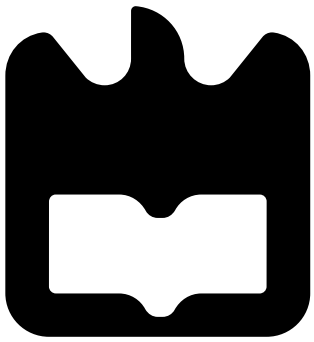
Universidade de Aveiro
Departamento de Electrónica, Telecomunicações e Informática,
2017

Patrícia Salomé Rocha Gomes

Easy Psycho Study: plataforma web para agilizar a realização de questionários de psicologia

Easy Psycho Study: web platform to streamline psychology questionnaires



Universidade de Aveiro
Departamento de Electrónica, Telecomunicações e Informática,
2017

Patrícia Salomé Rocha Gomes

Easy Psycho Study: plataforma web para agilizar a realização de questionários de psicologia

Easy Psycho Study: web platform to streamline psychology questionnaires

Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Engenharia de Computadores e Telemática, realizada sob a orientação científica do Professor Doutor Ilídio Castro Oliveira, Professor Auxiliar do Departamento de Electrónica, Telecomunicações e Informática da Universidade de Aveiro e Doutora Susana Manuela Martinho dos Santos Baía Brás, Investigadora do Instituto de Engenharia Electrónica e Informática de Aveiro.

o júri / the jury

presidente / president

Prof. Doutor José Luis Guimarães Oliveira
Professor Associado do Departamento de Eletrónica, Telecomunicações e Informática da Universidade de Aveiro

vogais / examiners committee

Prof. Doutora Ana Rita Costa Bonifácio Selores dos Santos
Professora Assistente da Escola Superior de Tecnologia de Águeda

Prof. Doutor Ilídio Fernando de Castro Oliveira
Professor Auxiliar do Departamento de Eletrónica, Telecomunicações e Informática da Universidade de Aveiro

agradecimentos / acknowledgements

Aos meus pais, por todos os sacrifícios feitos ao longo do meu percurso académico, por sempre me apoiarem nos bons e nos maus momentos e por nunca me deixarem desistir quando tudo parecia impossível. Sem vocês não era o que sou hoje. Ao João, meu namorado, por toda a paciência, por aturar a minha rabugice, por todas as horas passadas a tirar-me dúvidas ao longo destes anos de curso e por sempre acreditar em mim. Ao professor Ilídio e à professora Susana, por estarem sempre disponíveis para me ajudar, por toda a sabedoria que me transmitiram e por todo o apoio ao longo desta dissertação. Ao Scott e Miki, meus amores, por estarem comigo desde sempre. Aos meus colegas de curso com quem partilhei vários momentos e que tornaram os meus dias um pouco melhores. Ao Departamento de Educação e Psicologia, nomeadamente à Marta, Jacqueline, Ana e Joana pela ajuda e disponibilidade. Por fim, agradeço a motivação extra dada por todos os que exprimiram um sentimento de *Schadenfreude* em relação à minha vida pessoal e académica.

Resumo

A investigação em Psicologia faz um uso intenso de questionários, quer em papel ou em formato eletrónico, para agilizar a recolha de dados. As plataformas digitais para realização de estudos são caras e fechadas a possíveis integrações. O Easy Psycho Study (EPS) é uma aplicação web desenvolvida para apoiar psicológos no desenvolvimento e distribuição de questionários para investigação. Com o EPS o investigador pode construir questionários de maneira interativa e realizar a coleção de dados subsequente e revisão das respostas. Ao contrário das ferramentas generalizadas de construção de questionários, o EPS incluí escalas e outros componentes específicos dos protocolos de psicologia validados pela comunidade científica. Além disso, a plataforma pode publicar eventos que permitem a sincronização com sistemas externos. O sistema está a ser utilizado num grupo piloto para implementação de questionários de investigação na Universidade de Aveiro.

Abstract

Psychology research makes a heavy use of questionnaires, either paper-based, or in electronic format, to streamline the data collection. Digital platforms for studies are usually expensive and closed to possible integrations. Easy Psycho Study (EPS) is a web application to support psychologists with research questionnaires development and delivery. Using the EPS, the researcher can build the questionnaire interactively, perform the subsequent data collection and responses review. Unlike a generic questionnaire building tool, EPS includes assessment scales and other components specific to psychology protocols and validated by the research community. In addition, the platform can publish events to enable synchronization with external systems. The system is being used in a pilot group to deploy research questionnaires in the University of Aveiro.

Contents

Acronyms

ACID Atomicity, Consistency, Isolation and Durability.

AJAX Asynchronous JavaScript And XML.

CSS Cascading Style Sheets.

DB Database.

DEP Department of Education and Psychology.

DOM Document Object Model.

EPS Easy Psycho Study.

HTML HyperText Markup Language.

JS JavaScript.

JSON JavaScript Object Notation.

MVC Model-View-Controller.

NoSQL Non-relational Database.

ORD Object-relational Database.

ORM Object-relational Mapping.

SAM Self-Assessment Manikin.

SQL Structured Query Language.

SU System Usability.

SUS System Usability Scale.

VAS Visual analogue scale.

List of Figures

List of Tables

1 | Introduction

Research is in the basis of all knowledge. Without it, we would not possess the vast knowledge we currently have about the world and how it works. We would be confined to living in a world plunged into nothing more than theories without any proof of their truthfulness or plausibility [10].

Psychologists, in particular, focus their attention on trying to understand and study behaviour and physical/psychological/physiological reactions to stimulus, responses and group dynamics that trigger specific reactions in individuals.

1.1 Motivation

A research hypothesis is based on theories, and the researcher elaborates a study in order to validate it.

One of the most used methods of data gathering for research processes is the survey. It provides many advantages for researchers that include the ability to represent a large population, a low cost price, the possibility of being administered in various ways (e-mail, telephone or face-to-face) and the precise results they provide.

It is not always easy for researchers to find a tool that speeds up and facilitates the research process and that allows them to study the derived results from the research. The number of free psychology software available is scarce and researchers are forced to buy expensive licenses that most of the times do not provide all the tools they need and are also very complicated to use. This may be especially unpleasant for students of the area with little to no experience in using psychology software or for professionals who wish to execute studies without a high level of complexity.

Currently, in the Department of Education and Psychology (DEP), students of psychology and some psychologists are using Google Forms to deliver questionnaires to participants because this tool provides a drag-and-drop environment that agilizes the design of questionnaires and allows mass sharing of the questionnaire through people. However, this tool does not possibilitate the design of specific questionnaires with image or video stimuli which is a type of questionnaire often used in research psychology.

As an answer to these needs, the DEP discussed with the present engineering team the possibility of developing a way of providing an easy environment for researchers to create psychology studies, more specifically questionnaires, perform studies and record the observations.

1.2 Objectives

Our main objective with this work was to design and implement an application to assist psychologists in the deployment of research studies.

This objective can be broken down into more specific goals:

- Development of a web application to enable researchers to design, configure and explore new research surveys;
- Provide both face-to-face and remote options for collection of data from participants;
- Allow integration with external system, specifically bio-signals acquisition system.

The following list of requirements was requested by the DEP, and was followed during the development of this dissertation:

- Centralized data: all the data is saved in the same database, avoiding replication of crucial identifying information;
- Usability: the application is intuitive to the users and there is not the necessity of reading documentation on how to work with it;
- Scalability: the application is scalable, meaning the addition of new features can not compromise the existing ones;
- Security: the application deals with confidential data that can only be accessed by users with a credential;
- Performance: the time of response for executing tasks in the application is short, maximizing the performance of users when dealing with the system.

1.3 Structure

This dissertation is divided in seven major chapters:

- **Chapter 1: Introduction** – introduces the problem, motivations and objectives of this dissertation;

- **Chapter 2: Background concepts and state of the art** – presents the concepts of psychophysiology studies, tools to deliver research surveys in psychology, a comparison of frameworks for web applications development and technologies considered for the development of this dissertation;
- **Chapter 3: Use cases in psychophysiology research studies** – explains the intended usage scenarios;
- **Chapter 4: System architecture** – discusses the technical design of the system;
- **Chapter 5: Implementation** – explains the implementation approach used in the development of the application;
- **Chapter 6: Early results and validation** – discusses the practices adopted to verify and validate the application;
- **Chapter 7: Conclusions** – contains the appraisal of the work as well as difficulties found and future work.

2 | Background concepts and state of the art

Body reactions reflects human mind, mood, and affects. The science behind this is highly multidisciplinary, involving theories from anatomy, physiology, psychology, engineering, among other [11]. Anatomy and physiology explains the body parts and how they work and interact between them. Psychology studies the behaviour and experience of individuals in their physical and social environment. Psychophysiology is the science that joins the previous areas by the interpretation of the human behaviour and associated reactions by means of body responses.

Psychology research aims at:

- Explaining psychological phenomena and expand the base knowledge of Psychology;
- Applying the new knowledge to help individuals and society.

The interpretation of individuals reaction to stimulus is based on collected data from the participant, which allows to identify and explore phenomena associated with participants (individuals that participate in the research methods). The evaluated data in the explanation of individuals reactions may be from different sources [12]:

- **Surveys and psychometric tests:** measure variables that cannot be directly or easily measured, like attitudes, memory or emotions. Surveys are often called questionnaires or tests and consist on a number of items that require a brief answer from participants. Psychometric tests are very similar in the sense that they also can contain the same items as a survey but usually include different tasks, like completing a puzzle;
- **Focus groups:** small group of people with a researcher that leads the discussion and keeps the conversation flowing. The behaviours from the participants in a focus group are due to the interaction between them, so the collected data has a different profile than the data collected in an interview;
- **Interviews:** collect quantitative and qualitative data. They consist of a researcher asking questions to a participant. A difference between qualitative and quantitative data collection is presented at table 2.1;

	Qualitative	Quantitative
Conceptual	Understand human behaviour from the perspective of the informant.	Discover facts about social phenomena.
Methodological	Data is collected through participant interviews.	Data is collected through measurement of things.
	Data is reported in the language of the informant.	Data is reported through statistical analysis.

Table 2.1: Difference between qualitative and quantitative data collection [8].

- **Observational methods:** simple observation of the participant's behaviour, without questionnaires or interviews;
- **Psychophysiological methods:** Psychophysiological methods explore the relationship between physical stimuli (noise, smell or any other thing that leads to a sensory response) and the psychological experiences that they cause. Psychophysiology is the relation between physiological and psychological phenomena.

2.1 Psychophysiology studies

Psychophysiological research methods have a common feature: they measure one or more aspects of physiological functioning and examine how they relate to the participant's behaviour.

Psychophysiological research is focused on the interpretation of concepts of emotion, behaviour, anxiety, cognitive performance, intelligence and personality.
Psychophysiology can be divided in four major areas [12]:

- **Social psychophysiology:** study of the interactions between physiology and behaviour in social processes;
- **Developmental psychophysiology:** study of how the physiological systems and anatomical structures in the aging process affect behaviour;
- **Cognitive psychophysiology:** study the relationship between cognitive task performance and physiology;
- **Clinical psychophysiology:** study psychological disorders and their relationship with physiological functioning.

Tools like surveys and self-reporting data scales can be used to acquire additional information that helps interpreting the psychophysiological parameters and the experience of individuals in this type of investigations.

The most frequently used psychophysiological parameters can be classified into two categories: central and peripheral [13], which are related to the study of central (electroencephalogram) or peripheral (electromyogram, arterial blood pressure or respiratory function) nervous system.
The major idea in psychophysiology is to analyze these parameters alterations triggered by internal or external stimuli.

2.1.1 Use of surveys in psychology research

In surveys, participants report about their perceptions, attitudes or behaviours [14]. They can vary in size, from being very short to containing hundreds of items - in which they can be called questionnaires.

Questionnaires allow the obtaining of information from a large number of people over a wide geographical area, with the advantage of being cheap. They also offer the option for the people answering to them to remain anonymous, which makes them more prone to respond openly and freely.

There are two types of questionnaires: paper-and-pencil and electronic-based. Paper-and-pencil are questionnaires presented in a sheet whereas web-based ones can be done through a web-page that can be easily sent to the participants answering the questionnaire through E-mail or other electronic ways.

A study conducted as part of the Youth Health Monitor Rotterdam tried to find which type of questionnaire provided the more accurate and honest answers [15]. The researchers were concerned that because of the type of information disclosed by participants being sometimes sensitive, they could be concerned with the privacy of their answers and not answer honestly to the questionnaires. They tried to find if there were differences in the perceived level of privacy in the paper-and-pencil and electronic-based questionnaires but after the study, the researchers concluded that there were no significant differences between the two. However they do mention that regardless of the method of questionnaire, there are answers which indeed are influenced by the sense of privacy of the participant.

Another study conducted in the Danish part of NordChild 2011 [16], concluded that web-based questionnaires have advantages over paper-and-pencil ones that make them more appealing: they offer the possibility of checking for missing or inconsistent answers, they are cheaper and they can provide immediate feedback not only to the participant but also to the psychologist (or psychologists) that is supervising them.

Web-based questionnaires: good practices

Dr. Donald Dillman has compiled a set of good practices when it comes to the design of an effective web-based questionnaire. His most relevant suggestions and guidelines are the following [17]:

- Before the questionnaire, display a welcome screen that leaves the participant at ease

and that gives the impression it is legitimate;

- Give an identification number to the participant or a password, to restrict access to the questionnaire;
- Present questions in a similar fashion to paper-and-pencil questionnaires;
- Display a progress bar to give the participant an idea of how much of the questionnaire remains;
- Limit the use of color for a clean and easy-to-read questionnaire;
- Questions must have the same visual appearance;
- Allow participants to answer questions in an order defined by them.

Relation between psychophysiological studies and web-based surveys

Some psychophysiological studies resort to surveys to capture additional data in order to help in the interpretation of the physiological signals. Since most psychophysiological studies nowadays use equipment to capture physiological variables that are triggered by electronic devices, web-based questionnaires facilitate the integration of these two methods since it is possible to easily cross-reference captured signals with specific moments in the questionnaire filling by the participant.

2.1.2 Self-reporting data scales

Self-reporting data is any data collected from an individual that reports its personal behaviour, thoughts or feelings. With this type of data the researcher can obtain information that is not easily observable but there is the disadvantage that the individual's report may not be accurate.

The most efficient way of collecting self-reported data is through rating scales. These type of scales provide a standardized format to gather information about an individual's behavioural characteristics and can be used with either children or adult individuals. Their main advantages comprise the ability to provide behavioural information in a short amount of time, technical precision and practical utility [18].

The most used self-reporting scales in psychophysiological studies are the Likert Scale and the Visual Analogue Scale [19]. The Self-Assessment Manikin scale is also well-used for when there is intention of using a language-free scale [20].

Likert scale

The Likert scale was invented by psychologist Rensis Likert [21] and it is a psychometric scale, meaning it measures characteristics of an individual that are unobservable but believed to exist and that cause variations of behaviour. A Likert scale consists of a set of items (called Likert items) that are displayed with a visual aid that represents a simple scale. The whole set of Likert items together with the visual aid is called a Likert scale.

A common Likert item is a statement (that may be positive or negative) to which the individuals rate their level of agreement. Usually a 5 point or 7 point agreement scale is used. The levels of agreement in both these scales can be seen in table 2.2.

Number of Points	**Scale of Agreement**
5	1. Strongly Disagree 2. Disagree 3. Neither Agree or Disagree 4. Agree 5. Strongly Agree
7	1. Entirely Disagree 2. Mostly Disagree 3. Somewhat Disagree 4. Neither Agree or Disagree 5. Somewhat Agree 6. Mostly Agree 7. Entirely Agree

Table 2.2: 5 Point and 7 Point scale of agreement

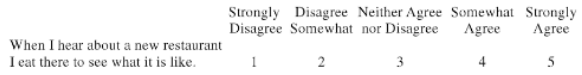


Figure 2.1: Example of a Likert item with a 5 point agreement scale [1]

Many variants of these agreement scales are used today, but they essentially comprise two characteristics that are important for the scale to be considered a correct Likert scale:

- They express degrees of disagreement and agreement with statements;
- They use an odd number of responses (points) allowing a neutral response.

Visual analogue scale

The VAS is a measurement scale that tries to measure a characteristic or attitude related to an individual that is believed to range across a continuum of values and cannot be directly measured [22]. The individual has a greater freedom to choose the intensity of what is being

evaluated with the scale. Usually, VAS is used to measure pain and differentiates between sensory pain and affective pain with a high level of reliability.

VAS is a psychometric scale and its main concept is that it can discriminate measures more effectively than a Likert scale, although some researches proved that one is not superior to the other and their efficiency when used in a questionnaire depends mostly on the circumstances [23] and individuals [24].

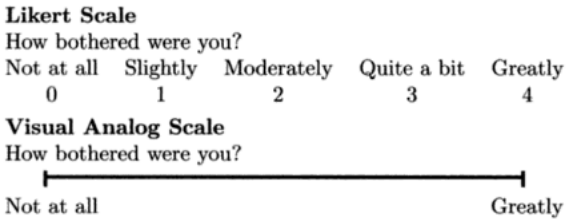


Figure 2.2: Difference between a Likert scale and a VAS [2]

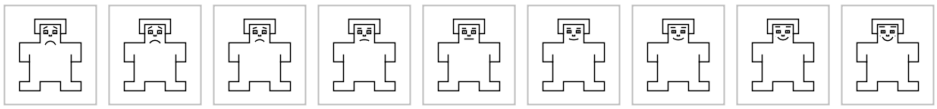
Self-Assessment Manikin

One of the most popular self-assessment scales is the Self-Assessment Manikin, proposed by Bradley and Lang in 1994 [25]. It is not only broadly adopted in psychophysiological studies but also in a wide range of fields, from marketing to advertising.

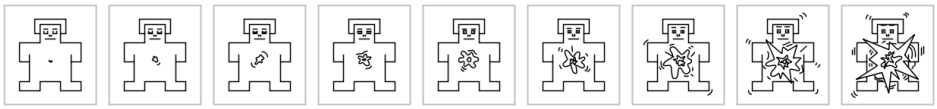
The SAM is a dimensional scale that measures emotional responses to various stimuli by serving as a visual representation of valence/pleasure, arousal and dominance, the three core dimensions of human emotion (also called PAD). The SAM is presented in the three emotions with drawings of a character [26].

- Valence: from a smiling character's face to a sad one;
- Arousal: from a sleeping character to one who appears to be excited;
- Dominance: from a character that is small to a large one.

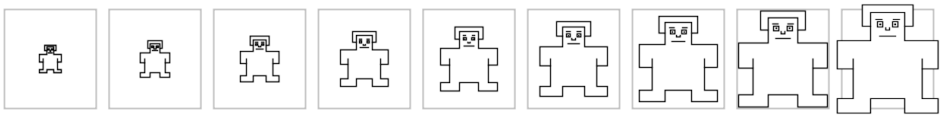
The scale is arranged according to a 9-point scale in the three different dimensions (figure 2.3), each point corresponding to a different level in the three different emotions. Other variants of the scale with 7 points and 5 points also exist.



(a) Self-Assessment Manikin scale corresponding to the Valence dimension



(b) Self-Assessment Manikin scale corresponding to the Arousal dimension



(c) Self-Assessment Manikin scale corresponding to the Dominance dimension

Figure 2.3: 9 Point Self-Assessment Manikin scale

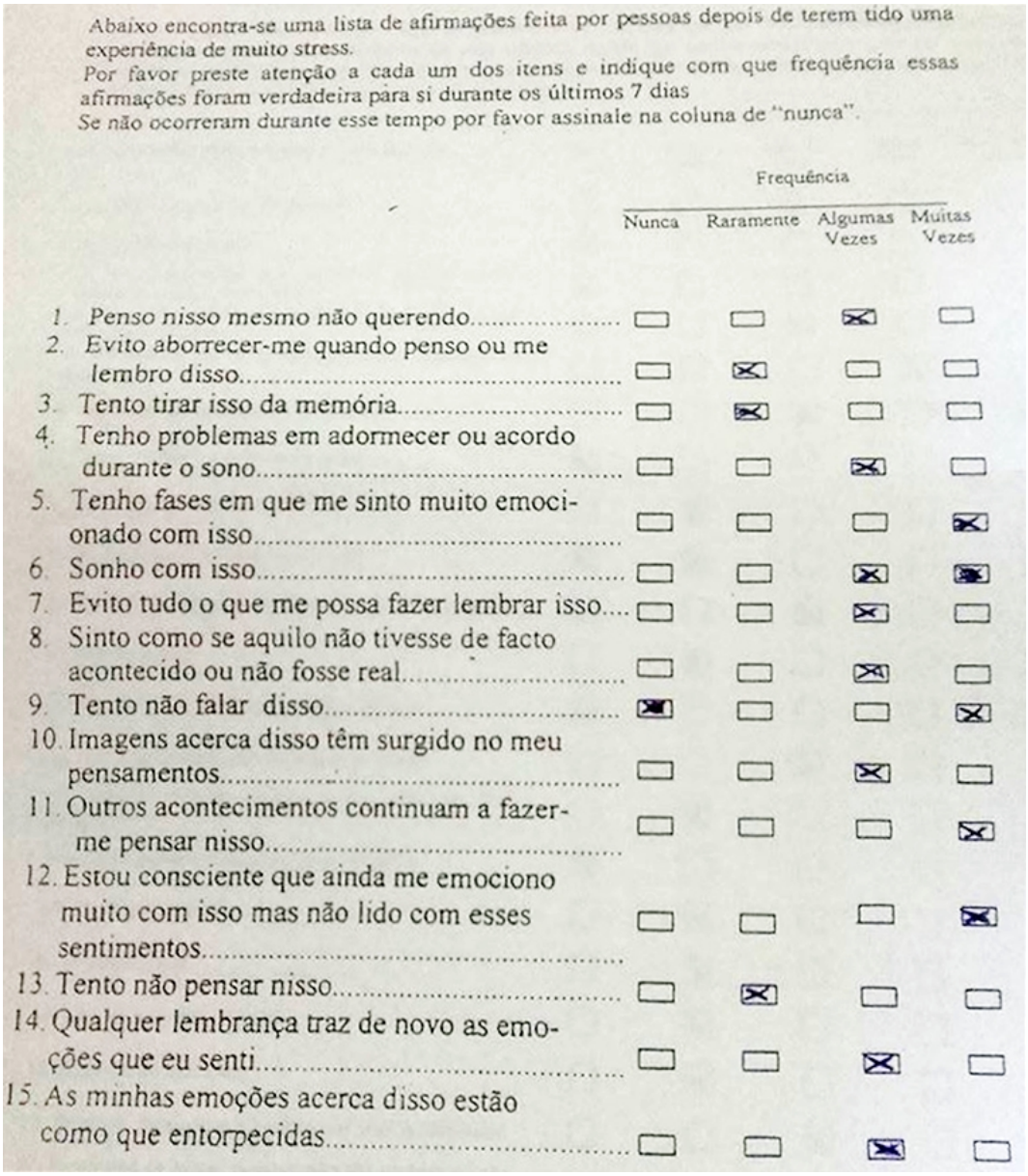
What makes SAM so interesting to be used in psychophysiological studies is that scales with a graphic representation cause less wear out in subjects when compared to verbal measures. SAM is also more likely to hold their attention and all the figures of the different emotional dimensions can be easily identified either by adults or children. SAM is also a culture and language free measurement, therefore it can be used with different languages and cultures [27].

2.2 Tools to deliver research surveys in Psychology

Surveys can be printed and delivered using the traditional paper and pencil method. The most common scale used in paper and pencil surveys is Likert (or variations of this scale). One example of a paper and pencil survey can be seen in figure 2.4. This specific survey was used in the context of a Portuguese hospital and evaluates post-traumatic stress events.

When the researcher collects enough paper responses, item responses are summed to create a score for a group of items. With this score, the researcher can make conclusions by comparing it to a table of cut-point scores.

Doing these studies with paper and pencil is an exhausting process and prone to error. A lot of psychologists end up doing these questionnaires in tools like Google Forms that are limited in terms of posterior data analysis.



Abaixo encontra-se uma lista de afirmações feita por pessoas depois de terem tido uma experiência de muito stress.
Por favor preste atenção a cada um dos itens e indique com que frequência essas afirmações foram verdadeira para si durante os últimos 7 dias
Se não ocorreram durante esse tempo por favor assinale na coluna de "nunca".

	Frequência			
	Nunca	Raramente	Algumas Vezes	Muitas Vezes
1. Penso nisso mesmo não querendo.....	☐	☐	☒	☐
2. Evito aborrecer-me quando penso ou me lembro disso.....	☐	☒	☐	☐
3. Tento tirar isso da memória.....	☐	☒	☐	☐
4. Tenho problemas em adormecer ou acordo durante o sono.....	☐	☐	☒	☐
5. Tenho fases em que me sinto muito emocionado com isso.....	☐	☐	☐	☒
6. Sonho com isso.....	☐	☐	☒	☒
7. Evito tudo o que me possa fazer lembrar isso....	☐	☐	☒	☐
8. Sinto como se aquilo não tivesse de facto acontecido ou não fosse real.....	☐	☐	☒	☐
9. Tento não falar disso.....	☒	☐	☐	☒
10. Imagens acerca disso têm surgido no meu pensamentos.....	☐	☐	☒	☐
11. Outros acontecimentos continuam a fazer-me pensar nisso.....	☐	☐	☐	☒
12. Estou consciente que ainda me emociono muito com isso mas não lido com esses sentimentos.....	☐	☐	☐	☒
13. Tento não pensar nisso.....	☐	☒	☐	☐
14. Qualquer lembrança traz de novo as emoções que eu senti.....	☐	☐	☒	☐
15. As minhas emoções acerca disso estão como que entorpecidas.....	☐	☐	☒	☐

Figure 2.4: Pen-and-paper questionnaire

There are seven steps considered in the design of a research process. Psychology software applications are designed to help researchers with the steps four to six shown in figure 2.5: design of the study, conduction of the study and subsequent analysis of the collected data.

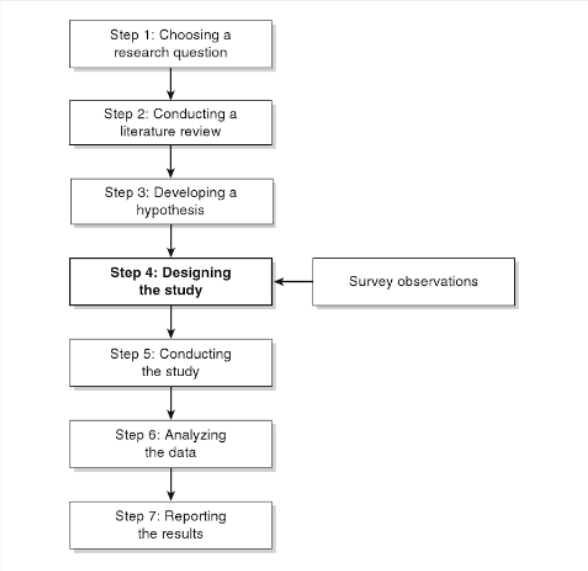


Figure 2.5: Steps in the research process [3]

Although several software applications exist in the market, we will focus on the most commonly used which are the ones better documented. All of them perform the following basic functions [28]:

- Allow the researcher to select what stimuli will be presented, in which order and what measures are going to be collected;
- Collect responses including self-reporting measures;
- Time the duration at which a stimulus is displayed to the participant and the elapsed time between the stimulus presentation and the participant's response;
- Write the collected data to a file suitable to be later imported into the application (if there is an accidental deletion or error).

We will talk about some general aspects of the best documented applications and present some general analysis of key features important for psychophysiology researches.

- **E-Prime:** created by Psychology Software Tools Inc. with single user licenses for educational institutions selling for 700 USD. One of the main disadvantages is the requirement of a small device connected to the device for copy protection that is also required for the development of an experiment;

- **OpenSesame:** platform-independent, free, graphical experiment builder. Is freely available under the General Public License. Has the disadvantage of slow performance reported by several users, more specifically in questionnaire rendering which ends up limiting the size of the questionnaire;

- **Psychopy:** written by Jon Pierce is freely available to use. It is used for experiments ranging from cognitive psychology to visual psychophysics and neuroimagining, however has the limitation of not running in mobile devices;

- **DirectRT:** developed by Empirisoft, sells for 475 USD for a single academic license and is mainly used for creating reaction time tasks requiring precision timing. Because of this, it lacks some features that do not require timing and is usually recomended to be used with other Empirisoft software, which requires further licensing;

- **Inquisit:** created by Millisecond Software. Comes in three different packages (individually charged for, which is a disadvantage): Inquisit Lab (psychology testing on dedicated computers), Inquisit Web (psychological testing on the web) and Inquisit EDU (psychology research tools for classrooms).

The tools are briefly compared in table 2.3.

Software Name	**GUI**	**Free**	**Platform**	**Requires Scripting**	**Special Requirements to Run**	**Support**
E-Prime	Yes	No	Windows	Yes	Hard drive space USB or parallel port	Yes
OpenSesame	Yes	Yes	Windows Mac OS Linux Android	Yes	None	Yes
Psychopy	Yes	Yes	Windows Mac OS Linux	No	None	Yes
DirectRT	Yes	No	Windows	Yes	None	Yes
Inquisit	Yes	No	Windows	Yes	Hard disk space	Yes

Table 2.3: Comparison between psychology software E-Prime, OpenSesame, Psychopy, DirectRT and Inquisit in terms of requirements and availability.

There are also special features that most researchers look for in a software but that are not always present. Performing remote data collections and synchronizing collection with biosignals acquisition are two interesting features that make data analyzing much more precise and robust. Table 2.4 presents information about if these special features are present in the software we analyzed [29].

Software Name	Requires Scripting	Remote Data Collection	Synchronization With Biosignals Acquisition	Web-ready
E-Prime	No	No	No	No
OpenSesame	No	No	No	No
Psychopy	Yes	No	No	Yes
DirectRT	No	No	Yes	No
Inquisit	No	Yes (*)	No	Yes (*)

Table 2.4: Comparison between psychology softwares E-Prime, OpenSesame, Psychopy, DirectRT and Inquisit in terms of special features

In table 2.4 we see that Inquisit presents a (*) on the remote data collection and web-ready features. This means that these are only present when a license for Inquisit Web is bought.

Each of the analyzed software requires time of practice in order for users to edit and deliver questionnaires. For Psychology students in the process of learning how to correctly design studies or people not familiarized with the software they also lack intuitiveness and ease-of-use.

2.3 Technologies for web applications development

In this section we describe some background information on the use of the web development framework of choice.

2.3.1 The web application advantage

Web-based applications offer a big range of advantages over certain traditional desktop applications. With the constant growth of population who access the Internet mainly through mobile devices, web-based applications are increasing in demand.

The main advantages of web-based applications are [30]:

- **Easy access**: Web applications can be used either in mobile phones, tablets or desktop computers. They are not constricted by what device they are running into and they can be run in more than one device at the same time. They also do not require installation, since they are a service being offered in the Internet;
- **Always up-to-date**: All users of a web application run the same version and do not have to worry about upgrades, since the information presented in the the web application is stored in the server of the provider;
- **No need for backups**: All the data from users is stored on the servers of the web

application. This way, users do not need to worry with backups, since everything is saved and back-up by the server provider.

Web-based applications also have disadvantages [31]:

- **Bandwidth limitation**: Because they require access to the Internet in order to retrieve and send information and data to the provider's server, a bad connection or limited bandwidth can be problematic;
- **Browser compatibility**: In order to run a web-based application a browser is necessary. Some technologies used in the development of web applications are not targeted for some browsers (for instance a lot of libraries used in programming for web are not compatible with older versions of Internet Explorer).

Although there are disadvantages present in web-based applications, the fact that Internet connectivity is vastly improving and becoming more widely available and old rudimentary browsers are being abandoned, we believe that these kind of software applications are here to stay.

2.3.2 Review of selected web frameworks

We chose Python full-stack frameworks as the underlying web development framework. Python as a lot of advantages when it comes to development of code [32]:

- Easy to learn and simple to use, specially for people who already have previous experience coding in other languages;
- Vast amount of resources for help and support;
- Code is easy to write and much shorter than in other programming languages, which means it takes less time to write;
- It runs immediately without the need of a compiler;
- It can work well with programs written in other languages.

The advantages of full-stack frameworks in relation to the non full-stack ones is that they supply all the functionalities needed to build a web application, also they let the coders add their own functionalities [33]. Usually a web application may use a combination of a base HTTP application server, a storage mechanism, a template engine, a request dispatcher, an authentication module and an AJAX toolkit, so that is why using a full-stack framework provides advantages, since these functionalities are already embedded.

Python.org has an official wiki page with information related to the latest updates, help contents and web frameworks. According to them, the most popular Python-based full-stack frameworks are the following:

- **Django:** Developed by Django Software Foundation, focuses on automating and adheres to the "Do not Repeat Yourself"principle, meaning snippets of code can be recycled;
- **TurboGears:** Developed by Kevin Dangoor, provides a fully customizable WSGI (Web Server Gateway Interface) stack;
- **Web2Py:** Developed initially by Massimo Di Pierro, allows a rapid development of fast, scalable, secure and portable database-driven web-based applications.

Because these frameworks are implemented in Python, they promote agile and rapid development. To find which one better fitted our needs we studied the differences presented in table 2.5. We compared the three different frameworks based on the following criteria:

- **Asynchronous JavaScript And XML (AJAX):** client-side technology used for making asynchronous requests to the server side where the responses do not cause an entire page refresh;
- **MVC Framework:** architectural pattern where three subsystems work together, forming a trio. The "model" stores the data that is used in the MVC trio, the "view" is the subsystem responsible for the visual display of the user interface and uses the "model" to draw itself and the "controller" is responsible for collecting the input and updating the model and view when necessary [34]. A diagram to better explain this architectural pattern can be seen in figure 2.6.

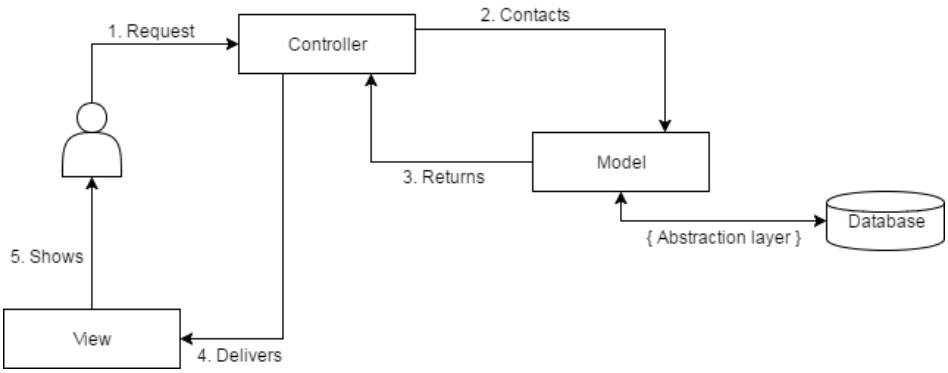


Figure 2.6: MVC diagram: how it works [4]

- **Object-relational Mapping (ORM):** technique that allows the manipulation of data in databases using an object-oriented paradigm. Basically, it consists of a library in the language of choice of the programmer that encapsulates the code needed to manipulate the data, so the use of Structured Query Language (SQL) is not required because the manipulation starts to be done with the same programming language as the rest of the code;
- **Database (DB) Migration Framework:** way of propagating changes made to models into the database schema. Migrations are basically a version control system for the database schema of the application;

- **Template Framework:** template engine that allows to have consistency between different themes and expect the same settings and features between them;
- **Security Framework:** security engine that addresses the majority of common security issues in web applications;
- **Form Validation Framework:** handles the validation of data inserted in forms.

Framework	**AJAX**	**MVC Framework**	**ORM**	**DB Migration Framework**	**Template Framework**	**Security Framework**	**Form Validation Framework**
Django	Yes	Yes	Yes	Yes	built-in Jinja2 Mako Cheetah	Yes	Yes
TurboGears	Toolkit independent	Full stack, best-of-breed based	SQL Alchemy	SQL Alchemy-Migrate	pluggable: Genshi	Repoze.what & Repoze.who	ToscaWidgets, utilizing FormEncode
Web2Py	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 2.5: Comparison between Python frameworks Django, TurboGears [9] and Web2Py

From these comparisons, we decided to use Django because it was the framework that better met our needs and because there was previous knowledge of the framework.

It is important to present the key elements that make the Django framework so appealing to be used by web developers:

- Provides an ORM. Since the application is thoroughly dependent of the database, there was a need to quickly manipulate the tables and data within;
- Is a very well documented and up-to-date framework;
- Comes with a customizable administration panel and authentication system that can be immediately used. To say it is extremely helpful in the development of a web application is an understatement;
- Provides a very robust database interaction, template language and sessions and does not require the developer to add extra features to make a scalable application.

2.3.3 Database Management

Just like the decision of which framework to use was a choice between Django, TurboGears and Web2Py, so was the database to use: on one side there was the option of using a Non-relational Database (NoSQL) and on the other side there was the option of using an Object-relational Database (ORD) like PostgreSQL.

Relational Vs Non-relational Database

It iss important to mention the main differences between NoSQL and ORD databases.

In a NoSQL database, each data table is self-describing and self-contained. This type of database model is great for storing data that is not dependent of more than one table [35], so it does not require the definition of primary keys or links between tables.

A ORD database follows the Atomicity, Consistency, Isolation and Durability (ACID) properties, a aspect that guarantees consistency in transactions in the database.

Another important aspect of a ORD database is that it allows to link information from different tables, establishing relations between them. It requires a structured mechanism and well defined tables.

PostgreSQL

PostgreSQL is a ORD database developed by the PostgreSQL Global Development Group that consists of companies and invididual contributors. Most ORD databases require high-class software licensing to be used. PostgreSQL has the advantage of being open source, meaning it is a free ORD database, ready to be used.

One of the main advantages of PostgreSQL in relation to other ORD databases is that it allows the addition of document data fields inside the tables, namely JavaScript Object Notation (JSON). We can therefore say that PostgreSQL combines the best of both worlds (ORD and NoSQL): it gives us all the advantages of having a ORD model and also the commodity of having NoSQL data inside it (figure 2.7).

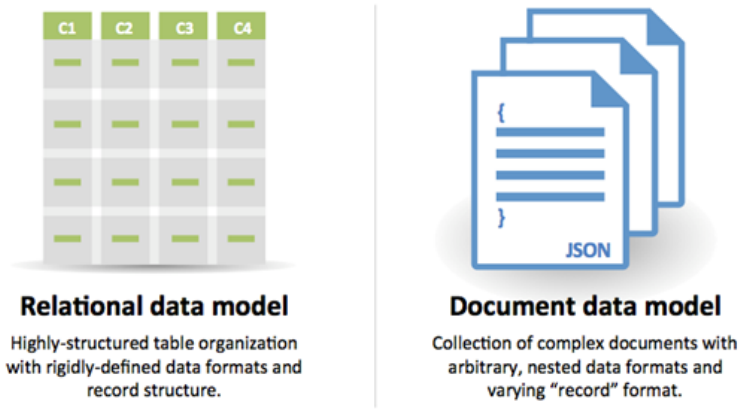


Figure 2.7: Relational Data Model and Document Data Model [5]

The decision between which database model will be used is related with the model that best manage the data. Taking in consideration the differences between the two models we opted for using PostgreSQL, since it provided the advantage of having well defined relations between tables but also, and most importantly, allowed to have JSON fields inside these tables.

ORD databases are also a mature technology (used since the 70s) and are still being used by most companies. PostgreSQL uses the ACID approach, so the execution of transactions is persistent.

2.3.4 Interface

The entire web application interface was built with the help of HyperText Markup Language (HTML) combined with Cascading Style Sheets (CSS), JavaScript (JS) and jQuery:

- **HTML:** standard markup language used for the creation of web pages and web applications. Was created by Tim Berners-Lee, the inventor of the World Wide Web;
- **CSS:** style sheet language that is used to format the visual style of web pages;
- **JS:** interpreted programming language that alongside HTML and CSS form the group of core technologies for content production in the World Wide Web;
- **jQuery:** JS library more focused on Document Object Model (DOM) manipulation and events management, trying to free the developers of dealing with web browser compatibility problems.

In order to make the web application more visually appealing, Bootstrap, Font Awesome and Toastr were used:

- **Bootstrap:** was developed by Mark Otto and Jacob Thornton and is a free open-source front-end web framework for website designing and web applications. It provides an extensive documentation for common HTML elements, CSS componentes and JS plugins;
- **Font Awesome:** was created by Dave Gandy and is a free font and CSS toolkit. It provides scalable vector icons that can be customized through CSS;
- **Toastr:** JS library for non-blocking notifications, giving them a more appealing appearance. It was created by John Papa, Tim Ferrell and Hans Fjällemark.

For the display of graphs in the application, two different libraries were used:

- **Chart.js:** is licensed under MIT provides simple HTML5 charts using the canvas element;
- **Highcharts:** developed by Highsoft, allows the creation of interactive charts.

3 | Use cases in psychophysiology research studies

3.1 Core scenarios

This section presents the core scenarios of the system, explaining their context and analyzing how they work, the users involved and their objectives.

There are several actors involved in the EPS application:

- **Administrator**: user of the system responsible for the management of the application. It can manage all data inserted in the system by the users and perform access and authorization control;
- **Psychologist**: user of the system that creates and manages questionnaires and collects data from participants using those questionnaires;
- **Participant**: user of the system that participates in the questionnaires.

The core scenarios that will be presented are all part of the main workflow of the questionnaire's dynamics, that can be seen in figure 3.1.

The workflow reflects the process of a questionnaire dynamics where information about the life cycle of a questionnaire can be identified as well as the functions that the system must have well supported.

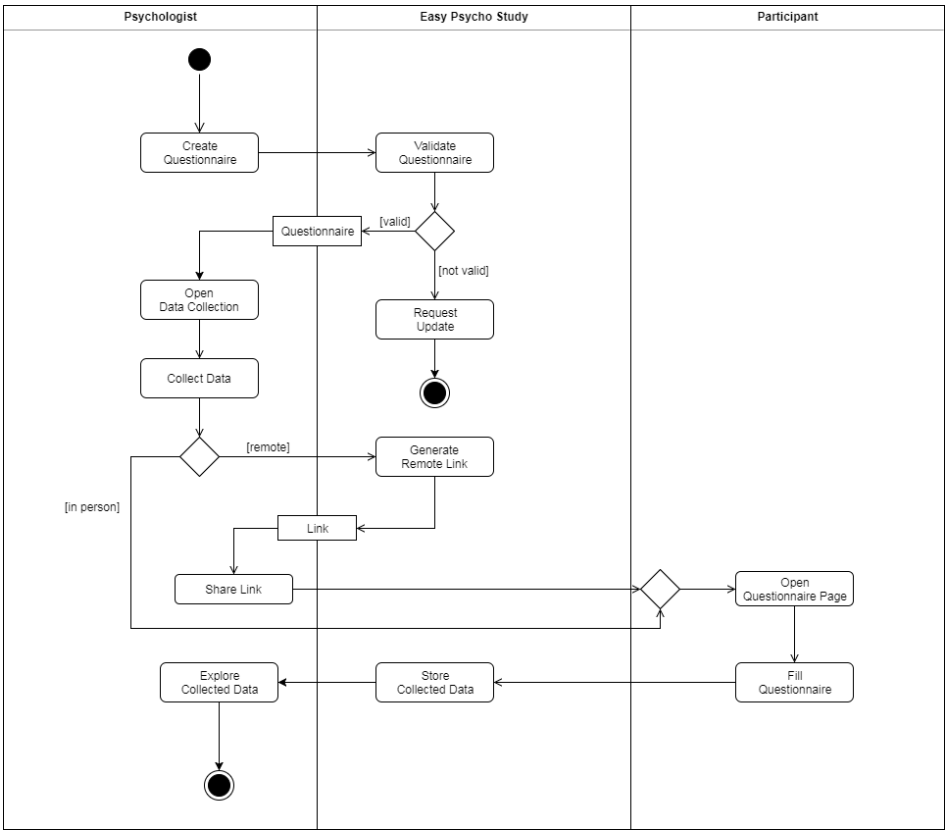


Figure 3.1: Questionnaire's worflow

To better illustrate these core scenarios, a use case diagram is presented in figure 3.2.

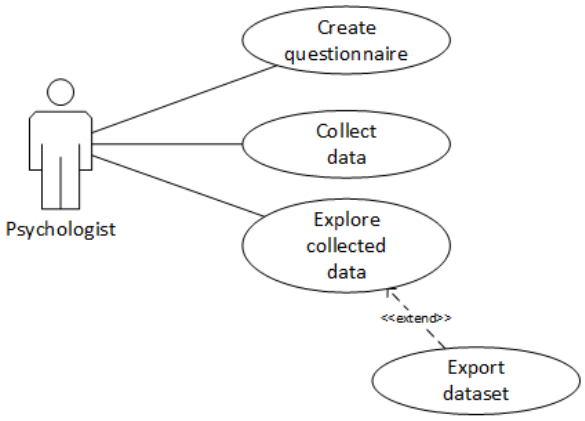


Figure 3.2: Use case diagram of core scenarios

Create a questionnaire

Questionnaires can be created by all the Psychologists with an active account in the system. In order for a questionnaire to be accepted by the system as valid it has to be in conformity with the following rules:

- Mandatory fields (name, description and background color) are filled;
- Has at least one task with one element that can be a question, an image stimulus, a video stimulus and a self-assessment scale.

Once a questionnaire is saved in the system it can be immediately accessed by the user who created it and it is ready to be used in the collecting of data from participants.

Collect data from participants

Once a questionnaire is in the system, the psychologists with permission of Owner for that questionnaire can authorize the collection of data from participants.

There are two types of collection of data: face-to-face (when the participant is at the same local of the psychologist) and remote (when the participant is at a different location).

Explore collected data from participants

All the psychologists with access to a questionnaire can explore the data collected from participants (either face-to-face or remote) in two different ways:

- Explore general statistics related to the entire set of collected data;

- Download an Excel file with sheets where the collected data is organized by participant with their answers to the entire questionnaire associated to the correct time-stamps of the time of answer.

3.2 Supplementary scenarios

After describing the core scenarios of the system, we will in detail explain and describe the supplementary scenarios. We will present the scenarios in different groups for better organization. These groups of scenarios are:

- **Questionnaire:** involving the management of questionnaires;
- **Account:** particular to the management of users;
- **Data:** involving the management of data collected with the questionnaires;
- **Session:** involving the management of sessions.

In table 3.1 all the use cases belonging to the groups mentioned are presented with a description of each one of them.

	Use Case	Description
Session	Log in	Authentication in the platform.
	Log out	Leave the platform.
Account	Register	Create a new account.
	Remove user	Remove a user from the system.
	Deactivate user	Forbid a user from using the system temporarily.
Questionnaire	Edit questionnaire	Edit an existing questionnaire.
	Clone questionnaire	Clone an existing questionnaire.
	Export questionnaire configurations	Export an existing questionnaire configurations together with the data collected with it.
	Import questionnaire	Import a questionnaire into the platform.
	Share	Control permissions for a questionnaire.
	Archive questionnaire	Archive a questionnaire.
	Delete questionnaire	Permanentely delete a questionnaire from the platform.
	Unarchive questionnaire	Unarchive a questionnaire that was previously archived.
	Revoke access to questionnaire	Revokes user permission of access to a questionnaire.
Data	Configure data collection	Configure a training questionnaire and scale explanation to be presented to the participants.
	Open data collection	Allow a questionnaire to be used for collecting data from participants.
	Close data collection	Forbid a questionnaire of being used to collect data from participants.
	Fill questionnaire	Fill a questionnaire.

Table 3.1: List of use cases of the supplementary scenarios

It is important to mention that some of the use cases presented in the table have different

stakeholders. For a better perception of the use cases that each one of them can perform, we will present illustrative diagrams.

Account

The use cases related to Account can be performed both by users that do not have an account in the system or by Psychologists that wish to have more than one account (for example if s/he wishes to have an account per Institution). In order to deactivate an account or remove a user from the system, the role of Administrator is required. This is represented in the diagram of figure 3.3.

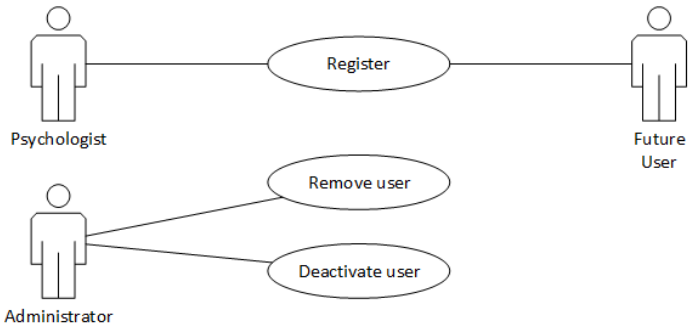


Figure 3.3: Use cases that can be accessed in Account scenarios

Questionnaire

The use cases related to Questionnaire can only be performed by the roles of Psychologist and Administrator. All of them can perform the use case of importing a questionnaire to the system. When a questionnaire is created or imported, it can only be accessed by the Psychologist who created/imported it and by the Administrator in the administration panel. This Psychologist has Owner permission over the questionnaire and so it can manage who also has the right to access it by inviting other Psychologists registered in the system. There are two types of permission the Owner can attribute to other Psychologists:

- **Owner:** perform the same use cases as the creator of the questionnaire;
- **Reader:** only access the questionnaire to collect data from participants, explore collected data and download an Excel file with the data collected.

There is one type of use case that is restricted to all roles except the Administrator, which is the Unarchive questionnaire one. Once a questionnaire is archived it means there is no longer an intention to use it for data collection. If there is a change of mind in regards to this aspect, the Psychologist can contact the Administrator.

The use cases by role can be better visualized in the diagram of figure 3.4.

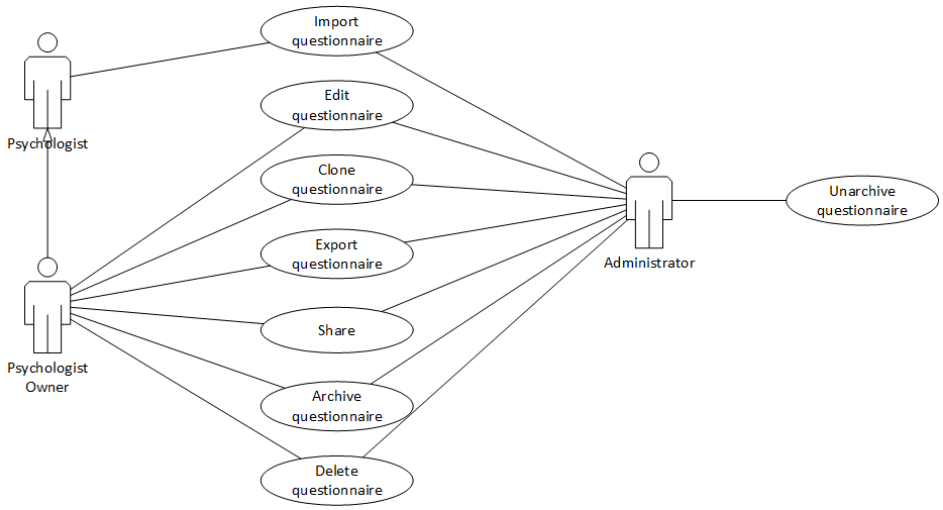


Figure 3.4: Use cases that can be accessed in Questionnaire scenarios

Data

The roles associated to the Data scenarios are Psychologist, Administrator and Participant, however there are restrictions in which use cases each one of them can perform. Only the Psychologists with Owner permission to a questionnaire can configure, open and close the data collection for a questionnaire. Only the Participants can perform the use case Fill questionnaire. This can be better visualized in the diagram of figure 3.5.

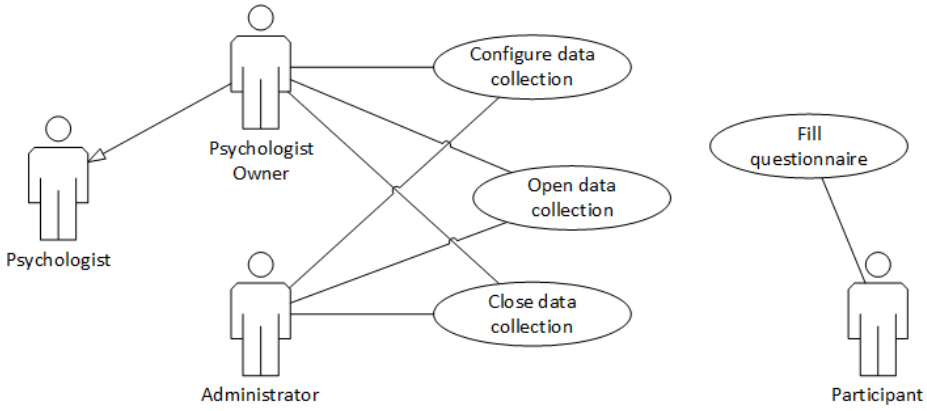


Figure 3.5: Use cases that can be accessed in Data scenarios

Session

The use cases related to Session can be performed by the users with Psychologist or Administrator role and they require the user to be registered in the system. This is represented in the diagram of figure 3.6.

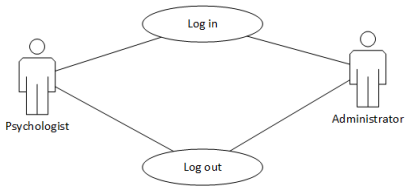


Figure 3.6: Use cases that can be accessed in Session scenarios

With both core and supplementary scenarios presented, the final use case diagram is presented in figure 3.7. This diagram comprises all use cases presented attributed to their respective actors.

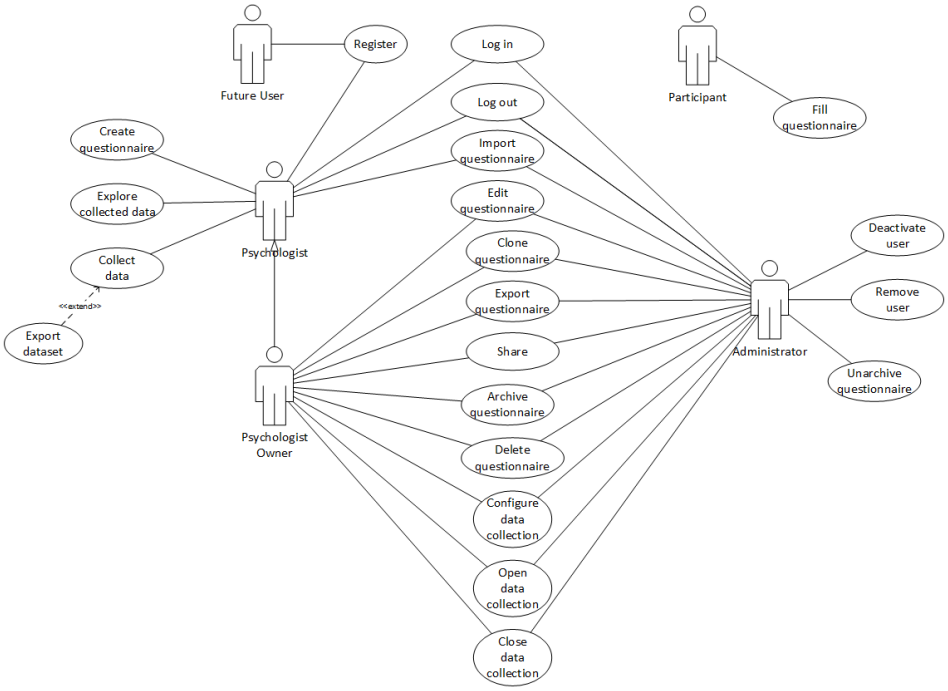


Figure 3.7: Use cases for core and supplementary scenarios

3.3 System Attributes

In this section we will discuss the non-functional requirements of the EPS application.

One of the main requirements was to make the application adaptable for web browsers. This reduces problems with compatibility issues and allows users to access the application in different devices (desktop, mobile or tablet) without any installation procedures.

Representation of self-assessment scales in a software application is another requirement, which has to be similar to the ones presented in paper versions of questionnaires.

The graphical environment has to be oriented to step-to-step interactions, making it immediate for the user to understand the mechanics of interaction with the system.

The application must be able to support more than one user accessing it at a time, providing a concurrent use.

4 | System architecture

Systems are constrained to follow an architecture which specifies the components of the system and how they interact as to satisfy the requirements of that same system. It is the template for guiding the development of a system to satisfy a given set of behavioral requirements [36].

4.1 Domain model

The domain of our application is related to psychology questionnaires. The purpose of a domain model is to capture the main entities of our application and the relationships between them [37]. The most important set of abstractions that describe the domain of the system that we need to build are identified in figure 4.1.

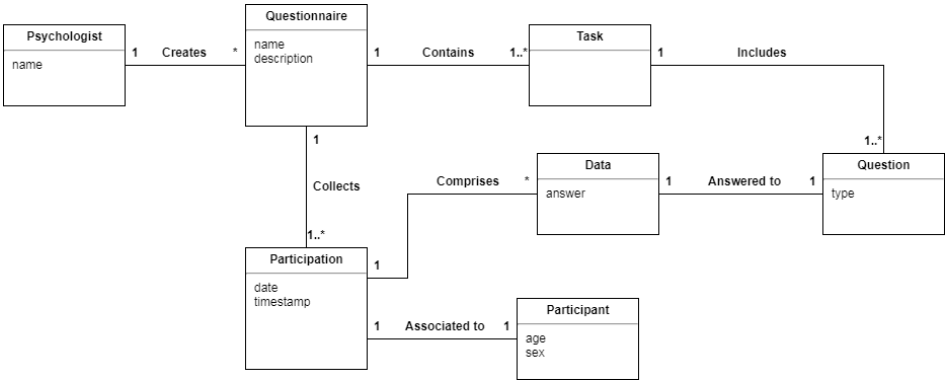


Figure 4.1: Domain model of the application

A questionnaire is created by a psychologist (no matter the method used) and always contains a name and a description, otherwise it would be impossible to identify it. A questionnaire can contain one or more tasks, each one with one or more elements.

The tasks are what the participants have to answer during the questionnaire, and the answers are given according to the type of element displayed, which can be a direct question or a self-assessment scale.

A questionnaire can be used to collect one or more participations (the act of answering to

a questionnaire) that always contain an associated date and time-stamp (important variables for cross-reference with bio-signals acquisitions) and that belong to a participant that is characterized usually by their age and sex. Participations also contain data that correspond to the answers given in the questionnaire, that is associated to the said questionnaire.

4.2 Modular architecture

The EPS application will be composed of a combination of several components that work together to implement the overall system. These components are represented in the diagram of figure 4.2 that shows the relations between them and with the external environment with the user that is represented by the Web browser.

The main components of the system will be:

- **Django Views:** views are essentially what the user sees displayed in the browser. Views also provide an interface to collect input from users. The Django Views comprises 4 different components:
  - **Responses View:** comprises all the functions related to the presentation of questionnaires to participants;
  - **Form View:** comprises all the functions related to the construction and edition of questionnaires;
  - **Authentication View:** comprises all the functions related to the log-in of users and registrations;
  - **Main View:** comprises all the functions related to the presentation of the user's questionnaires, import and export of questionnaires, export of collected data in questionnaires and visualization of graphics related to the collected data.
- **CloudAMQP:** message broker to send messages to the external application of bio-signals' acquisition;
- **SMTP2GO:** message transfer agent responsible for the transmission of e-mail messages from users in the system to users outside of the system;
- **Dropbox:** API to allow the integration of videos in questionnaires;
- **Web Browser:** allows the interaction between the user and the system. In the case of Easy Psycho Study, since it is a web application, it works as the user interface.
- **Controller:** controls the flow of information between the Model and the View. It decides what information is pulled from the database via the Model and what information is passed to the View. It also receives output from a user via the View and decides what to do with it: whether changes the View accordingly and/or modifies data through the model;
- **Model:** interacts with the application's data. It allows the user to pull data from the database without knowledge of how it is organized.

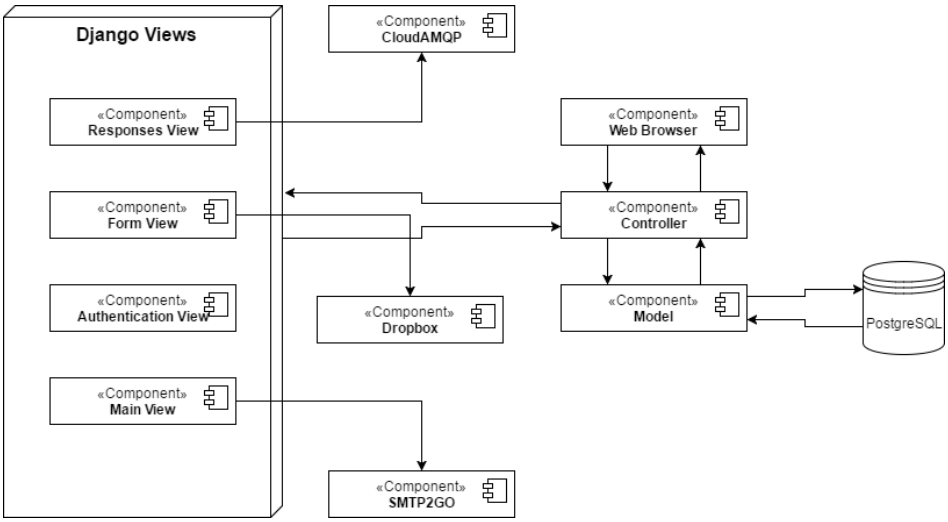


Figure 4.2: System architecture diagram of the application

4.3 Integrations

Our application needs to communicate with the external bio-signals capturing system in order to send it relevant information about what a participant is reacting to in specific time-stamps, so this information can be compared with certain abnormalities in bio-signals variables by the researchers.

The communication between our system and the bio-signals system is established using a publish-subscribe method. This method contains publishers (the ones that produce messages), subscribers (the ones that consume messages) and a topic (destination used for the publishers to exchange messages with the subscribers) [38].

In this method, the publishers send messages to a broker that contains the topic. The subscribers that have subscribed that topic will receive a copy of these messages. This process is illustrated in figure 4.3, where the interaction between EPS and the bio-signals system can be seen.

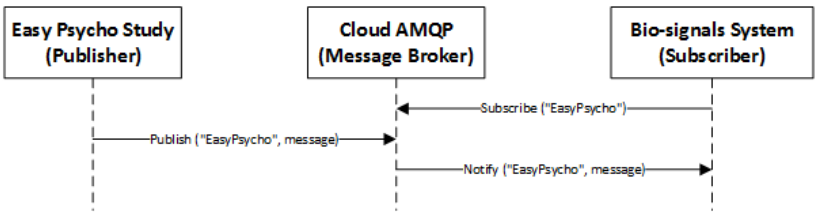


Figure 4.3: Publish-Subscribe sequence diagram for Easy Psycho Study

The communication between our system and the bio-signals system is established using cloudAMQP, a free message broker server. The EPS system acts as a publisher and the bio-signals acquisition system acts as a subscriber.

There is also a need to integrate the application with an external application for dataset exporting. For this, datasets that are exported of EPS can be opened in the Excel application to be better visualized and explored.

5 | Implementation

In the previous chapters we discussed the functionalities the system should provide. In this chapter we will discuss how users interact with them by presenting how the application was developed.

To a straightforward system understanding by the users, it was important to design an interface that was both simple and intuitive. Consistency and predictability were also two important aspects that were considered.

A total of seven practices were followed when designing the application [39] [40]:

- **Simplicity:** the language used in labels and messages is clear and the overall aspect of the application does not "hurt the eyes";
- **Feedback from the system:** the users are informed when they execute actions with feedback messages of success, warning or error;
- **Control over exits:** the user can cancel an action whenever they want;
- **Consistency:** the same command in different pages must be available in the same place and perform the same action;
- **Help:** the application provides a help panel that explains how the system works and how the user can interact with it;
- **Strategical use of colors:** elements that perform the same action have the same color;
- **Responsiveness:** the elements of the application adapt to every screen size, independent of the device.

In the following sections we will discuss how we implemented the functionalities of the system based in these good practices. We will divide the interface implementation description in two different sections since they present clear differences between each other:

- **Psychologist Area:** the interface implementation of the web application area for psychologists and participants;
- **Administrator Area:** the interface implementation of the web application administration area;

5.1 Psychologist Area

The interface for the psychologist area follows the same template design in all its pages, except for the log-in and register pages.
As can be seen in figure 5.1, all the pages display a page identifier in the top left corner to inform the user about what section they are using. A menu with buttons is also presented and it varies depending on the page the psychologist is at. The work area is also dependent on the page the psychologist is at the moment.

Figure 5.1: Template of the page

In order for psychologists to enter in the psychologist area, they have to either register in the application or log-in with their credentials.

5.1.1 Main dashboard

The main dashboard is the page where psychologists have access to all the actions they can perform with their role (detailed in chapter 3).

When the psychologist first logs in the system, his/her dashboard is empty because no questionnaires were yet created. The user immediately sees two different panels: the top one presents the questionnaires for which the psychologist has Owner permissions; the bottom one presents the questionnaires for which the psychologist has Reader permissions. Both panels are collapsible.

Once a questionnaire is created by the psychologist or if another psychologist gives them permissions of access to a questionnaire created by them, the panels display the questionnaires in the same fashion, as can be seen in figure 5.2: questionnaires that are accepting data collections or that have data collections closed at the moment are presented on the white section of the panel (1) and archived questionnaires are presented in the grey section of the panel dedicated to that effect (2).

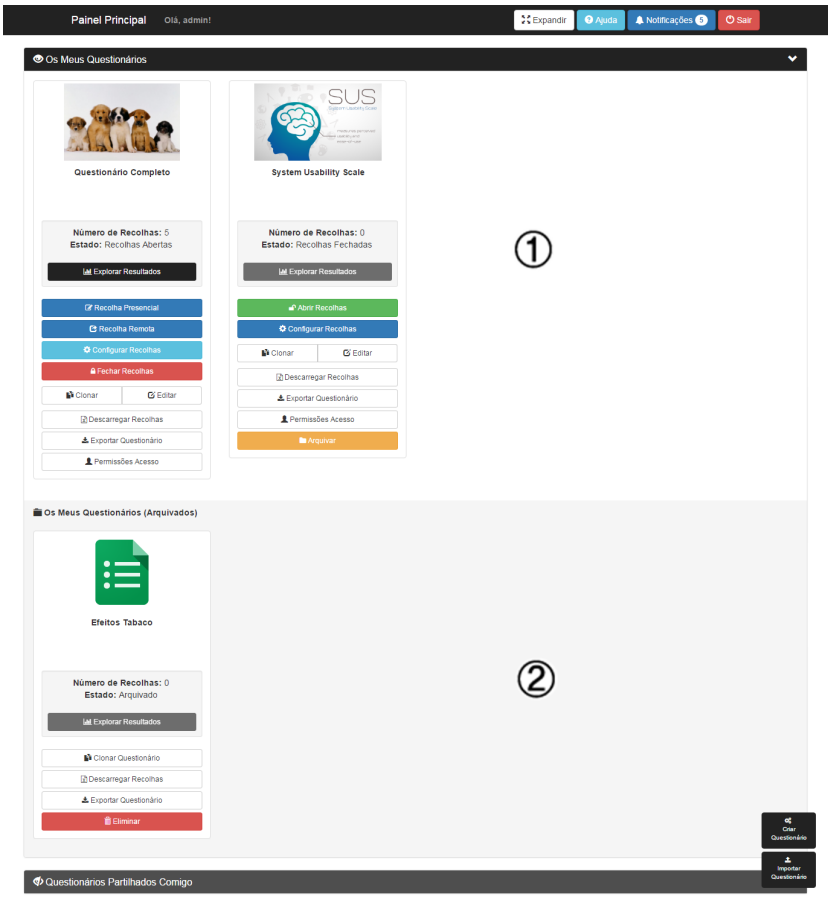


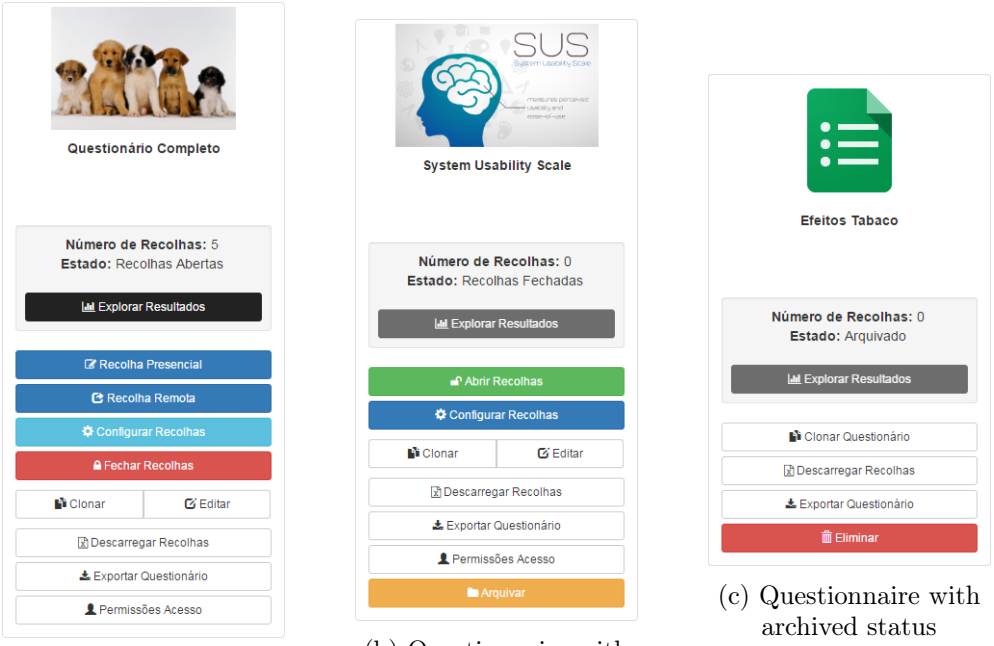
Figure 5.2: Organization of questionnaires inside the panel

Each questionnaire is displayed in a distinguishable mini-panel and all the questionnaires have elements in common that are always displayed: thumbnail, name, number of data collecting sessions performed, current state and a button to access the dashboard for exploring the collected data.
The functionalities displayed in the questionnaire's mini panel are different depending on the state of the questionnaire and permissions the psychologist has for it.

For a questionnaire in which the psychologist has **Owner** permissions, the actions available in the mini-panel are as mentioned in table 5.1 and can be seen in figure 5.3.

Status of questionnaire	Available actions											
	Open data collection	Close data collection	Face-to-face data collection	Remote data collection	Configure data collection	Clone	Edit	Download collected data	Export questionnaire	Control access permissions	Archive	Delete
Open	–	x	x	x	x	x	x	x	x	x	–	–
Closed	x	–	–	–	x	x	x	x	x	x	x	–
Archived	–	–	–	–	–	x	–	x	x	–	–	x

Table 5.1: Available actions in questionnaires for which the psychologist has Owner permissions



(a) Questionnaire with open status

(b) Questionnaire with closed status

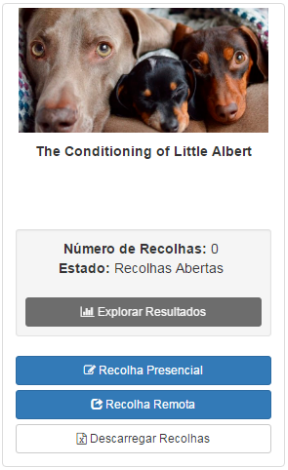
(c) Questionnaire with archived status

Figure 5.3: Mini-panels in questionnaires for which the psychologist has Owner permissions

For a questionnaire in which the psychologist has **Reader** permissions, the actions available in the questionnaire's mini-panel are as mentioned in table 5.2 and can be seen in figure 5.4.

Status of questionnaire	**Available actions**		
	Face-to-face data collection	**Remote data collection**	**Download collected data**
Open	x	x	x
Closed	–	–	x
Archived	–	–	x

Table 5.2: Available actions in questionnaires for which the psychologist has Reader permissions



(a) Questionnaire with open status

(b) Questionnaire with closed status

(c) Questionnaire with archived status

Figure 5.4: Mini-panels in questionnaires for which the psychologist has Reader permissions

On the navigation bar (figure 5.5), psychologists are presented in the left side with the name of the section they are currently at and a welcome message with their username. On the right side four different actions are available:

- **Expand:** indicates how the psychologist can expand the application to full mode in Desktop browsers;
- **Help:** provides help topics about the application and the functionalities each button triggers;
- **Notifications:** shows important notifications belonging to the questionnaires displayed in the psychologist's dashboard;
- **Log-out:** logs-out of the application.

Figure 5.5: Navigation bar in main dashboard

At the bottom right corner of the page (can be seen in figure 5.2) two buttons are displayed: the top one directs the psychologists to create a new questionnaire, and the bottom one opens a modal window (box pop-up) that allows the psychologists to import a questionnaire configuration into the system.

The main dashboard presents a lot of functionalities that do not require page refresh and maintain fluidity between the psychologist's actions. In the following subsections we will present them.

Export questionnaire

A psychologist with Owner permissions for a questionnaire can export it to a local personal storage system if s/he wishes so. A file with *.psyconfig* extension will then be downloaded with the configurations of the questionnaire and configurations of the participants in that questionnaire (if any).

The *.psyconfig* file is structured in the following way :

```
{
    "id": "s1P7ED1nZCyoLDTKWFygLTyz5ltSYtgW",
    "nome": "Avaliação de imagens das advertências dos maços de
    tabaco e imagens afetivas",
    "descricao": "Este questionário consiste em avaliar ao nível da
    valência e do arousal imagens afetivas e imagens presentes nas
    advertências nos maços de tabaco.",
    "corFundo": "branco",
    "passos":
        [
            {
                "nPasso": 1,
                "fixo": "sim",
                "nomePasso": "Dados demográficos",
                "questoes": ["Idade", "Sexo (F/M)", "É fumador?",
                "Tem alguma perturbação psiquiátrica?"]
            },
            {
                "nPasso": 2,
                "nomePasso": "Imagens negativas",
                "escalasSAM": ["Valência", "Alerta"],
                "nomeDoEstimulo": "EasyPsychoStudy_27.jpg",
                "fonteDoEstimulo": "
                QSkZJRgABAQIAJQAlAAD/2wBAAYEBQYFBAYGBQYHBwYIChAKCgk
                JChQODwwQFxQYGBcUFhYaHSUfGhsjHBYWICwgIyYnKSopGR8tMC
                0oMCUoKSj...",
                "tempoEstimulo": 6
            }
        ]
}
```

Listing 5.1: Example of a .psyconfig file structure

Import questionnaire

Importing a questionnaire is the quickest way for psychologists to have a brand new questionnaire on their panel. EPS allows the import of files with extension *.psyconfig* into the system (figure 5.6).

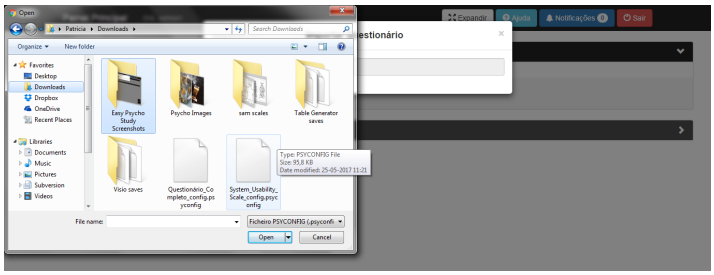


Figure 5.6: File explorer in Import questionnaire

Once a psychologist chooses which questionnaire configuration s/he wants to load, the system reads it and three possible outcomes may arise:

- The system detects a configuration of a questionnaire and immediately loads it into the system (figure 5.7);

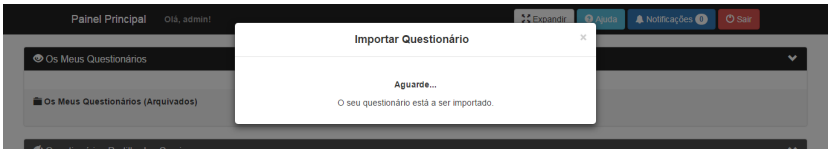


Figure 5.7: Loading screen in import questionnaire

- The system detects a configuration of a questionnaire and configurations belonging to participants in that questionnaire and asks the psychologist if s/he wants to load everything or just the questionnaire's configurations (figure 5.8);

Figure 5.8: Confirmation message in import questionnaire

- The system detects an error in the configurations and stops the process, warning the psychologist that an error occurred (figure 5.9).

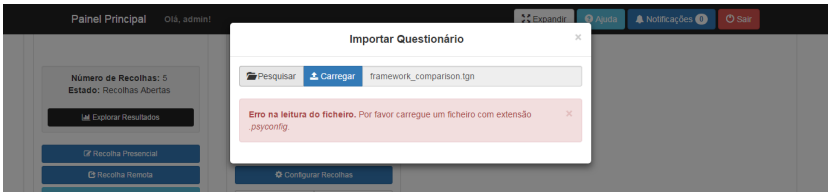


Figure 5.9: Error message in import questionnaire

Notifications

The psychologist is informed about the number of notifications s/he has in his notification box through a label that is displayed together with the Notification's button, displayed in the navigation bar that can be seen in figure 5.10 (1).

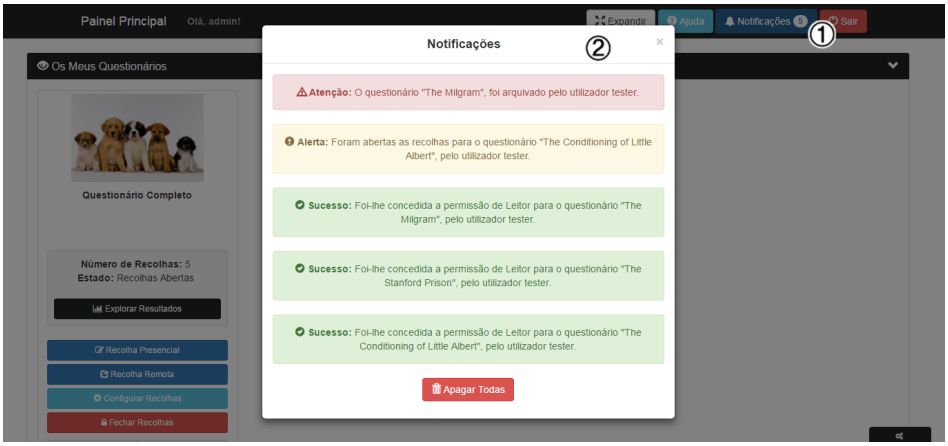


Figure 5.10: psychologist's notifications window

When the same questionnaire is shared by more than one psychologist, all of them start receiving notifications regarding that questionnaire as seen in figure 5.10 (2). When a psychologist is invited to access a new questionnaire, s/he is also notified of that occurrence. The psychologist will receive a notification every time one of the following actions occurs:

- A psychologist is invited to access a questionnaire;
- A participant submits a remote answer to a questionnaire;
- The permission of access to a questionnaire is upgraded;
- A questionnaire is opened/closed for data collections;
- A questionnaire is archived;
- A questionnaire is deleted;
- A questionnaire gets its collection configurations changed.

Configure data collections

When preparing for data collection, the psychologist should configure the response gathering. The psychologist can optionally enable a pre-filling mode in which the participant can learn the tool by taking a training questionnaire.

A training questionnaire is an option, both in open and closed questionnaires, particularly if SAM scales are present a brief explanation will be presented to participants (figure 5.11).

Training questionnaires are regular questionnaires, but usually made shorter for whose the responses will not be recorded.

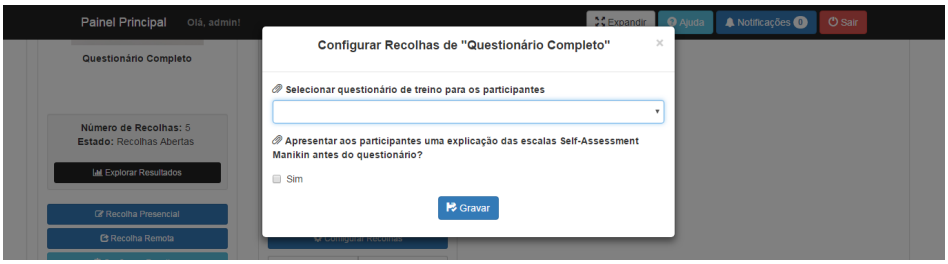


Figure 5.11: Configuration of data collection window

When choosing a training questionnaire, the psychologist can choose from a selection of questionnaires for which s/he has either owner or reader permission (figure 5.12).

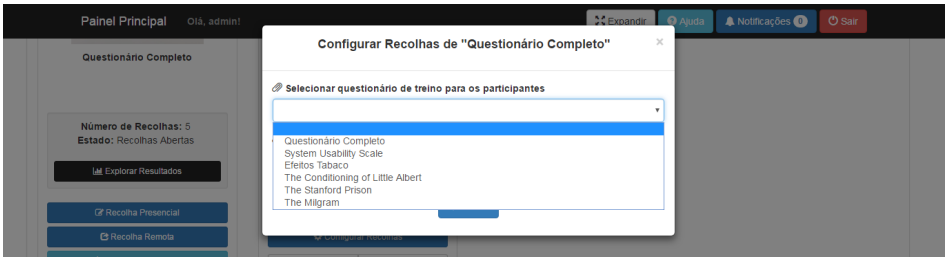


Figure 5.12: Configuration of data collection window

If a psychologist has reader permission for a questionnaire and the owner of that same questionnaire configures a training questionnaire for which the psychologist has no permissions of access, a reader permission will be automatically attributed to it.
In the case a questionnaire that was configured as a training to another one gets deleted, then no training questionnaire will be shown to participants until a new one is configured.

Access Permissions

A psychologist can easily manage the access permissions to a questionnaire through the Access permissions button present in both opened and closed questionnaires' mini-panel.

The psychologist can check which psychologists can access that questionnaire, what type of permission they have, and they can invite new psychologists to access the questionnaire (figure 5.13).

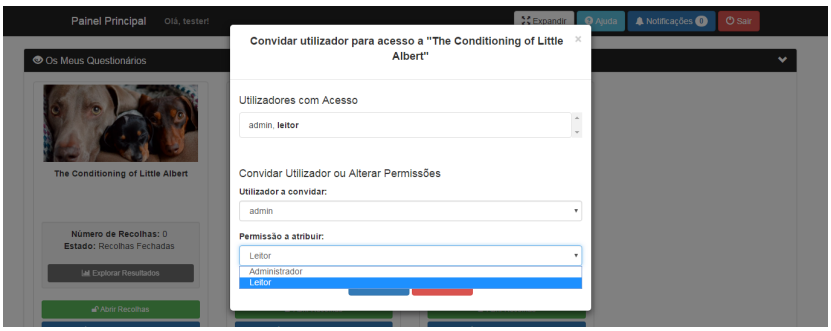


Figure 5.13: Access permissions management window

A psychologist can never remove an access permission from another psychologist. In order for a permission to be revoked, the Administrator of the system needs to be contacted.
Once a psychologist concedes a permission to another psychologist, a confirmation message is displayed on the screen (figure 5.14) and the invited psychologist receives a notification on their notification panel.

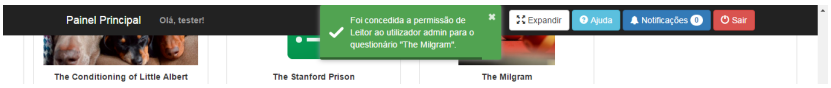


Figure 5.14: Confirmation message for access permission

Archive

Once a psychologist study gets concluded, s/he may choose to archive it. After this decision is made, the questionnaire will still be available for cloning, exporting, exploring or downloading the results of the collected data. If however the psychologist wishes to revert the action, s/he needs to contact the Administrator.

Delete questionnaire

Only archived questionnaires can be deleted by psychologists with owner permission. When the psychologist clicks the delete button (present in the questionnaire's mini-panel), a confirmation modal appears asking to confirm the action (figure 5.15). If the psychologist confirms it, the page is refreshed, the questionnaire gets deleted of the system and all the psychologists that add permissions to it receive a notification.

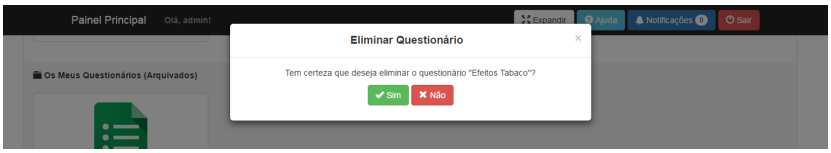


Figure 5.15: Confirmation window for deleting questionnaire

Help

If the psychologist has trouble understanding the meaning of a button or what action it triggers, it can consult the help modal window through the button available in the navigation bar, which provides small and easy-to-understand definitions for each button.

Figure 5.16: Button for help window

Log-out of system

When the psychologist wishes to log-out of the system, s/he can click on the red button present in the navigation bar. When this action is triggered, a confirmation window is presented (figure 5.17) to the psychologist asking to confirm the action. Once s/he confirms it, the session for that psychologist is closed and the log in page is presented.

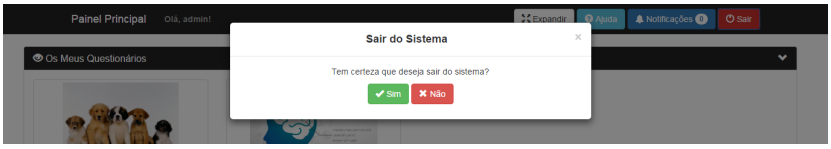


Figure 5.17: Confirmation window for leaving the system

5.1.2 Create questionnaire

The psychologist can quickly create a new questionnaire. On the left side of the page four different alert panels are displayed with basic instructions and tips to facilitate the psychologist's integration with the page, as can be seen in figure 5.19.

The navigation bar (figure 5.18) is similar to the one in the main dashboard but the buttons are slightly different:

- **Preview:** generates a preview of the questionnaire being created;
- **Help:** similar to the help modal in the main dashboard, it provides help on how to create a questionnaire and the function of each element;
- **Save:** saves the questionnaire in the system;
- **Cancel:** cancels the creation of the questionnaire and sends the psychologist to the main dashboard.

Figure 5.18: Navigation bar of the create questionnaire page

The questionnaire already comes with an added and already filled task dedicated to the demographic data in order to spare the psychologist's time (since these types of data are always requested).
The mandatory fields for questionnaire identification are also tagged with a red asterisk.

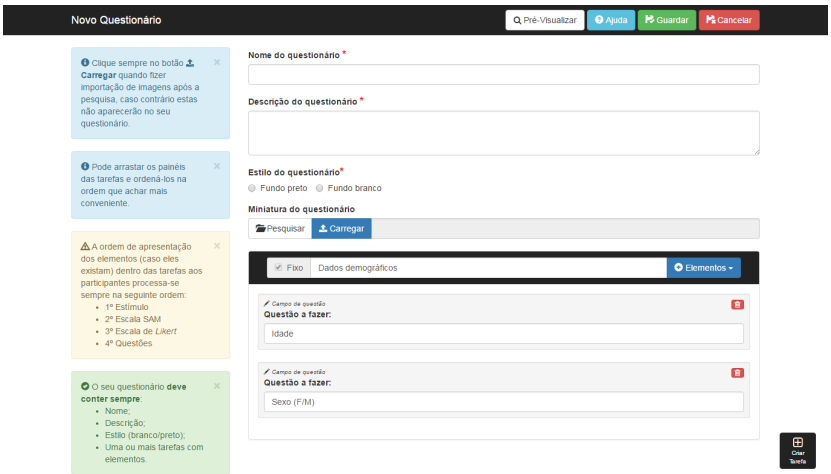


Figure 5.19: General view of the create questionnaire page

A questionnaire is composed of various tasks. Each task can contain several elements that have a relation with each other. In the questionnaire editor, each task is represented by a panel with it's elements contained inside it, and can be added by clicking the grey button on the right bottom corner button (figure 5.20).

Figure 5.20: Sequence to add a task with elements: 1 - Add task; 2 - Choose element to add; 3 - Add element inside task

The psychologist can name a task. This is useful for questionnaire editing or cloning and the task name is never presented to the participants in data collections.

The psychologist can also choose to fix the order of presentation of a task. A fixed task will always be displayed at the position and will never be randomized. Any tasks that are not fixed and are contained between two tasks that are fixed will be randomized between them. To better explain the randomization process the following example can be considered:

- Task 1 - Fixed;
- Task 2 - Not fixed;
- Task 3 - Not fixed;
- Task 4 - Fixed;
- Task 5 - Not fixed;
- Task 6 - Not fixed.

The mentioned tasks can appear in the following order:

- 1 - 2 - 3 - 4 - 5 - 6
- 1 - 2 - 3 - 4 - 6 - 5
- 1 - 3 - 2 - 4 - 5 - 6
- 1 - 3 - 2 - 4 - 6 - 5

At any given time during the creation of the questionnaire the psychologist can delete a task and also change the order of the tasks by performing a drag and drop action (figure 5.21).

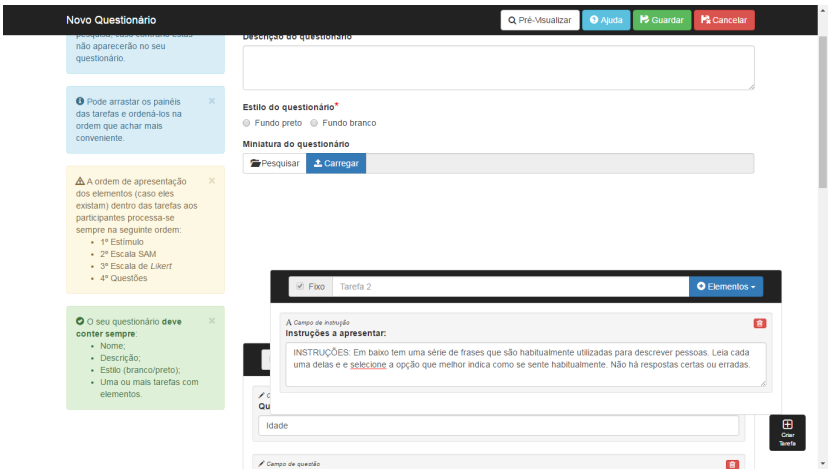


Figure 5.21: Action of drag and dropping a task

Elements inside questions

There are several elements the psychologist can add inside a task. Each element has an identifier associated and a red button for deletion.

The elements available to be inserted in a task are the following:

- **Question** (figure 5.22)**:**

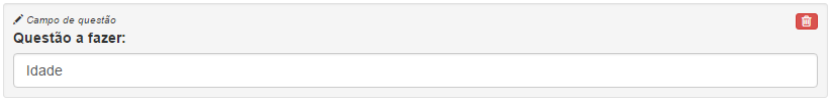


Figure 5.22: Question element in questionnaire creation

A task can contain an infinite number of questions that can be combined with other elements.

- **Instructions** (figure 5.23)**:**

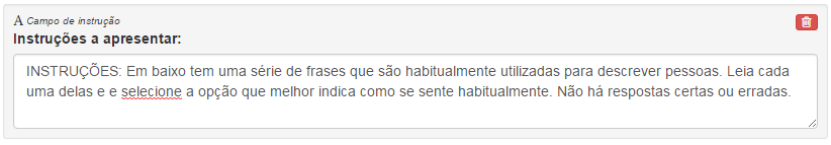


Figure 5.23: Instruction element in questionnaire creation

An element of instructions can only be added to an empty task and does not allow the addition of any other element. It is used when the psychologist wants to start a new phase of the questionnaire and needs to provide instructions or warnings to the participant.

- **Image stimulus** (figure 5.24)**:**

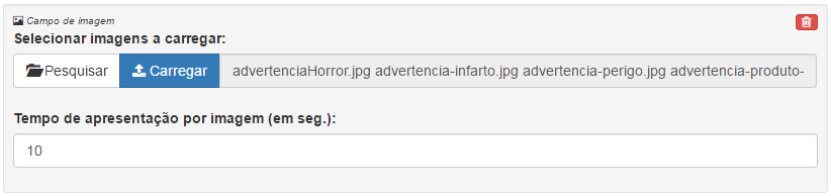


Figure 5.24: Image stimulus element in questionnaire creation

In an image stimulus element the psychologist can upload one or many images to the questionnaire. When the search button is clicked, the file explorer is opened and the psychologist can choose the images s/he wants to present in that task. After that s/he has to click in the button to upload the images to the system. After they are uploaded, a confirmation message is displayed to the psychologist to inform it if the uploading was successful.

There is also a field for defining the amount of seconds a stimulus will be displayed to the psychologist in the data collection.

- **Video stimulus** (figure 5.25)**:**

Besides the image stimulus, the psychologist can also upload videos to the questionnaire to be presented to participants. Once a video is uploaded, its name is displayed in a list of uploaded videos.

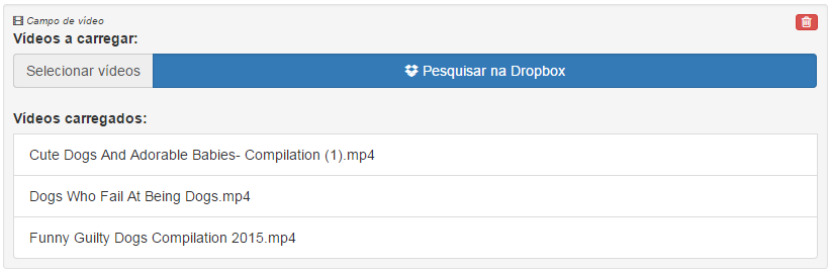


Figure 5.25: Video stimulus element in questionnaire creation

Unlike images, videos are uploaded from the psychologist's Dropbox account (figure 5.26) because their size has considerable length, so storing them in the database would take a long time due to conversion rates. Dropbox is a largely popular and used application [41] specially for storing large files.
The videos selected by the psychologist need to be available for the entire duration of the questionnaire's lifetime.

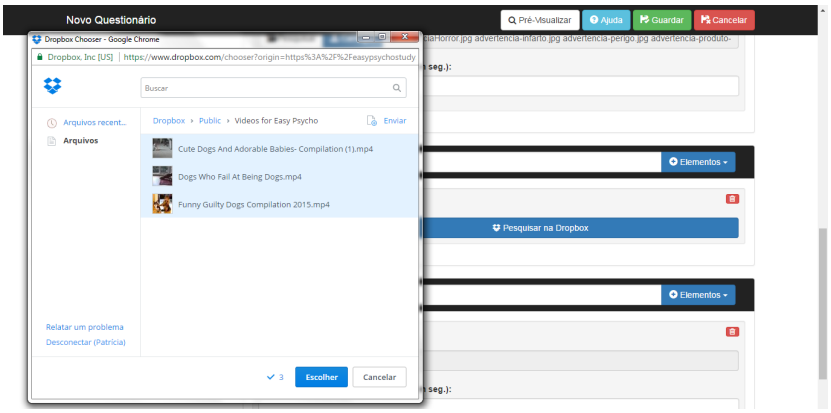


Figure 5.26: Video stimulus element being uploaded from Dropbox account

- **SAM scale** (figure 5.27)**:**

  If a task contains either an image stimulus element or a video stimulus element, a SAM scale can be added to it. The psychologist can then choose which dimension or dimensions s/he wants the participant to rate.

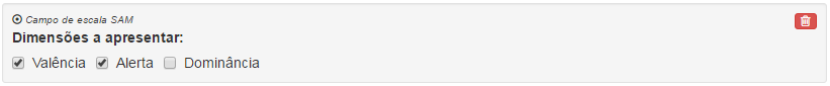


Figure 5.27: SAM scale element in the questionnaire creation

- **Likert scale** (figure 5.28)**:**

  Another type of scale that is available to add in a task is the Likert scale. This scale can either be added to a task containing a stimulus to be associated with it, or in an empty independent task.

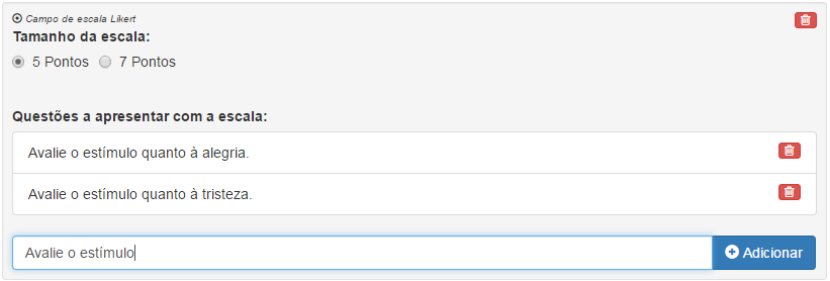


Figure 5.28: Likert scale element in the questionnaire creation

The psychologist can choose between two different sizes of Liker scale: five points or seven points. S/he can also add questions to a list that will be presented with the scale in order to be evaluated. If the psychologist wishes to remove a question from the list, s/he only needs to click the deletion red button, similar to the deletion button present in the elements.

Preview questionnaire

If the psychologist wishes to see how the questionnaire will be presented to participants, a preview can be generated at anytime by clicking the preview button available in the navigation bar (as can be seen in figure 5.18). The system will display a message while is generating the preview (figure 5.29), and when it concludes the generation a pop-up window will open with a preview questionnaire that the psychologist can close at any moment (figure 5.30).

Figure 5.29: Loading preview message

Figure 5.30: Preview questionnaire page

Save questionnaire

The questionnaire can be stored in the system by clicking the save button. Once the psychologist triggers this button, a verification will run to verify if all the elements are filled and in conformation and display an error message with a list of the found errors (figure 5.31).

Figure 5.31: Verification error message

If the questionnaire passes the verification a loading modal will be displayed to the psychologist similar to the one in figure 5.29. The questionnaire's configurations are saved in a Json file that is stored in the database.

After the process the psychologist will be taken to the main dashboard and the brand new questionnaire will appear as a closed questionnaire in there.

5.1.3 Clone and Edit questionnaire

The clone questionnaire option allows to duplicate an existing questionnaire and use it as a starting point to a new but related study, which can be a convenient kick-start.

The edit questionnaire option allows to change the elements or add new ones in an already created questionnaire.

The page aspect is exactly the same as in the questionnaire creation page shown in section 5.1.2 (figure 5.32), including feedback messages and navigation bar buttons, except that in these pages the fields are loaded from the Json file that was saved on the questionnaire creation.

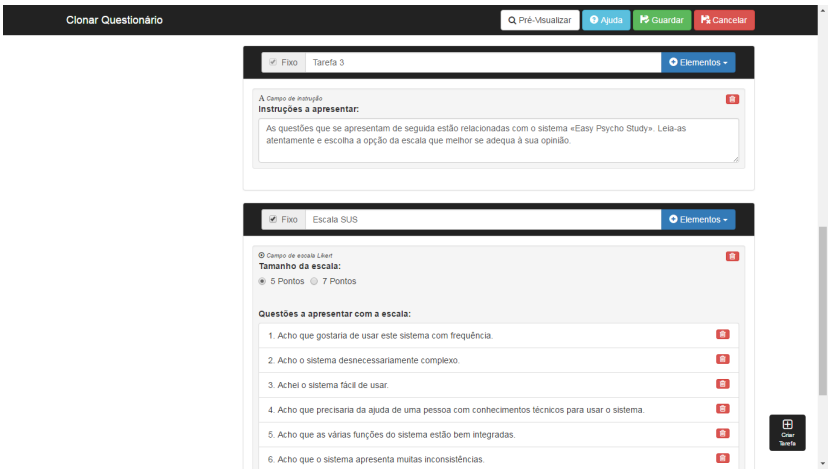


Figure 5.32: Example of fields filled from Json file information, in Clone questionnaire page

5.1.4 Collect data from participants

In the mini-panel of open questionnaires there are two options of data collection: face-to-face data collection and remote data collection.
To execute a face-to-face data collection, the psychologist only needs to trigger the button present in the mini-panel of the questionnaire of choice. To execute a remote data collection, the process is the same but a modal window is open with a remote link to the questionnaire (figure 5.33).

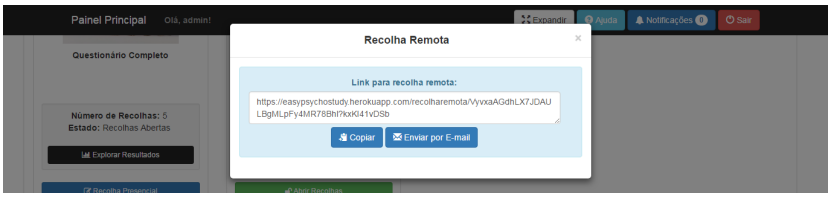


Figure 5.33: Welcome screen in face-to-face questionnaire page

The psychologist can then either choose to copy the link to the clipboard and send it directly to a participant or s/he can send an e-mail[1] directed to several e-mail addresses with an invitation message containing the participation link (figure 5.34).
Feedback messages are displayed if the e-mails are successfully sent or if the delivery fails.

A remote link generated by the psychologist includes an access token (in the url parameters). The participant can only access the questionnaire if this token is in the url, otherwise an error message will be displayed. This acts as a measure of security and the token for a questionnaire can be invalidated at any time by the Administrator.

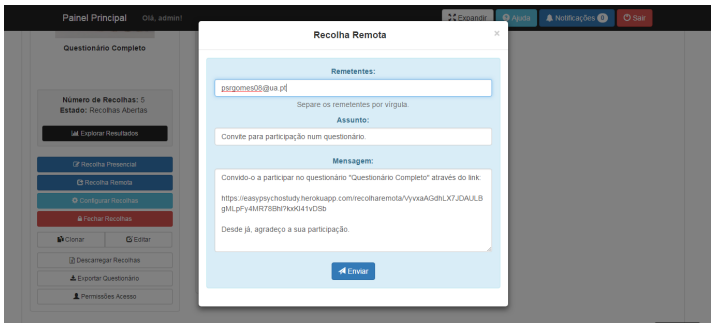


Figure 5.34: E-mail form for sending participation links

The page presented to participants in the different types of collection is the same, except for the welcoming screen (figures 5.35 and 5.36).

Figure 5.35: Welcome screen in face-to-face questionnaire page

[1]The e-mails are sent using the SMTP2GO free plan service, which supports the sending of 1000 monthly e-mails, with a restriction of 25 e-mails per hour.

Figure 5.36: Welcome screen in remote questionnaire page

In the face-to-face data collection, the ID of the participant should be provided by the psychologist in charge of conducting the data collection.
In remote data collection the ID of participants is automatically generated by the system and when participants submit their answers to the questionnaire, a notification appears in the notifications section of all the psychologists that have permissions to access that questionnaire.

If a trial questionnaire and/or scale explaining was configured for a questionnaire, after the welcoming screen the tutorial information will be the first thing to be displayed (figure 5.37). After that, a screen will inform the participant that s/he can do a trial questionnaire first. The trial questionnaire page design is equal to the one shown in Preview questionnaire. This trial can be closed at any time and when that action occurs the participant will be able to start the real questionnaire.

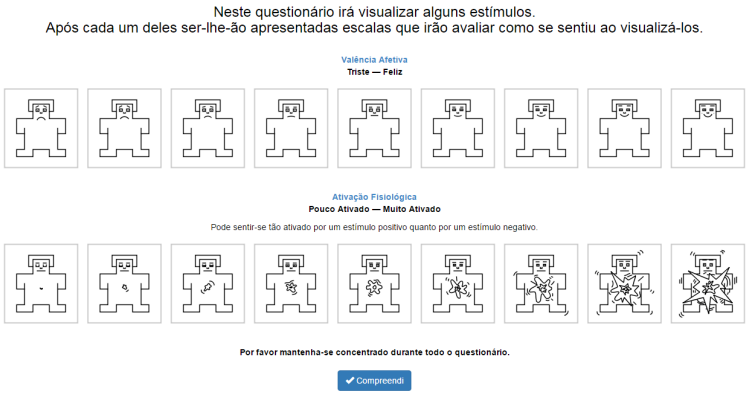


Figure 5.37: Tutorial information page

Display of elements in data collection

All the elements request input from the participant except for the video stimulus, image stimulus and instructions.
When the participant does not answer an input request on the questionnaire and triggers the next button, a warning message is displayed informing what fields need to be answered before s/he can move to the next task.

Figure 5.38: Warning message during data collection

The image and video stimulus elements are displayed without any other type of distraction on the screen (figure 5.39). In the case of the video stimulus there is a next button for the participant to click when the video is finished (figure 5.40).

Figure 5.39: Image stimulus element in data collection

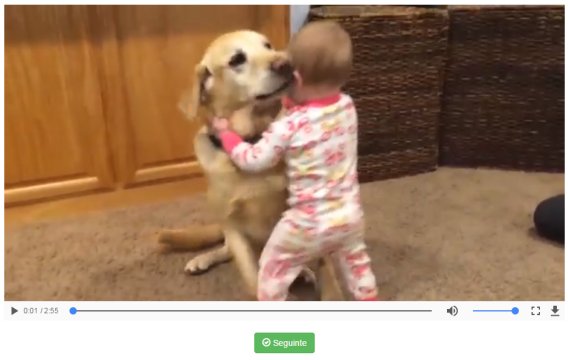


Figure 5.40: Video stimulus element in data collection

With the other elements (figures 5.41, 5.42 and 5.43), a progress bar is always displayed to inform participants of their progress. The progress percentage is calculated based on the number of total tasks the questionnaire contains.

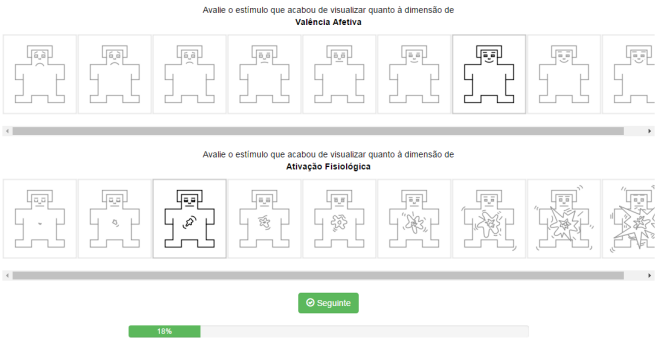


Figure 5.41: SAM scale element in data collection

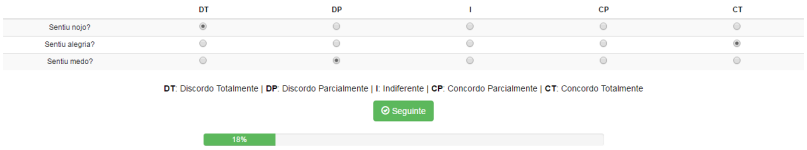


Figure 5.42: Likert scale element in data collection

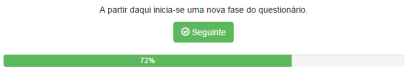


Figure 5.43: Instructions element in data collection

All the answers given by a participant (and associated date and hour the answer was given) to a questionnaire are saved in a Json file that is stored in the database and associated to the questionnaire, in a very similar fashion to the create questionnaire page.

Data acquisition synchronization trigger

Both methods of data collection (face-to-face and remote) can be integrated with the capturing of bio-signals. EPS can post messages to a shared pool, managed by an AMQP compatible browser. These messages are the relevant events on the participation.

This is achieved using the CloudAMQP server[2], a message broker that exchanges messages between the EPS web application and the bio-signals capturing application.

A message is sent whenever the participant starts the questionnaire, visualizes an image stimulus, visualizes a video stimulus or submits the questionnaire (as can be seen in figure 5.44 that present a log in the server where the application is hosted).

[2]Our application makes use of a free CloudAMQP plan with a capacity for 1000000 monthly messages.

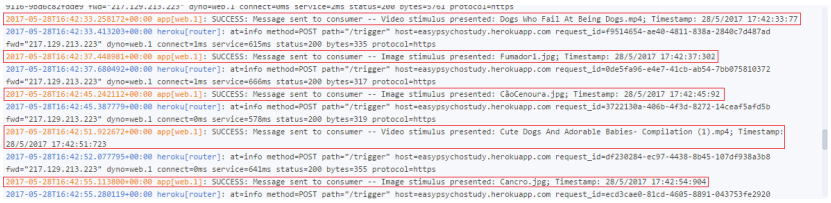


Figure 5.44: Successful messages sent to the bio-signals system

A possible set-up for this integration is illustrated in figure 5.45 where the participant, in order to have his/her bio-signals captured has electrodes on his/her body connected to the system that is capturing the bio-signals. (1) The participant starts the questionnaire in the EPS application (2) and every time that a relevant event occurs a message defining that event is sent to CloudAMQP. (3) The bio-signals acquisition system that is subscribed to the queue in the CloudAMQP can then consume the messages with the relevant events. (4)

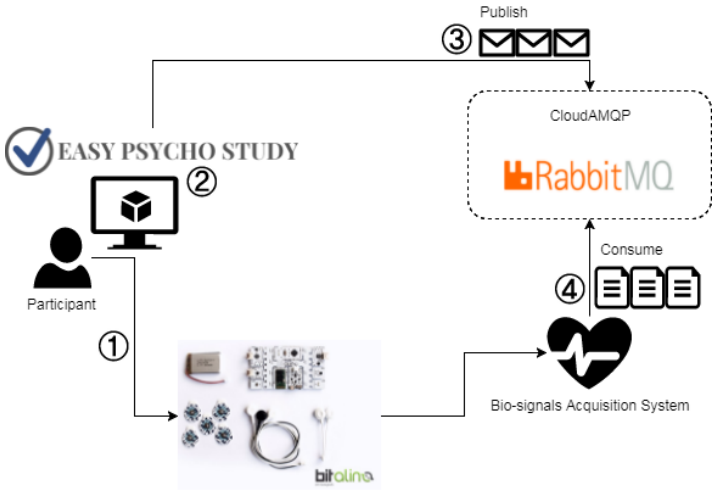


Figure 5.45: Diagram of possible set-up for integration between EPS and Bio-signals acquisition system

This type of integration is very useful in posterior data analysis, since it allows psychologists to match unusual values of the captured bio-signals to what stimulus was displayed to the participant in the questionnaire.

5.1.5 Explore collected data from participants

When a questionnaire has been used for data collection the psychologist can either explore in the system some statistics related to the answers given by participants or download an Excel file with all the data.

Results file (Excel compatible)

The results file follows Microsoft Excel format (version 2007 and later) and is organized in four sheets (figure 5.46). All psychologists with Owner or Reader permission for a questionnaire can download the file, no matter the state of the questionnaire.

Ordem Tarefa	Timestamp Estímulo	Estímulo	Timestamp SAM	Valência	Alerta	Ordem Tarefa	Timestamp Estímulo	Estímulo	Timestamp SAM	Valência	Alerta
10	27/6/2017 13:48:12:263	EasyPsychoStudy_12.jpg	27/6/2017 13:48:29:224	5	1	9	27/6/2017 13:48:1:640	EasyPsychoStudy_05.jpg	27/6/2017 13:48:5:616	5	1
13	27/6/2017 13:15:47:357	EasyPsychoStudy_12.jpg	27/6/2017 13:15:51:315	5	1	11	27/6/2017 13:15:17:933	EasyPsychoStudy_05.jpg	27/6/2017 13:15:28:782	4	1
7	27/6/2017 13:12:45:949	EasyPsychoStudy_12.jpg	27/6/2017 13:12:52:271	3	8	3	27/6/2017 13:11:39:518	EasyPsychoStudy_05.jpg	27/6/2017 13:11:56:431	2	7
6	27/6/2017 12:10:59:244	EasyPsychoStudy_12.jpg	27/6/2017 12:11:5:53	5	1	9	27/6/2017 12:11:40:200	EasyPsychoStudy_05.jpg	27/6/2017 12:11:45:899	4	2
3	26/6/2017 10:57:41:408	EasyPsychoStudy_12.jpg	26/6/2017 10:57:45:557	4	2	12	26/6/2017 10:59:13:885	EasyPsychoStudy_05.jpg	26/6/2017 10:59:17:43	5	1

Figure 5.46: Table in results file with collected data from participants

The first sheet has all the data collected from participants with information about what task they visualized at a certain moment and the order that task was shown to them. The second, third and fourth sheets display the values attributes by participants to stimuli in the three dimensions of Valence, Arousal and Dominance (figure 5.47).

ID Participante	EasyPsychoStudy _02.jpg	EasyPsychoStudy _12.jpg	EasyPsychoStudy _05.jpg	EasyPsychoStudy _14.jpg	EasyPsychoStudy _17.jpg	EasyPsychoStudy _23.jpg	EasyPsychoStudy _27.jpg	EasyPsychoStudy _32.jpg
7yEPCrwvc70qtuzSgc	4	5	5	5	5	5	6	6
0BxacfBfgzGxlzGkDH	2	5	4	5	5	5	8	5
ydSQBhTNBodzTCKNR1	1	3	2	6	5	5	6	5
UnCYMKkDcKwHCZrPYK	1	5	4	5	5	5	9	6
1	1	4	5	5	5	5	9	5

Figure 5.47: Table in results file with values attributed by participants to the Valence dimension

Explore results

After a data collection, the psychologist can explore the results obtained with it.
All psychologists with Owner or Reader permission can explore results, no matter the state of the questionnaire (similar to the downloading of Excel file).
In the page of Explore results, the graphs are organized by graphs associated to SAM scale and graphs associated to Likert scale. If one or none of them exists, the page will be empty.

The graphs associated to SAM scale are the following:

- **Box plot:** represents the numerical data through quartiles (maximum, 75 percentil, median, 25 percentil, minimum) (figure 5.48);

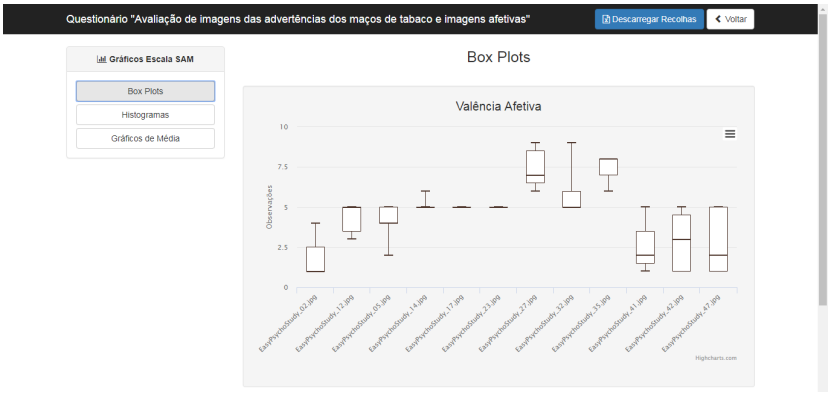


Figure 5.48: Analysis of the aggregated responses by stimuli with Box plot

- **Histogram:** represents the distribution of the numerical values attributed to each stimulus by participants (figure 5.49);

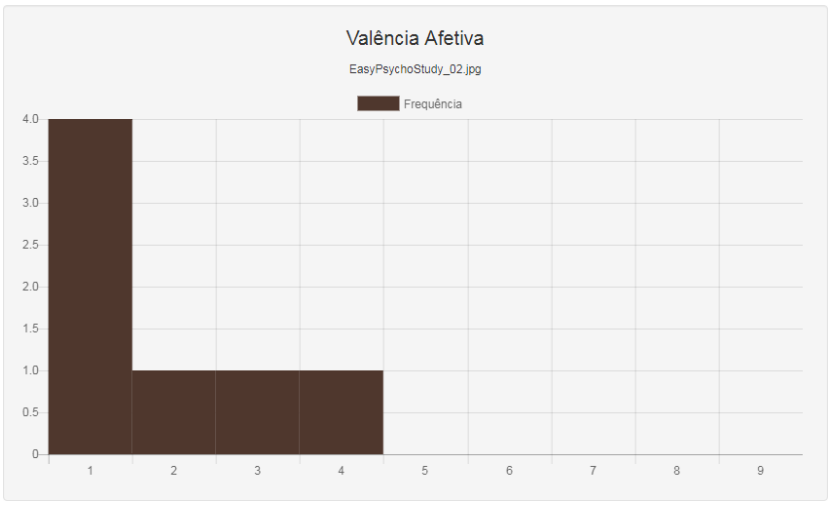


Figure 5.49: Analysis of the frequency of responses by stimulus

- **Average graph:** represents the average, maximum and minimum numerical value attributed to each stimulus(figure 5.50). These numerical values are represented in a line graph to show the variation in the dimensional values for each stimulus.

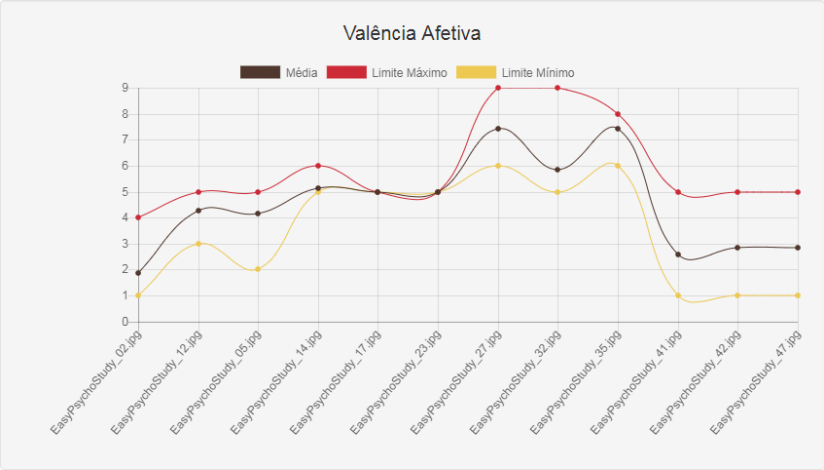


Figure 5.50: Average graph in Explore results page

The graphs associated to the Likert scale are only Histograms, however they are divided into two categories: histograms associated to stimulus (figure 5.51) and histograms of likert scales without any association (figure 5.52).

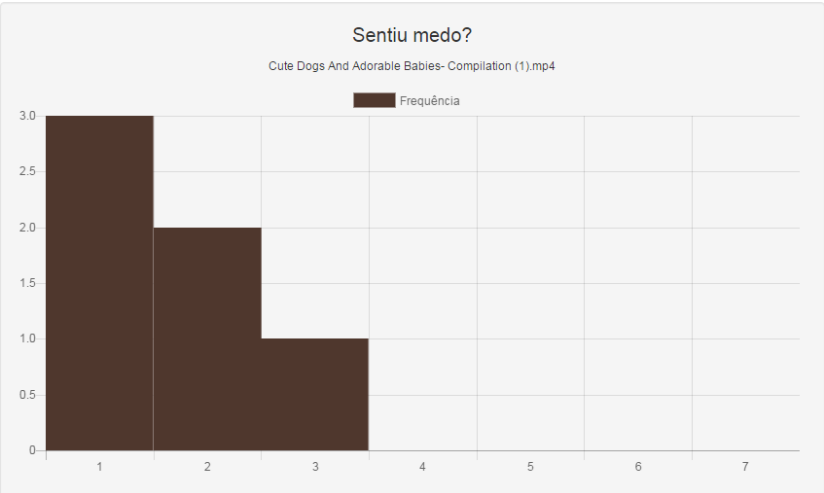


Figure 5.51: Likert histogram associated to a stimulus

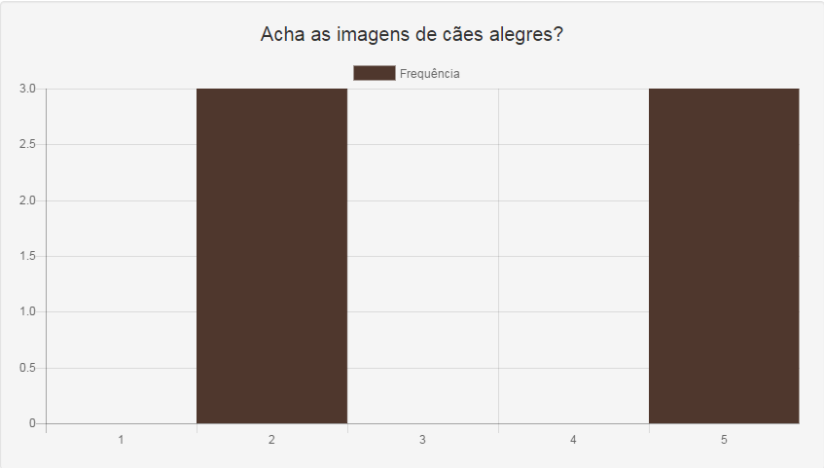


Figure 5.52: Likert histogram of answers given by participants

All graphs were drawn with Chart.js JS library, except for Box plots, that were drawn with the Highcharts library, since Chart.js did not provide Box plot drawing. Both libraries provide responsive canvas, which makes them adapt to lower resolution screens in tablets or mobile phones.

In the Explore results page, the user can also download the same dataset results file that is available for download in the questionnaire's mini-panel in the main dashboard.

5.1.6 Authentication pages

Log-in page

The log-in page is simple and it is the first page to be displayed when a psychologist enters the url of the system, as can be seen in figure 5.53. It displays only the application logo so the psychologists can identify in which platform they are logging in, a form to insert the username and password and a confirmation button to submit it.
If the psychologist does not have an account, a link to create a new account is provided in the bottom center of the page.

Figure 5.53: General view of the log-in page

Register page

The register page follows the same design as the log-in page, as can be seen in figure 5.54: a logo is presented to identify the application, a form to insert the required data to create a new account and two different buttons: one for submitting the form and the other to cancel the creation of a new account.

Figure 5.54: General view of the register page

When the psychologist successfully creates an account, the page is refreshed and the log-in page is shown. The psychologist can then enter the main dashboard.

5.2 Administration Area

Our web application was developed using Django framework, as mentioned before. Django has the advantage of providing a fully implemented default administration area (figure 5.55) that allows managing directly the data inside the system databases and manage the accounts of users.

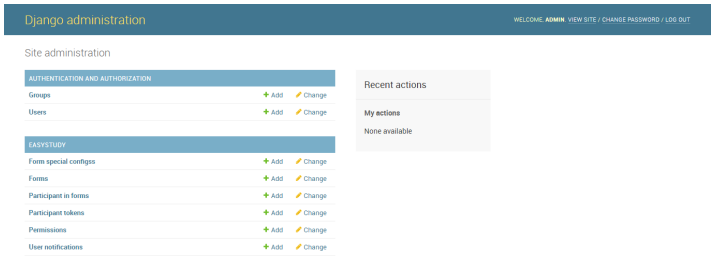


Figure 5.55: Main page of the Administration area

All users with Staff Status associated can access the administration area and perform changes to the database that were authorized by a psychologist with Superuser Status. This last type of user can manipulate the entire database and user management without restrictions (figure 5.56).

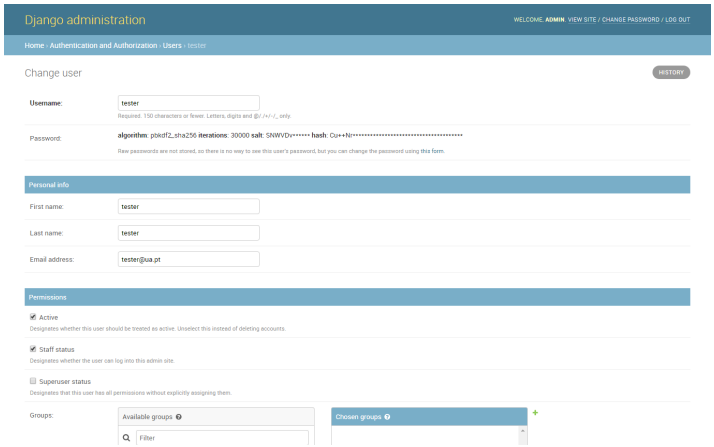


Figure 5.56: Management of user in the Administration area

All the information the system contains can be easily accessed, read and altered (if the user has the permissions for it).

5.3 Responsive design

The entire application is adaptable to mobile and tablet, without losing any of the functionalities available. All the elements are responsive and fit all screen sizes. This feature is especially useful when doing remote data collections, since a participant can easily access the application in any format of device. Some screenshots of how the application looks in different screens can be seen in figures 5.57, 5.59 and 5.58.

(a) Warning message being displayed. The SAM scale that can be seen is horizontally scrollable

(b) Main page of face-to-face data collection

Figure 5.57: Page displays in GalaxyS5

Figure 5.58: Main dashboard of user in an iPhone6

Figure 5.59: Questionnaire creation page in an iPad

5.4 Data security and privacy

All the data inserted in the system by psychologists in questionnaires or when they register as well as the data collected from participants in the studies is stored in a PostgreSQL database in Heroku, the server where the application is hosted.

If a psychologist has permissions of access to a questionnaire, s/he can download the results file or explore the results inside the application but s/he can never visualize the "raw"data as is stored in the Administrator panel. In order for this to happen, the psychologist must have a staff account that can only be authorized by the system's Administrator.

Personal data related to participants is dependent on what type of questions the psychologist asks in a questionnaire (there may be sensitive questions or not). However, the answers are not available for every psychologist to read and can only be read by psychologists that are authorized to visualize and explore the questionnaire.

Data related to the registry of psychologists, mainly the chosen password, is encrypted inside the database and there is no way to see it, not even for the Administrator.

6 | Early results and validation

In order to verify the efficiency and usability of our application, we executed two types of tests with users: validation tests and usability tests. In this chapter we will talk about how these tests were implemented and what was the outcome.

6.1 Validation tests

Validation is a procedure that is used to verify if an application is in conformity with the specified requirements made by the client. It assesses the quality level of the application [42]. In a simple approach, a validation test answers the question "does the system meets the requirements and expectations of users".
The basic process of validation testing can be seen in figure 6.1.

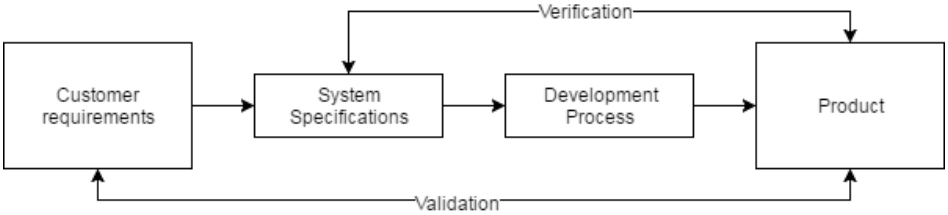


Figure 6.1: Application validation process [6]

Two psychologists were invited to participate in the validation tests: one with a vast experience using psychology software and more prone to technology (we will call it Tester A) and another with less experience and not too enthusiastic about using psychology software (Tester B).

Each tester made the tests in different days, as to avoid one psychologist influencing the other's opinion. The adopted testing procedure was the following:

- The tester is asked to execute a certain task (eg.: build a new questionnaire) and while doing it provides feedback about the design and style of the application;
- The tester tries to execute the task;

- The tester tells if the task is in accordance to the requirements, and if not, makes a suggestion of how it should be implemented.

The set of tasks to be executed was the same for both testers, and were the following:

- Build a new questionnaire and while doing it generate a preview;
- Collect data using the questionnaire;
- Explore the collected data via Excel file and in Explore results page.

Tester A

Tester A performed the validation on a Wednesday. From the set of tasks executed, the following feedback was collected:

- In the design of the questionnaire there were functionalities missing like changing the order of tasks or allowing sequential sets of stimuli;
- Sharing a link for a remote data collection was tiresome has it would not allow sending the same link to several participants at a time;
- The only scale available in the questionnaire design was the SAM scale, which was very limiting and the scale was not displayed according to the Psychology protocol in the questionnaire for participants.

Tester B

Tester B performed the validation on a Friday, two days after Tester A. All the suggestions and warnings made by Tester A, except for the Likert scale suggestion, had already been implemented by then.
From the set of tasks executed, the following feedback was collected:

- In the design of the questionnaire there was a missing scale of measurement in the time of display of stimuli, there was lacking the option of deleting individual elements inside tasks;
- Some technical terms had incoherent translations.

Aftermath of validation tests

All of the suggestions and corrections made by both testers were taken into consideration and implemented, as could be seen in chapter 5. The application, with the implemented suggestions, can cover a larger number of different types of questionnaires, making it more appealing to psychologists to build their questionnaires.
A more detailed feedback given by the testers is presented in appendix A.1.

6.2 Usability tests

Usability tests were used to evaluate our application with representative users. With this type of test we were able to:

- Learn if participants were able to complete the required tasks successfully;
- Identify the amount of time each task takes to complete;
- Find out the level of satisfaction of the participants in regards to our application;
- Identify changes required to improve performance;

Usability test planning and procedure

In order to evaluate the usability of the application, a total of eleven participants were submitted to a usability test with two parts.
At the beginning of the test, the participants were asked to answer some personal questions to better identify what type of user they were - if they had experience building questionnaires or not (table 6.1).

Participant ID	Age	Sex	Experienced in creating questionnaires	Has experience using Psychology software
1	23	M	No	No
2	23	M	No	No
3	26	M	No	No
4	25	M	Yes	No
5	24	M	No	No
6	23	M	No	No
7	23	M	Yes	No
8	27	F	Yes	Yes
9	25	M	Yes	No
10	24	F	Yes	No
11	22	F	Yes	Yes

Table 6.1: Participants in the usability test

The participants were orally informed about the type, main functionalities and purpose of the application they were going to use.
It was explained to them that they would be participating in a usability test with two parts.

In the first part the participants executed ten different tasks without assistance and with no time restrictions. We only intervened when they asked for help to finish a task, providing them with tips on how to execute it. The participants were able to think aloud and report

what they were currently doing. They were also able to make suggestions and report any kind of difficulty they were having.

The tasks that were asked for the participants to perform in the first part were the following:

- 1. Create a questionnaire with:
  - One task with one question;
  - One task with two images and a SAM scale with dimensions Valence and Alert associated;
  - One task with a video with a 5-point Likert scale with two questions associated.
- 2. Preview the questionnaire;
- 3. Save the questionnaire;
- 4. Edit the first question in the previously created questionnaire;
- 5. Open data collections for the questionnaire and make a face-to-face data collection;
- 6. Explore collected results and visualize the average graphs page;
- 7. Download file with collected data;
- 8. Invite the user *admin* to access the created questionnaire with "Owner"permissions;
- 9. Import a questionnaire called "Grandes Questões da Vida"without data from participants;
- 10. Exit the system.

The task that required more assistance was the first one, when the participants were asked to add elements to the questionnaire. Participants that had no previous experience in creating questionnaires were the ones that had more difficulty with this task. The other type of participants completed it without trouble and reported that the system was very similar to other tools of building questionnaires and because of that it was intuitive to them.

Some suggestions were also given by participants and they were all in relation to the visual aspects of the application, more precisely with the styling and placement of some of the buttons.

In the second part of the test the participants were asked to fill a SUS questionnaire. Since our application had the option to build questionnaires and collect data with them, we used it to collect the answers in the SUS questionnaire.

The SUS questionnaire for the participants was a ten item questionnaire (A.2) with five possible choices of response (from totally disagree to totally agree), that was manually translated to Portuguese. It was created by John Brooke and it is used to evaluate websites, software and applications [43].

After collecting all the SUS questionnaire participations, we generated a box plot (figure 6.2) with the scores given by the participants in each item. The box plot allows us to see if there was consensus in the given scores between all participants.

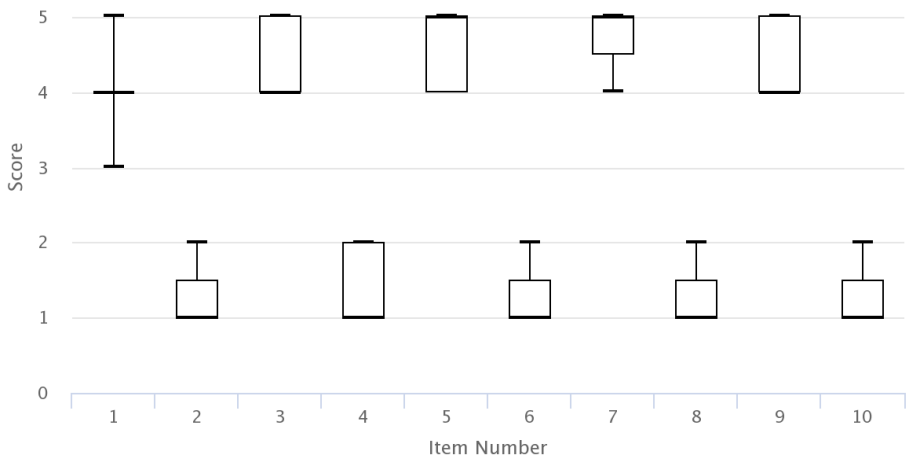


Figure 6.2: Summary graph of responses to all items in the SUS questionnaire

With the median score of each item we calculated the value of System Usability (SU) of our application, in accordance to the rules of the SUS questionnaire:

- The median score for each item is converted to a new number:
  - Odd items: $newscore = currentscore - 1$
  - Even items: $newscore = 5 - currentscore$
- The new scores are summed and the total is multiplied by 2.5;
- The number obtained after the multiplication is the overall value of SU. This value is not a percentage and is considered only in terms of its percentile ranking.

After the calculations, a value of 92.5 was obtained. In figure 6.3 the final SU score can be mapped to adjective ratings. With our calculated score, we got an Excellent result, that corresponds to an Acceptable acceptability rating and grade scale of A.

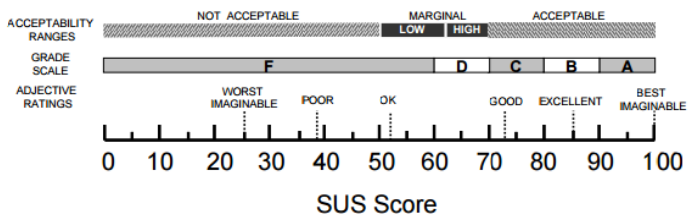


Figure 6.3: Adjective ratings, acceptability scores and school grading scales in relation to the average SUS score [7]

6.3 Pilot: Study of smoking habits

After the validation and usability tests, our application was used in a real scenario. There was a study being prepared which was exploring the hypothesis if images present in cigarette packs provoked any effect on smokers and non smokers.

We invited the psychologist that was running this study to design the questionnaire she was going to use in EPS. She had no previous contact with the application.
The scope of the application and the various functionalities available in it were briefly explained, so the psychologist could have a notion of how to use the application.

The psychologist designed the questionnaire alone. The questionnaire contained the following sequence of tasks:

- Task 1 – demographic questions: "age", "sex", "do you smoke?"and "do you have any psychiatric disorder?";
- Task 2 – image stimulus evaluation: a randomized sequence of twelve images corresponding to four different categories (neutral, positive, negative and tobacco) with a SAM scale with dimensions Valence and Arousal after each stimulus. A time of six seconds of display was attributed to each image.

There was a total of six participants in the study that were volunteers who were asked to participate and to who was explained in what the study consisted.

The collection of data from these participants was made in two ways: face-to-face and remotely.
The face-to-face participations were scheduled for a Monday and were conducted by the psychologist. For those who could not be present in the scheduled date, the option of remote participation was given and they were able to still participate from their location.

After the data collections were closed, the psychologist was able to download the results file with all the answers given by participants (figure 6.4).

	F	G	H	I	J	K	L	M	N
1	Sexo (F/M)	É fumador?	Tem alguma perturbação psiquiátrica?	Ordem Tarefa	Timestamp Estímulo	Estímulo	Timestamp SAM	Valência	Alerta
2	F	Sim	Não	3	27/6/2017 14:34:51:589	EasyPsychoStudy_02.jpg	27/6/2017 14:35:6:394	3	5
3	M	Não	Não	4	27/6/2017 13:47:0:222	EasyPsychoStudy_02.jpg	27/6/2017 13:47:12:319	4	1
4	F	sim	não	5	27/6/2017 13:13:55:892	EasyPsychoStudy_02.jpg	27/6/2017 13:14:5:537	2	5
5	F	nao	nao	10	27/6/2017 13:13:23:120	EasyPsychoStudy_02.jpg	27/6/2017 13:13:25:703	1	7
6	F	Não	Não	7	27/6/2017 12:11:11:72	EasyPsychoStudy_02.jpg	27/6/2017 12:11:17:492	1	5
7	M	Não	Não	10	26/6/2017 10:58:49:552	EasyPsychoStudy_02.jpg	26/6/2017 10:58:54:404	1	9
8									

Figure 6.4: Some of the data present in the Excel file of the pilot study

The application also generated graphs associated to the study that allowed the psychologist to immediately draw some conclusions about how the participants reacted to some of the stimuli.

With the generated box plots for the two affective dimensions (figures 6.5 and 6.6), the psychologist was able to visualize important characteristics of the distribution of scores for all stimuli presented in the questionnaire.

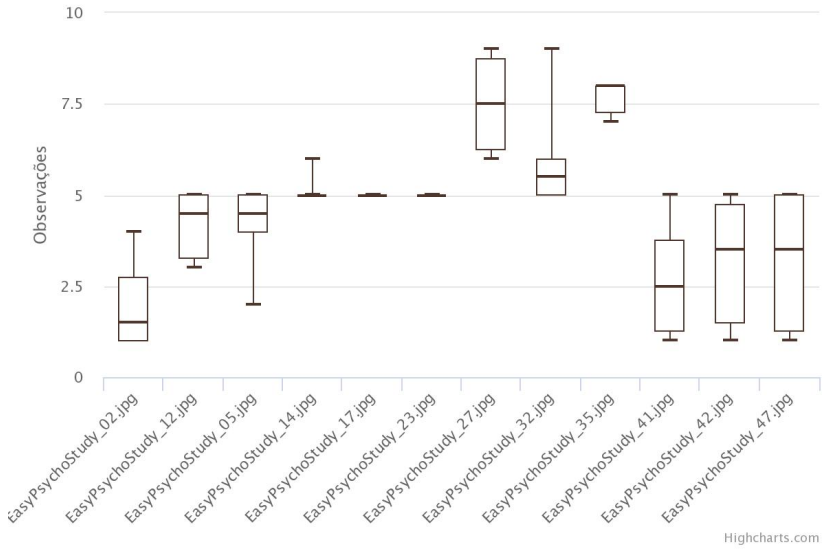


Figure 6.5: Valence box plot associated to the pilot study

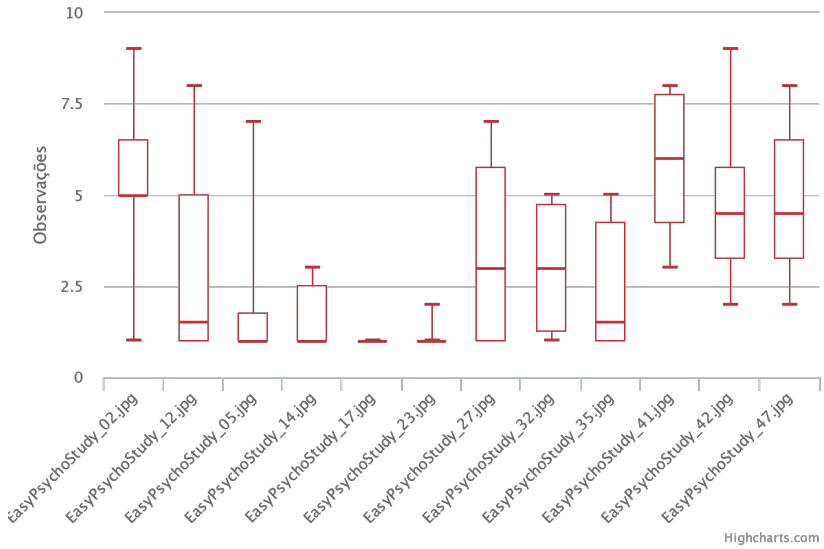


Figure 6.6: Arousal box plot associated to the pilot study

The psychologist could also visualize histograms that showed the frequency of scores for each presented stimuli (in figures 6.8 and 6.9 we can visualize the histograms of Valence and Arousal for the positive image EasyPsychoStudy_27, presented in figure 6.7).

Figure 6.7: Positive image stimulus EasyPsychoStudy_27

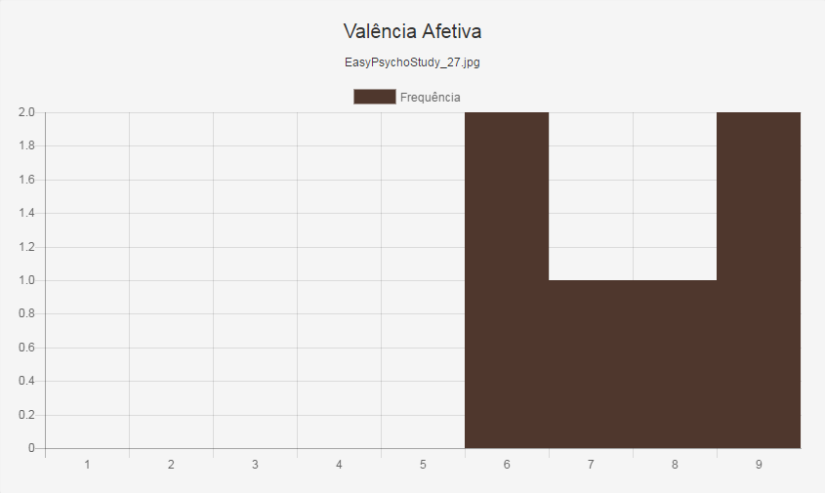


Figure 6.8: Valence histogram associated to the positive image stimulus EasyPsychoStudy_27

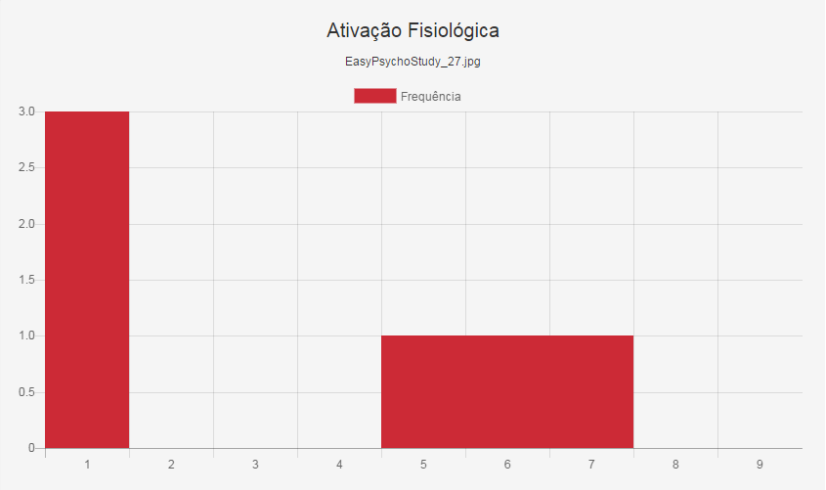


Figure 6.9: Arousal histogram associated to a positive image stimulus EasyPsychoStudy_27

Finally, to show the variation in the dimensional values for each stimulus, the psychologist could visualize the graph of average, maximum and minimum (figures 6.10 and 6.11).

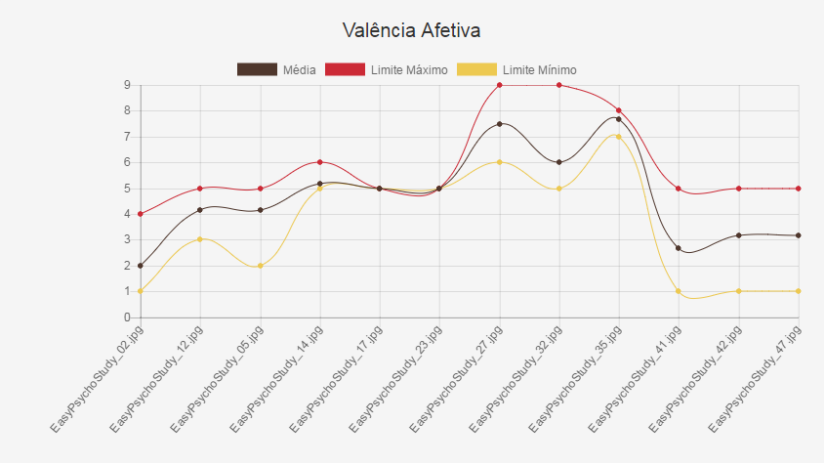


Figure 6.10: Graph of minimum-average-maximum for valence of the stimuli presented in the study

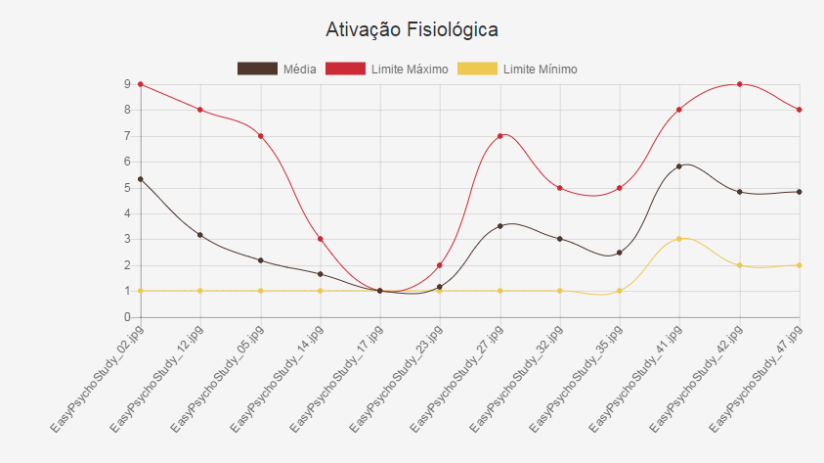


Figure 6.11: Graph of minimum-average-maximum for arousal of the stimuli presented in the study

7 | Conclusions

The main goal of this work was to provide an easy environment for researchers to create psychology studies, more specifically surveys, conduct studies and register the observations.

To that end, we developed EPS, a web application to develop and deliver research questionnaires, that also allows users to perform subsequent data collection and responses review. Communication between EPS and a bio-signals acquisition system was also tested and established, a feature that allows researchers to conduct surveys and physiology monitoring.
The EPS offers a more appealing method of performing research questionnaires over paper-based questionnaires, with the possibility of checking for missing or inconsistent answers and the immediate display of feedback to both participant and psychologists.

Validation tests were run in order to verify the adequacy and usability of EPS. The psychology team that collaborated in this work highlighted as strengths the possibility of collecting data remotely from participants with questionnaires, the fact that the processes of designing the questionnaire, data collection and subsequent analysis can be carried out in the application - centralizing them, the fact that the application is adaptable to any device screen size making it portable and the integration with a system of bio-signals capturing.

Usability tests were also run in order to calculate the overall usability of the web application with good results, meaning the users felt the application was effective and provided a satisfactory experience.

7.1 Future work

The page for questionnaire building can be improved by adding more elements to tasks, especially new self-assessment scales. The possibility to customize these scales would also be a good addition to the web application.

As of now, the application is only available in Portuguese. It would be of great value to translate it to English, a global language. Turning the application into open source would also increase the possibility of finding developers interested in expanding it with new features relevant to psychology studies.

The development of an API would also be of great value, since third parties would be able

to import questionnaire data and process it at will in other psychology applications. Third parties could also submit questionnaires into EPS or even develop a mobile application that would interact with EPS through the API.

References

[1] Joseph F. Hair. *Essentials of Business Research Methods*. M.E. Sharpe, 2015.

[2] Diane L. Fairclough. *Design and Analysis of Quality of Life Studies in Clinical Trials*. CRC Press, 2002.

[3] Dawn M. McBride. *The Process of Research in Psychology*. SAGE, 2012.

[4] James Sugrue. *Beginning Backbone.js*. Apress, 2014.

[5] Transitioning from rdbms to nosql. interview with couchbase's dipti borkar. `https://www.infoq.com/articles/Transition-RDBMS-NoSQL`. Visited in March 2017.

[6] Thomas W. Otani Doron Drusinsky, James Bret Michael and Man-Tak Shing. Verification and validation for trustworthy software systems. *IEEE Software*, 28:86–92, 2011.

[7] James Miller Aaron Bangor and Philip Kortum. Determining what individual sus scores mean: Adding an adjective rating scale. *Journal of Usability Studies*, 4:114–123, 2009.

[8] Victor Minichiello. *In-depth Interviewing: Researching People*. Longman Cheshire, 1990.

[9] Turbogears official documentation. `https://turbogears.readthedocs.io`. Visited in June 2017.

[10] Wayne Goddard and Stuart Melville. *Research Methodology: An Introduction*. Juta and Company Ltd, 2004.

[11] Louis G. Tassinary John T. Cacioppo and Gary G. Berntson. *Handbook of Psychophysiology*. Cambridge University Press, 2016.

[12] Martin Dempster Wiley and Donncha Hanna. *Research Methods in Psychology For Dummies*. John Wiley & Sons, 2015.

[13] R. Amrein R.G. Priest, U. Vianna Filho and M. Skreta. *Benzodiazepines: Today and Tomorrow*. Springer Science & Business Media, 2012.

[14] Steve M. Jex and Thomas W. Britt. *Organizational Psychology: A Scientist-Practitioner Approach*. John Wiley & Sons, 2014.

[15] Petra M van de Looij-Jansen and Erik Jan de Wilde. Comparison of web-based versus paper-and-pencil self-administered questionnaire: Effects on health indicators in dutch adolescents. *Health Services Research*, 43:1708–1721, 2008.

[16] Mika Gissler Stefan Hrafn Jonsson Max Petzold Lena Hohwü, Heidi Lyshol and Carsten Obel. Web-based versus traditional paper questionnaires: A mixed-mode survey with a nordic perspective. *Journal of Medical Internet Research*, 15, 2013.

[17] Frances L. Niles Gregory Spitz and Thomas J. Adler. *Web-based Survey Techniques.* Transportation Research Board, 2006.

[18] Charles Donald Spielberger. *Encyclopedia of applied psychology: A-E, Volume 1.* Academic Press, 2004.

[19] Josef S. Smolen Michael E. Weinblatt Marc C. Hochberg, Alan J. Silman and Michael H. Weisman. *Rheumatology E-Book.* Elsevier Health Sciences, 2014.

[20] Nathan C. Hall and Thomas Goetz. *Emotion, Motivation, and Self-Regulation: A Handbook for Teachers.* Emerald Group Publishing, 2013.

[21] Ian Brace. *Questionnaire Design: How to Plan, Structure and Write Survey Material for Effective Market Research.* Kogan Page Publishers, 2008.

[22] Tetyana Kendzerska Gillian A. Hawker, Samra Mian and Melissa French. Measures of adult pain: Visual analog scale for pain (vas pain), numeric rating scale for pain (nrs pain), mcgill pain questionnaire (mpq), short-form mcgill pain questionnaire (sf-mpq), chronic pain grade scale (cpgs), short form-36 bodily pain scale (sf-36 bps), and measure of intermittent and constant osteoarthritis pain (icoap). *Arthritis Care & Research*, 63:S240––S252, 2011.

[23] Dan Hasson and Bengt B. Arnetz. Validation and findings comparing vas vs. likert scales for psychosocial measurements. *International Electronic Journal of Health Education*, 8:178–192, 2005.

[24] van der Zaag-Loonen HJ van Laerhoven H and Derkx BH. A comparison of likert scale and visual analogue scales as response options in children's questionnaires. *International Electronic Journal of Health Education*, 6:830–835, 2004.

[25] Therese J. M. Overbeek Joyce Westerink, Martin Ouwerkerk and W. Frank Pasveer. *Probing Experience: From Assessment of User Emotions and Behaviour to Development of Products.* Springer Science & Business Media, 2007.

[26] Elizabeth Graham Elizabeth M. Perse Rebecca B. Rubin, Alan M Rubin and David Seibold. *Communication Research Measures II: A Sourcebook.* Routledge, 2010.

[27] Jon D. Morris. Sam: the self-assessment manikin. an efficient cross-cultural measurement of emotional response. *Journal of Advertising Research*, pages 63+, 1995.

[28] Charles Stangor. *Research Methods for the Behavioral Sciences.* Cengage Learning, 2014.

[29] Christoph Stahl. Software for generatingpsychological experiments. *Experimental Psychology*, 53:218–232, 2006.

[30] Jon Raasch. *Smashing WebKit.* John Wiley & Sons, 2011.

[31] Navin Narayan Jithesh Sathyan, Anoop N. and Shibu Kizhakke Vallathai. *A Comprehensive Guide to Enterprise Mobility.* CRC Press, 2016.

[32] Simone Payment. *Getting to Know Python.* The Rosen Publishing Group, 2014.

[33] Anna Ravenscroft Alex Martelli and Steve Holden. *Python in a Nutshell: A Desktop Quick Reference.* O'Reilly Media, Inc., 2017.

[34] Danny Patterson and Joey Lott. *Advanced ActionScript with Design Patterns.* Adobe Press, 2007.

[35] Paul Cornell. *Excel as Your Database.* Apress, 2007.

[36] James Vera David C. Luckham and Sigurd Meldal. Three concepts of system architecture. *Technical Report Stanford University Stanford, CA, USA*, 1995.

[37] Doug Rosenberg and Kendall Scott. *Applying Use Case Driven Object Modeling with UML: An Anotated E-commerce Example.* Addison-Wesley Professional, 2001.

[38] Philip A. Bernstein and Eric Newcomer. *Principles of Transaction Processing: The Morgan Kaufmann Series in Data Management Systems.* Morgan Kaufmann, 2009.

[39] Jesse James Garrett. *The Elements of User Experience: User-Centered Design for the Web.* New Riders, 2003.

[40] Peter Morville and Louis Rosenfeld. *Information Architecture for the World Wide Web: Designing Large-Scale Web Sites.* O'Reilly Media, Inc., 2006.

[41] Michael R. Miller. *Top 100 Windows 8.1 Apps.* Que Publishing, 2014.

[42] Eric W. Olsen Michael Haug and Luisa Consolini. *Software Quality Approaches: Testing, Verification, and Validation: Software Best Practice 1.* Springer Science & Business Media, 2012.

[43] William Albert and Thomas Tullis. *Measuring the User Experience: Collecting, Analyzing, and Presenting Usability Metrics.* Newnes, 2013.

[44] System usability scale (sus). `https://www.usability.gov`. Visited in June 2017.

A | Appendix

A.1 Validation tests

The detailed feedback provided by the psychologists in the Validation tests presented in section 6.1 was the following:

Tester A

- In the questionnaire building page:
  - An element of video/image stimulus could be fixed if more than one video/image was selected. The tester suggested to eliminate this rule because there were questionnaires that could have a sequential set of videos/images;
  - There was no specific task for demographic data. The tester suggested that there should be a pre-created task with some demographic questions, since this was required data in every single questionnaire;
  - There was no way of changing the order of tasks after they were created. The tester suggested that the user should be able to change the order of tasks at will;
- The remote data collection was being generated in the following way: the user would insert a participant ID and a link associated to only that participant would be generated. The tester complained about this limitation as it would be impracticable when performing remote collections with a big number of participants;
- The remote data collection link could only be copied from the application. The tester suggested a way of sending the link via e-mail through the application;
- The only self-assessment scale present in the questionnaire building was the SAM scale. The tester complained this was very restrictive because it only gave the option of having a dimensional scale. It was suggested the implementation of the Likert scale, since this is a commonly used one;
- The SAM scale on the questionnaire page for the participant, was not being displayed in a correct way. The 9 point scale was being divided in a 3x3 form and by the standards of a correct psychology scale this is incorrect. This was warned by the tester to be corrected;

- There were no suggestions on the design of the pages or elements inside of them. The design was considered good and when questioned if they would use it for simple questionnaires, the answer was yes.

Tester B

- In the questionnaire building page:
  - On the image stimulus elements, the amount of time to display each stimulus is requested but there is no mention about what the scale of measure is. It was suggested to inform the users that the measure was in seconds;
  - The elements inside a task could not be deleted, only the entire task had this option. The tester suggested there should be an option of deleting the elements individually;
  - The tester B also suggested there should be the option to add a Likert scale to a task;
- The tester corrected some technical terms in the SAM scale explanation page, suggesting better terms to be written instead;
- There were no suggestions about the design of the pages or elements;
- When the tester was asked if the application was useful and if s/he would use it, the answer was yes.

A.2 Usability tests

The SUS questionnaire [44] the participants answered had the following set of questions:

- 1. I think that I would like to use this system frequently.
- 2. I found the system unnecessarily complex.
- 3. I thought the system was easy to use.
- 4. I think that I would need the support of a technical person to be able to use this system.
- 5. I found the various functions in this system were well integrated.
- 6. I thought there was too much inconsistency in this system.
- 7. I would imagine that most people would learn to use this system very quickly.
- 8. I found the system very cumbersome to use.
- 9. I felt very confident using the system.
- 10. I needed to learn a lot of things before I could get going with this system.

A.3 Students@Deti event

The following poster (figure A.1) was elaborated to present the theme and features of this dissertation to the academic community during the Students@Deti event that occurred in June 12th 2017 in the University of Aveiro. In this event the students of University of Aveiro have an opportunity to showcase their annual work in dissertations and courses.

students @deti

Easy Psycho Study

Patrícia Gomes
Orientadores: Prof. Ilídio Oliveira, Prof. Susana Brás

Dissertação, 5º ano, MIECT.

2017

EASY PSYCHO STUDY

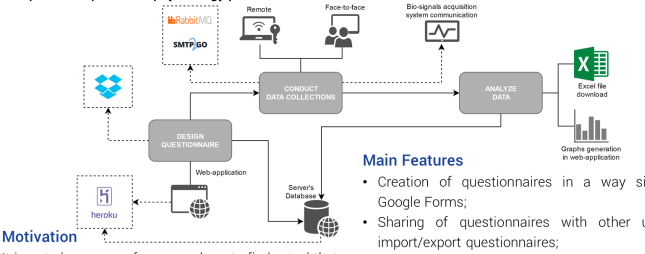
Abstract

Easy Psycho Study (EPS) is a web application to support psychologists with research questionnaires development and delivery. Using the EPS, the researcher can build the questionnaire interactively, perform the subsequent data collection and responses review. Unlike a common questionnaires building tool, EPS includes scales and other components specific to psychology protocols.

Keywords

Psychology, Study, Survey, Questionnaire, Web-based Application, Data Collection

Read this QR Code to access the application in your mobile phone or tablet.

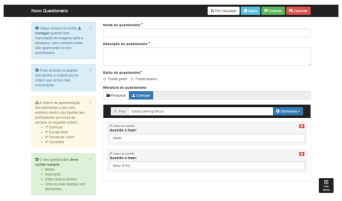


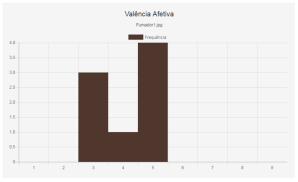
Motivation

It is not always easy for researchers to find a tool that speeds up and facilitates the research process and allows them to study the derived results from the research. The number of free psychology software available is scarce and researchers are forced to buy expensive licenses that most of the times don't provide all the tools they need and are also very complicated to use. This may be especially unpleasant for students of the area with little to no experience in using psychology software or for professionals who wish to execute studies without a high level of complexity. As an answer to these requirements, we developed, in collaboration with the Department of Education and Psychology of the University Of Aveiro an application that provides an easy environment for researchers to create psychology studies, more specifically surveys.

Main Features

- Creation of questionnaires in a way similar to Google Forms;
- Sharing of questionnaires with other users or import/export questionnaires;
- Two different types of data collection: face-to-face or remote;
- E-mail sender in-app for remote link sharing;
- Communication with bio-signal's acquisition system for cross-reference of "what the participant saw" with "what was the participant's body reaction";
- Analysis of collected data with downloadable Excel file or in-app auto graphics;
- Available for any screen size or device.





universidade de aveiro
theoria poiesis praxis

deti departamento de electrónica, telecomunicações e informática

Figure A.1: Poster presented at Students@Deti event