Orientation Discrimination: Lesson 1

This **step-by-step** tutorial teaches you how to build and run your first experimental design. More specifically, you will learn how to:

1) create the hierarchical structure of a basic experiment using the Method/Procedure/Stimulus design paradigm,
2) customize the events,
3) use variables to connect procedural and stimulus events,
4) run the experiment,
5) and inspect & visualize the results.

After this lesson, you will be able to create many real psychophysical experiments that rely on the staircase method and a n-forced choice procedure.

***Tip**: This tutorial will be straightforward if you have already been through the **Visual Acuity** or **Contrast Sensitivity** Tutorials since it follows essentially the same design. If you haven't, this tutorial will still teach you the same basic concepts in addition of the use of a 2-interval-forced choice procedure.*

Difficulty: 4/5
Duration: 30 mn to 1 h

BASIC TASK

The aim of this experiment is to measure orientation discrimination thresholds with Gabor stimuli using a staircase method and a 2IFC procedure. To learn more about **Orientation Discrimination**, see for example:

Beaudot & Mullen (2006) Orientation discrimination in human vision: Psychophysics & Modeling, Vision Research 46(1-2):26-46

Step 1: Opening the "Designer" Panel

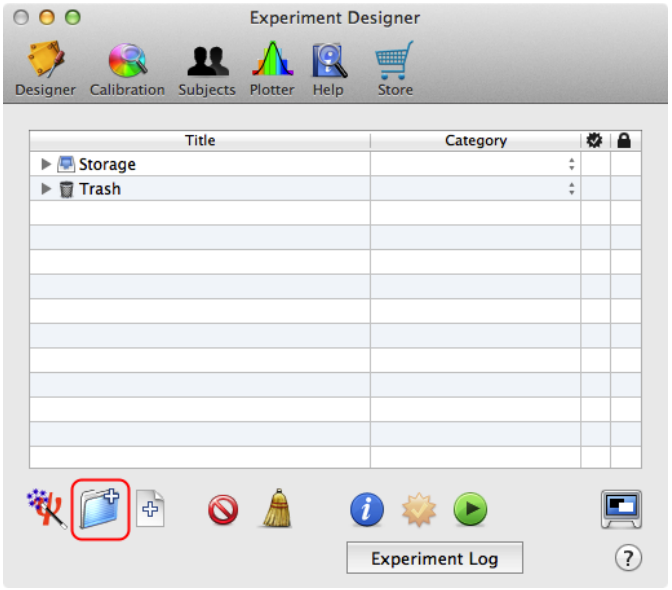
Launch Psykinematix, and select the **Designer** panel by clicking on its icon in the toolbar.

Step 2: Adding an Experiment Event

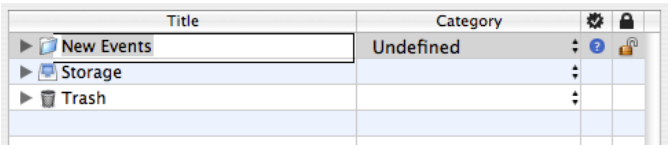
The **Experiment Designer** panel presents a hierarchical view of the experiments. Before going further, make sure to deselect any event by clicking on an empty row or ⌘-clicking on the selected event to deselect it.

Now, create a new **group** event by clicking on the folder icon with the '**+**' symbol in the bottom toolbar.

***Tip**: A group event embeds one or several other events. This allows to create the hierarchy of the design structure.*

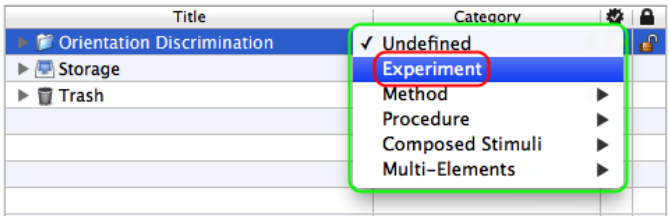


The new event appears at the top in the table with a default title (***New Events***). Change its title to ***Orientation Discrimination*** to reflect the experiment purpose (double-click on the title to edit it).



Note the two last columns of the designer table: the right-most one indicates the lock status of the event (either unlocked or locked to protect it from changes) and the 2nd right-most column shows the event status (for example, a question mark or a warning sign would indicate that the event function and properties are still undefined, while a check mark would indicate the event is fully specified).

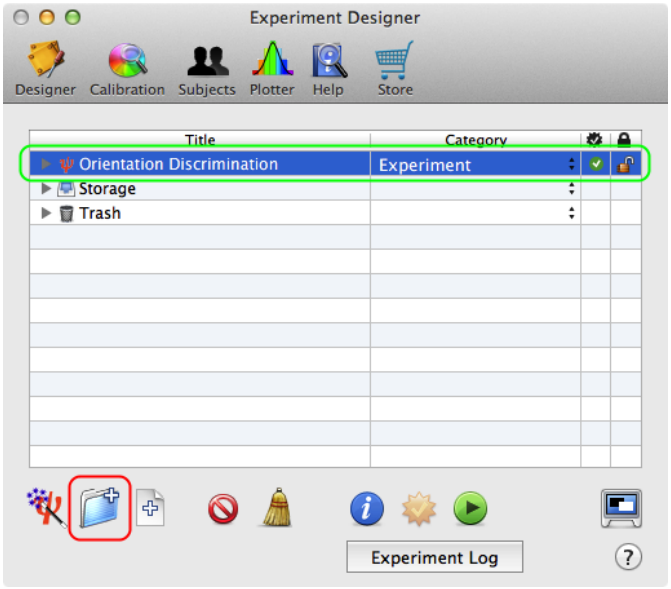
Each event is characterized by a category (and a sub-category if available) that defines its function inside your experimental design. To change the default category (**Undefined**), use the pop-up menu to select the **Experiment** entry. Note how the small icon in front of the event changed from a small folder to a small red **psi** icon specific to the **Experiment** event.



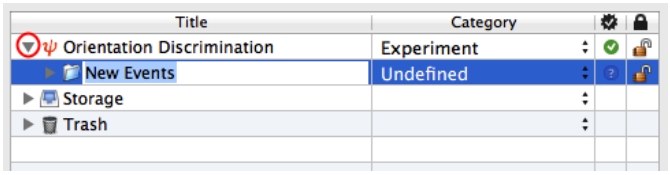
Tips:
- Each category of events has its own small icon to depict its function.
- The Undefined category with the small folder icon can still be used to group several experiments under one roof (eg: all experiments related to the same study).

Step 3: Adding a Staircase Method

Select the **Experiment** event you just created (***Orientation Discrimination***), and add a new **group** event by clicking on the '**+**' folder icon again.

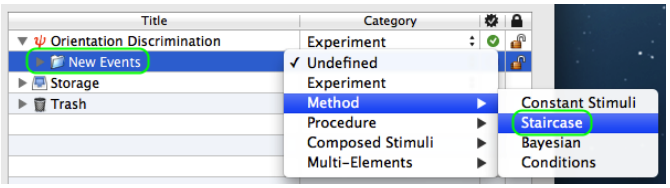


A new **Undefined** event embedded in the **Experiment** event is automatically revealed with its title ready to be renamed.



***Tip**: Click on the small arrow in front of a group event to expand or collapse any level of this hierarchical structure (option-click to reveal the whole hierarchy). The content of any group event can be also revealed or hidden by selecting the event and pressing the space bar.*

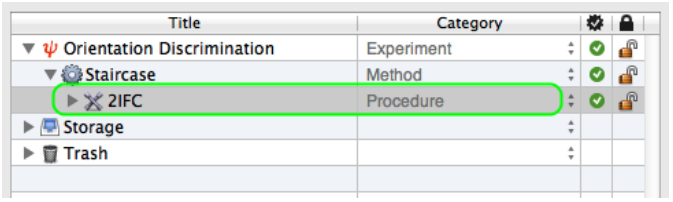
Select the **Staircase** sub-category **Method** to automatically rename the new event ***New Staircase***. You can then simply rename it ***Staircase*** if you wish.



***Tip**: If you do not select a sub-category yet but instead select the **Method** category, the event will be renamed **New Method** by default and you will have to specify the sub-category at the customization stage (see step 6 below).*

Step 4: Adding a 2AFC Procedure

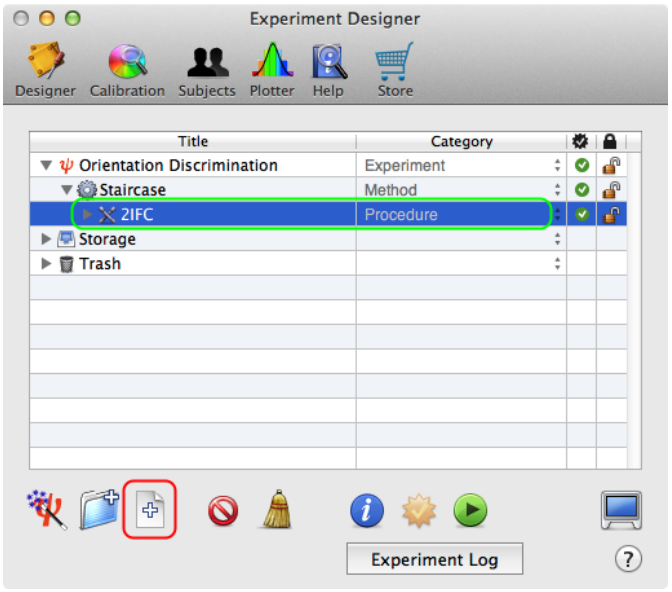
Similarly to the previous step, select the ***Staircase* Method** event, add a new **group** event, and change its sub-category and title to **Procedure/n-Forced Choice** and ***2IFC***.



***Tip**: If you do not select a sub-category yet but instead select the **Procedure** category, the event will be renamed **New Procedure** by default and you will have to specify the sub-category at the customization stage (see step 7 below).*

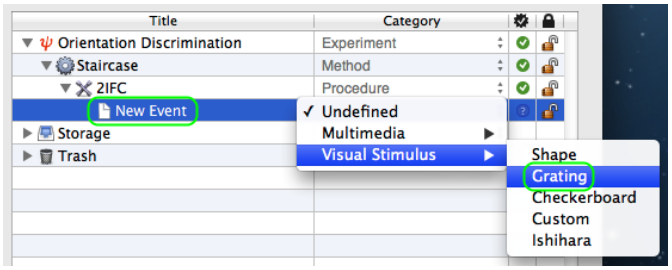
Step 5: Adding a Gabor Stimulus

Now, select the ***2IFC* Procedure** event, and add a new **leaf** event by clicking on the file icon with the '**+**' symbol in the bottom toolbar.



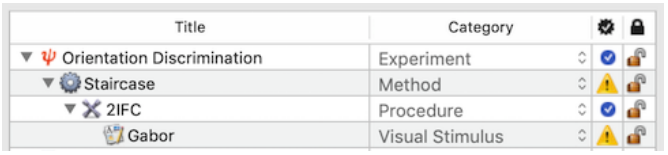
***Tip**: As atomic events, leaf events do not embed other events hence the absence of the small arrow in front of their descriptive mini-icon.*

Change the sub-category and title of this leaf event to **Visual Stimulus/Grating** and ***Gabor***.



***Tip**: If you do not select a sub-category yet but instead select the **Visual Stimulus** category, the event will be renamed **New Visual Stimulus** by default and you will have to specify the sub-category at the customization stage (see step 8 below).*

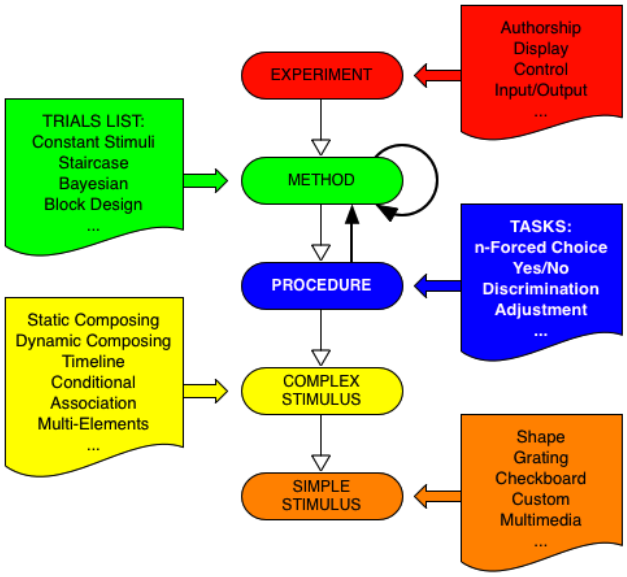
Your description of the experiment should now look very similar to this.



Note the warning signs in the status column: they indicate that the event properties are still unspecified or incomplete. We will update them in the next step.

The Method/Procedure/Stimulus Experimental Paradigm

As you can see, the design follows the Method/Procedure/Stimulus paradigm depicted here which is the basis of many behavioral experiments, not just the psychophysical ones. This experimental paradigm is both conceptually simple, intuitive, and powerful enough, and constitutes a well-proved template for most experimental needs.

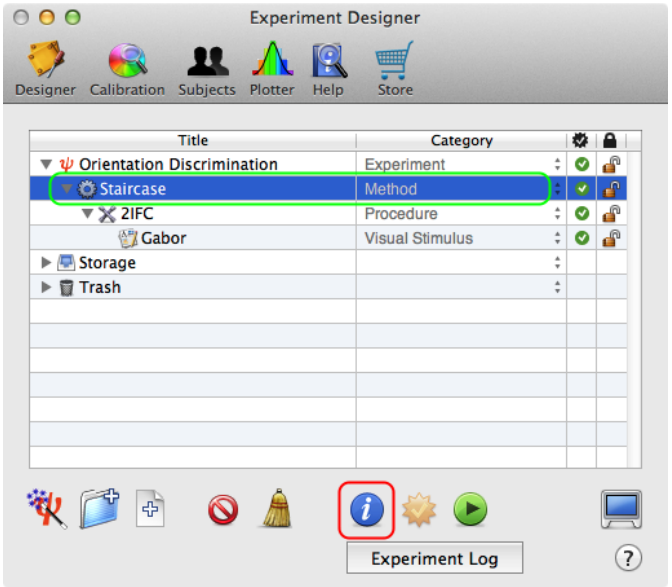


***Tip**: This hierarchical description describes the logic of the experiment both in terms of its conceptual semantics and operational execution. Most of the experiments created by Psykinematix should follow the above **Method/Procedure/Stimulus** hierarchical template as experimental paradigm.*

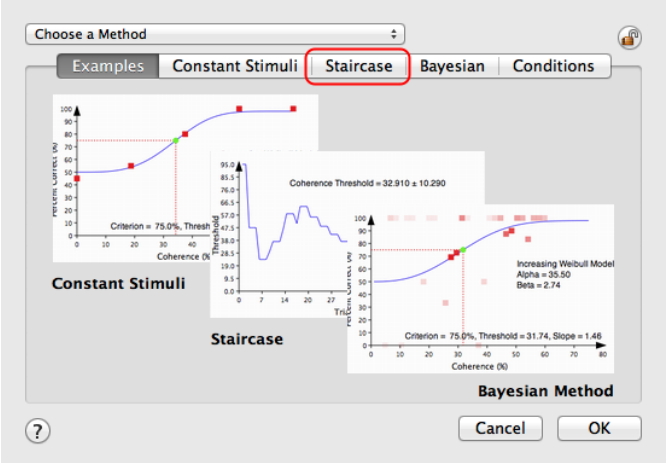
We have completed the basic hierarchical structure of the experiment, so let's move on to the customization of each event.

Step 6: Customizing the Method

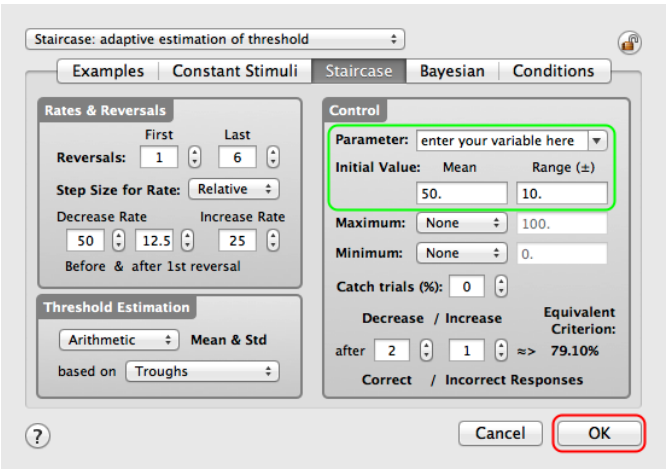
Click on the ***Staircase*** event to select it, and click on the **Inspector** button (or press the **⌘-i** keystroke) to inspect the properties of the **Method**.



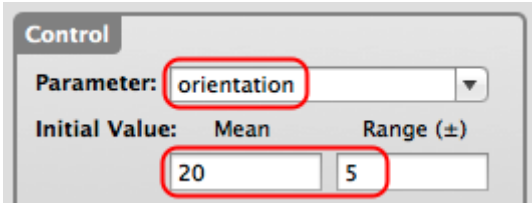
If you did not select yet a sub-category for the **Method** event in step 3 above, then the properties page for this event appears with the **Examples** tab selected by default. In this case, click on the **Staircase** tab to select the Staircase Method and view/edit its properties.



The default settings are suitable for a standard staircase method but should be customized to better fit your experimental requirements. The mandatory changes are those associated with the **dependent variable** of this experiment, that is the stimulus parameter that drives the threshold estimation during the experiment, which is the **Gabor orientation** in this design as illustrated below.



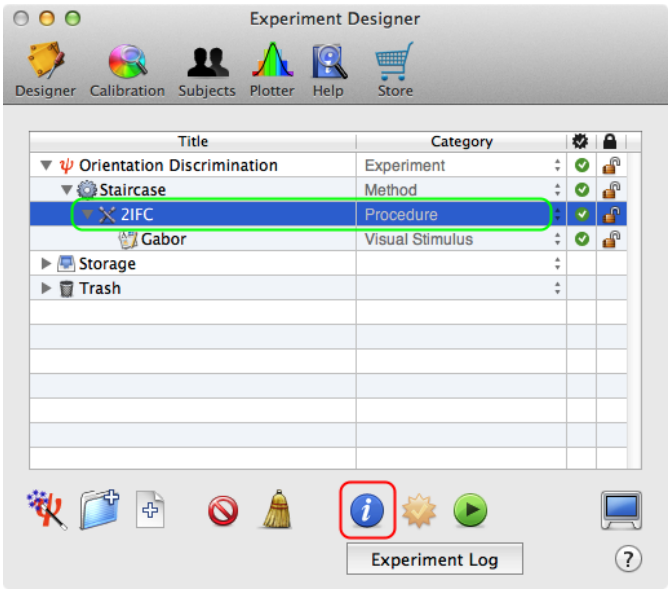
The name of the stimulus parameter and its initial value (in the range specified by a uniform distribution, mean ± deviation) need to be set appropriately. Change these values to match those of the figure: the parameter is named "***orientation***" and its initial value is set in the range ***20*** ± ***5*** (degrees).



Click on the **OK** button on the properties page to validate these changes and return to the **Designer** panel.

Step 7: Customizing the Procedure

Once you have returned to the **Designer** panel, select the ***2IFC*** **Procedure** event, and click on the **Inspector** button to inspect its properties.

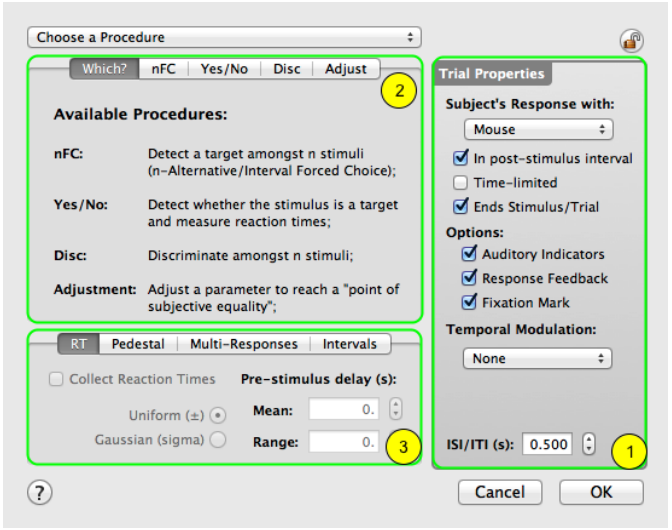


The properties page for the **Procedure** event consists of three sections:

1) A right side common to all procedures that specifies the properties to be applied to each trial

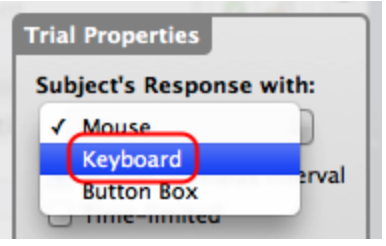
2) A top-left section that specifies the type of procedure (**Which?** tab selected by default) and its properties

3) A bottom-left section that provides more customization for some of the procedures (reaction times, pedestal, etc)

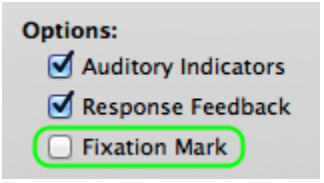


Let's customize each of these sections:

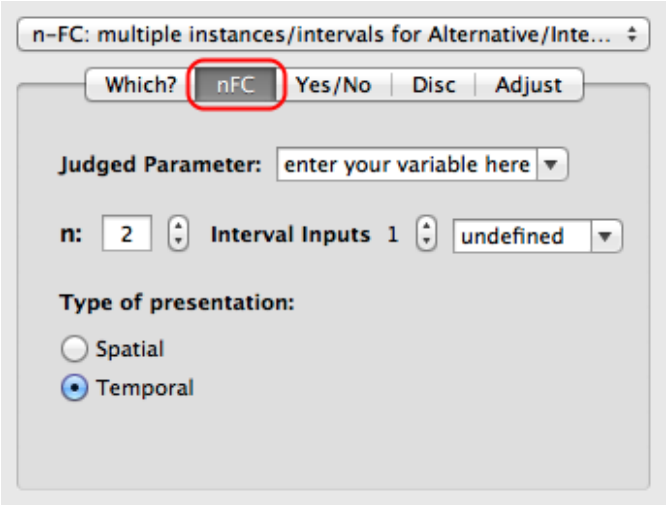
1) First, in **Trial Properties** change the type of inputs used by the subject to provide his/her responses: select the **Keyboard** device instead of the default (**Mouse**). The left/right arrows will be used by the subject to indicate whether the change in orientation between the 2 intervals is anti-clockwise or clockwise (see below).



Uncheck the **Fixation Mark** option, so no fixation is displayed during the stimulus presentation (pre- and post-stimulus fixations may be still present). This minimizes the possibility of interference between vertical cue in the fixation and the orientation judgement.

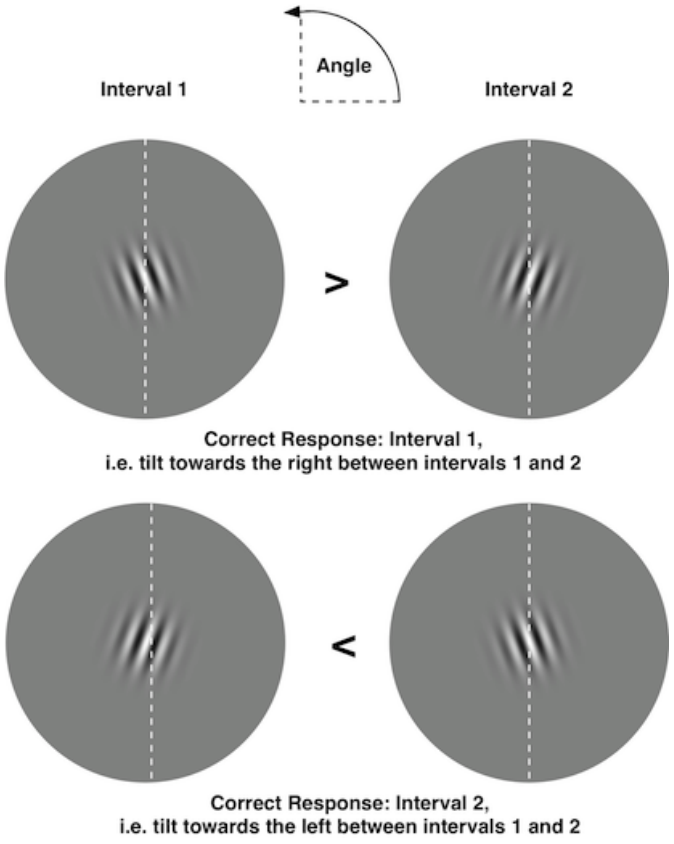


2) If you did not select yet a sub-category for the **Procedure** event in step 4 above, then the procedure-specific section appears with the **Which?** tab selected by default. In this case, click on the **nFC** tab to select the n-Forced-Choice Procedure and view/edit its settings.



Select the ***orientation*** variable from the **Judged Parameter** pop-up menu (it appears in the menu because you entered it in Step 6 above). This is the stimulus parameter the subject will be judging so it is essential to make sure the method, procedure, and stimulus are connected via this parameter.

***Remember**: in Psykinematix, the correct response in a n-AFC/IFC task is always associated with the highest value of the judged parameter.*



In this orientation discrimination **2IFC** task, the correct response would then correspond to the interval with the highest value for the **orientation** parameter (with the angle increasing in the anti-clockwise direction). As illustrated here, this is equivalent to asking the subject what is the direction of the tilt between the 1st and 2nd interval:

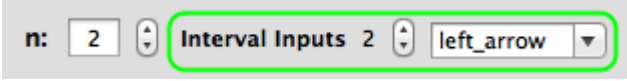
- a tilt towards the right side when the stimulus orientation is higher in the 1st interval than in the 2nd interval (1>2) using the ***right_arrow*** key to indicate interval 1, or vice-versa,
- a tilt towards the left side when the stimulus orientation is higher in the 2nd interval than in the 1st interval (2>1) using the ***left_arrow*** key to indicate interval 2.

To indicate that the correct response corresponds to the tilt direction of the stimulus and the associated response keys, make sure to configure the nAFC/IFC properties as follows:

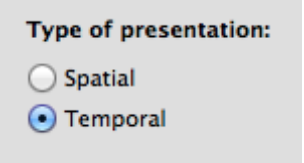
Make sure a 2IFC is specified by setting **n** to ***2***; **n** also corresponds to the number of inputs as there is one input for each stimulus interval in the **nFC Procedure**.

Enter the subject response associated with each stimulus interval: select the first interval index with the stepper (1 in the above figure) and enter the keyboard key used by the subject to indicate his choice for interval 1 (***right_arrow*** in the figure).

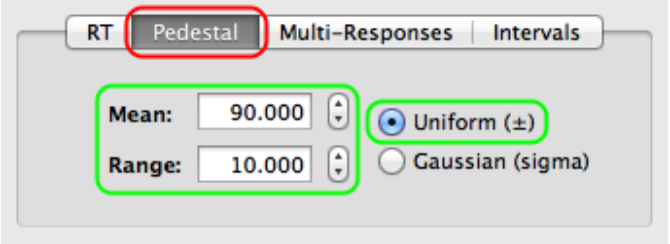
Similarly, set the ***left_arrow*** response key for the second interval.



Make sure the 2IFC is of the temporal type so the first interval (index 1) is the expected correct response when the subject presses the ***right_arrow*** key, and the second interval (index 2) is the expected correct response when the subject presses the ***left_arrow*** key.



3) In the bottom-left section, select the **Pedestal** tab. In each trial, the pedestal level is added to the value of the parameter indicated in the **nFC** properties; therefore, the subject's judgment is relative to the pedestal level.



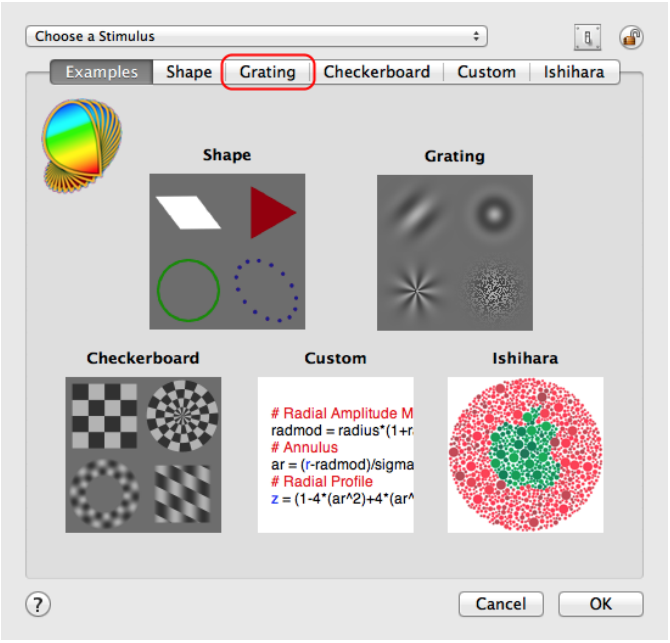
Set a uniform distribution of ***90*** ± ***10*** for the pedestal so the orientation threshold measurement is relative to the vertical. Random variation is required to prevent the use of the absolute vertical as a reference by the subject.

4) Click on the **OK** button to validate the changes and return to the **Designer** panel.

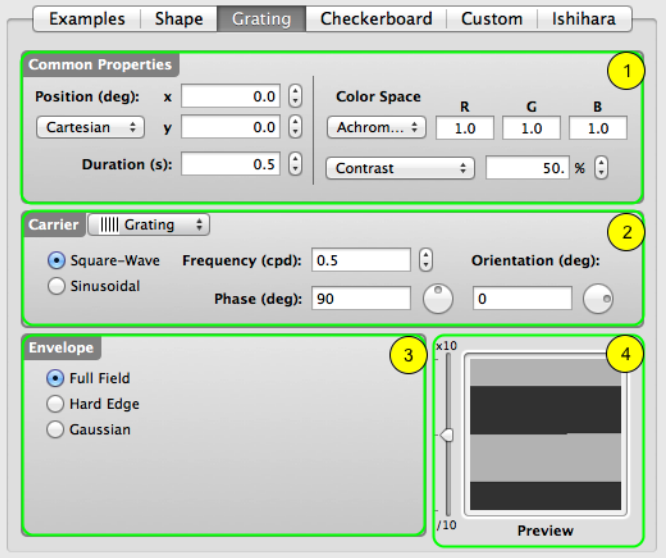
Step 8: Customizing the Visual Stimulus

From the **Designer** panel, select the ***Gabor* Visual Stimulus** event, and click on the **Inspector** button to inspect its properties.

If you did not select yet a sub-category for the **Visual Stimulus** event in step 5 above, then the properties page for this event appears with the **Examples** tab selected by default. In this case, click on the **Grating** tab to select the Grating-like Stimulus and view/edit its settings.



The properties page for the **Visual Stimulus** event consists of four sections:



1) A top section common to all types of visual stimulus that specifies their position, duration, and appearance,

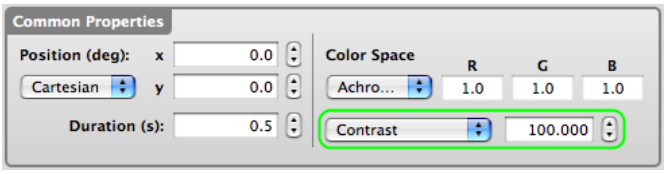
2) A middle section that specifies the carrier properties,

3) A bottom-left section that specifies the envelope properties,

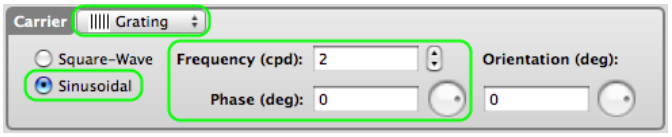
4) A real-time preview in the bottom right-hand corner that can be zoomed in and out.

Let's customize each of these sections:

1) Set the stimulus contrast to the maximum: 100%.

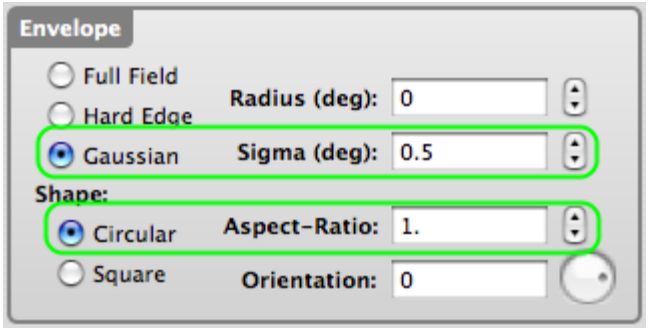


2) To create the Gabor stimulus: select the **Grating** type from the Carrier pop-up menu in the middle section; select **Sinusoidal** modulation; and set the values for the tested spatial frequency and phase.

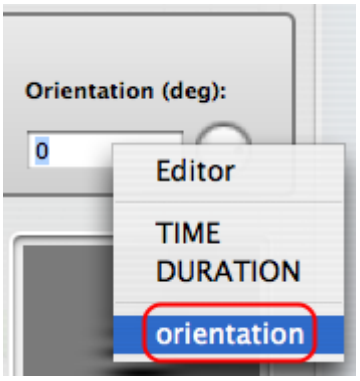


3) In the bottom-left section, select a **Gaussian** envelope and set the value for its sigma. Select the circular shape with an aspect-ratio of 1.

4) Note how the preview is automatically updated with your changes (use the slider to zoom the preview in and out).



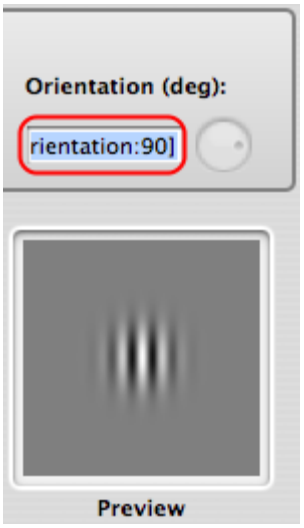
Finally and most importantly, connect the **Carrier Orientation** to the parameter used by the Method and Procedure by selecting the ***orientation*** variable that appears in the contextual menu when control-clicking on the text field, as illustrated above. Make sure to select the entire content of the text field before selecting the variable in the menu so the selection completely replaces the previous content.



Once selected, the variable name appears in **brackets**, thus indicating that the variable is providing a value to the stimulus parameter.

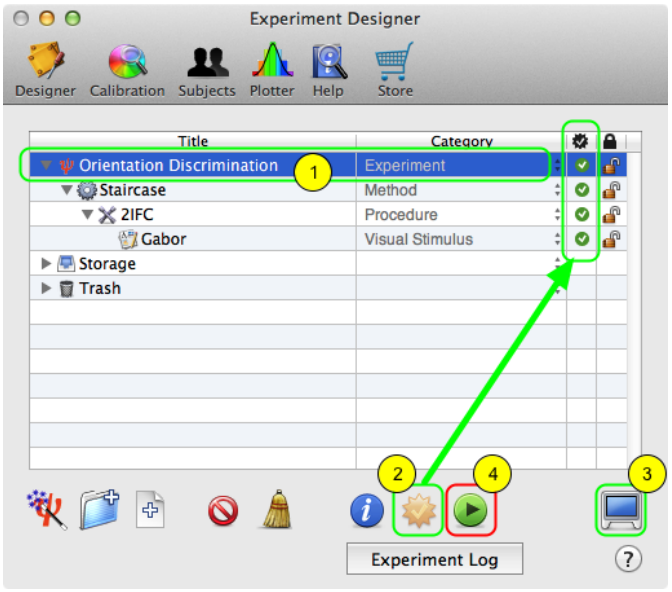
When using a variable-based expression to define a stimulus parameter, the preview is generated assuming a default value of 0 for each variable. To display a preview for a variable value other than the default one, add the desired value preceded by a colon before the closing bracket (eg: [orientation:90]). This value is used only for preview purposes and has no effect on the experimental design or during its execution.

We have finished with the experimental design so click on the **OK** button to validate the changes and return to the **Designer** panel.



Step 9: Checking & Running the Experiment

To run an experiment, simply do the following:



1) Select the ***Orientation Discrimination* Experiment** event which is at the root of your experiment design.

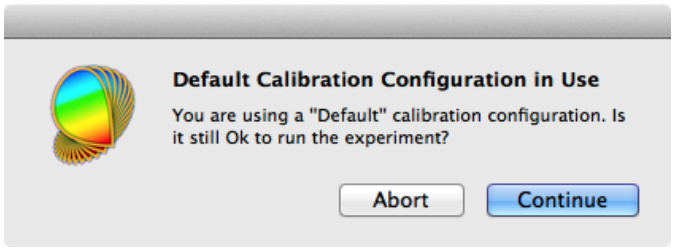
2) Check the validity of your design by clicking on the **Check** button in the button toolbar (if this button is greyed out the checking is done automatically): if correct, all the indicators in the check column turn into green check marks. If these indicators do not appear as green marks, then review your design and make sure that you have carefully followed the previous steps.

3) Toggle the experimental session between windowed or full-screen mode: ***the windowed mode is appropriate for testing purposes only as neither Gamma correction nor timing checks are performed during the experiment, and the session results are not saved into Psykinematix database.*** The full-screen mode should **always** be used to collect data you intent to include in your study.

4) Click on the **Run** button to run the experiment.

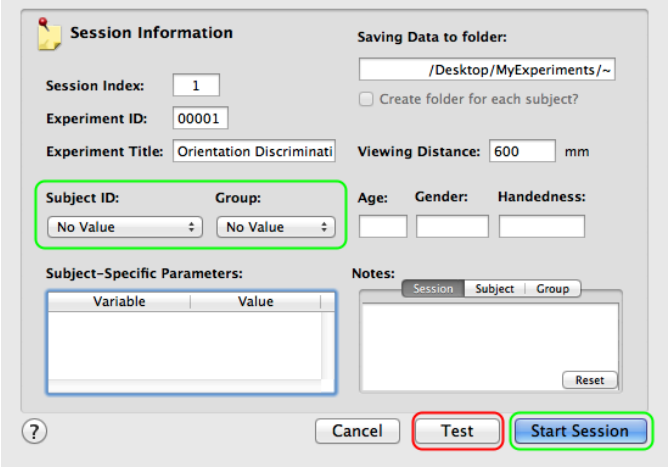
***Tips**:*
*- Experiments can also be run through the **Experiments** menu which contains an up-to-date list of all the experiments present in the **Designer** panel.*
*- If the **Check** button is disabled/grey out, Auto-Checking is activated so an event status is automatically updated every time the event is modified (see related option in the Preferences panel).*

This warning message is displayed when no calibration configuration is specified for the experiment running (see the end of the Calibration Tutorial to learn how to specify a

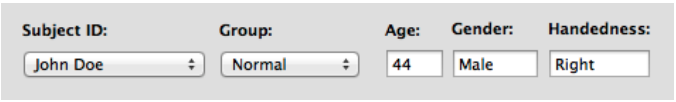


calibration configuration); however, you can still run the experiment using a default calibration by clicking on the **Continue** button.

Before the session starts in full-screen mode, a panel summarizing the **Session Information** is displayed. You can either run the session in testing mode (***Test*** button), which does not require the specification of the subject and group, or in real mode (***Start Session*** button) if you specify them. ***In testing mode, the session data will only appear as temporary data*** under the **Plotter** panel ***and will not be actually saved in the results database*** (shown under the **Subjects** panel).



If you have already entered subjects and groups in the **Subjects** panel (see the ***Subjects Tutorial)***, you can select them using the two pop-up menus provided. Their age, gender, and handedness are then shown.



Click on the **Test** or **Start Session** button.

Press **ESC** (escape keyboard key) to stop the session at any time.

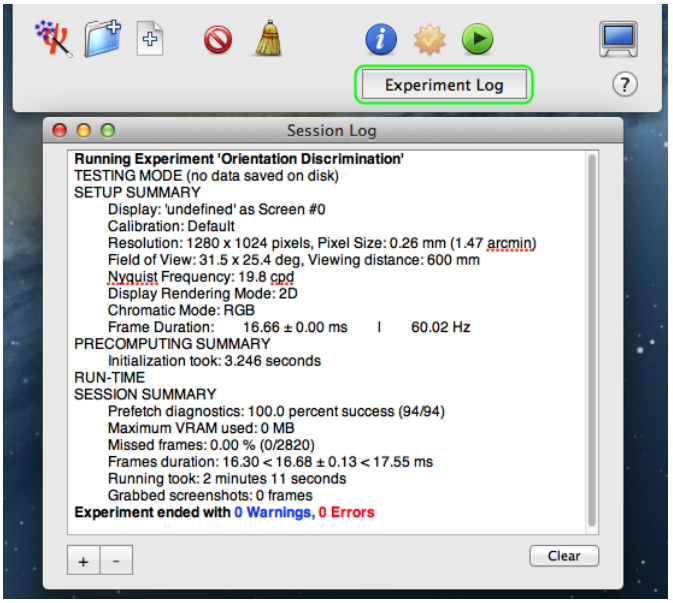
If the experiment aborts by itself because some critical error occurred during the session, the logging panel will automatically show up with the relevant error messages. In that case, carefully review the different steps above using the indications provided by these error messages.

Important note: *To save the session results in Psykinematix database for future retrieval, always make sure to:*

- run the experiment in full-screen mode by toggling the display icon in the ***Designer*** *bottom toolbar,*
- select the subject and group in the ***Session Information*** *panel,*
- click on the ***Run Session*** *button in the* ***Session Information*** *panel.*

Step 10: Inspecting & Visualizing the Results

Once the session has completed normally, you are asked to press **ESC** to return to the **Designer** panel. If an error occurred during the session, a logging panel will automatically show up with relevant error and warning messages. This panel also includes a summary of the experimental conditions in terms of subject, display setup, and various other diagnostic information. If no error occurred, you can still reveal this panel by clicking the **Experiment log** button at the bottom on the **Designer** panel.



Upon termination of an experimental session, the results data can be visualized immediately from the **Plotter** panel:

1) Click on the **Plotter** icon in the toolbar to access the panel. The results for the last session appear at the top of the table.

As noted above, the results are saved in the Psykinematix database only if the session was run in real mode. In this example, the **Subject (Group)** column shows **Testing Mode (None)** (highlighted in blue) which indicates that the session has not been run in real mode and that these results will not be saved in the database after quitting Psykinematix.

2) Option-click on the small arrow in front of the session entry to expand the whole hierarchy of the results data.

3) Select one of the entries in the final level of the hierarchy to plot its attached dataset (each entry contains a different dataset).

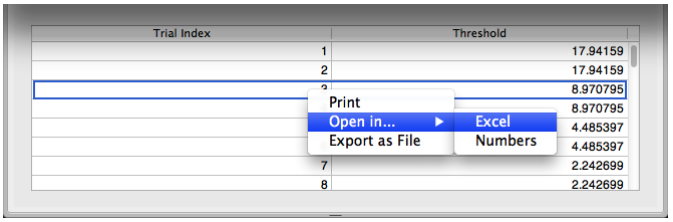
4) You can customize the appearance of the graph by clicking the "Graph Settings" button to access the **Graph Properties** palette (6) or the "Data Settings" button to access the **Data Analysis** palette (5).

5) Some data analysis options specific to the selected dataset are available from the tabs available in the **Data Analysis** palette on the right side of the results table: for staircase data for example, it is possible to select whether an arithmetic or geometric mean is used, or whether troughts or/and peaks of the reversal data points are considered to estimate the displayed threshold. The threshold estimate (mean ± std) is automatically updated on the graph.

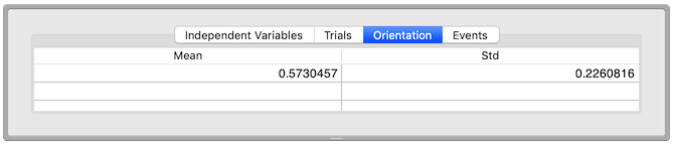
6) Numerous aspects of the graph appearance can be customized using the **Graph Properties** palette: here for example, a more specific title, a log scale, a minimum value of 0 and a maximum value of 30 were selected for the y-axis and the legend showing the orientation threshold estimate was repositioned.

7) Control-click inside the graph to print, copy, or save it to a file.

8) Click on the **Data Table** button to reveal the spreadsheet containing the selected data (3) used to plot the graph (control-click inside the spreadsheet to print or export the data).



When selecting the root object of the session entry (named in this example ***00006 - Orientation Discrimination***), the data table will present a summary of the measurements, in this example the threshold estimate (mean ± std) under the ***Orientation*** tab also shown on the graph above.



See the ***Subjects Tutorial*** and the ***Plotter Tutorial*** to learn how to select, import, and plot data collected during previous Psykinematix sessions.

Conclusion

In this lesson, you learned the Psykinematix basics: how to create the hierarchical structure of an experiment, how to customize the events, how to use variables to connect procedural and stimulus events, and how to run a session.

The next few lessons in this tutorial elaborate on this experimental paradigm by introducing various improvements over this single, static, stimulus version:

- **Lesson 2** interleaves several staircases to investigate the effects of several experimental conditions, including spatial frequency and size.
- **Lesson 3** implements a sandwich paradigm with forward and feedback masking noise.
- **Lesson 4** adds a spatial and temporal context.
- **Lesson 5** adds motion & dynamics through the use of a 1st-order drifting Gabor.