Dialectologia. Special issue, VI *(2016), 245-275.*
ISSN: 2013-2247

Received 22 February 2016.

Accepted 11 May 2016.

FOLERPA: A TOOL FOR BUILDING AND CONDUCTING PERCEPTUAL EXPERIMENTS[1]

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Abstract

The objective of this article is to present a new tool for building and conducting perceptual tests, FOLERPA (*Ferramenta On-Line para Experimentación Perceptiva* 'Online Tool for Perceptual Experimentation'). This is a package of online tools with open and free access which allows high-quality auditory perceptual experiments to be carried out in a visual, friendly and interactive environment, without the user needing programming skills. In this article the different development modules of a perceptual test, test diffusion, data administration and analysis, are explained one by one. These make up the platform and allow full perceptual experiments to be carried out. FOLERPA is designed principally for the development of experiments in the field of linguistics, but is also useful for other disciplines in the social sciences and humanities which employ perceptual methodology.

Keywords

experimental perception, perceptual methodology, speech perception

[1] This work was supported in part by the Xunta de Galicia and the European Union (under the grant GCR2013/40). This work has been carried out with the financial support received from the research group FILGA Galician Philology and Linguistics (GI-1743): Consolidation and structuring of Galician University System competitive research units (2013-PG069), and the TecAnDaLi Research network (R2014/007).

[2] This author also acknowledges a MECD-Spain FPU 13/06568 grant.

FOLERPA: UNHA FERRAMENTA PARA A ELABORACIÓN DE EXPERIMENTOS PERCEPTIVOS

Resumo

O obxectivo deste artigo é presentar unha nova ferramenta para a creación e desenvolvemento de tests perceptivos, FOLERPA (*Ferramenta On-Line para Experimentación Perceptiva*). Trátase dun paquete de ferramentas en liña, de acceso libre e gratuíto, que permite realizar experimentos de percepción auditiva de alta calidade nun contorno gráfico amigable e interactivo, sen necesidade de que o usuario conte con coñecementos de programación. Neste artigo explícanse un a un os diferentes módulos de Elaboración dun test perceptivo, Difusión de tests, Administración e Análise dos datos, que forman a plataforma, e que permiten desenvolver un experimento perceptivo completo. FOLERPA está deseñada principalmente para desenvolver experimentos no campo da lingüística, pero tamén é útil para as outras disciplinas das ciencias sociais e humanas que utilicen unha metodoloxía perceptiva.

Palabras chave

experimentación perceptiva, metodoloxía perceptiva, percepción da fala

1. Introduction

In recent decades there has been an exponential increase in experimental studies in the field of cognitive linguistics, for the most part transferred from the world of psychology. This development has been possible on account of developments in information technology which have enabled research methodology in different branches of linguistics, such as phonetics and phonology, to improve quantitatively and qualitatively. In this sense, new computer tools that are related to the study of perception (López-Bascuas, Carrero & Serradilla 1999; MacWhinney et al. 2001), and which enable the design and development of perceptual tests, have appeared. They represent an important advance for the study of perceptual phonetics and phonology as well as for studies in psychology:

> (…) improvements in the methodology of science inevitably lead to empirical and theoretical advances. (…) it has allowed us far greater precision in experimental control and measurement. But (…) it has forced many a budding psychologist to spend more time on programming than on experimental psychology (Cohen, MacWhinney, Flatt & Provost 1993: 3).

This work will present FOLERPA, a new online platform for carrying out perceptual experiments of an auditory nature and focused principally on the field of phonetics and phonology. In the following sections the characteristics of this platform, together with the advantages and inconveniences that it presents in comparison with other tools of this kind, will be set out.

2. Perceptual experimentation tools

From the end of the 1980s and the beginning of the 1990s, the first computer tools for perceptual text development began to appear, and were directed in the beginning towards the field of psychology research. PsyScope[3] (Cohen, MacWhinney, Flatt & Provost 1993), developed in the 1990s at Carnegie Melon University, was one of the first tools for perceptual experimentation that represented a great advance for experimental studies in the field of psychology, since it very quickly implemented an interactive graphical environment. Soon, similar programs began to appear within what was called 'Experiment Generation Systems' (MacWhinney et al. 2001), such as S.O.A.P (Howard-Jones & SAM Partnership 1991), created in the 1990s within the framework of the European Project SAM, which allowed perceptual tests to be undertaken and the results obtained analyzed.

Currently, the field of applications development in perceptual experimentation has continued to increase, in tandem with the development of computing. Amongst the more accepted current software there is Direct RT[4] (Empirisoft), E-Prime[5] (Schneider, Eschmann & Zuccolotto 2002), Paradigm[6] (López-Bascuas, Carrero & Serradilla 1999), PsychoPy[7] (Peirce 2007, 2009), PsyScope (Cohen, MacWhinney, Flatt & Provost 1993) and SuperLab[8] (Cedrus Corporation).

[3] http://psy.ck.sissa.it/
[4] http://www.empirisoft.com/directrt.aspx
[5] https://www.pstnet.com/eprime.cfm
[6] http://www.paradigmexperiments.com/
[7] http://www.psychopy.org/
[8] http://www.superlab.com/

The greater part of the programs such as Direct RT, Super Lab, E-Prime, Paradigm or PsychMate, amongst others, is *proprietary software*, and the use of these requires the user to purchase the license. However, there are exceptions, such as PsychoPy (Peirce 2007, 2009), a free program developed by J.W. Pierce at the University of Nottingham. When it began to be distributed, PsychoPy functioned through Python programming, whereas a graphic interface has been developed currently.

The most important differences between these tools lie in their capacity to create different experimental designs and their temporal precision when measuring the reaction time of a subject to a stimulus. Since these software are employed in auditory as well as visual studies, many of the improvements that some systems propose in comparison to others are focused on video reproduction and the support of different image formats, or in the compatibility with different external hardware created for specific experimental designs (fMRI, Eyetracker, etc.).

However, the great majority of the programs mentioned have a series of disadvantages:

1. They are not free, and one license for every PC station is required for most of them. As a result, work capacity in a laboratory is limited to a large extent, and simultaneous data collection from a large number of participants is hampered.

2. In general they are designed to function in a specific operating system, which means that in some cases only equipment whose operating system is Windows, such as E-Prime, or in other cases, Macintosh (like PsyScope), work. Moreover, they tend to require the machine where the license is installed to have specific characteristics (a minimum quantity of available RAM, minimum processor speed, etc.).

3. Other software which attempted to overcome the previous disadvantages function through scripting in a specific programming language. An example is PsychoPy, created with the objective of contributing a free tool which would function with different systems and hardware, and which requires the researcher in question to be familiar with Python and OpenGL, which hampers accessibility for those users who are not accustomed to programming through scripts.

At a later stage, programs for carrying out perceptual experiments focused on the field of phonetic and perceptual phonology began to appear. Amongst the most

well-known is PERCEVAL[9] (André, Ghio, Cavé & Teston 2003; Ghio, André, Teston & Cavé 2003), a free application developed in the Laboratoire de Parole et Langage, at the Université de Aix-en-Provence. PERCEVAL has a modular architecture which allows tests to be built and conducted by the participants, in addition to data preprocessing, without any kind of statistical analysis. It functions through scripts and has a processing wizard, although good management of this tool requires the researcher to be proficient in scripting with PERCEVAL. This program has different test design options: different typographical sources, spatial location of response options, background colors, delimitation of inter-stimulus time, stimuli presentation order, trial, etc.

Furthermore, there is also Praat,[10] a free acoustic analysis software, created by Paul Boersma and David Weenink at the University of Amsterdam (Boersma & Weenink 2010), which has developed a system for undertaking perception tests, the ExperimentMFC, which functions within Praat itself through a script. Praat offers great flexibility to the researcher, as it allows identification and discrimination tests to be carried out with different experimental variants. However, Praat does not have any kind of wizard or graphic interface for the development of scripts, hence the same disadvantage as PsychoPy. In spite of this, Praat does have a manual in which the different experimental paradigms which can be set are explained, as well as how to program them. Furthermore, it is constantly being improved and has a wide range of tutorials and scripts developed by the scientific community and available on line.

3. The FOLERPA platform

FOLERPA[11] is an online tool for carrying out perceptual experiments (acronym in Galician of ***F****erramenta* ***O****n-****L****ine para* ***E****xpe****R****imentación* ***P****erceptiv****A***), which has been

[9] http://www.lpl-aix.fr/~lpldev/perceval/
[10] http://www.fon.hum.uva.nl/praat/
[11] http://ilg.usc.es/FOLERPA/

developed since 2013 in the Instituto da Lingua Galega [Galician Language Institute] (University of Santiago de Compostela).

The principal objective of this project has been to provide researchers with an open-access and free perceptual experimentation tool which enables auditory perception texts within a friendly environment and with the greatest possible flexibility to be carried out, without the need for the researcher to be knowledgeable in programming, Therefore, one of its most important characteristics is that there is no need for the user to program scripts for the undertaking of the test. Instead, it enables this to take place through a friendly environment in which all that is required is a series of forms, which guide the user through the process, to be completed.

The platform allows auditory identification (i.e. yes/no question, stimuli categorization) and discrimination (i.e. AX, ABX, and Oddity Task) tests to be carried out. However, it does not currently allow tests in which the participant can respond before the trial's range of stimuli has been conclude. It does allow tests with mixed designs (i.e. tests which vary according to the participant progress in it) to be carried out, but not adaptive tests (in which tasks are more or less complicated according to the participant's success rate).

FOLERPA seeks to provide the researcher with a platform which enables a perceptual test to be carried out from start to finish, and through various modules (to be discussed presently) which allow the complete building of the perceptual experiment. Moreover, access is free, which allows researchers as well as students to access research methodology regarding auditory perception in a straightforward manner and with a high experimental quality.

Another characteristic of FOLERPA is that the entire experimental process takes place online. This represents an enormous advantage with respect to the majority of the aforementioned systems, since it allows access to the platform from any computer equipment with an Internet connection, and allows the opportunity for different participants to undertake the text simultaneously from different computers with Internet access. Amongst the principal advantages offered by it being an online platform, the following can be highlighted:

1) An online platform avoids having to open the application on each client´s

machine, and administrator rights are not required. In educational environments, student users tend to have limited privileges which prevent them from installing applications, and it is therefore necessary to coordinate the use of applications with system administrators.

2) The solution to web application problems and updates are much simpler. In a traditional application there is an array of scenarios in which an installation or modification of the application is necessary: reinstallation of the operating system, change of operating system, error solution of the application, update of the application, etc. For each one of these situations it is necessary to rely once again on administrator rights in order to apply application updates or to install it again. However, in a new web application there is just one version of the application which is housed on the server, and all the updates or errors are resolved at the same point, so that a distribution of the application each time that a problem must be resolved or update carried out is not required.

3) It allows the platform to be independent from the operating system. This application works with any compatible browser, independently from the operating system which runs it, and it is necessary to develop different versions of the same application for different operating systems (Windows, Mac, Linux, etc.).

4) The user can access the web platform from any device with Internet access and compatible browser, and furthermore the user interface is more consistent, since the appearance depends on the browser and the operating system. However, the online presentation of the platform also has some disadvantages, amongst which the following should be highlighted:

a) A web application does not run directly on the operating system, but depends on the browser, and as a result is limited to the resources offered by it.

b) If the web browser experiences an error, the data generated up to that point can be lost. If it is indeed true that a browser update may produce a malfunction in the application, the solution will always be less costly than carrying out an update of the desktop application, since it would have to be downloaded by all the clients who have previously installed it, whilst on the web application just the code that is contained on the server would have to be updated.

3.1 User and access profiles registration

FOLERPA has two kinds of access profile: researcher and participant. Access to the platform as a researcher facilitates all the tools for the construction, distribution and analysis of experiments. It is the researcher who provides the participant with the access code in order that he or she can access the tests which will be taken.

In order to begin to use FOLERPA, as a researcher or participant, it is necessary to register on the web platform by entering a username and a password. This will allow the researcher to access a personal workspace in which different sections of the experimental design can be found. The participant is given access, as has been previously stated, to the perceptual experiment or experiments in which he or she is going to take part.

Within the workspace, each researcher has access to his or her text and the data table (participant data and responses) and each one of the tests from his or her personal area to which only he or she will have access. This allows each user researcher to manage his or her tests, to replicate or delete them, and to consult the results table, amongst other options.

3.2 User researcher working environment

The working environment of the user researcher consists of a top menu, where information concerning the development apparatus of the platform and the publications produced from this can be found; and a left-hand side menu, where the different sections of the perceptual experiment building as well as the user manual, glossary and bibliography can be found (Figure 1).

Figure 1. Workspace within researcher profile

Within the researcher profile administration area, the FOLERPA platform presents four modules which allow for the complete development of the perceptual experiment and those which can be accessed from the side menu: a module for the creation of the text (*Elaborar un test* 'Create a test'), a module which allows the administration of tasks or tests (*Administrar tests* 'Tests administration'), a module in which the distribution of the test takes place (*Difundir un test* 'Distribute a test'), and a module in which tables are stored for data analysis (*Análise dos datos* 'Data analysis'). Each one of these is explained in detail in the following section.

Currently, the FOLERPA platform workspace is only available in Galician, although it is programmed to introduce versions in different languages in the near future.

3.3 Creation of perceptual test

The test creation module is presented as a form with options that the user researcher must fill in across successive screens, according to the kind of design that

he or she wishes to generate. An upper area tells the researcher in which part of the test he or she is, and once the parameters for each section are entered, he or she can move between the different sections of the test construction.

3.3.1 Test data

The first step in the creation of the test is the introduction of some informative data on which the test is going to be created, such as the title, the test code, the research objective or some observations. The greater part of these fields is optional, even though their completion is recommended, since they allow for it to be identified from amongst the other tests that have been created. The fields 'Title' and 'Test code for participants' are obligatory, since it is necessary for the participants to access that test specifically. Moreover, each test created within the platform has an exclusive test code. It is the researcher who enters the code, but the platform informs the researcher in those cases in which the code has been employed yet through the message 'Code XXX is now available for another test', preventing the creation of the test to continue, as is shown in Figure 2.

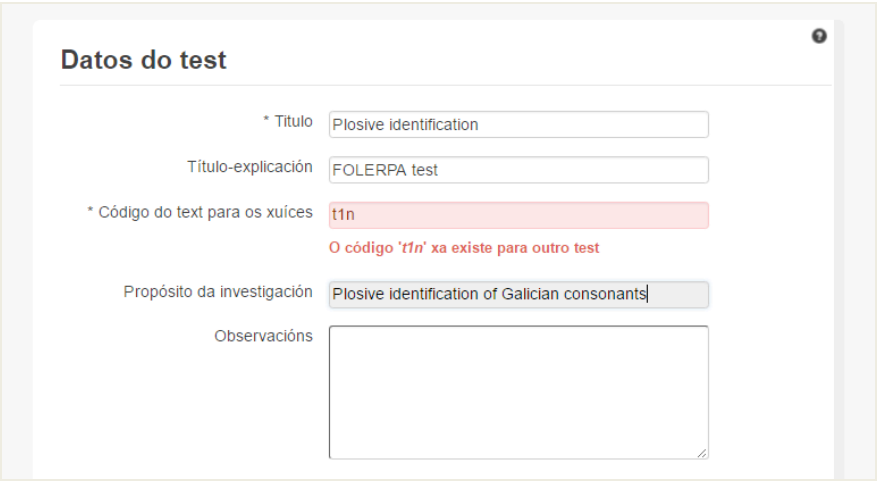


Figure 2. Introduction screen for test data

3.3.2 Participants' data form

On the second screen of the test creation form (Figure 3), the platform enables the creation of a standard questionnaire for collecting information relating to the participants. This questionnaire is what participants see on their screens when they access the perceptual test and which they should complete immediately before starting the experiment itself. When the researcher creates this questionnaire, he or she must enter the study variables pertaining to the participants, together with the possible values for each one of these variables. This takes the form of a pull-down menu for each category appears on the form seen by the participants.

For example, an experiment in which the maternal language of the speaker influences the perception of certain vowels in Galician is intended to be tested. For this, a group of Galician-speaking participants, whose maternal language is intended to be identified, is put together. In this way, the variable that could be entered in the form is 'mother tongue', and the possible values could be 'Galician', 'Spanish', 'Galician and Spanish'. Therefore, for the question 'mother tongue', the participants should choose one of the three options that appear. This allows the variability caused by providing a field of open comments to be removed, since the options selected by the participants for each category appear, once that participant has completed the test, in the form of a table, together with the table of responses, and therefore can form part of the results analysis. If, for example, the origin of participants needs to be monitored, the category 'place of birth' and the different possible entries 'rural' and 'urban' can be introduced. Once the participants access the test, they should choose one of these options before proceeding. The responses given on the form are linked to the answers of the perceptual test for each participating participant, and can be consulted by the researcher in the 'Participant tests' module. This form allows as many categories and values as are necessary to be added.

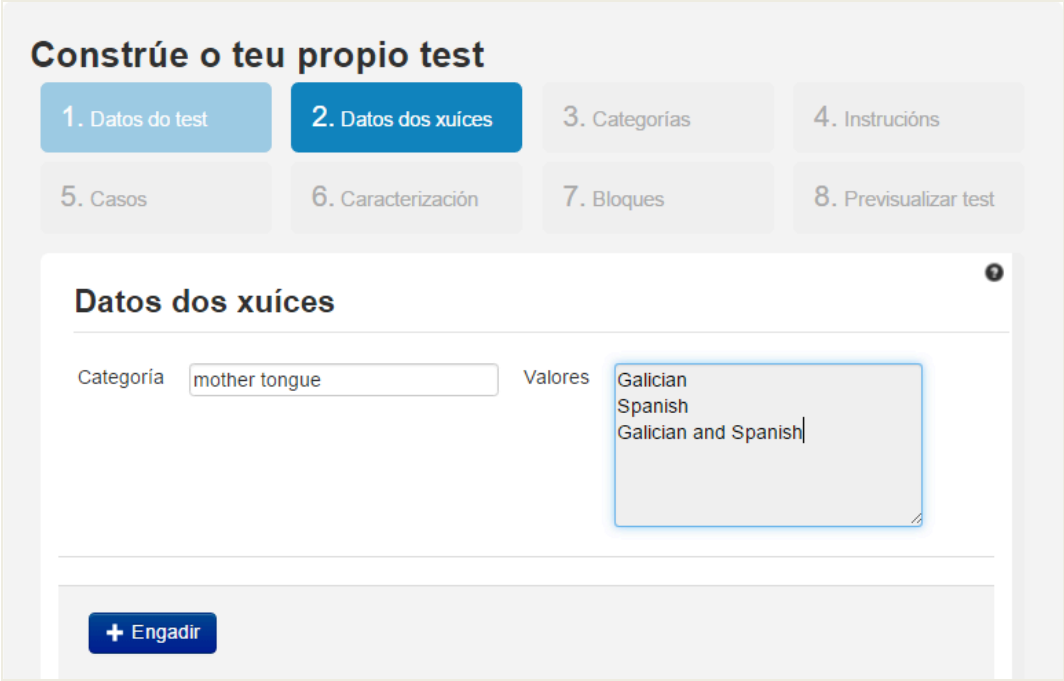


Figure 3. Creation of participant data questionnaire

3.3.3 Categories associated with stimuli

In all perceptual experiments, a hypothesis is intended to be corroborated though the responses of participants to stimuli. In this section of the form, those features or characteristics of stimuli employed and to be studied or which are to be taken into account in our experimental design, are introduced.

If, for example, an experiment is being carried out on the identification of plosive consonants in Galician, one of the categories which would define stimuli of the test would be 'place of articulation', and the possible values would be determined by the stimuli employed; for example, 'bilabial', 'dental' and 'velar'. Another possible category would be 'voicing', with '+' and '-' options.

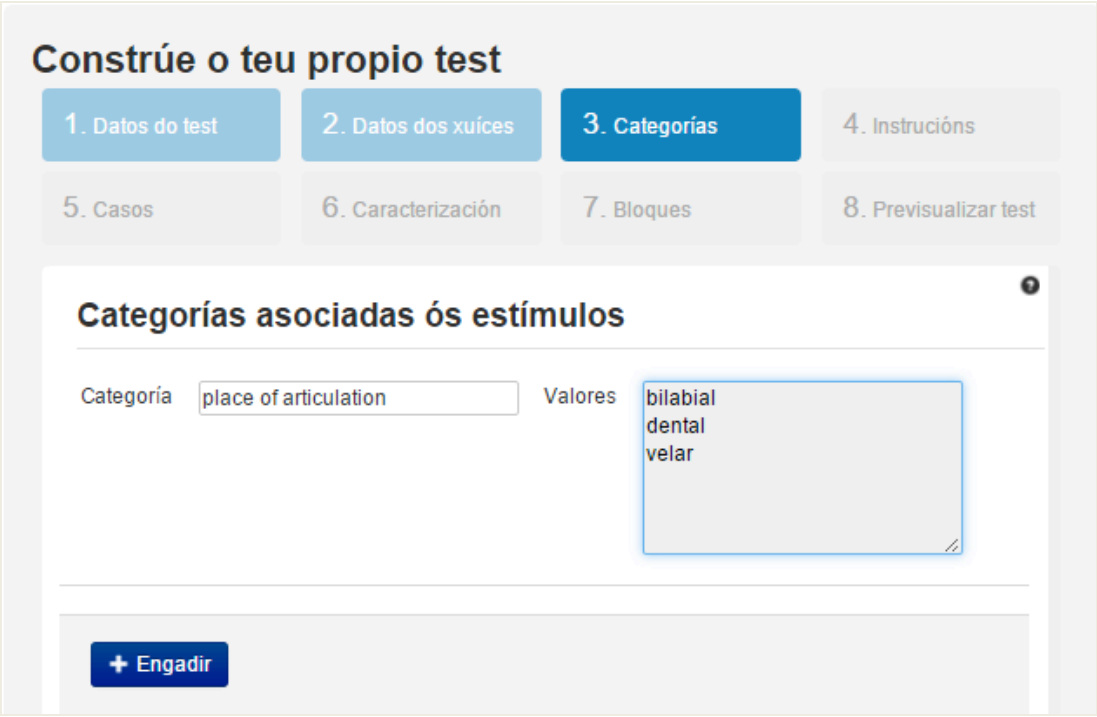


Figure 4. Form for introducing categories associated with stimuli

In the same way that would occur with the questionnaire data that needs to be provided by participants, the data entered in this part of the form can also be analyzed afterwards. In this manner, for example, the level of identification of the stimuli of a specific place of articulation in terms of the participants' mother tongue can be analyzed.

3.3.4 Instructions

In the following section, the space where the instructions for taking the text is found, which appears on the participants' screen before the test begins, and immediately after completing the form (§ 3.3.1). The introduction of a final text is optional. This section contains, furthermore, some formatting options, such as choice of font, the introduction of a list or numeration, or even external links, amongst others.

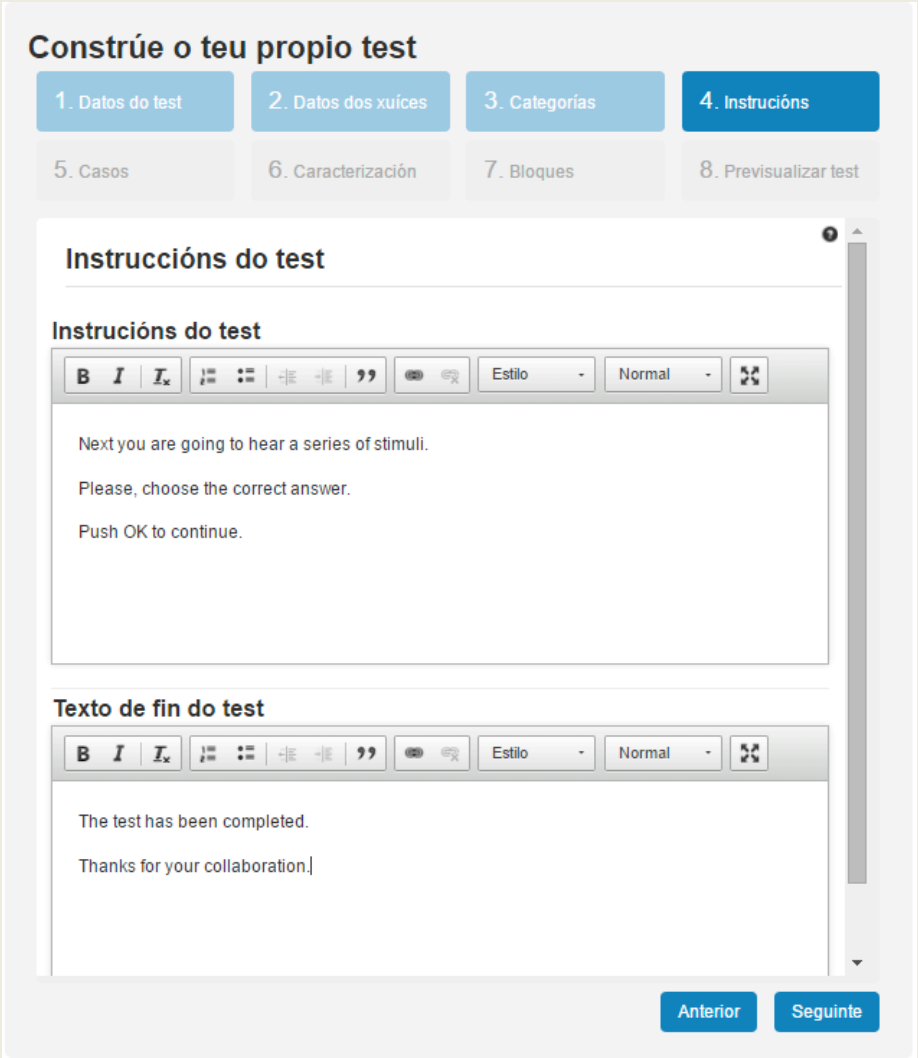


Figure 5. Instruction section in test creation form

3.3.5 Parameterization of trials

In the *Predefinición de casos* 'Predefining of trials', the researcher must enter the parameters which will shape the test: the number of stimuli for each trial; the number of response options which will appear on the screen; if trials are going to be repeated and, in that event, how many repetitions will occur for each one; if pauses will be introduced between trials and, in that event, their duration; if pauses will be introduced between stimuli where there are more than one, what the duration of the pause will be; and the way in which trials will be presented: randomly or in the order in which the researcher introduces them. All these parameters will vary, obviously, in terms of the experiment that is intended to be designed. Continuing with the example

of the test for identifying Galician plosive consonants, the objective of the test might be to verify if participants identify pairs of plosive consonants in terms of voicing; that is, if 'b' and 'p' are identified as different units. For this, a design with a single stimulus per trial can be produced, and with two response options, whose answers are established in the following section.

However, what is intended to be carried out is a discrimination test in which it must be checked whether two stimuli are perceived as different or equal, and where what the stimuli are must be selected in option 'No. of stimuli per trial'. In this test paradigm, the participant can be given two response options; for example, 'yes' and 'no' for a question such as 'Are the stimuli the same?'. The number of stimuli and response options will vary in terms of the experimental paradigm employed.

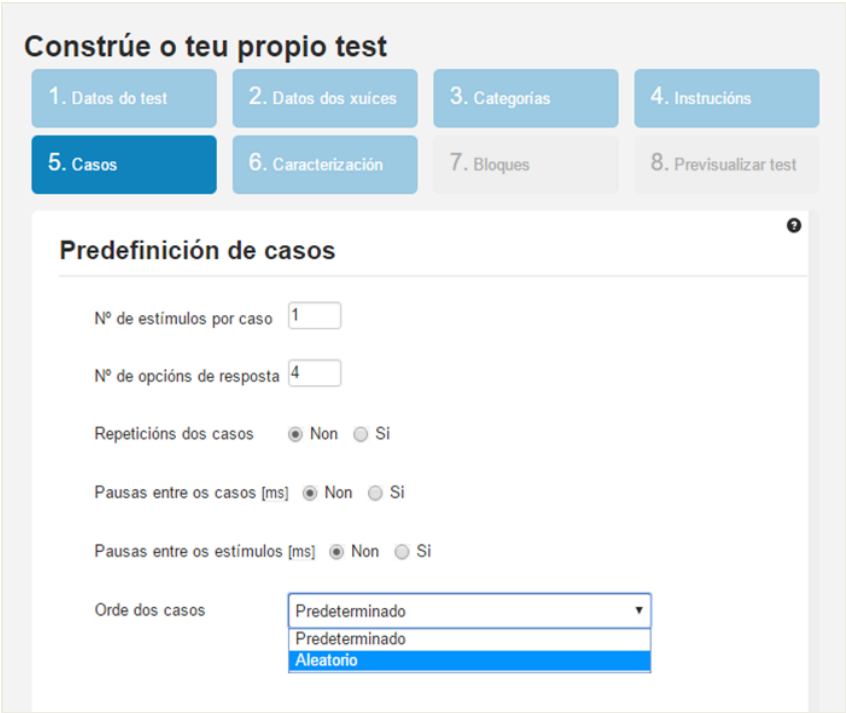


Figure 6. Screen for predefinition of test trials in *Elaborar un test perceptivo 'Creating a perceptual test'* module

This section allows the *Repetición dos casos* 'Repetition of trials' option to be selected as well as the number of repetitions of the same. With choosing this option, each one of the trials designed for assessment will be repeated according to the number of times indicated. Therefore, the repetition of a trial refers to the repetition

of the complete trial, which includes a question, stimulus or group of stimuli, with or without these being repeated, and a response option or options.

This step also allows a pause between trials and between the stimuli to be introduced. The pause between the stimuli refers to the Inter Stimulus Interval, the time which transpires between the end of the stimulus reproduction and the beginning of the following one, although it is only useful in those trials in which there is more than one stimulus in each trial, such as for example in a discrimination test, where the participant must listen to two stimuli. The pause time, with precision in milliseconds, is determined by the researcher, since in its length will vary depending on the experimental paradigm and the kind and length of the stimulus employed.

In this same screen, the researcher can select that the trials are presented in the text according to the order in which they are inserted manually by the researcher, or in a random order.

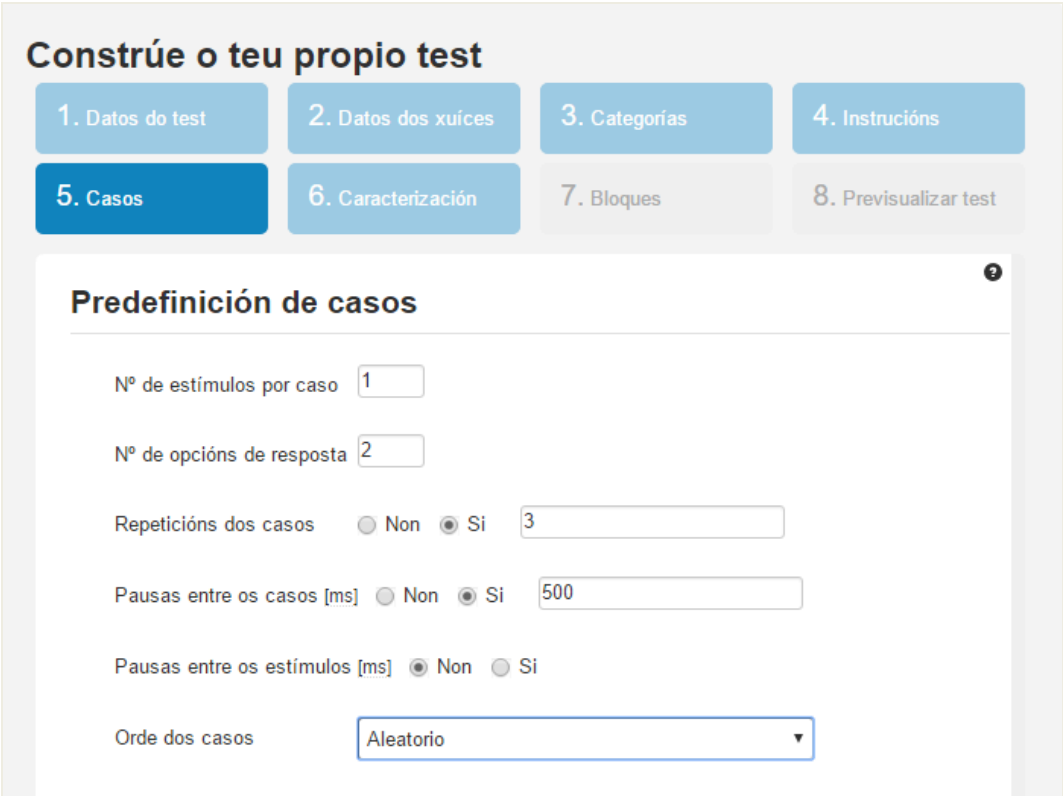


Figure 7. Screen showing design of the perceptual test trials

3.3.6 Characterization of trials

If in the previous section the structure of the test in terms of the experimental paradigm employed is designed, in this section the specific fields for each trials of the test would be introduced individually.

Firstly, the question that is asked of the participants in each trial can vary or be the same throughout the test. Also here the corresponding audio is uploaded for each one of the test stimuli, together with an option that allows the uploaded audio or audios to be heard. For each one of the stimuli, a pop-up will appear on the right-hand side with the categories that have been previously established in section 3 of *Caracterización dos casos* 'Characterization of trials'. The researcher must choose which answers match each one of the stimuli. Continuing with the example of the identification test for plosives, on the premise that the audio corresponding to the stimulus 'path' is uploaded, the answer 'bilabial' should be selected for the category termed 'Place of articulation', and '-' for the category termed 'voicing', as is shown in Figure 9.

On this same screen, response options are introduced which appear on the screen when the participant undergoes the test. The number of response options that appear here will be determined by the number introduced in the previous section. As has been commented previously, the researcher can go back and modify any option that has been introduced. If once on this screen he or she decides that three and not two response options should be introduced, he or she can navigate, through the main menu (Figure 8) to the relevant section and select three response options.

Figure 8. Main menu within the *Elaborar un test* 'Create a test module'

In this section, the researcher should choose which of the options is correct. This is the field that will appear in the response tables and enable the quantification of the identification or discrimination rate, etc.

Finally, the group of stimuli can also be selected to repeat as many times as necessary. This means that before the participant can respond, the stimulus will be repeated or the group of stimuli that comprise the trial, as often as is selected in this field.

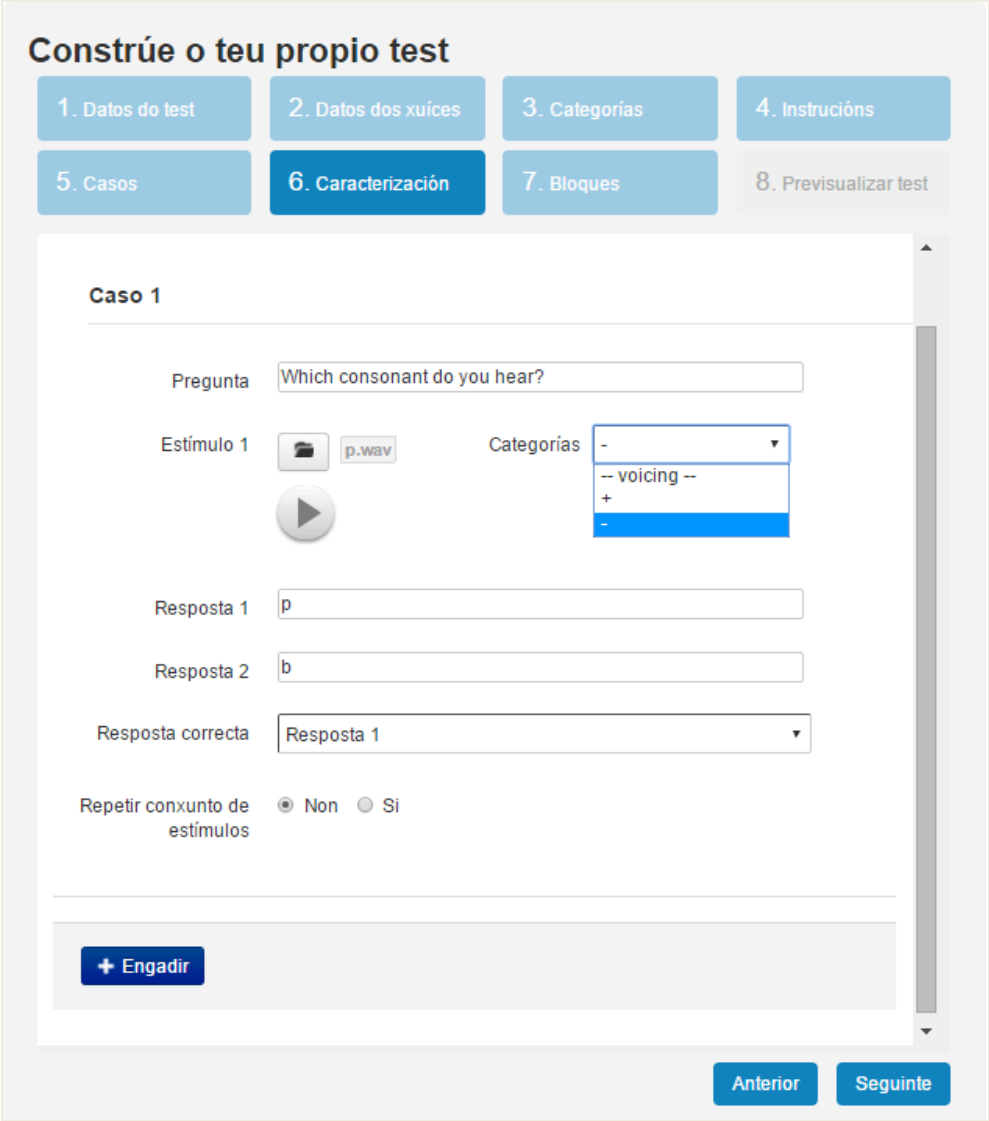


Figure 9. Screen of trials characterization of the test.

To add a new trial the *Engadir* (*add*) button, located in the lower left-hand corner, must be pushed. When this is done, a new trial will appear, for which the

relevant audios and videos must be added. Given that the greater part of the test will have trials with the same characteristics, the fields for trial characterization will be copied from the first, in such a way that the researcher can click on the specific field and modify it. In the proposed example, given that the objective is to check if three pairs of plosives /p-b/, /t-d/ and /k-g/ are identified in terms of their voicing, when the corresponding audio is introduced to the stimulus /g/, the values which define this stimulus should be changed, as should the response options. Moreover, if the order of response options is modified, the option chosen as being correct should also be modified.

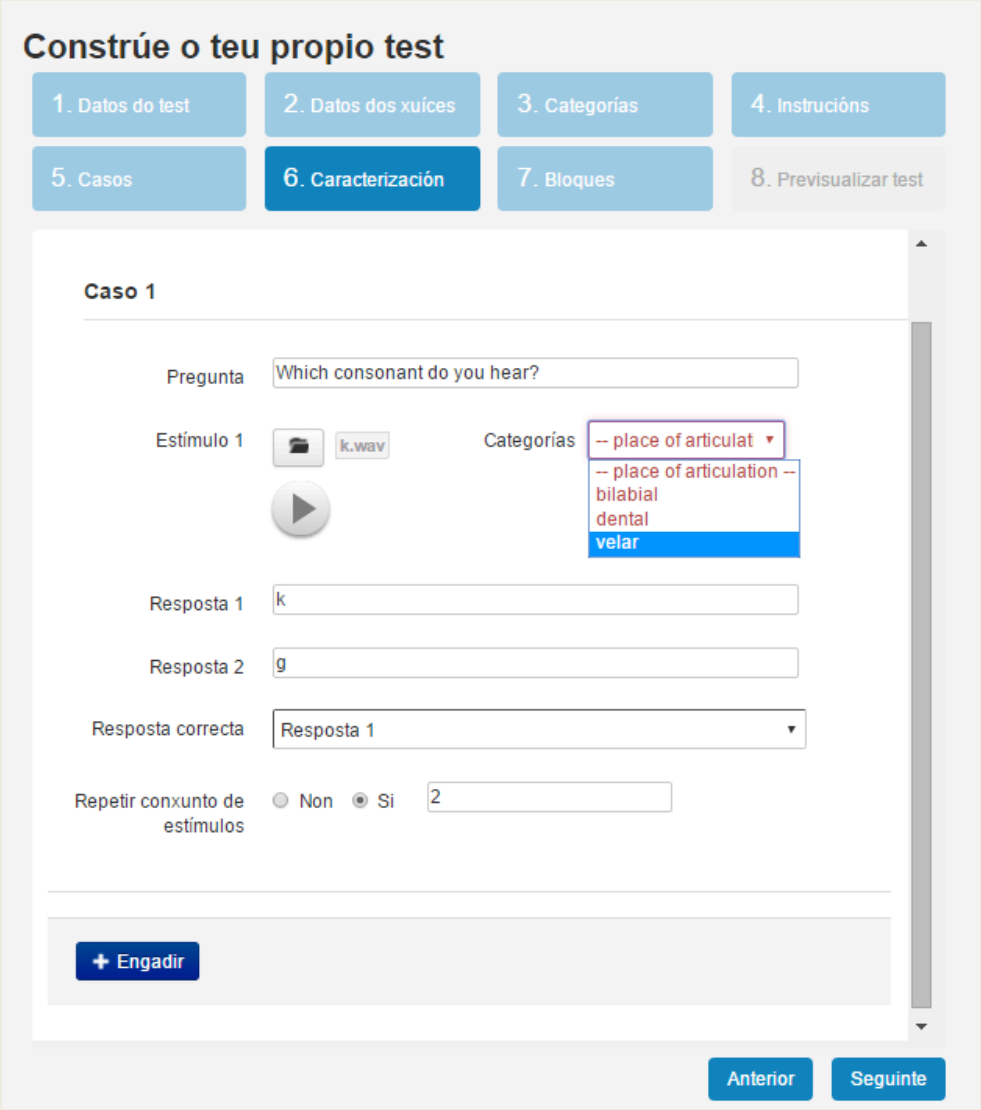


Figure 10. Screen for trials characterization in the *Elaborar un test* 'Create a test' section

The decision behind this section being structured in that way arises from one of the principal objectives of the project: to offer the greatest flexibility possible within an interactive and easily-managed work environment.

The examples that have been used up to this point in order to illustrate how to complete the forms used responses of a categorical nature, although obviously a test can be created also whose response options are Likert scales. For example, a discrimination text (AX) can be created where the participant is asked to rate from 1 to 5 the degree of similarity between the pair of stimuli that they hear. For this, five options of response will have to be included: '1', '2', '3', '4' and '5'.

3.3.7 Blocks

This screen (Figure 11) allows us to divide our test into blocks. For example, if a test comprises 24 trials which are repeated 5 times, giving a total of 120 trials, and two blocks are created, each one of the blocks will be formed by sixty trials. Furthermore, the blocks can be chosen to be repeated, as can the order of presentation of the blocks. Between each block there is a pause, during which the opportunity to introduce a text which will appear on the screen when each one of the blocks is finalized is also offered.

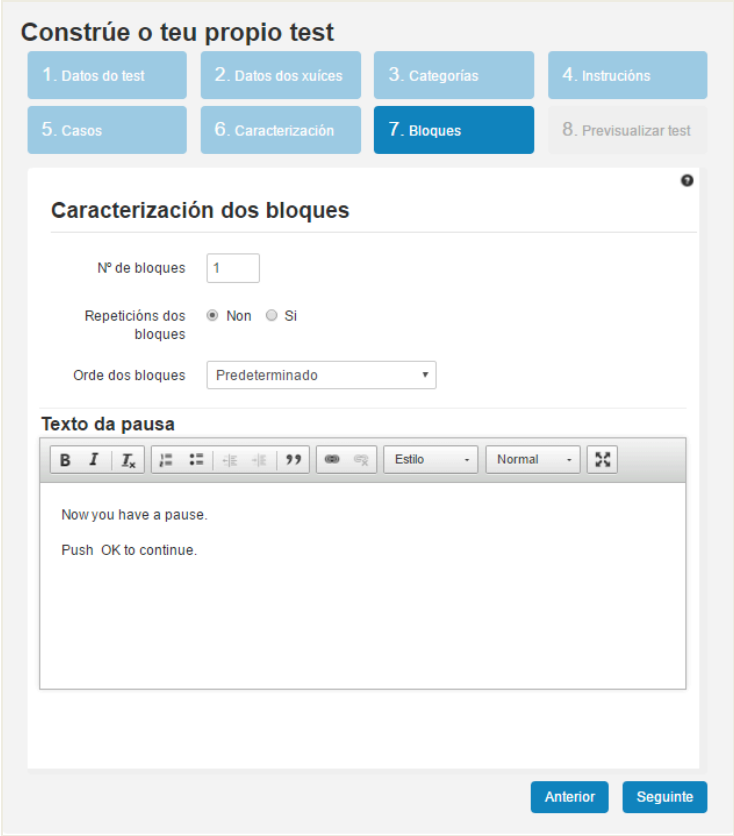


Figure 11. Blocks characterization screen

3.3.8 Preview test

The final step in the creation of the test is to check that all the data and parameters entered are correct. For this, FOLERPA has a last step consisting of a preview of the test created, which allows the test to be seen such as participants will see it. This enables the researcher to eliminate errors introduced in some point of the creation of the test, since different stages of the creation of the test can be navigated through the main menu. Any change will be displayed immediately in the preview. In addition to the preview (Figure 12), there is a schematic overview of the principal test data (Figure 13), which allows the researcher to detect possible errors rapidly, for example, in the creation of the test, and to check if the parameters distribution is sufficiently balanced.

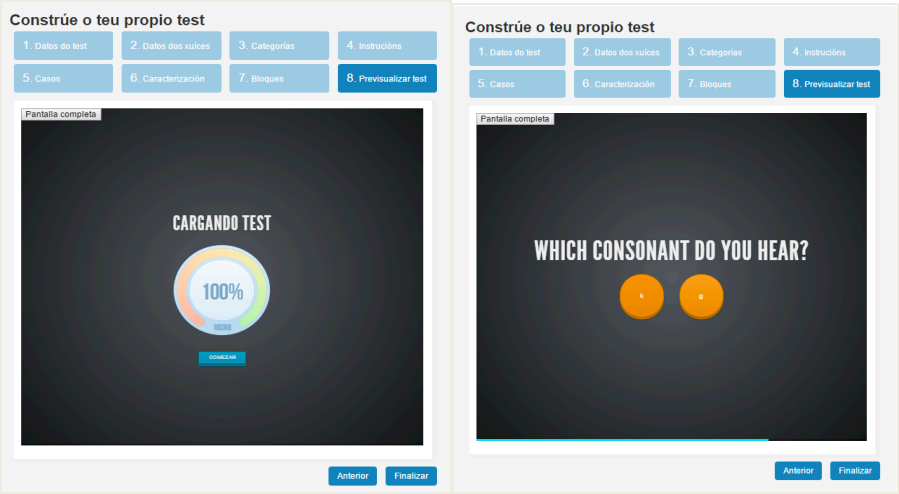


Figure 12. Test preview screen

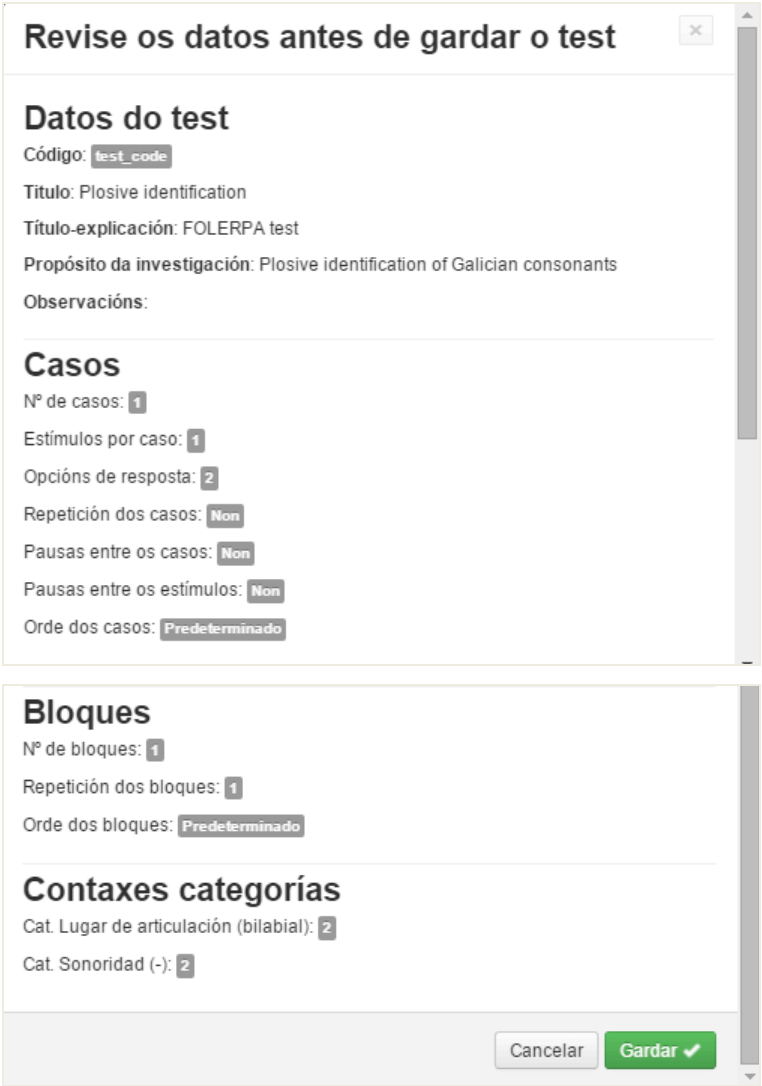


Figure 13. Schematic summary with data relating to the test created

3.4 Distribution of the perceptual tests

The platform therefore provides a section for the distribution of the perceptual tests through two possible channels: copy the URL of the test in question and distribute it amongst the participants or even distribute it by email, for which the email address of those people who are going to assist as participants in the experiment is required.

As was already commented in section 3.1, given that the tests are also undertaken online by the participants, they must be registered within the platform by filling in basic data such as username and password. The reason why the participant has to register is related to the storing of the responses that he or she provides. This characteristic has other advantages, such as the possibility that a single participant undertakes more than one test or repeats a single test at different moments. For example, within a single project, the researcher may be interested in carrying out different perceptual tests and contrasting the responses provided by a single participant for each one of them, or may want to evaluate the evolution of a subject who has gone through specific training.

3.5 Administration of the tests

The test administration module enables the researcher user to access the tests that he or she has created. In this section a series of options is offered, such as the recovery of information related to the test (Figure 2, § 3.3.1) or the preview of each one of them. Moreover, it provides a recount of the number of participants who completed each one of the tests. Amongst the administration options there is also that of previewing the participants' responses (Figure 14). This is especially useful when, for example, an idea is needed of the identification rate of the stimuli when all the anticipated participants have still not undertaken the test.

It is also possible to erase a test that is no longer needed, as well as to replicate a test that is already created. When a test is replicated, all the design parameters of the test that are being replicated are preserved and it is only necessary to select the audio

archives. It is clearly necessary to introduce a new test code, since this dialogue is unique for each test within the platform. Given the flexibility of the platform, any of the parameters of the new replicated test can be modified by moving through the different sections of the main menu (Figure 8, § 3.3.6).

id	id_Xuiz	Data_intento	Caso	Pregunta	Estímulo	Resposta	Resposta correcta	Tempo resposta (ms.)
4	usuario_1	02/05/2016	6	Which consonant do you hear?	t.wav	t	t	126
5	usuario_1	02/05/2016	6	Which consonant do you hear?	t.wav	d	t	719
6	usuario_1	02/05/2016	6	Which consonant do you hear?	t.wav	t	t	424
7	usuario_1	02/05/2016	6	Which consonant do you hear?	t.wav	t	t	79
8	usuario_1	02/05/2016	6	Which consonant do you hear?	t.wav	d	t	350
9	usuario_1	02/05/2016	2	Which consonant do you hear?	b.wav	b	b	621
10	usuario_1	02/05/2016	2	Which consonant do you hear?	b.wav	p	b	338
11	usuario_1	02/05/2016	2	Which consonant do you hear?	b.wav	p	b	466
12	usuario_1	02/05/2016	2	Which consonant do you hear?	b.wav	p	b	326

Figure 14. Preview of the participants' responses

3.6 Data treatment

The fourth module offered by FOLERPA is that of the *Análise dos datos* 'Data analysis' (Figure 15).

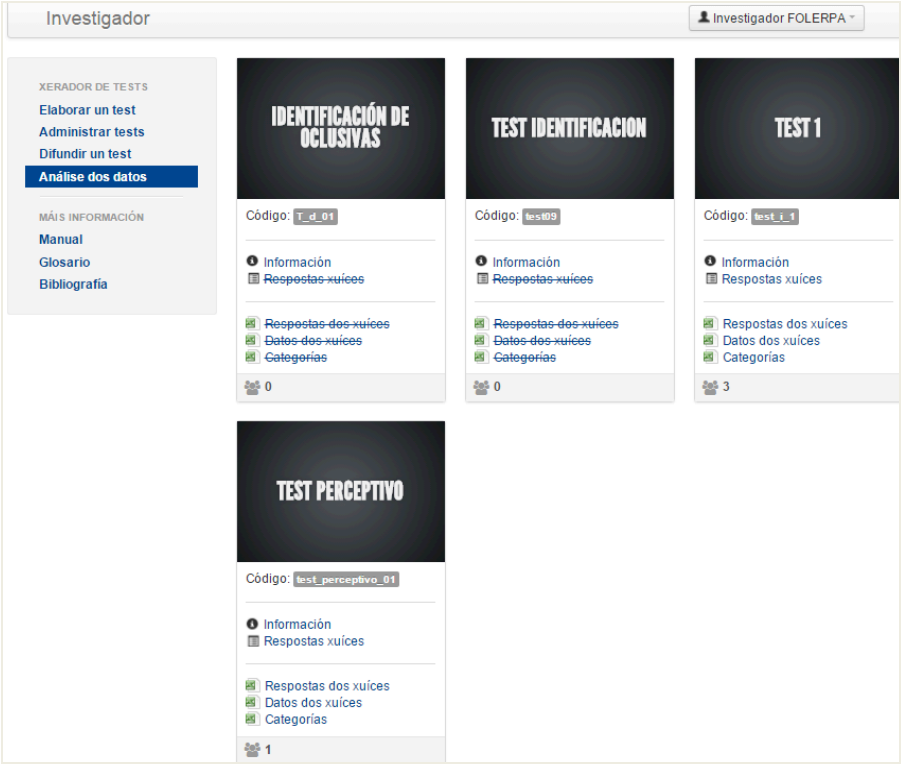


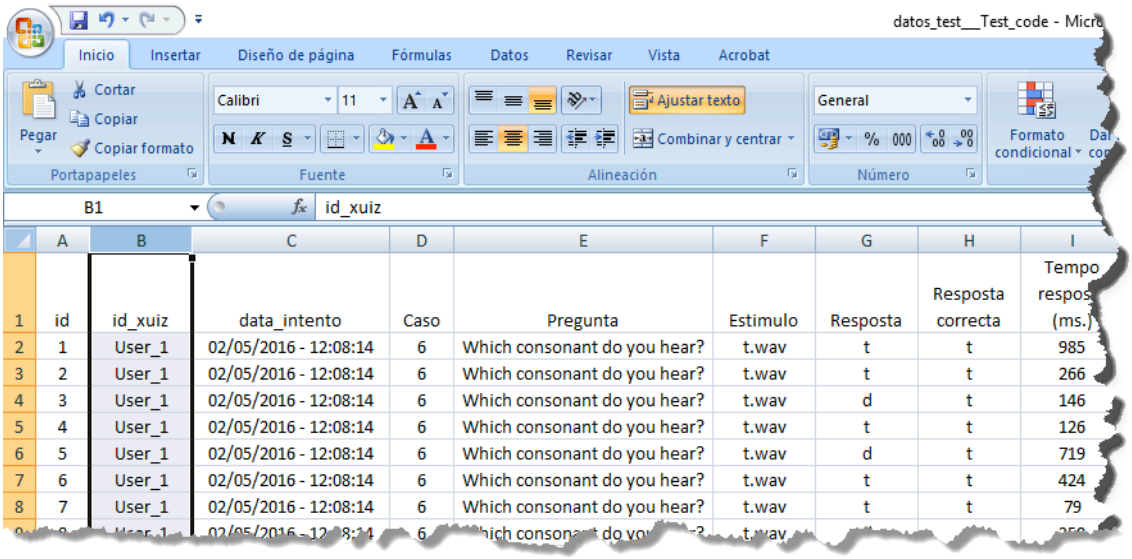
Figure 13. 'Data analysis' module screen.

As with the *Difundir un test* 'Distribute a test' or *Administrar tests* 'Test administration' modules, all those tests that have been created by the user can be found here also. Each one of them can be downloaded in three different tables: a table with information related to stimuli categories, where the values that were associated with each stimulus in sections 3 and 6 of the *Elaborar un test* 'Create a test' module are listed; a table with the participants' responses for the questionnaire of personal data created in section 2 of the *Elaborar un test* 'Create a test' module; and the table of the participants' responses, where each one of the responses given by each participant together with the correct response and reaction time is specified.

The three tables generated by FOLERPA for each test can be downloaded in CSV format (Figure 16), which allows them to be used in different statistical analysis applications. The table of the participants' responses (*datos_test__*testcode*.csv*) is made up of nine different columns,[12] and the number of rows depends on the number

[12] The columns are: *id* (individual identifier for each response), *id_xuíz* (participant identifier), *data_intento* (date [dd/mm/year] and *time* [hh:mm:ss] of the response), *caso* (trial number to which it relates), *Pregunta* (a question that is posed to the participant in this specific trial), *Estímulo* (name of the

of total trials which make up the test. If the test created has 5 trials which are repeated twice (in total, 10 trials), the table will have 10 rows (equivalent to ten responses) for each participant.



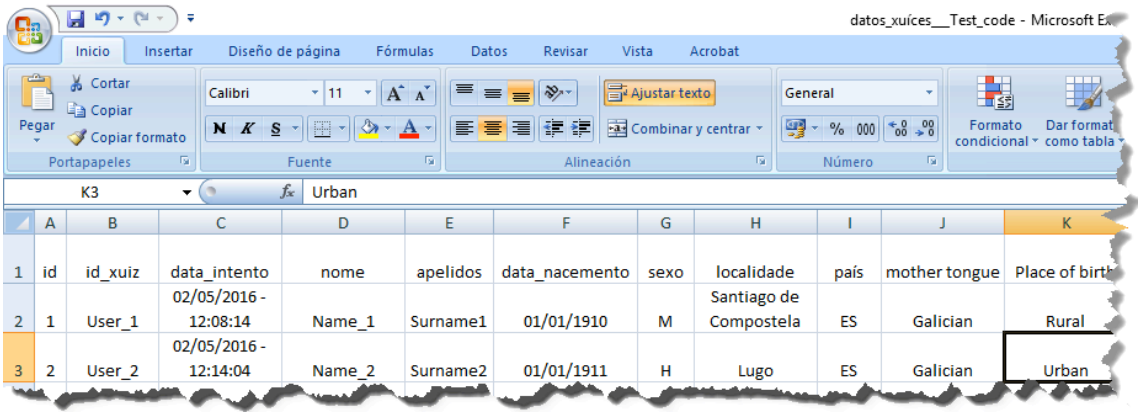
	A	B	C	D	E	F	G	H	I
1	id	id_xuiz	data_intento	Caso	Pregunta	Estimulo	Resposta	Resposta correcta	Tempo respos (ms.)
2	1	User_1	02/05/2016 - 12:08:14	6	Which consonant do you hear?	t.wav	t	t	985
3	2	User_1	02/05/2016 - 12:08:14	6	Which consonant do you hear?	t.wav	t	t	266
4	3	User_1	02/05/2016 - 12:08:14	6	Which consonant do you hear?	t.wav	d	t	146
5	4	User_1	02/05/2016 - 12:08:14	6	Which consonant do you hear?	t.wav	t	t	126
6	5	User_1	02/05/2016 - 12:08:14	6	Which consonant do you hear?	t.wav	d	t	719
7	6	User_1	02/05/2016 - 12:08:14	6	Which consonant do you hear?	t.wav	t	t	424
8	7	User_1	02/05/2016 - 12:08:14	6	Which consonant do you hear?	t.wav	t	t	79

Figure 16. Table of the participants' responses (.csv) displayed in Excel

In the date table for the participants (*datos_xuíces__*testcode*.csv*), each row relates to a participant, and each column with a piece of data related to that participant. This table contains data entered by the user participant at the moment when he or she registered on the platform, such as the fields introduced by the researcher in the *Datos dos xuíces* 'Participants' data' section (§3.3.2, Figure 3). Therefore, this table contains nine fixed columns pertaining to the user registry form[13]. The following columns will correspond with the categories inserted by the researcher in the *Datos dos xuíces* 'Participants' data' section, as has been stated previously (Figure 17).

audio or audios related to the stimulus or group of stimuli that comprise the trial in question), *Resposta* (Response chosen by the administrator for this trial) *Resposta correcta* (Response marked by the researcher as correct), *Tempo resposta (ms)* (participant reaction time in milliseconds). Notice that the reaction time in FOLERPA is measured in milliseconds, after the stimulus or group of stimuli has ended, which is when the participant can reply.

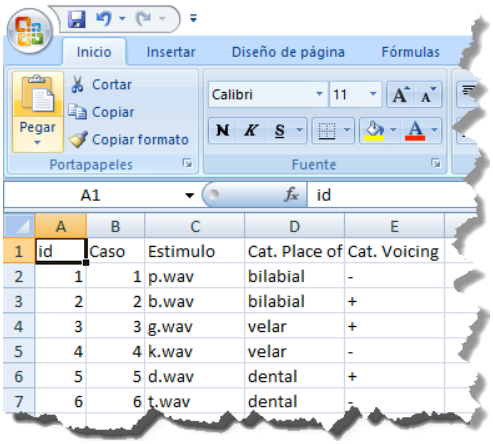
[13] *id* (sole identifier in the row), *id_xuíz* (participant identifier), *data_intento* (date [dd/mm/year] and *time* [hh:mm:ss] of the response), *nome* (name with which the user participant was registered), *apelidos* (surname with which the user participant was registered), *data_nacemento* (birthdate [dd/mm/year]), *sexo* (sex), *localidade* (place which was referenced when registering on the platform), *país* (country which was referenced when the participant was registered).



	A	B	C	D	E	F	G	H	I	J	K
1	id	id_xuiz	data_intento	nome	apelidos	data_nacemento	sexo	localidade	país	mother tongue	Place of birth
2	1	User_1	02/05/2016 - 12:08:14	Name_1	Surname1	01/01/1910	M	Santiago de Compostela	ES	Galician	Rural
3	2	User_2	02/05/2016 - 12:14:04	Name_2	Surname2	01/01/1911	H	Lugo	ES	Galician	Urban

Figure 17. Table of the participants' data (.csv) displayed in Excel

The table of the stimuli data (*datos_cats__*códigotest.*csv*) contains the data related to the stimuli which constitute the test. Each one of the rows of the table corresponds to a stimulus and a trial. This allows all the stimuli employed in the test to be categorized[14] (Figure 18).



	A	B	C	D	E
1	id	Caso	Estimulo	Cat. Place of	Cat. Voicing
2	1	1	p.wav	bilabial	-
3	2	2	b.wav	bilabial	+
4	3	3	g.wav	velar	+
5	4	4	k.wav	velar	-
6	5	5	d.wav	dental	+
7	6	6	t.wav	dental	-

Figure 18. Table of the stimuli data (.csv) displayed in Excel

Furthermore, a section of basic statistical analysis is also in the process of being implemented within this module. The objective is to be able to obtain a first description of the test, the participants and responses, with recounts, percentages and trust intervals.

[14] The first column of this table contains a single id for each stimulus or row; the second column (*caso*) contains the number of the trial with which the data corresponds; the third column (*estímulo*) contains the name of the audio for the stimulus in question. The remaining number of columns corresponds to the categories introduced by the researcher in section 3 *Categorías asociadas aos estímulos* '*Categories associated with stimuli*' of the *Elaboración do test* '*Creation of the test*' module (§3.3.3, Figure 4).

3.7 Platform requirements

The FOLERPA platform runs entirely online. This eliminates many of the problems of compatibility with specific operating systems, as it is only necessary to have a last generation web browser (Mozilla Firefox, Chrome, Safari, etc.) currently present in all the operating systems, and allows researchers as well as participants to access tests from any equipment with access to the internet.

FOLERPA supports any audio format, but not all navigators can reproduce any format. In order to maximize the compatibility between the different web browsers, FOLERPA employs a hybrid audio reproducer, which employs the native browser support for the audio reproduction, and in the event that the browser cannot reproduce audio, a Flash Player is used transparently.

FOLERPA incorporates a system which downloads the entire test, in such a way that the user does not have to wait for the audio archives to be loaded between questions, thereby reducing in this way problems stemming from a low-speed network data connection. Similarly, all audio archives are downloaded in the browser before the user begins to respond to the test. This improves precision in the measurement of the response time substantially. This even occurs with responses provided by the participant, which are uploaded as a block once the test has been carried out, in order to avoid potential losses.

In any event, there are different factors which intervene in the precision with which the participants' response time is measured, and which range from the parameters employed to the amount of time elapsed from holding the mouse to clicking its button (Shizimu 2002), and which cannot be controlled by the program or application developers. It would be interesting to study the accuracy of response time measurement of the FOLERPA platform with different systems and browsers.

3.8 Help functions and tutorial

As was commented in section 3.2 (Figure 1) of this article, FOLERPA has a main menu, accessible for its non-users as much within the work environment. This menu

has a Help section in which some basic concepts are explained in order to begin to manage the platform. Moreover, in each section of the experimental design the researcher is guided with rapid assistance which facilitates the creation process, distribution or data analysis.

Moreover, FOLERPA allows a glossary of perceptual experimentation to be downloaded, in which each one of the terms employed in the platform is explained in detail, and with a section in which the bibliography employed in the platform design or its evaluation can be consulted. It also has a user manual in which each step of the experimental design is explained, and in which examples of different designs of perceptual tests are displayed.

4. Conclusion

In this article, the perceptual experimentation tool FOLERPA, which is being developed at the Instituto da Lingua Galega at the University of Santiago de Compostela, has been presented. It is a free online tool which allows high-quality perceptual experiments to be carried out in a friendly and intuitive environment. FOLERPA is structured in four modules that range from the construction of the test to the distribution of the test amongst participants to the analysis of the data obtained, all of which is within a personalized work environment in which different tests created can be managed.

Furthermore, this tool brings to linguists a good model on how perception tests have to be carried out and offers a relevant progress for the scientific community because it fits to psychologists' purposes suggesting more care on the linguistic know-how which is needed for speech-perception variables' assessment.

In spite of this tool still being in development, from the moment of its creation it has experienced a large acceptance by the scientific community and currently registers a total of 78 user researchers, 741 user participants and more than 150 tests have been created. Furthermore, its capacity has been tested broadly owing to studies in perceptual phonetics and phonology which have been developed with this platform

(Fernández Rei & Moutinho 2012; Basanta Llanes 2013; Fernández Rei, Moutinho & Coimbra 2014; Aguete Cajiao 2014, 2015).

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