Usability Evaluation of Biometric Recognition Systems

Ramon Blanco-Gonzalo, U. Carlos III Madrid
Belen Fernandez-Saavedra, Cirrus Logic
rbgonzal@ing.uc3m.es
http://guti.uc3m.es/ramon_blanco-gonzalo

Contents

Biometric Evaluations

-Performance testing  Technical performance: error throughput rates

-Conformance testing  Determine if specific requirements are fulfilled

-Security testing  Security requirements, vulnerabilities, etc.

-Privacy testing  Privacy regulations about personal information

-Usability testing  Users – Biometric system interaction

-...

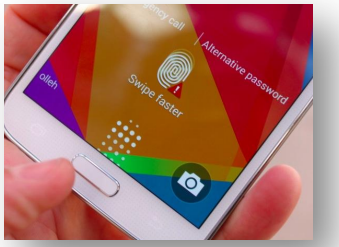
Usability Testing

What is Usability?

*"The extent to which a product can be used by specified users to achieve specific goals with **effectiveness**, **efficiency**, and **satisfaction** in a specified context of use."* (ISO 9241-11:1998)

Users use final products. Overlook usability may cause misuses and rejection of the technology

Usability testing and Influence of Usability (or HCI) on Biometrics performance is not the same…



Differences

Usability Testing

- Focused on the user
- User satisfaction as main goal
- Widely applied
- Standardized definitions and methodologies:
  - ISO 9241 multi-part standard
  - SQuaRE – CIF
- Not Biometrics-specific

HCI influence on Performance

- Focused on the system performance
- Improve results as main goal
- Not widely applied (?)
- Non standardized definitions or methodologies:
  - Application of definition (ISO 9241)
- Biometrics-specific

Main Works

NIST

Usability Testing

HCI influence on Performance

-First Works in usability-biometrics
-Several studies based on the ISO 9241
-Huge contribution to standards

HBSI

HCI influence on Performance

-Usability model based on ISO 9241
-Focused on the FTA
-Great contribution
-Not standardized

ISO

Usability Testing

-SQuaRE – CIF (25062, 63, 64, 66, etc.)
-ISO 9241 multipart
-SC 37-TR 29156: Usability Considerations
-Not a proper methodology…

UNIVERSIDAD CARLOS III DE MADRID
homo hominis sacra res

Usability Testing

HCI influence on Performance

-NIST and HBSI as references
-Usability-Performance Methodology
-SC 37 – PNWI in Biometrics - Usability

How to Evaluate ?

I want to measure the HCI influence on the Biometric system performance…BUT…

- Applying traditional usability testing? Then…what about the influence on performance?
- Applying the ISO/IEC 19795? Then…what about the usability?
- There are several metrics to measure…but how to proceed?
- Several different approaches…How should I start?

Definition

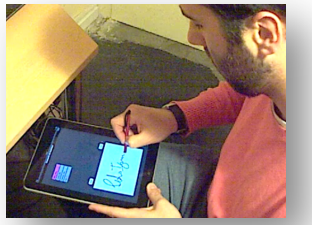
HB-i

H-B interaction testing is a kind of functional test in which a set of users interact with a biometric system(s) with the objective to calculate the accuracy and speed of the recognition algorithms when one or more of the following circumstances occur:

1 *Characteristics related to the Biometric Capture Device have been modified*

2 *Human beings or their biometric characteristic have certain attributes*

3 *Other factors related to the H-B interaction process itself have been modified.*



Definition

HB-i

-Scenario Evaluation
-Online Testing

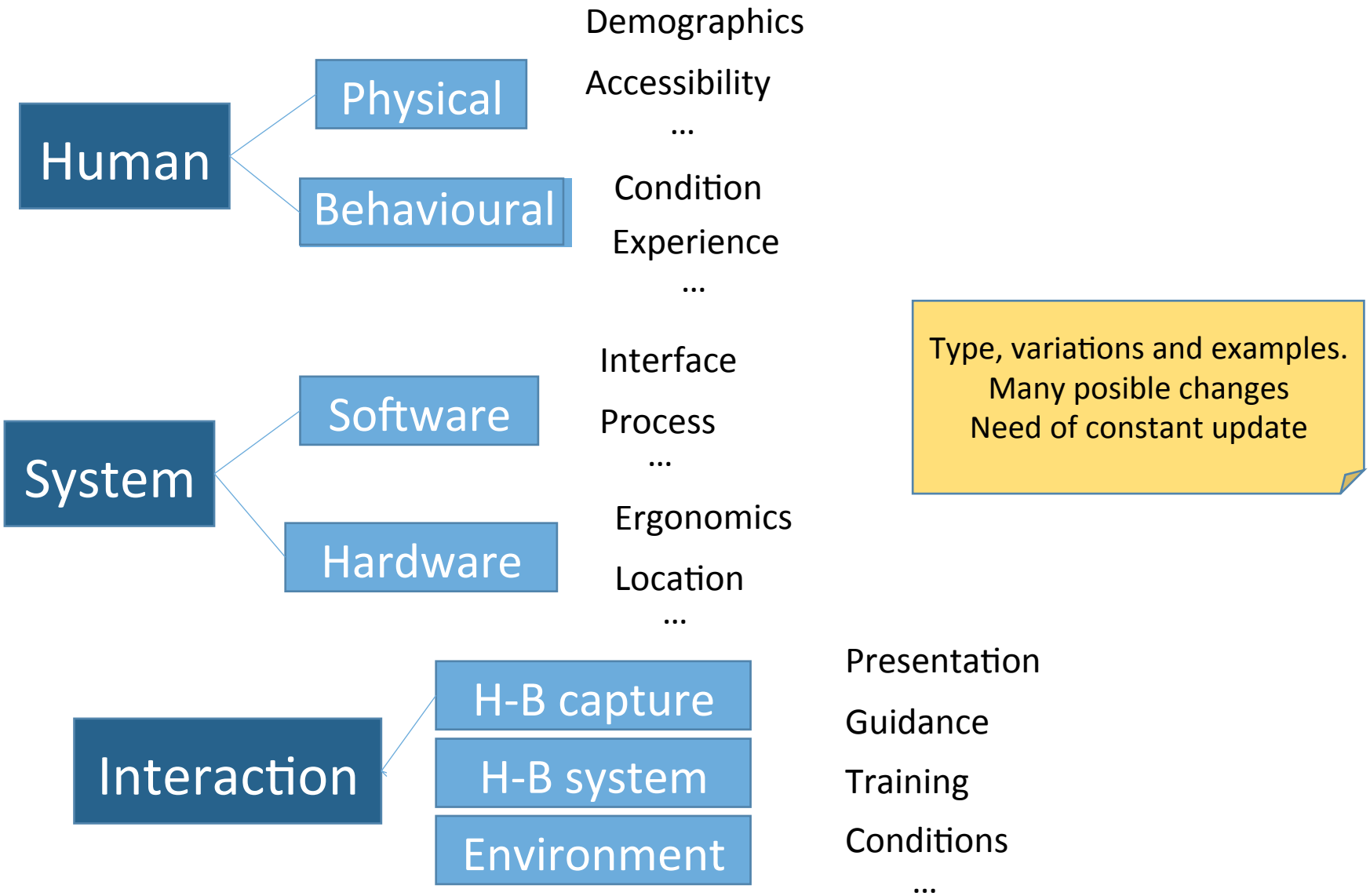
- ***Factors*** *(NIST, 19795-3, HBSI)*
  - *Human, Biometric system, H-B interaction*
- ***Metrics*** *(9241, HBSI, 19795)*
- ***Evaluation Model*** *-> Target vs Reference*

- ***Evaluation Conditions Specification***
  - *Definition of Conditions*
  - *Selection of Conditions*
  - *Reference and Target Evaluation Conditions*
  - *Generation and Control of Conditions*
- ***Fundamental Requirements for:***
  - *Planning a HB-i testing*
  - *Executing a HB-i testing*
  - *Reporting a HB-i testing*

ISO/IEC 19795

Factors

HB-i


Human
Physical
Behavioural
Demographics
Accessibility
…
Condition
Experience
…
System
Software
Hardware
Interface
Process
…
Ergonomics
Location
…
Interaction
H-B capture
H-B system
Environment
Presentation
Guidance
Training
Conditions
…
Type, variations and examples.
Many posible changes
Need of constant update

Factors (ex.)

HB-i

Type	Possible variations			Examples
Physical	Anthropometric data	Body dimensions		Tall, thin
		Physical features		Eyes color, hair color, language accent, human laterality
	Demographics	Age		Children, seniors
		Gender		Men, women
		Ethnic origins		Caucasian, Afro-Americans, mongoloid
		Occupation		Hand-works, under stress
	Interaction-influential	Fixed	Natural	Hair (beard, head, eyebrows, moustache), nails, birth marks, loss of voice, bruises, sties, allergies, reflex
			Artificial	Tattoos, piercings, clothes, contact lens, surgeries
		Non-fixed	Artificial	Piercings, glasses, handkerchiefs
			Natural	Sweeting
	Accessibility concerns	Temporal	Long term	Pregnancy, ictus
			Short term	Dizziness, vertigo, tiredness

Metrics

HB-i

Interaction metrics

HBSI ISO 9241

Type	Variables	Definition
Usability	Effectiveness	Errors, assistance actions, tasks completion
	Efficiency	Time spent in the processes
	Satisfaction	Degree of users satisfaction
	Learnability	User who learnt how to use the system
	Memorability	User who remember how to use the system
	User Acceptance	Willingness to use the system
Accessibility	Physical	Subjects that can use the system
	Cognitive	Subjects that know how to use the system
Signal Processing	Biometric sample	Quality metrics
		Time to capture
	Processing capability	Number of segmentation errors
		Number of features extraction errors
		Segmentation time
		Features extraction time

Performance related metrics

HBSI ISO/IEC 19795

Traditional metrics. Error rates and Throughput rates

HBSI interaction metrics*
Erroneous presentation: DI, CI, FI
Correct presentation: FTD, FTP, SPS

*Continuously updated

Definitions

HB-i

HB-i Factor *"any characteristic, feature, property or condition of human beings, biometric systems or their interaction processes that may influence on biometric system performance"*

Factor specification *"detailed description of the design, feature, property or condition of a specific H-B interaction factor"*

This description defines the factor and its possible variation unequivocally. Depending on the type of evaluation condition the specification can be:

- A **reference specification**. This is the factor specification established for reference evaluation conditions.
- A **target specification**. This is the factor specification defined for target evaluation conditions.

Definitions

HB-i

Evaluation conditions

"each of the conditions which involve a different H-B interaction circumstance and which are tested for analysing their influence on biometric system performance"

- **Reference evaluation conditions (REC)**. These evaluation conditions entail the analysis of a reference specification for the H-B interaction factor(s) under test. For these conditions the biometric system is analysed to obtain baseline performance metrics for making comparisons.

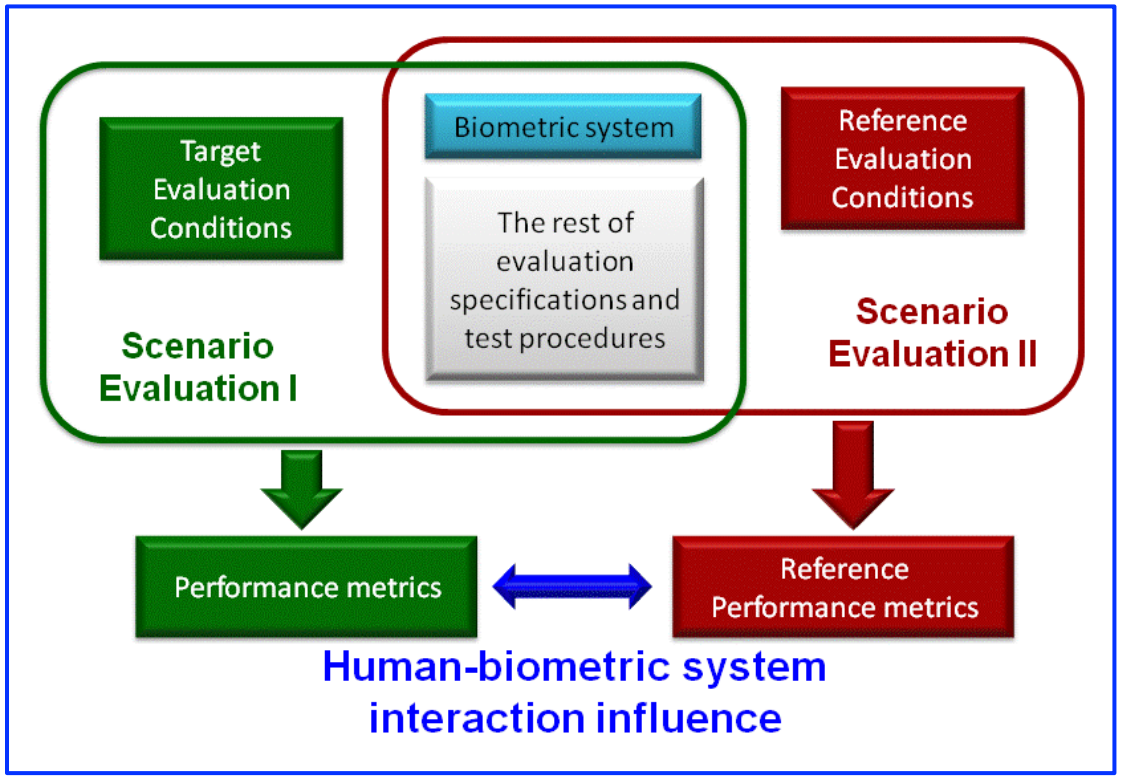
- **Target evaluation conditions (TEC)**. These evaluation conditions involve the analysis of the target specification for the H-B interaction factor under test. For these conditions the biometric system is analysed to obtain performance metrics for studying the influence of one or more H-B interaction factor(s), by comparing with the results obtained at the REC.

Parties involved

"entities or organizations (the test laboratory conducting the evaluation and the developer or customer who requests the evaluation) interested in the evaluation and have responsibilities in the evaluation process."

Model

HB-i



1. Test subjects interact with the biometric system.

2. Biometric system recognition outcomes and the test subjects' interactions are recorded.

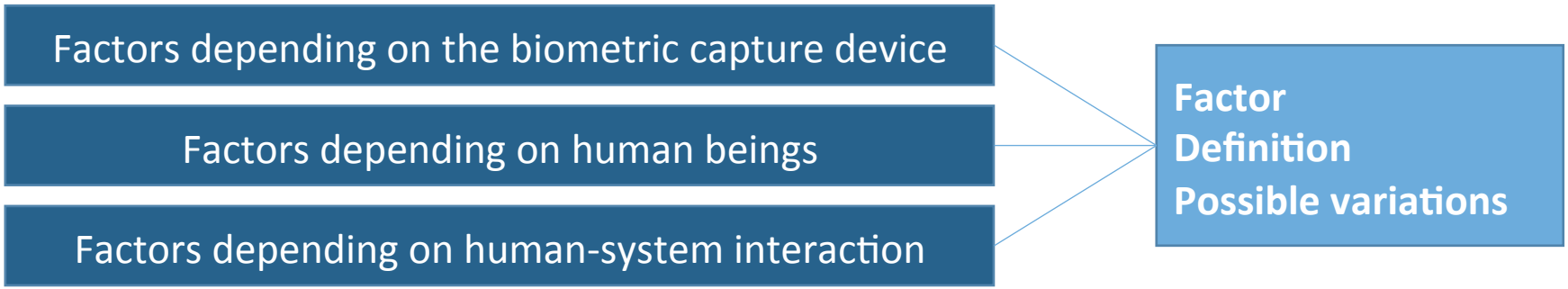
3. Then, it is possible to determine the biometric system performance in addition to HCI metrics for the specific evaluation conditions.

4. The comparison between results of REC and TEC shows whether the biometric system is influenced by the analysed H-B interaction factor, as well as quantifies this influence.

Evaluation Conditions Specification

HB-i

Definition of the evaluation conditions: determining which H-B interaction factors will be assessed during the experiments



Selection of the evaluation conditions: determining which H-B interaction factors will be assessed during the experiments

- Shall be done by the parties involved in the evaluation.
- This decision should be based on several parameters: the biometric modality of the system under test, the type of technology used by its capture device, the target application, as well as the target population (refer to ISO/IEC TR 19795-3 which lists factors that can impact biometric performance for the most relevant modalities).

Evaluation Conditions Specification

HB-i

Reference Evaluation Conditions (REC)

Enrollment

Conventional conditions when the operational conditions are similar for enrolment and recognition processes, or values according to the real enrolment conditions when the enrolment is executed in particular controlled conditions. **Not Always covered by HB-i.**

Recognition

The reference specification for recognition evaluation conditions shall be **identical to the enrolment evaluation conditions** except when enrolment is carried out in particular controlled conditions.

Target Evaluation Conditions (TEC)

Enrollment

When the purpose of the evaluation includes the comparison of the enrolment process for a specification of factors **different from the reference specification**.

Recognition

Shall be selected by **parties involved** in the evaluation according to the particular factors and their possible variations that are going to be tested

Generation of the evaluation conditions: For conducting the scenario evaluation in each evaluation condition, the specification of the relevant factors shall be satisfied.

- **For factors that depend on the biometric capture device** it is essential to prepare the system as indicated. It may require the usage of a proper structure which models the desired locations.

- **For factors that depend on the human beings** it is necessary to provide the test subjects with the corresponding physical element or chemical product and explain them how to proceed. In some cases it is not possible to provide a particular element (e.g. piercings), so test subjects composing the test crew shall be selected according to the defined characteristics.

- **For factors that depend on the interaction process** it is necessary to develop guidelines for instructing test subjects about how they must present their biometric characteristics to the biometric capture device in compliance with the evaluation conditions specifications.

Evaluation Conditions Specification

HB-i

Control of the evaluation conditions: it is required to control exhaustively that test subjects proceed according to the evaluation conditions.

- **For factors that depend on the biometric capture device** test operators shall check that the biometric capture device is placed as it has been specified for the evaluation conditions which have being tested at that moment.

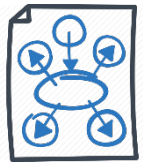
- **For factors that depend on the human beings** operators shall check that users are proceeding properly. It depends on the exact evaluation conditions to test.

- **For factors that depend on the interaction process** it is necessary to develop guidelines for instructing test subjects on how to present their biometric characteristics to the biometric capture device in compliance with the evaluation conditions specifications.

Requirements

HB-i

Fundamental Requirements for



PLANNING

- Define evaluation objectives
- Operational environment
- Test crew
- Level of effort
- Test procedures and execution sequence
- Error protocols
- Data to record and results

EXECUTING

- Pre-test activities
- Test activities (visit 1, 2,…)
- Post-test activities

REPORTING

- Test plan
- Modifications
- Final test crew

per condition

- Description of particular factors specification that has been tested.
- Specific evaluation configurations for each evaluation (e.g. diagrams)
- Test results
- Errors during the experiments.
- Any relevant comment on error logs.

- The baseline performance results.
- General results and analysis
- Final conclusions

Conclusions

HB-i

A new proposal for assessing HCI influence on biometric systems performance

Further inputs from Usability Testing may be considered

Currently in PNWI state within the ISO/IEC/JTC1/SC37/WG5

Open for comments and contributions

Usability Evaluation of Biometric Recognition Systems

Thank you for your attention

Ramon Blanco-Gonzalo, U. Carlos III Madrid
Belen Fernandez-Saavedra, Cirrus Logic
rbgonzal@ing.uc3m.es
http://guti.uc3m.es/ramon_blanco-gonzalo

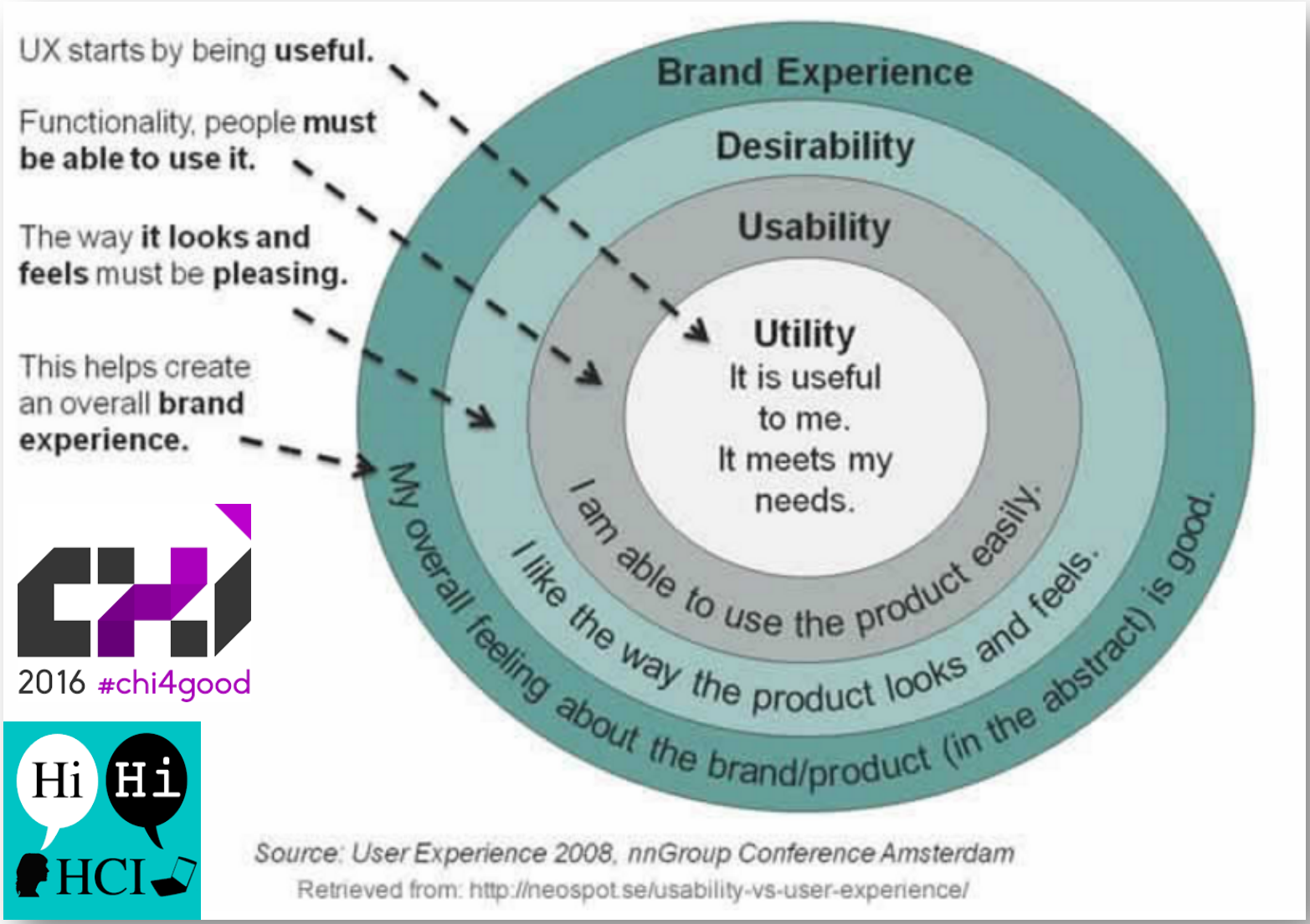
Common Criteria and H-B-i

Common Criteria *provides* ***assurance*** *that the process of specification, implementation and evaluation of a computer security product has been conducted in a* ***rigorous and standard and repeatable*** *manner at a level that is commensurate with the* ***target*** *environment for use*

Target Of Evaluation (TOE): The TOE is the IT product, or the part of an IT product, or the set of IT products that is going to be assessed considering only the selected configuration/s to be tested.

H-B-i → Isolate usability factors to properly measuring their influence in biometrics performance → **Targeting factors TOEs**

Usability/UX/HCI



Usability standards

Non biometrics-related Performance influences!

	Principles and recommendations	Specifications
Use in context	ISO/IEC 9126-1: Software Engineering - Product quality - Part 1: Quality model	ISO 20282: Usability of everyday products
	ISO/IEC TR 9126-4: Software Engineering - Product quality - Part 4: Quality in use metrics	
	ISO 9241-11: Guidance on Usability	
Interface and interaction	ISO/IEC TR 9126-2: Software Engineering - Product quality - Part 2 External metrics	ISO 9241: Ergonomic requirements for office work with visual display terminals. Parts 3-9
	ISO/IEC TR 9126-3: Software Engineering - Product quality - Part 3 Internal metrics	ISO/IEC 10741-1: Dialogue interaction - Cursor control for text editing
	ISO 9241: Ergonomic requirements for office work with visual display terminals. Parts 10-17	ISO/IEC 11581: Icon symbols and functions
	ISO 11064: Ergonomic design of control centres	ISO 13406: Ergonomic requirements for work with visual displays based on flat panels
	ISO 14915: Software ergonomics for multimedia user interfaces	ISO/IEC 14754: Pen-based interfaces - Common Gestures for text editing with pen-based systems
	IEC TR 61997: Guidelines for the user interfaces in multimedia equipment for general purpose use	ISO/IEC 18021: Information Technology - User interface for mobile tools
		ISO 18789: Ergonomic requirements and measurement techniques for electronic visual displays
Documentation	ISO/IEC 18019: Guidelines for the design and preparation of software user documentation	ISO/IEC 15910: Software user documentation process
Development process	ISO 13407: Human-centred design processes for interactive systems	ISO/IEC 14598: Information Technology - Evaluation of Software Products
	ISO TR 16982: Usability methods supporting human centred design	
Capability	ISO TR 18529: Ergonomics of human-system interaction - Human-centred lifecycle process descriptions	
Other	ISO 9241-1: Part 1: General Introduction	
	ISO 9241-2: Part 2:Guidance on task requirements	
	ISO 10075-1: Ergonomic principles related to mental workload - General terms and definitions	
	ISO DTS 16071: Guidance on accessibility for human-computer interfaces	

ISO/IEC 25062:2006: Software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability test reports

ISO/IEC TR 25060:2010: Systems and software engineering -- Systems and software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: General framework for usability-related information

ISO/IEC 25063:2014: Systems and software engineering -- Systems and software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: Context of use description

ISO/IEC 25064:2013: Systems and software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: User needs report