University Studies, Series XLI, Informatic, Peter Lang: Frankfurt, Paris, New York.

Beringer, J. (1990). Validierung von ERTS. In Empfehlenswerte apparative Methoden zur Arzneimittelentwicklung innovative Verfahren, Collegium Internationale Psychiatriae Sclorum (CIPS), (internal report).

Plant, R.R. (2002). Experimental Timing Standards Lab Validation Report ETSL/ERTS3.33/RP/20020729: „Experimental Run-Time System (ERTS) version 3.33 by BeriSoft Cooperation“. LTSN Psychology, University of York, YO10 5DD, UK

A unique advantage of the ERTS psychometric test system is that the software platform for executing the tests is used in about 450 laboratories world-wide for cognitive and neuropsychological research. The continuous feedback from this research community and the continuous product improvements ensure a high level of robustness and maturity.

The system provides state-of-the art technology that guarantees maximum accuracy on PC platforms

- Millisecond timing based on high frequency timer chip. This timing is independent of CPU speed
- Asynchronous response registration generating time stamps within interrupt service routines
- Dual-buffer image flipping with synchronization of vertical retrace to achieve accurate visual stimulus onsets
- Single thread real-mode architecture to avoid distortions due to parallel system activity

The system itself provides several built-in validation options that can be applied in concrete implementations as part of SOP

- Checking high resolution timer and refresh sync
 - This procedure measures screen refresh period and displays 100 measurements
- Measuring signals with well-defined timing behavior
 - Measuring Keyboard Auto-Repeat Rate
 - Measuring self-triggered responses

ERTSCODE data processing tool for generating case report

ERTSCODE is a descriptive data processing tool that relies on a job-language proprietary to BeriSoft Cooperation that supports the definition of computation rules, the calculation of descriptive parameters, and the generation of multi-factorial tables.

The ERTSCODE application has been originally tested by means of sample raw data files that reproduce examples from statistical books.

As part of the ERTS software package for professional research, this module is in use in hundreds of research laboratories world-wide.

ERTS session launcher for automated session coding

The ERTS session launcher is part of the psychometric test battery and is responsible for session coding based on subject disks, for data synchronization between subject disk and test station, and launching of test battery.

The VBASIC for DOS application is only responsible for session management, but not for data itself. Consequently, there is no generic validation available except testing of proper behavior in context of setting up psychometric batteries for new studies.

Individual test applications (tailored to individual study)

Psychometric tests are applications on top of the ERTS platform which is validated with respect to general performance. Session coding, timing, randomization, and proper response registration and classification must be reviewed.

Therefore, with any new test battery and any new study sample sessions are run to check those aspects. Besides manual test runs, the ERTS system also provides automated test runs that check general functionality and produce sample results files that can be used to check randomization and completeness of test conditions

- Running test sessions
 - /S Accelerated execution of session
 - /A Non interactive execution (auto-demo mode)

The following additional test procedures can be applied by request

- Checking time intervals
 - /w Checking realization of event timing
 - /p Create time stamps for every trial to verify absolute timing
- Monitoring timing of sync signals with second PC
 - Connect two PCs via LPTs (use two independent timer)
 - Send sync signals with trial events
 - Record sync signals for each trial event and display lap time with SHOWTTL

Intended performance of test paradigms

For one particular study, psychometric test applications are selected out of larger pool of candidates based on the objective of the study. This process is driven by experts on the client side, by Berisoft's expertise, and if required assisted by additional academic advisors. An example of such efforts is documented in an internal report

Berisoft (2002). Validation study for selected psychometric ERTS tests (Internal Report)

Most if not all test applications are originating from cognitive research or clinical practice. The meaning and typical outcomes of such experimental paradigms are described in scientific literature. Pilot tests are testing whether the general result pattern as reported in publications can be replicated or not.

The quality metrics of test applications are determined as follows

- Training and placebo data from previous studies are used to estimate re-test reliability.
- Factor Analysis and Pathfinder Similarity Graphs are used to investigate what cognitive concepts are measured with each of the test. Although this process is to mainly to optimize configuration of test batteries in terms of non-redundant testing, the results can also be used to review what test application is measuring what concept. This is an ongoing effort in the entire psychopharmacological research community. Our expertise benefit from our academic installed base.
- Regarding sensitivity we can only make the statement that in many clinical trials some of the test applications revealed drug or dose effects that made sense or were expected. An exhaustive reference of sensitivity with respect to component classes is not available. The power of the ERTS system is that the data from each individual test application can be accessed and analyzed individually. This enables the client to fully track cognitive effects on the level of individual cognitive test paradigms.

By request, new test applications can be pre-tested prior to the study.

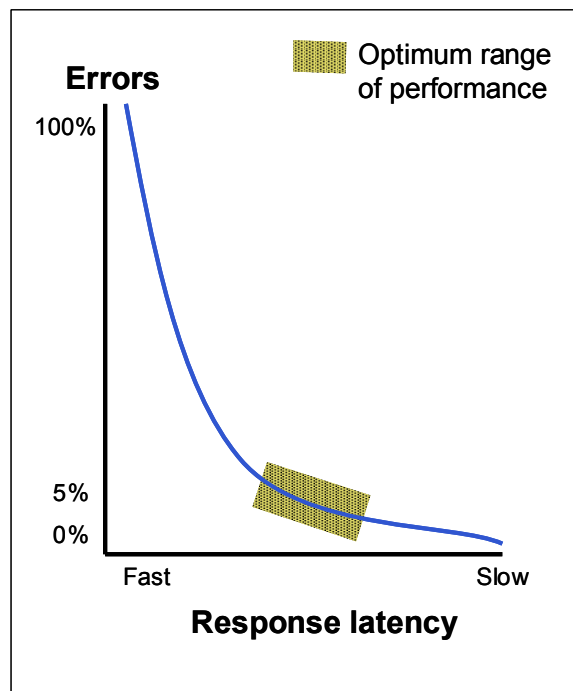
As most of the studies have been phase I studies, results from ERTS studies have not been published.

Intended performance of subjects

Psychometric tests require that subjects understand the experimental task and follow the overall instructions in terms of speed and accuracy of their performance.

The following SOPs and system features are implemented to increase quality of test performance

- Lab technicians are trained and informed about the importance of standardized instructions and the need to push subjects close to their limit to reach the sensitive range of speed and performance



- 2-3 trainings sessions are required by SOP in which subjects are instructed and trained.
- Where appropriate, in each test a warm-up block is embedded in which all trials are repeated until subjects perform correctly. Because of this system-supported quality check

it is guaranteed that every subject starts the test not before having a sound understanding of the task.

Ability to discern invalid and altered records

All data are listed in ASCII-table like format which is open for inspection and printing.

- The file name, date, and time is coded within the file again and can be compared. Any editing of files changes the file's system date and time (built into DOS) and would be recognized as an exception by comparing actual time and date with that stored in the file.

§11.10b: Accurate and complete copies of records

The format of the raw data follows the standard format of the ERTS platform.

Completeness

The ERTS runtime kernel produces a standard ASCII result file format that ensures complete coding of test data and suitability for inspection. The relevant elements are

- A file header that include information about software version, session date and time, Name of test application, record of the command line that as been used to launch the test.
- Each line in the raw data file comprises data of one trial and records subject's responses in form of key and millisecond latency, treatment conditions, randomly generated values.
- Line-wise coding of session data such as study identification code, subject number, subject initials, day of study, measurement point, name of test application

Inspection and Readability

All data records are plain ASCII format and therefore accessible for inspection by using standard text editors or print-outs.

- Case reports can be generated immediately after each session to inspect test parameters.
- By request, the system supports direct-reporting including base-line corrected performance data for individual subjects.
- Although not part of the general practice, raw data files can be inspected if needed because they are plain ASCII format. System malfunctions or invalid subject performance can easily be tracked by looking at raw data.

§11.10c: Protection of records

The ERTS psychometric test battery stores raw data in electronic format. The IT environment for running the tests and collecting data is as follows

Persistency and flow of data records

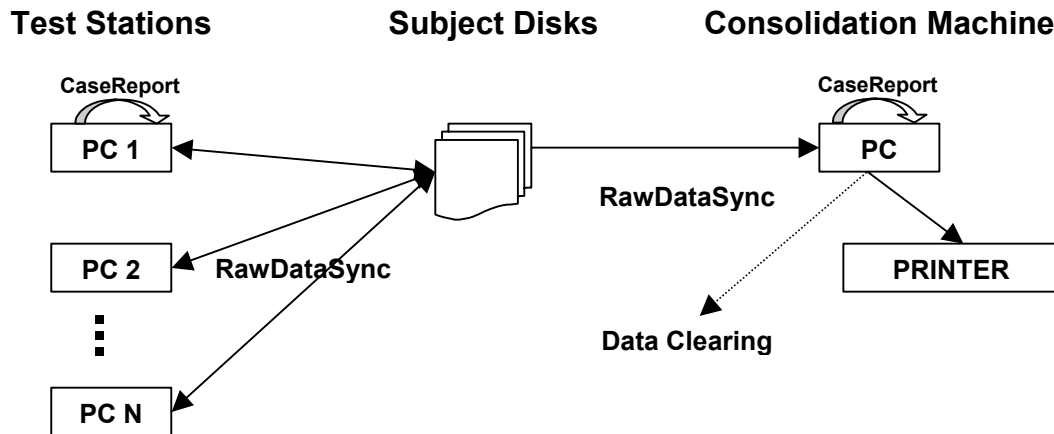


Figure 1: Handling of data records during testing period

1. After insertion of subject disk into test station, raw data files are synchronized in both directions to make sure that all existing data of one subject are stored on the floppy disk and on the corresponding hard disk of the test station.
2. After each sub-test a new raw data file is written to the hard disk. It includes all responses, response latencies, and coding information per trial.
3. After each session raw data are copied to subject disk
4. If subject disk is inserted into consolidation machine, data are copied onto hard disk of consolidation machine.
5. On consolidation machine, the lab assistant may generate case report files from raw data files for selected sessions and print them on printer.
6. From time to time raw data are cleared from consolidation machine by zipping them and copying them on disk or sending them by email in encrypted format.

Protection of data records

Protection of data records are achieved by a combination of system operating features and versioning.

- Raw data are tagged with the DOS read-only flag which prohibits and other user to alter, delete, or overwrite this file.
- File names of raw data files are derived from the session code which in turn is derived from the subject number, day of study, measurement point and a file versioning index.
- A file versioning mechanism makes sure that intended of erroneous replications of identical sessions do not overwrite existing raw data but create a new file with a higher version number.

§11.10d: Limiting system access

Access to the system is mainly controlled by standard features not specific to the system

- Test stations can be protected by BIOS enabled password protection for PC or Laptop during boot process
- Consolidation machine can be protected by MS-Windows user accounts
- Session launcher is protected by one single password common for all technicians

According to SOP all test stations must be local machines not being connected to a network. System access is also controlled by limiting physical access to the test lab.

§11.10e: Time-stamped audit trails

The system does currently not implement a fully independent audit trail to log operator entries related to the creation or modification of data records. Such logging is currently included in the data records and not specific to one operator

- Data and time of launching session is coded in the raw data file
- Date and time of generating case reports is coded in the case reports.
- Previously recorded data cannot be changed due to the file versioning system

§11.10f: System checks

The following system checks are realized as part of SOP

- Display and confirmation of computers system data and time during boot time of test station
- System check of external response devices that requires pressing each external response key once before proceeding

System-initiated auto-coding of sessions ensures proper order of test sessions

- Scheduled sessions are pre-configured and the coding of session is automatically incremented accordingly. When launching a session the system prompts the session code and asks for confirmation.
- The system does not auto-initiate sessions. Date and time must be controlled by the lab technician.
- The session launcher display all data that exist for the selected subject to provide information about subject's history.
- The system notifies the lab technician if an existing session is repeated which always represents an exception. Even if continued, the file versioning makes sure that previously existing data records are not overwritten.

- During warm-up trials, the system notifies the lab technician (and the subject) if subjects perform incorrectly (wrong responses).

§11.10g: Authority checks

The system currently has no own concept of user accounts or authorization checks. All checks are delegated to

- Password protection mechanism of BIOS or MS-Windows
- Physical access to test room

§11.10h: Device checks

- During boot time the external response devices are checked by asking the lab technician to press each external response key once before proceeding
- Stimulus presentation is done via standard main VGA screen of computer. This is implicitly tested when launching the session
- According to SOPs, the room should be protected against direct day light

§11.10i: Training and education

As part of the SOPs, all lab technician receive a one day training on

- how to use the system
- how to instruct the subjects
- how to control test performance by means of inspection of case reports

Most tests include a warm-up block with extended feedback. Trials are repeated until subjects perform correctly.

§11.10j: Accountability and responsibility

Not applicable because electronic signatures are not used ???

§11.10k: System documentation

General documentation of test battery and session launcher is provided for each client and study.