QTEST 2.1 TUTORIAL

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Tutorial Version of December 2017 (Zwilling, Regenwetter, Fields & Wang)

QTEST: Quantitative Testing of Theories of Binary Choice (Regenwetter et al., 2014)—henceforth 'QTBC1'—and *QTEST 2.1: Quantitative Testing of Theories of Binary Choice Using Bayesian Inference* (Regenwetter et al., 2017)—henceforth 'QTBC2'—present a general quantitative diagnostic framework for testing theories of binary choice. However, QTBC1 and QTBC2 do not provide the prospective user of QTEST with the knowledge and tools for using the software. This QTEST Tutorial—henceforth 'the tutorial'—is a companion document to QTBC1 and QTBC2 and will allow one to recreate all the figures and replicate the tables of results in QTBC1. It will also allow one to recreate one figure and replicate the tables of results in QTBC2. Ideally, after completing the tutorial, a prospective user of QTEST will know how to use QTEST for their research. QTBC1 and QTBC2 also have supplements posted online (*Online Supplement to QTEST* and *Online Supplement to QTEST 2.1*) and references to these documents will be henceforth made as 'online supplement 1' and 'online supplement 2', respectively.

If you need to reference this tutorial, please cite QTBC1 and QTBC2 (*QTEST: Quantitative Testing of Theories of Binary Choice* and *QTEST 2.1: Quantitative Testing of Theories of Binary Choice Using Bayesian Inference*). While every attempt has been made to ensure the accuracy of the QTEST software program, we cannot guarantee that a user of QTEST will not find an error.

This tutorial will teach a prospective user of the QTEST software interface all the functions by way of recreating the figures and tables of QTBC1 and one figure and tables of QTBC2. The tutorial contains 5 parts:

Part I: Downloads
Part II: Generating the Figures
Part III: Data Analysis
Part IV: Online Supplements
Part V: QTEST Options

Part I: Downloads
This provides instructions for downloading and installing the QTEST software.

Part II: Generating the Figures

This provides detailed instructions and screenshots to recreate all the Figures of QTBC1 and Figure 4 of QTBC2. Figures 1-3 of QTBC2 are easy to show following the steps of sections A-E of the tutorial.

Part III: Data Analysis
This provides instructions for analyzing data and using QTEST to generate the results of the Tables of QTBC1 and QTBC2.

Part IV: Online Supplements

Part V: QTEST Options

Parts II, III and IV are further subdivided by sections, denoted by capital letters (e.g. A or C). Part II encompasses section A through section F, Part III encompasses section G through section N while Part IV includes section O through section R. Almost all sections have subsections, denoted by a number following the section letter (e.g. section A.1 or section C.3). These section headers organize the tutorial, clarify internal tutorial references and enable a reader of the tutorial to navigate the document.

The Microsoft Word format of this tutorial was designed with the Navigation Pane and the Adobe Acrobat format allows a user to use Bookmarks to easily navigate the entire document. Please visit the following link for more guidance on using the Navigation Pane in Word or Bookmarks in Adobe, if you are not already familiar with these tools: http://labs.psychology.illinois.edu/DecisionMakingLab/qtest/Tutorial/ .

PART I: Downloads

The main QTEST website is located at:
http://internal.psychology.illinois.edu/labs/DecisionMakingLab/qtest/

From this website, you can download the QTEST software, tutorial files and the tutorial.

QTEST software
Download the QTEST software from:
http://internal.psychology.illinois.edu/labs/DecisionMakingLab/qtest/Software

QTEST is written in Matlab code; but Matlab does not need to be installed on a computer to run QTEST. When visiting the website to download QTEST, you will need to download both a version of QTEST and an MCR installer. For computers with Windows operating systems, the bit size of both the QTEST software and the Matlab MCR installer need to match the bit-size of your computer (e.g. Windows 32-bit or Windows 64-bit).

QTEST tutorial files
Download the data, QTEST input files, and QTEST output files referenced in the tutorial from: http://internal.psychology.illinois.edu/labs/DecisionMakingLab/qtest/Files
This webpage contains a zipped file with all the files needed for the entire tutorial. (Alternatively, one may download these zip files one section at a time.)

You will find two sets of files in the folder "AllTutorialFiles." File names that do not end with 2.1 contain results that match the ones in *QTEST: Quantitative Testing of Theories of Binary Choice* obtained using an older version of QTEST. File names that end with 2.1 contain results that are obtained when following the steps in the tutorial using QTEST 2.1. You might also obtain slightly different results for the analyses due to different operating systems, different versions of MATLAB, or from using different random seeds.

QTEST tutorial
Finally, a Microsoft Word and Adobe Acrobat PDF version of this tutorial can be found at: http://internal.psychology.illinois.edu/labs/DecisionMakingLab/qtest/Tutorial/

PART II: GENERATING THE FIGURES

Part II of the tutorial provides step-by-step instructions for creating the figures in *QTEST: Quantitative Testing of Theories of Binary Choice* and one figure in *QTEST 2.1: Quantitative Testing of Theories of Binary Choice Using Bayesian Inference.* It is designed in such a way so that each of the sections below labeled Section A through Section F, leads to different figures in QTBC1 and QTBC2. All files referenced in Part II for QTBC1 of this tutorial are in the folder "SectionsA-F_Figures", which can be downloaded by following the instructions in Part I of the tutorial (above).

Because we have figures in QTBC1 and QTBC2 and figures that result from QTEST, we use a different notation to refer to each of these figure types. Figures referenced in QTBC1 follow the format: Figure # of QTBC1. The "F" of Figure is capitalized, the "#" represents a figure number of QTBC1 (e.g. "2") and "of QTBC1" means, specifically, that Figure # of the paper *QTEST: Quantitative Testing of Theories of Binary Choice.* Figures referenced in QTBC2 follow the format: Figure # of QTBC2. The "F" of Figure is capitalized, the "#" represents a figure number of QTBC2 (e.g. "3") and "of QTBC2" means, specifically, that Figure # of the paper *QTEST 2.1: Quantitative Testing of Theories of Binary Choice Using Bayesian Inference.*

The QTEST software interface also generates figures. These are always denoted as figures, with a lower case "f" and never referenced by figure numbers. QTEST automatically produces a figure number in the upper left-hand corner of each window each time it generates a new figure. This figure number is determined by the number of existing figure windows open. If only the QTEST interface is open, and a figure is generated, the resulting figure will be labeled "Figure 1" by QTEST. If one figure window is already open, and a new figure is generated, QTEST labels this as "Figure 2." We NEVER refer to a figure label generated by QTEST in this tutorial. Any correspondence between figure labels from QTEST output and Figure numbers of the papers are coincidental.

The figures in Part II and Part IV of this tutorial can be generated three different ways. These methods are now described in more detail.

<u>Method 1 for generating figures of the papers</u>
The first method is designed to allow a user to simply follow the instructions within the tutorial, section by section, to generate all figures of QTBC1 and one figure of QTBC2. The advantage to this method is that one can see step by step screen shots for creating the figures. Continue reading this tutorial to take advantage of this method.

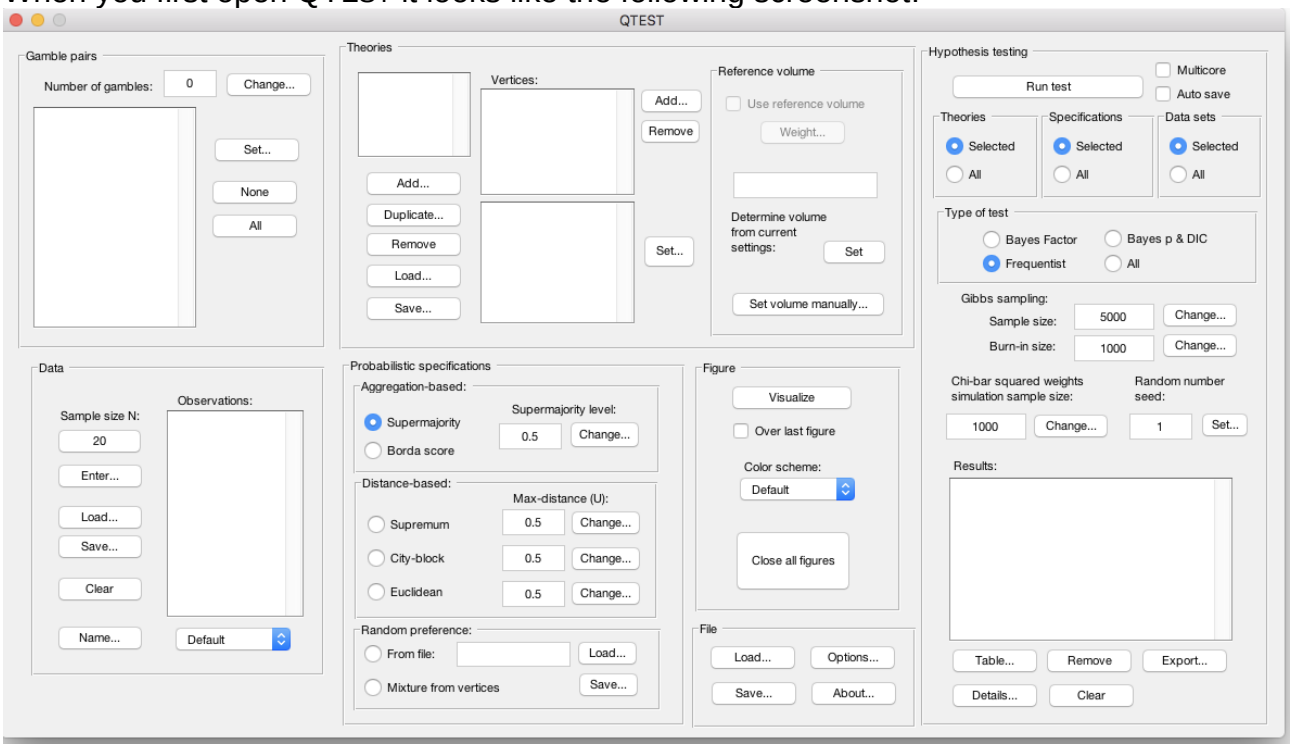
<u>Method 2 for generating figures of the papers</u>
If you are only interested in looking at the figures themselves, you may load the file corresponding with the Figure number of the paper directly into QTEST. These files are found within the QTEST tutorial files on the website. (See Part 1: Downloads, above, on the location of these files.) These files have the format "Figure#.png", where "#" denotes a Figure number of QTBC1.

Method 3 for generating figures of the papers

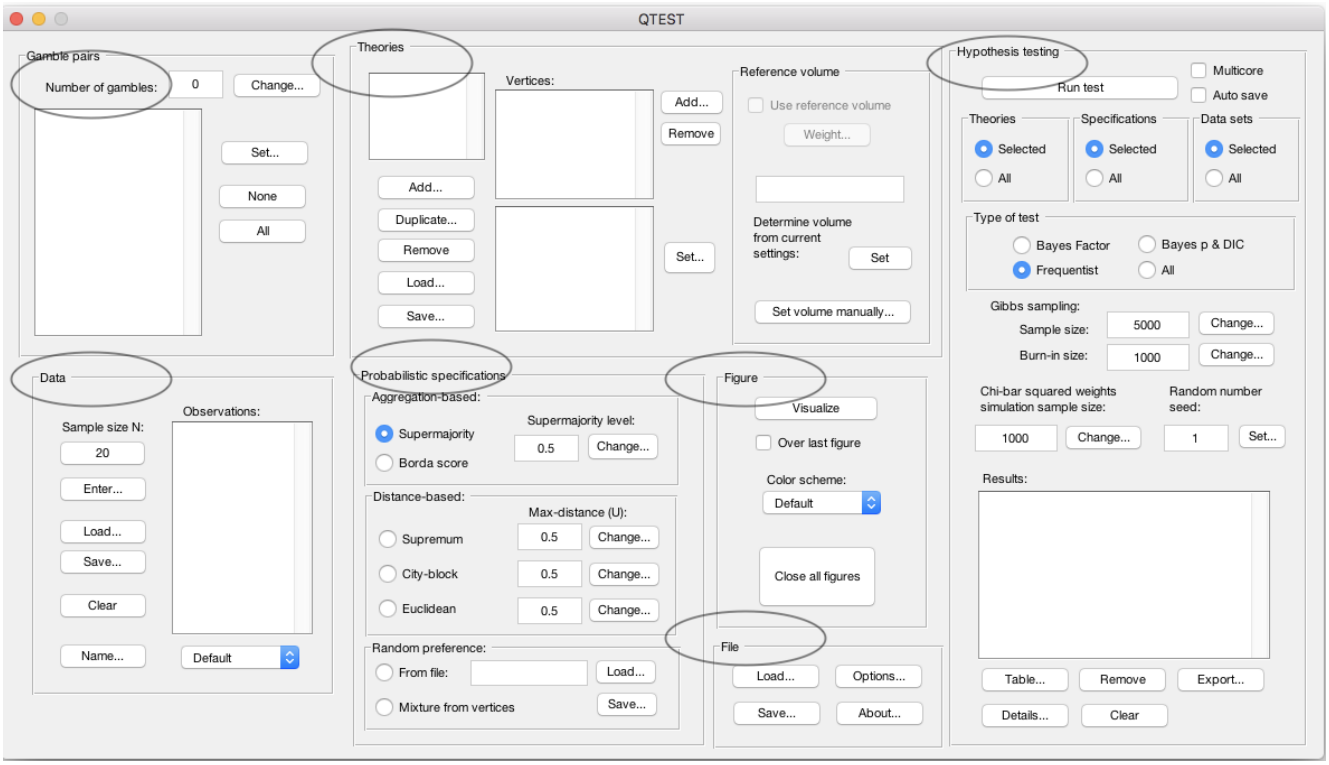
The third method is basically a shortcut of Method 1. Instead of reading Parts II and IV of the tutorial, one can load a file in QTEST that already has the options specified and contains the necessary input files. In the folder 'SectionA-F_Figures', for instance, one will find files of the type "Figure#.mat", where "#" denotes a Figure number of QTBC1. With the QTEST GUI open, one selects 'Load' (instructions below) and navigates to the .mat file of interest. In this same folder, one will also find files of the type "Figure#Note.txt", which has a very truncated version of the instructions needed to successfully generate the figure, once you have loaded the .mat file. The notes in these text files are a highly compressed set of instructions that are spelled out in more detail in the tutorial for each figure.

QTEST allows a user to save their work at any point in time, load it and resume where they left off. Another approach some users of this tutorial may adopt is to work through each of the sections independently, where, after completing one section, the user does not save their work, closes QTEST and begins a new section with a new session of QTEST later. The tutorial can accommodate both strategies.

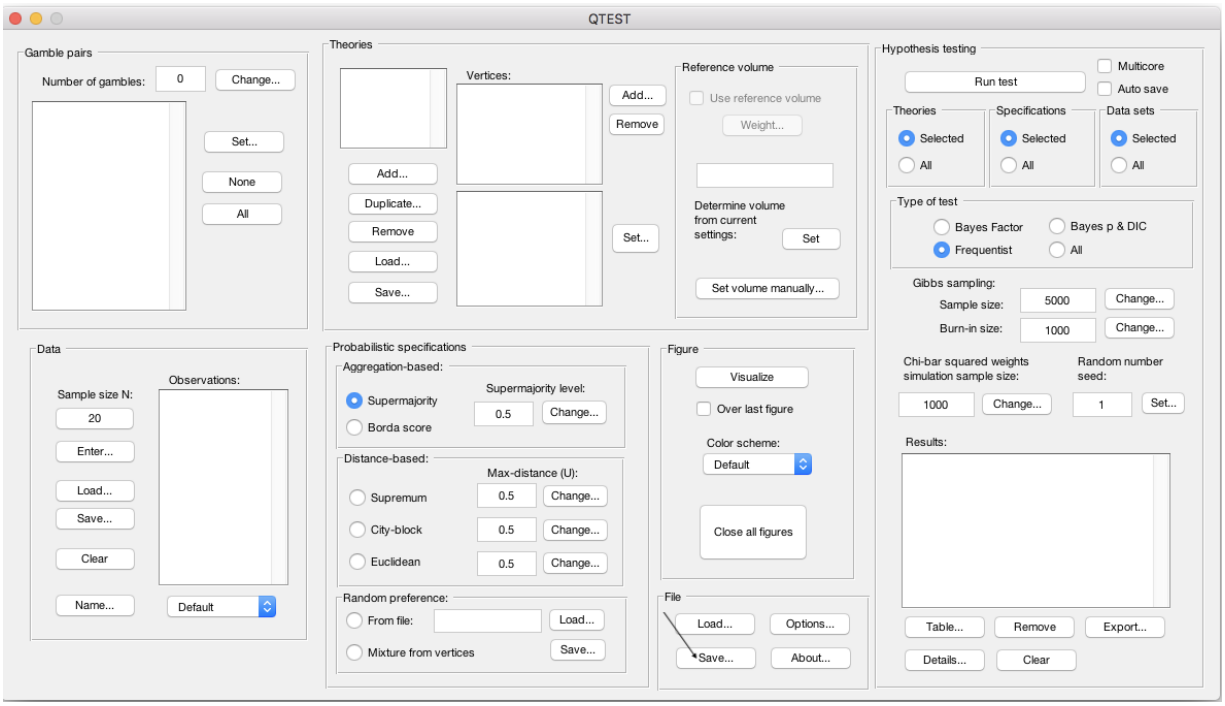
When you first open QTEST it looks like the following screenshot:



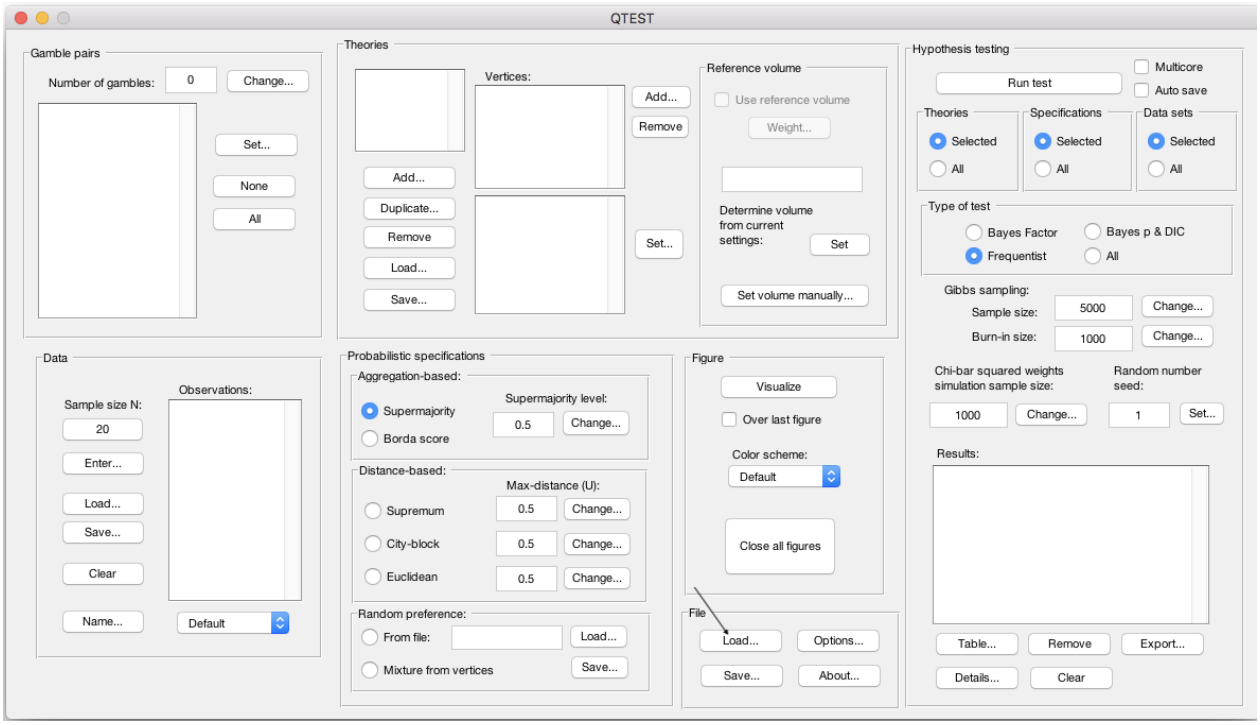
The QTEST interface has 7 spatially distinct areas, which contain a set of related functions. From left to right, and top to bottom, these are: “Gamble Pairs”, “Theories”, “Hypothesis Testing”, “Data”, “Probabilistic specifications”, “Figure” and “File.” These 7 names are circled in the screenshot below:



We now illustrate how to save and load a file. Suppose you have completed a section of this tutorial and wish to save your work. In the QTEST interface, under "File", select "Save…". Then navigate to a location on your computer to save the QTEST session, which will have a "*.mat" format, where the asterisk represents the file name and the ".mat" extensions stand for a Matlab file.



And then, when you are ready to resume, under “File” select “Load…” and navigate to the location of your saved “*.mat” file. Once again, the asterisk represents your file name and the .mat is a Matlab file extension.



This demonstration of saving and loading a file illustrates notation carried throughout the tutorial. First, the tutorial will begin instructions by indicating the location referenced, like “File” was just used. Then the functions within that location are demonstrated. We just learned how to use “Save…” and “Load…”. And usually these are illustrated by screenshots. So, whenever you see words in double quotation marks, “ ”, these refer to an explicit representation on the QTEST interface. These are words that currently exist on the interface or user input to be entered (or user input entered previously). Black arrows on top of screenshots point to an input selection the user needs to make with their cursor. Black open ovals on top of the QTEST interface screenshots draw the users’ attention to something that has been updated because of an action taken by the user.

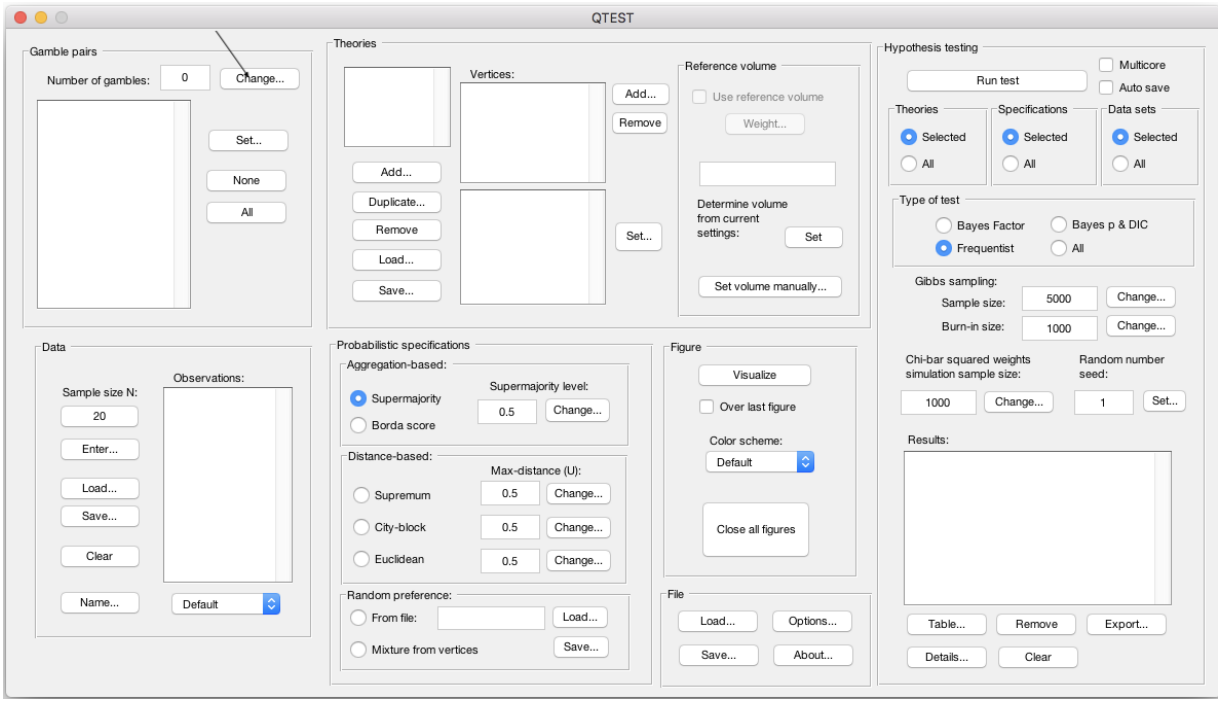
We now turn to the first section of the tutorial, A, where we recreate Figure 2 of QTBC1.

A. Theory ABC (Figure 2 of QTBC1)

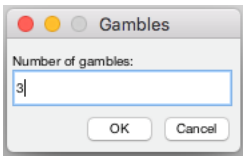
Upon completion of section A of the tutorial, a version of Figure 2 of QTBC1 will be created. To create this figure, we will learn how to use QTEST to create gamble pairs, define a decision theory, specify the theory's prediction and finally create (and visualize in 3-dimensional space) the 0.50-majority/modal choice specification of this theory.

A.1 Create the gamble pairs

The basic entity on which QTEST builds every analysis is a set of gamble pairs. We start with the gambles in Figure 2 of QTBC1, labeled *A, B,* and *C*. In the QTEST interface, under "Gamble pairs", select "Change".

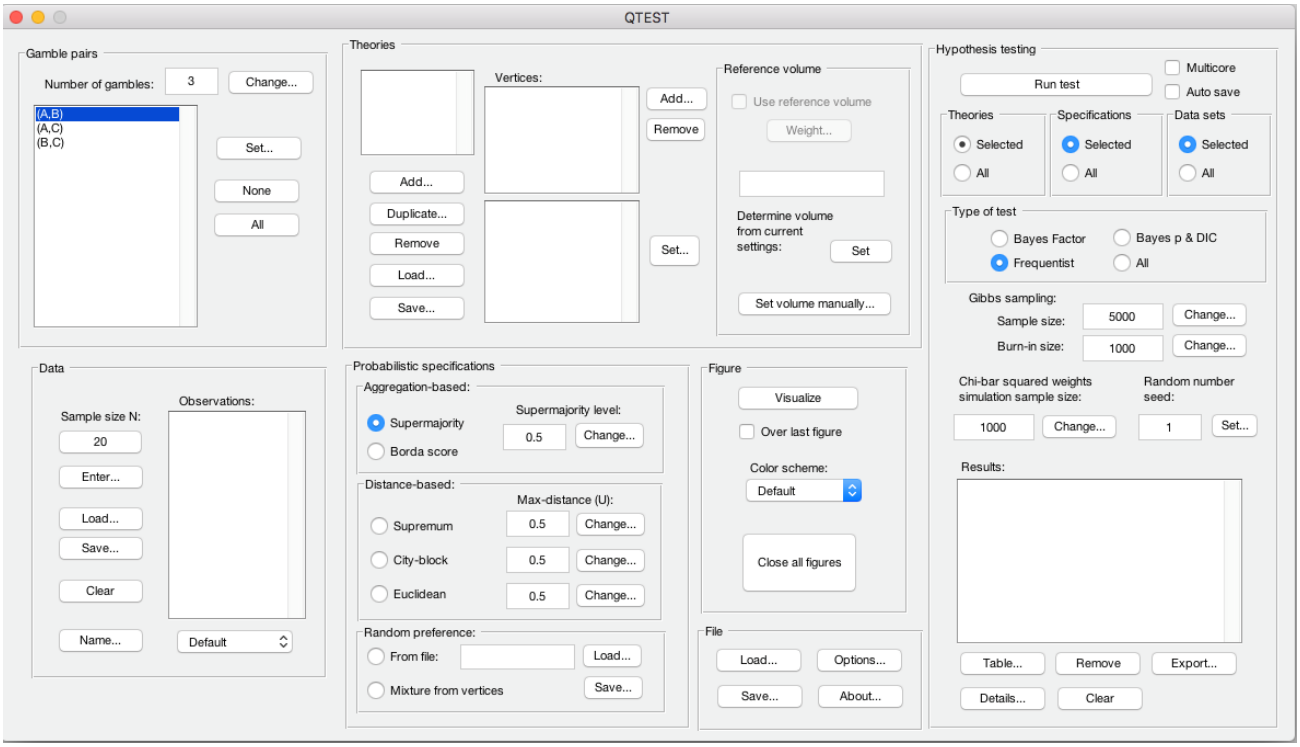


In the "Gambles" dialogue box that pops up, type "3". Then select "OK".



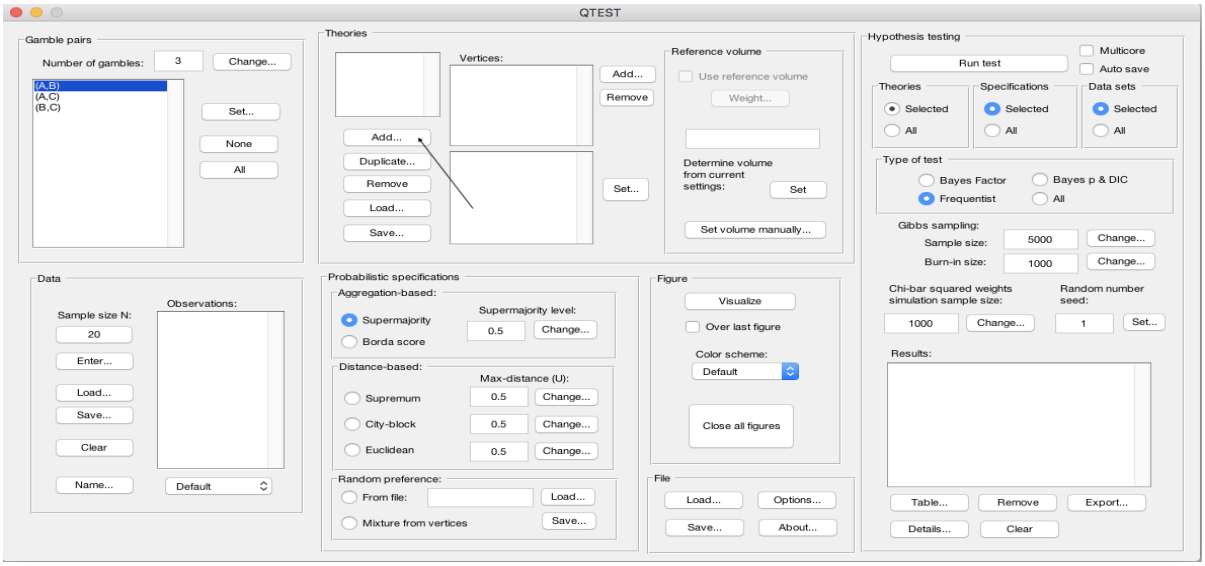
Notice the “Number of gambles” under “Gamble pairs” in the QTEST interface is “3”. Next, select “All” under “Gamble pairs”. This will create all possible pairs of gambles from 3 gambles.

Under “Gamble pairs”, the list of gambles has updated to include “(A,B)”, “(A,C)” and “(B,C)”, which are all the possible pairs of gambles.

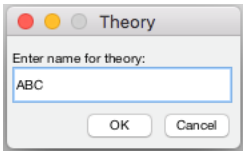


A.2 Define one decision theory, ABC

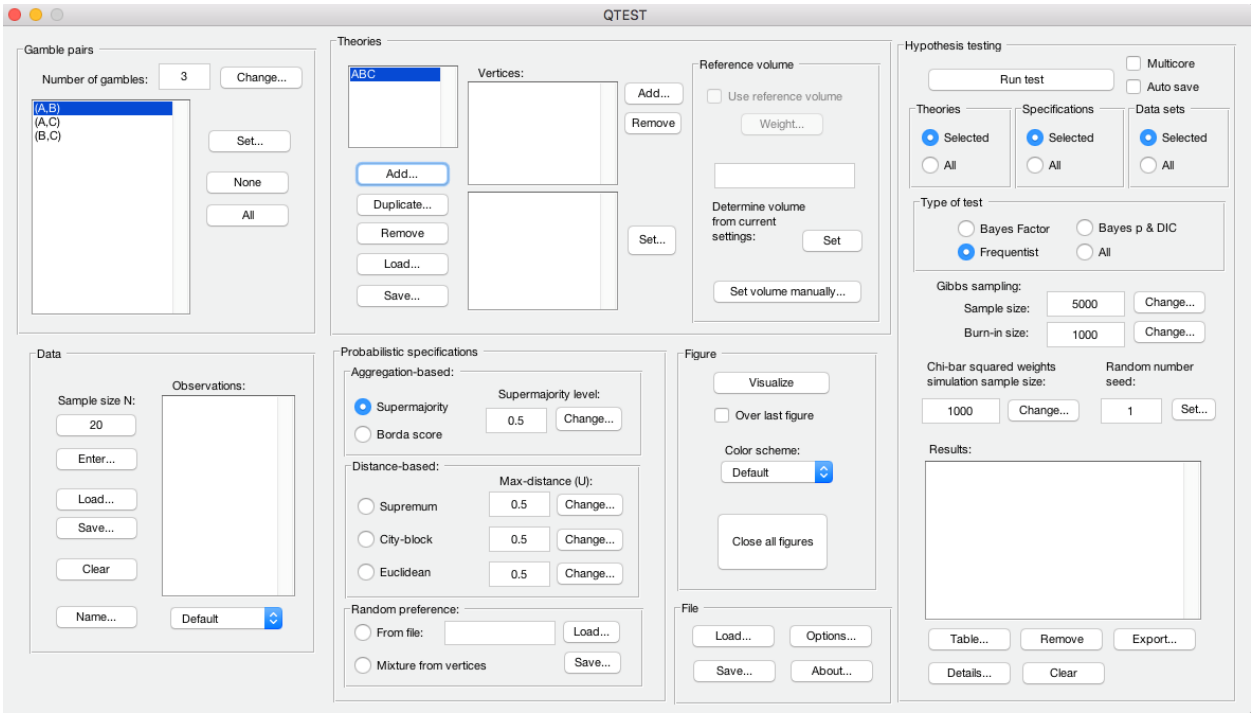
Having created the gamble pairs, we now define a decision theory. In the QTEST interface, under “Theories”, select “Add…”.



In the “Theory” dialogue box that pops up, enter “ABC”. Select “OK”.

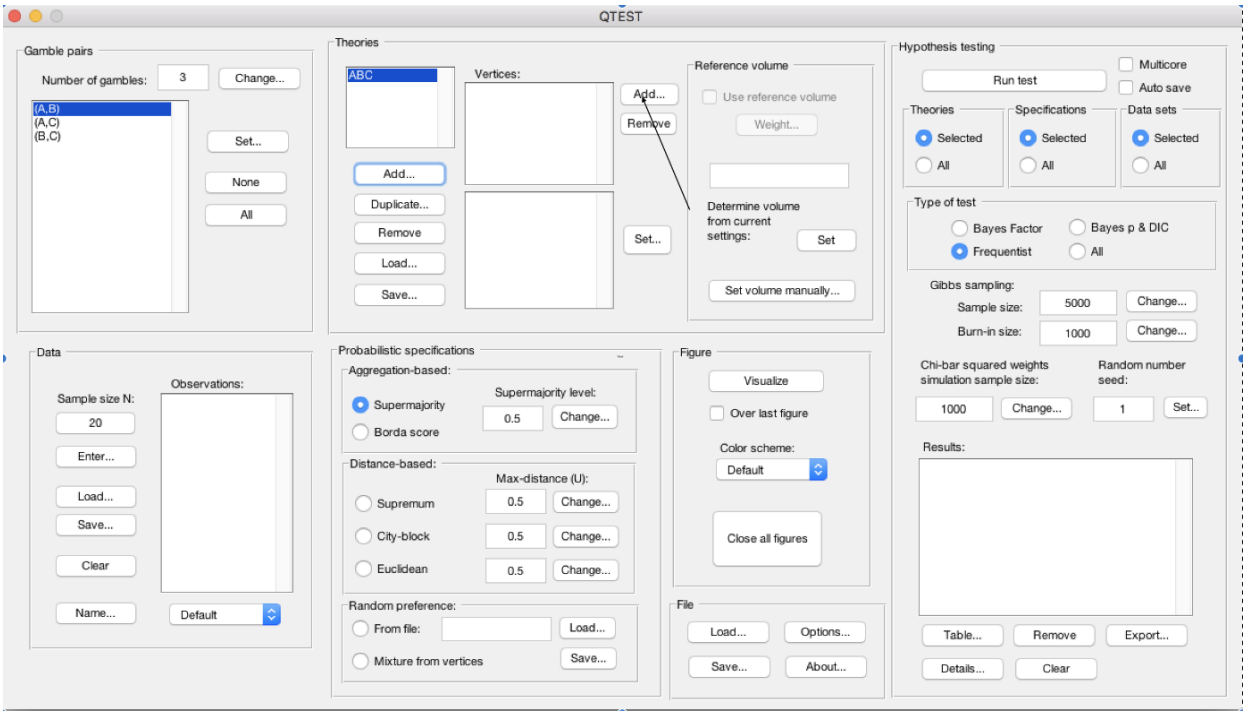


Notice “ABC” listed under “Theories”.

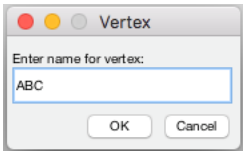


A.3 Specify the prediction of decision theory ABC

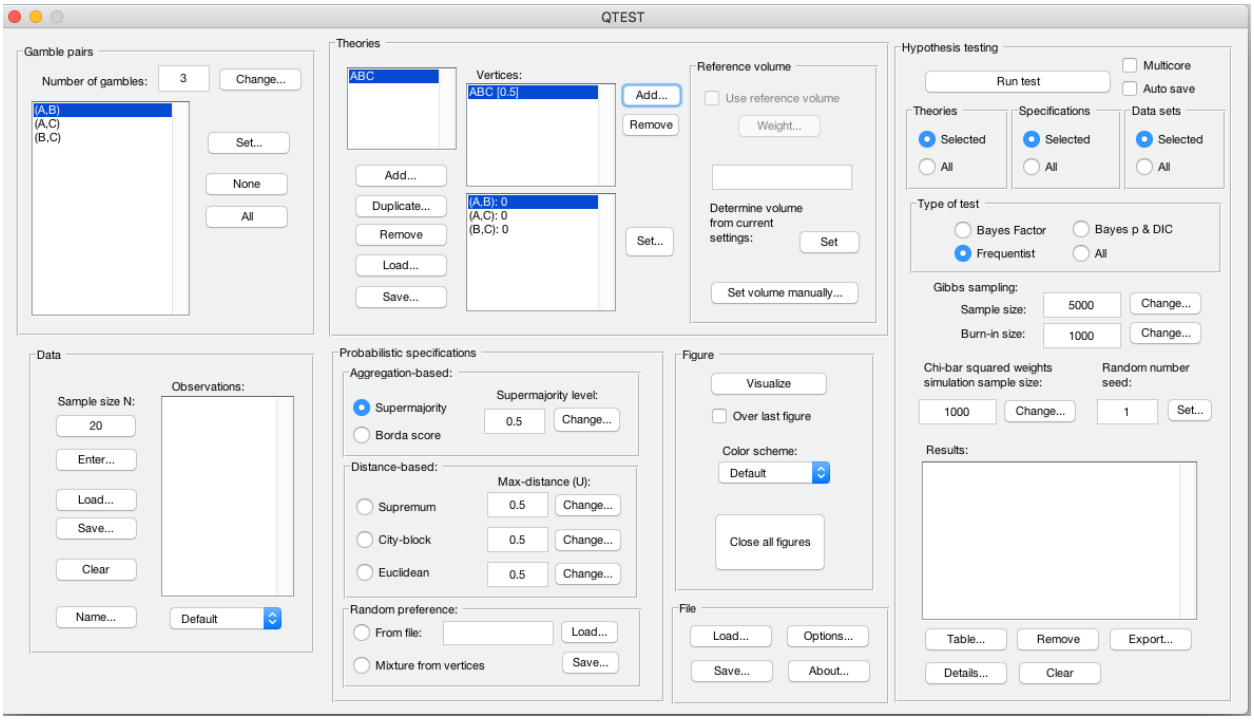
We can now specify the prediction of theory ABC. Under “Theories”, select “Add…”, just right of “Vertices:”.



Enter “ABC”, as a name for the ranking ABC, in the “Vertex” dialogue box that pops up. Then select “OK.”

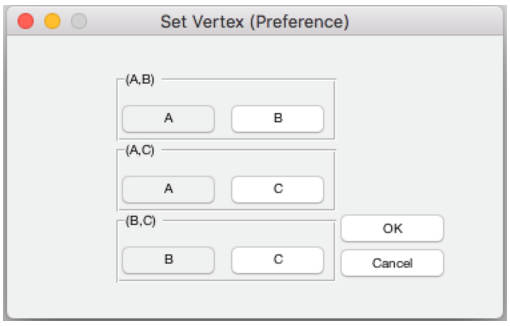


In Figure 2 of QTBC1, the vertex ABC is represented geometrically by a corner of the 3-D cube. Specify the coordinates of this vertex by selecting “Set…”.



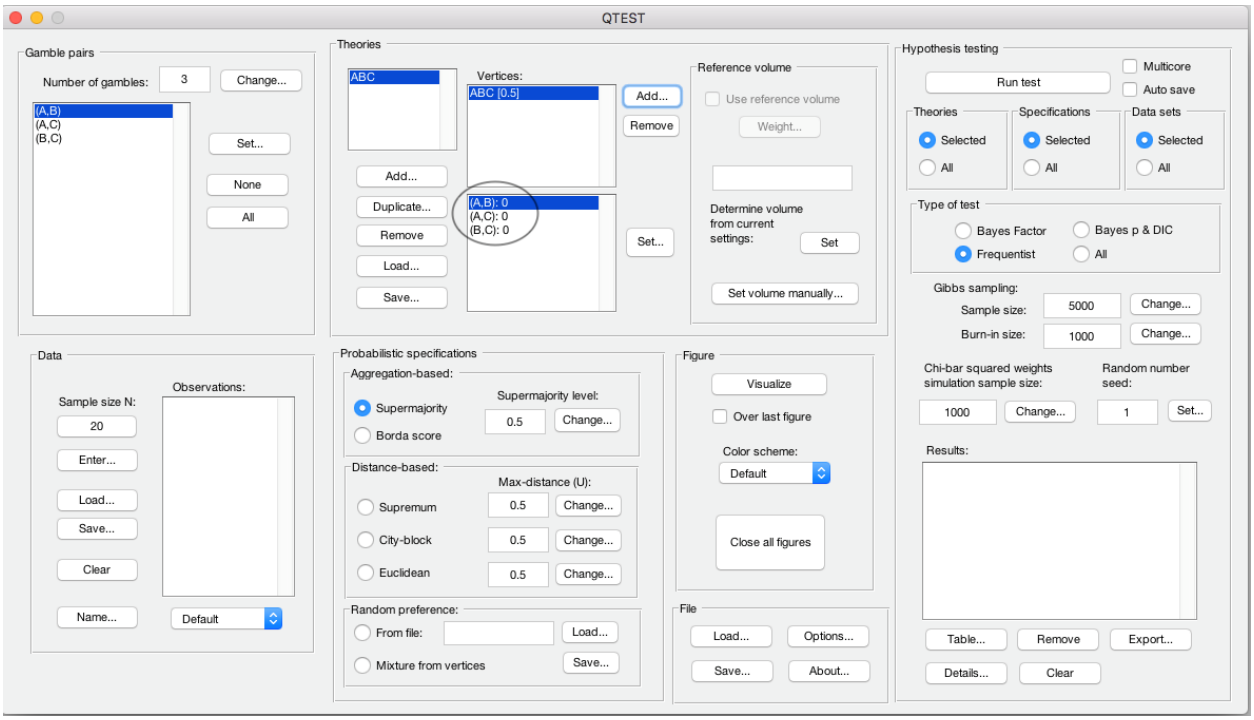
The “Set Vertex (Preference)” window pops up. For each gamble pair, select the gamble preferred under the ranking ABC. Since A is preferred to B in pair (A,B), select “A”. Likewise, A is preferred to C in pair (A,C), so select “A”. Finally, B is preferred to C in pair (B,C) so select “B”.

And then select “OK”.



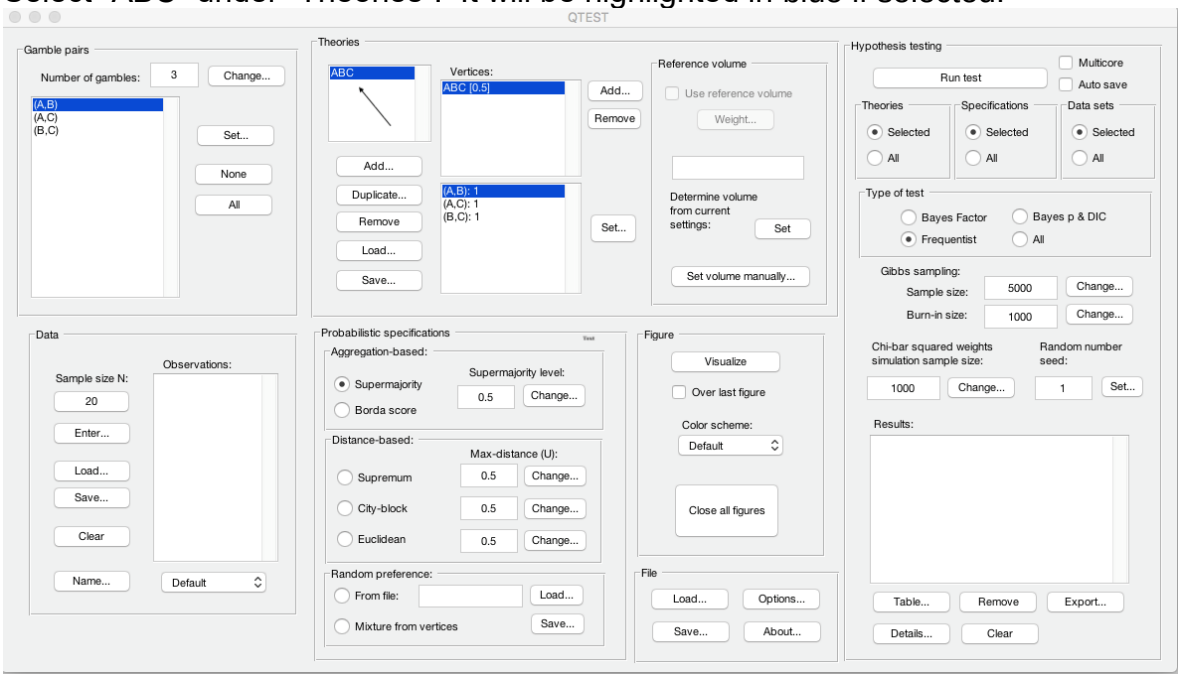
Above, MAC Users Selections window
(Windows users will have each selection option blue high-lighted)

The QTEST interface now shows theory “ABC” with the vertex representation corresponding to the ranking ABC that has coordinates (1,1,1). These coordinates are listed in the bottom half of “Vertices:”. Note that the Vertex label “ABC” is only a name and QTEST does not know what it stands for, so the user must specify the coordinates of the vertex.

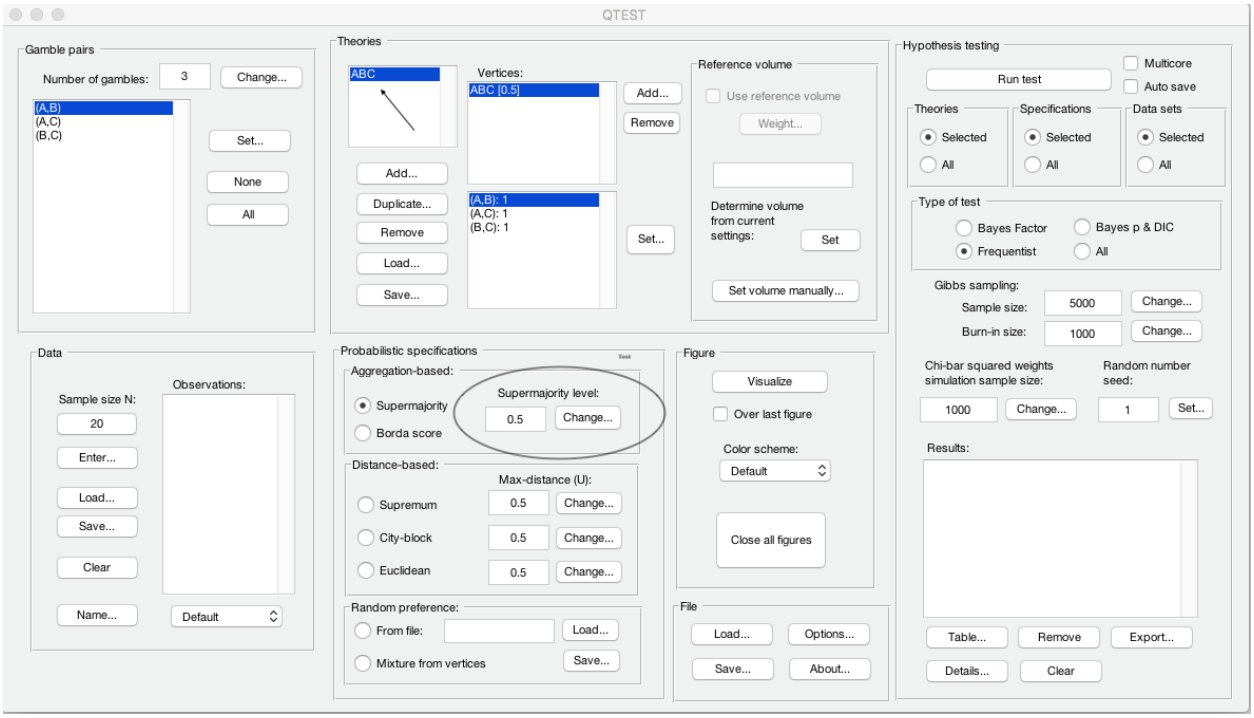


A.4 The 0.50-Majority/modal choice specification of theory ABC

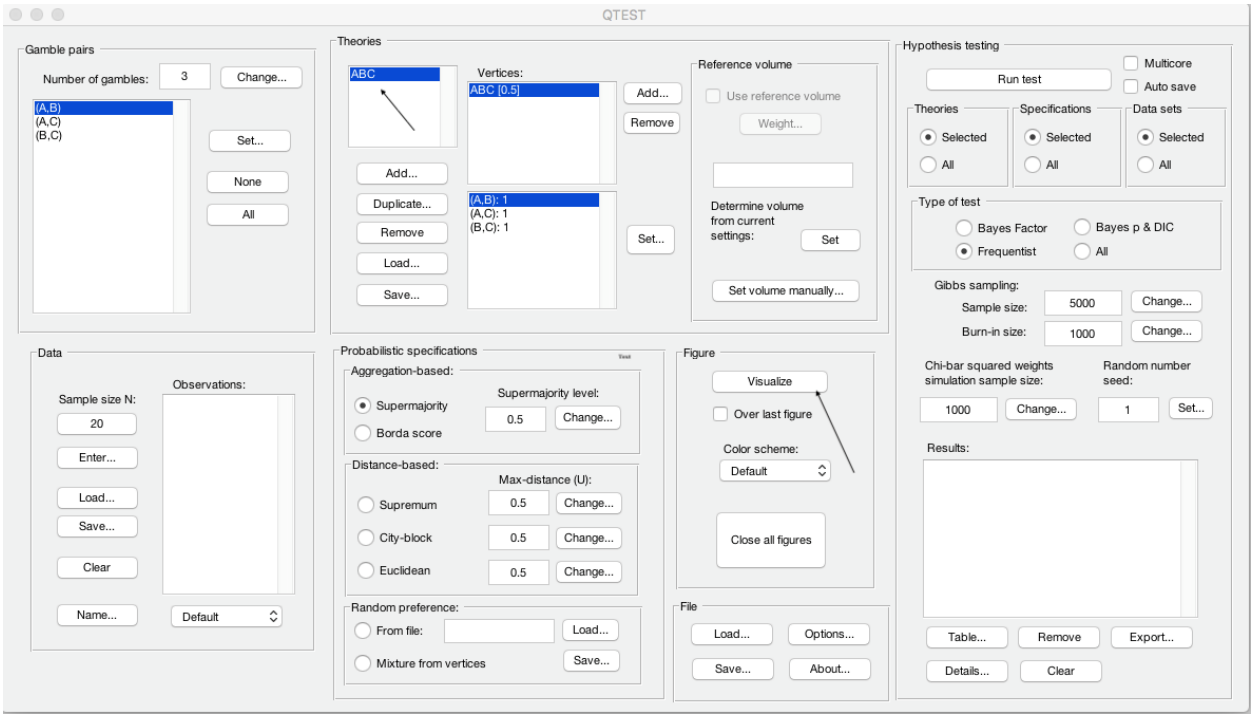
Now we use QTEST to create a 0.50-majority/modal choice specification for vertex ABC. Select “ABC” under “Theories”. It will be highlighted in blue if selected.



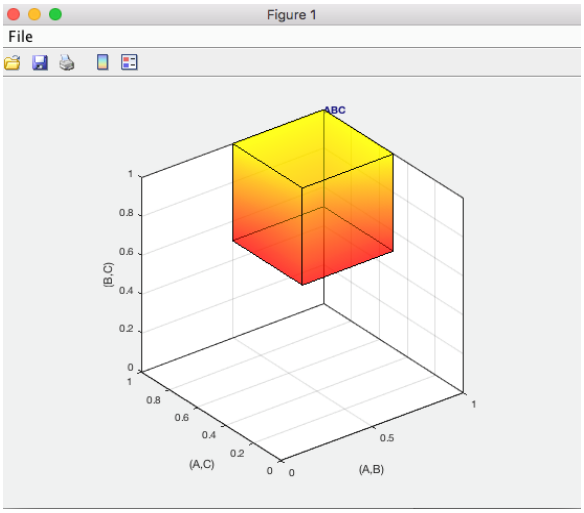
Under “Probabilistic specifications”, the radio button left of “Supermajority” should be selected, and the “Supermajority level” should be set to “0.5”.

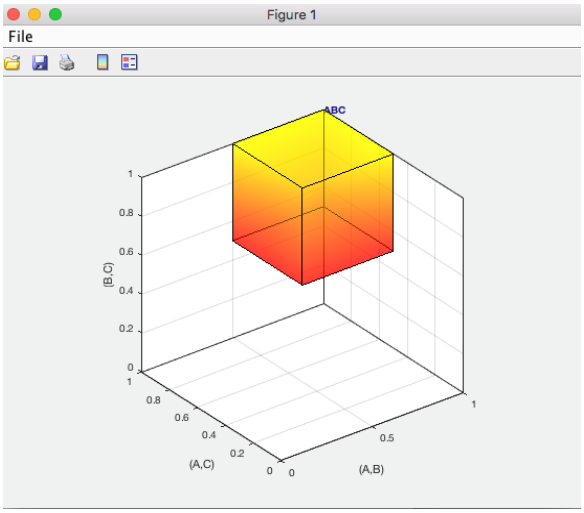


To create a rudimentary version of Figure 2 of QTBC1, press “Visualize”, under “Figure”.



A new figure window will pop up, like the one on the left, below. This figure can be rotated, printed, saved, etc., as indicated with the menu buttons in the top of the window. For instance, press once on the circle with an arrow icon inside, and then drag the cursor into the 3-D figure. Press the button on the mouse and then rotate the figure, to get the figure on the bottom.





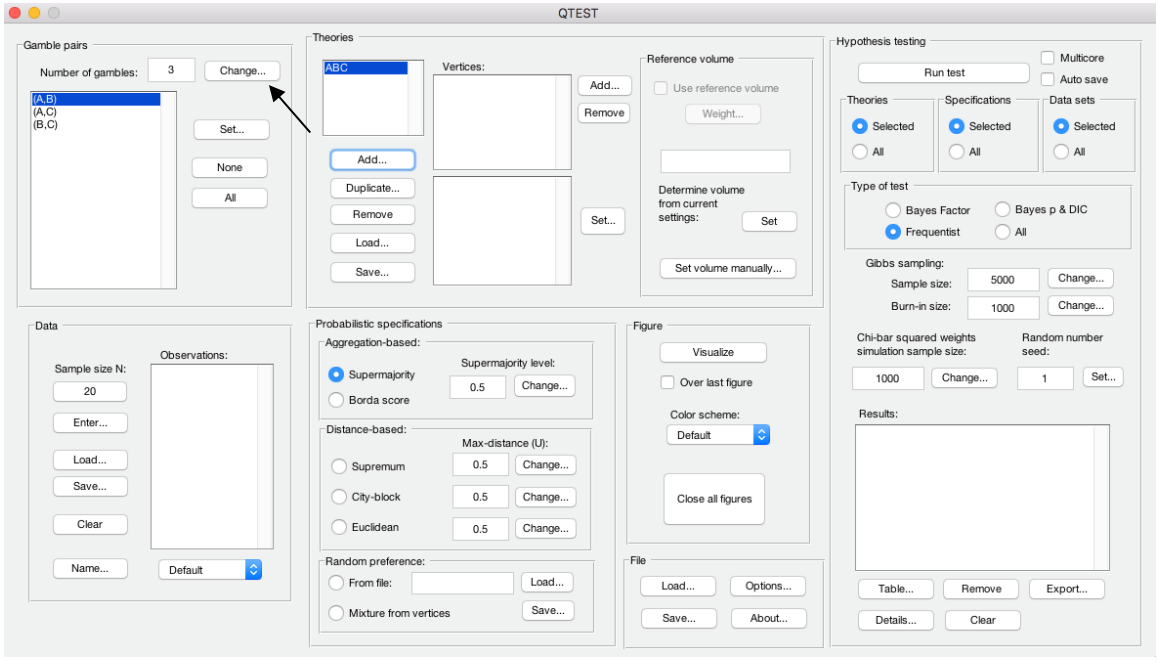
This completes the 0.50-majority specification of vertex ABC for Theory ABC. Notice that Figure 2 of QTBC1 shows additional information, namely seven other preference patterns. These are BAC, ABCA, BCA, ACBA, CBA, CAB and ACB. We do not discuss here how those were added, since they were added only for explanatory purposes in QTBC1.

B. KT-V4 (Figures 3-5 of QTBC1)

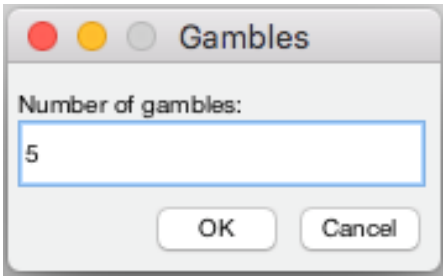
After finishing Section B of the tutorial, we will have created Figures 3, 4 and 5 of QTBC1. There are two important differences between the figures created in Section A and those created now in Section B. First, we use a different theory and different vertex. Second, Figures 3, 4 and 5 of QTBC1 are based on the gambles A, B, C, D and E in Table 1 of QTBC1. And of those 5 gambles we only consider gambles A, C, and D for the present section.

B.1 Create the gamble pairs

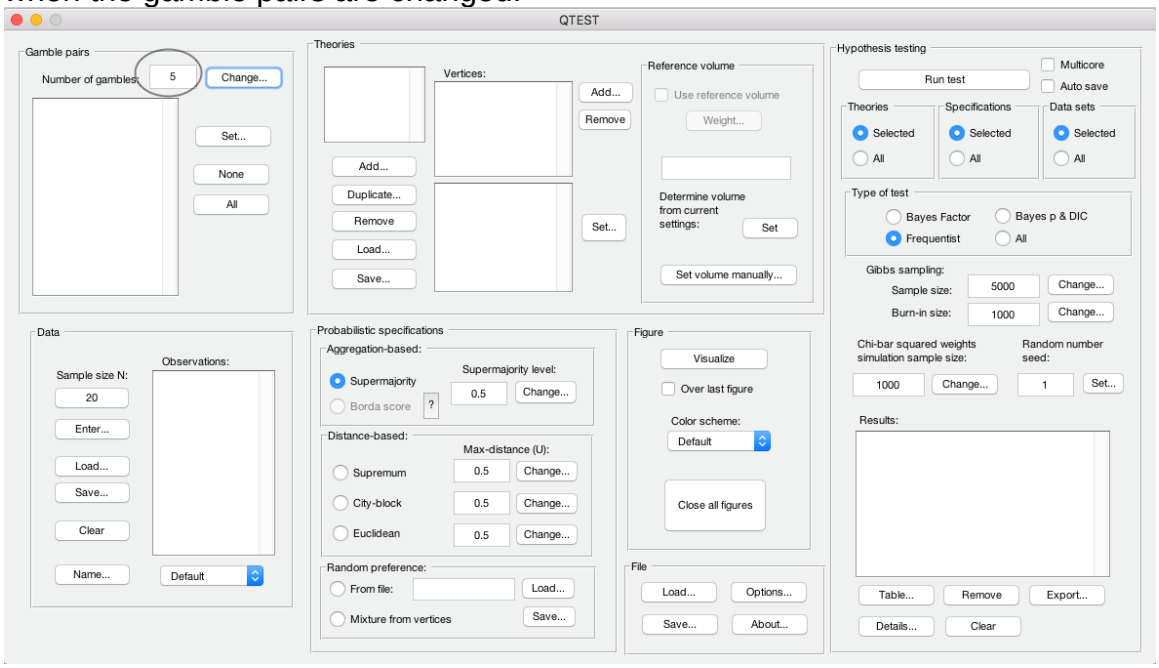
In the QTEST interface, under “Gamble pairs”, select “Change”.



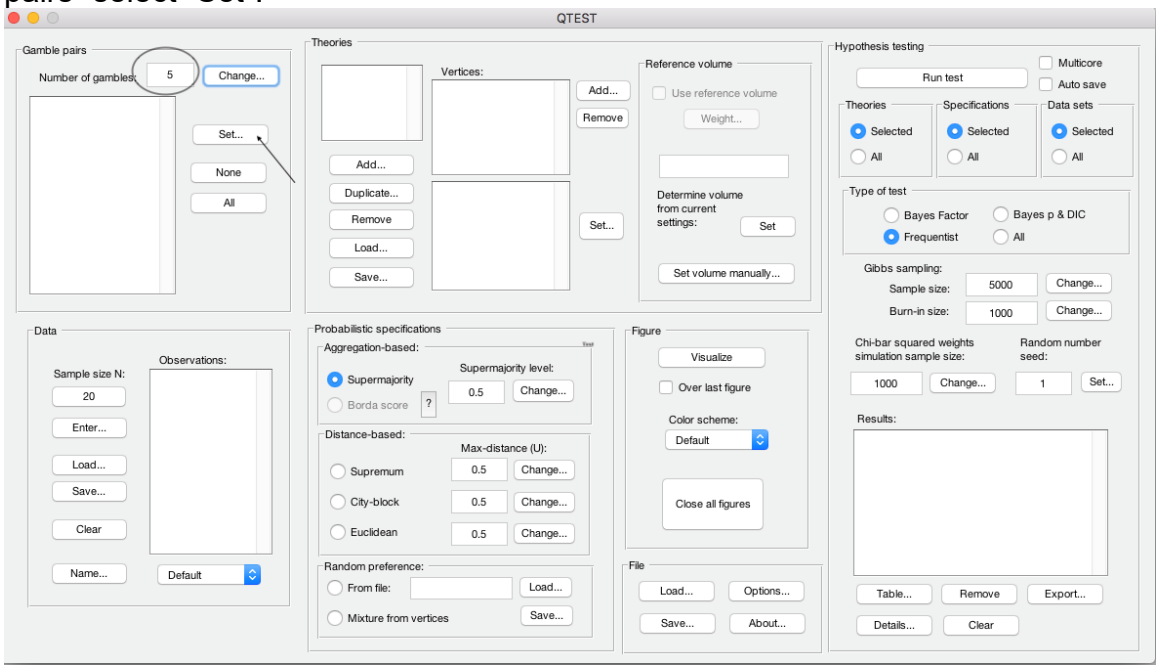
This will bring up the “Gambles” dialogue box. Enter “5” and press “OK.”



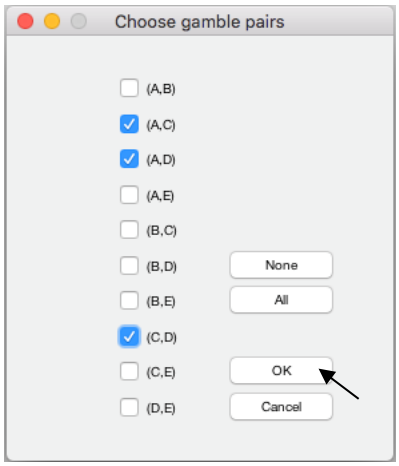
Under “Gamble pairs” notice the “Number of gambles:” has updated to “5”. Also notice that the rest of the interface has been cleared. This will always happen when the gamble pairs are changed.



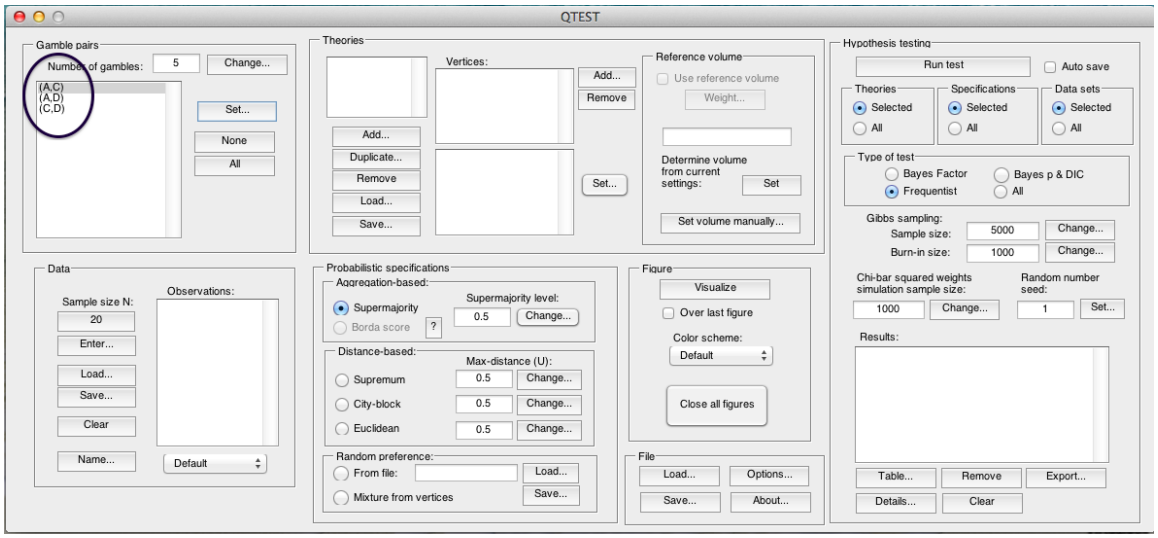
In Section A.1, with the 3 gambles A, B and C, we selected “All” in the “Gamble Pairs” section to create all 3 pairs of gambles. If we selected “All” for the 5 gambles A, B, C, D and E, this would result in the construction of 10 gamble pairs. However, in Figure 3 of QTBC1, to stay in 3-D space, we focus only on 3 of these 10 possible pairs: AC, AD and CD. So, we now show how to create this subset of 3 gamble pairs from the 10 pairs that are possible. Under “Gamble pairs” select “Set”.



In the “Choose gamble pairs” dialogue box that pops up, select the boxes next to gamble pairs “(A,C)”, “(A,D)” and “(C,D)” and then select “OK”.



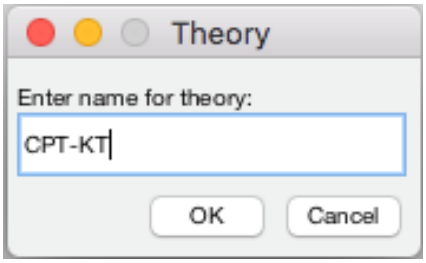
Under “Gamble pairs”, only the 3 gamble pairs selected are listed.



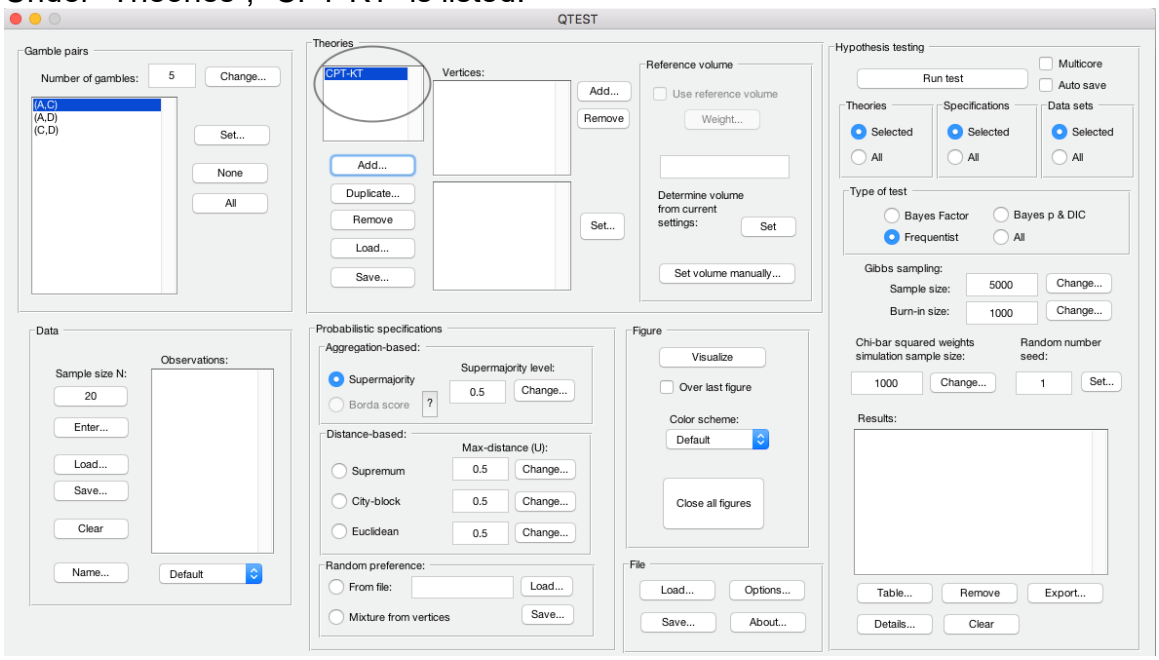
This is how to create a subset of gamble pairs if all gamble pairs are not needed. We now define our next decision theory.

B.2 Define one decision theory, *CPT-KT*

This time we will use the decision theory specified in Figure 3 of QTBC1: *CPT-KT*, or Cumulative Prospect Theory with a "Kahneman-Tversky" weighting function. Under "Theories" select "Add". In the "Theory" dialogue box that pops up, enter "CPT-KT". Then select "OK".

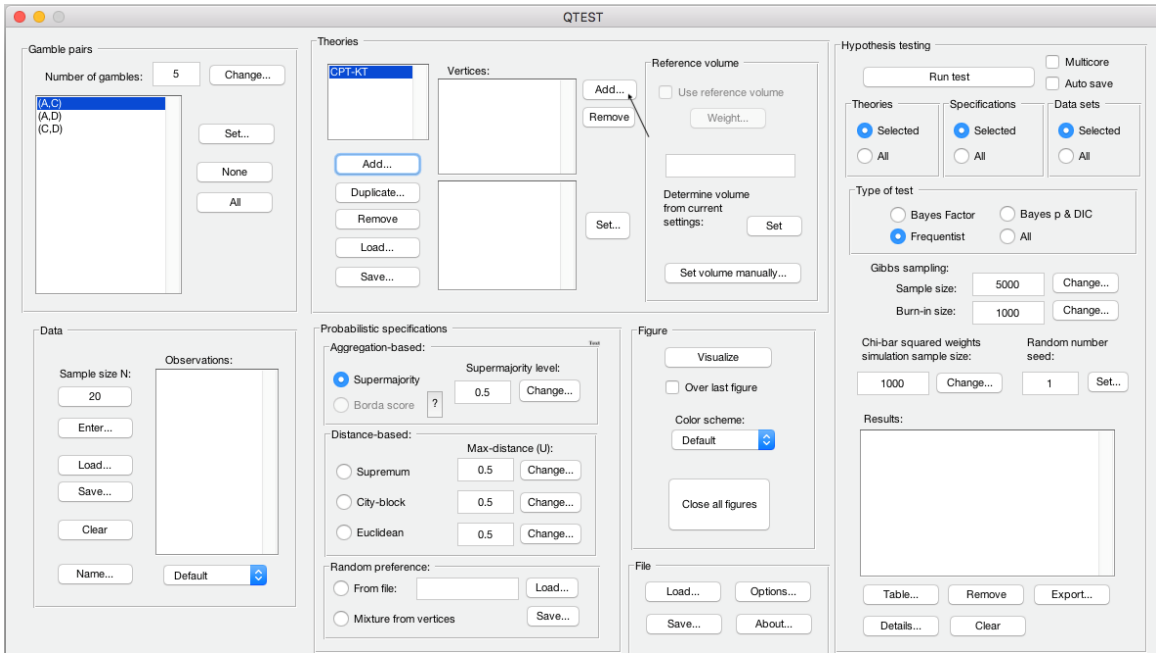


Under "Theories", "CPT-KT" is listed.

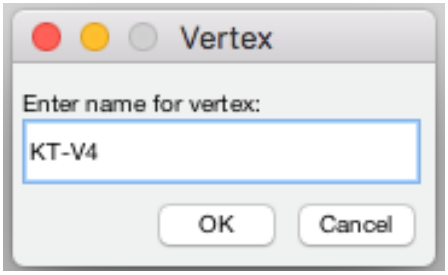


B.3 Specify a prediction of decision theory *CPT-KT*

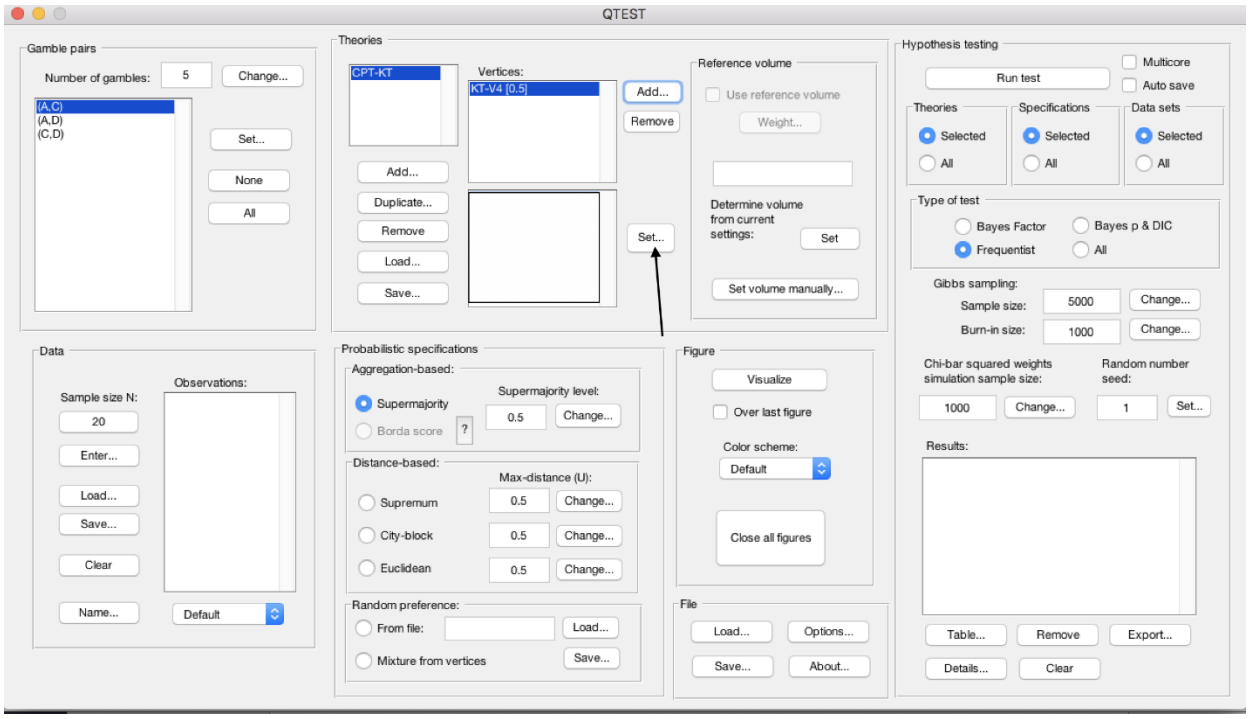
Having defined *CPT-KT*, we now specify a prediction of the theory. Under "Theories", just right of "Vertices:", select "Add."



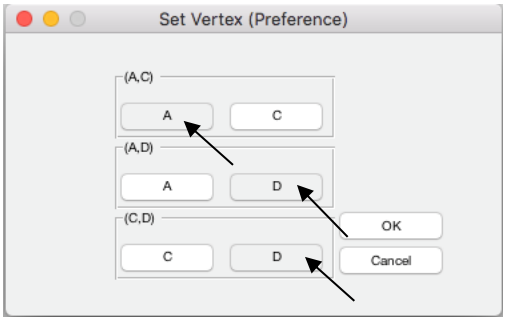
The “Vertex” dialogue box that pops up will prompt you for a label name of the vertex associated with theory $CPT\text{-}KT$. Figure 3 of QTBC1 labels this vertex KT-V4. Enter “KT-V4”. Select “OK.”



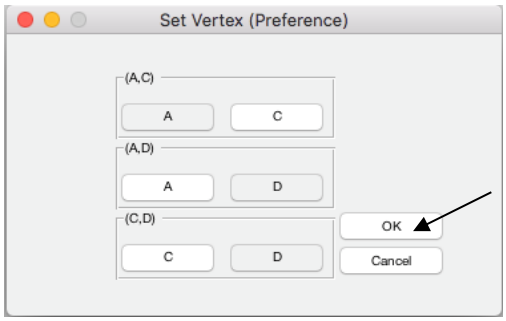
Next, specify the coordinates of this vertex. Under “Vertices:” select “Set…



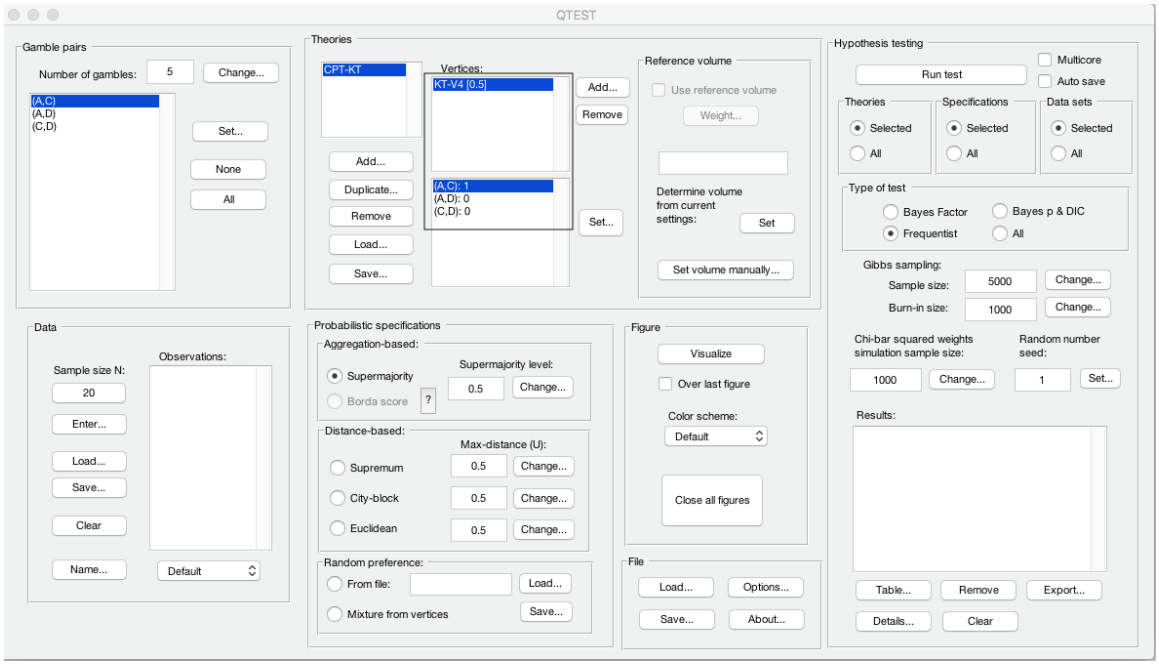
The “Set Vertex (Preference)” window pops up. For each gamble pair, select the button associated with the preferred gamble according to the ranking DAC. A is preferred to C in pair (A,C) so select “A”. D is preferred to both A and C so select “D” from pairs (A,D) and (C,D), respectively.



Then select “OK”.

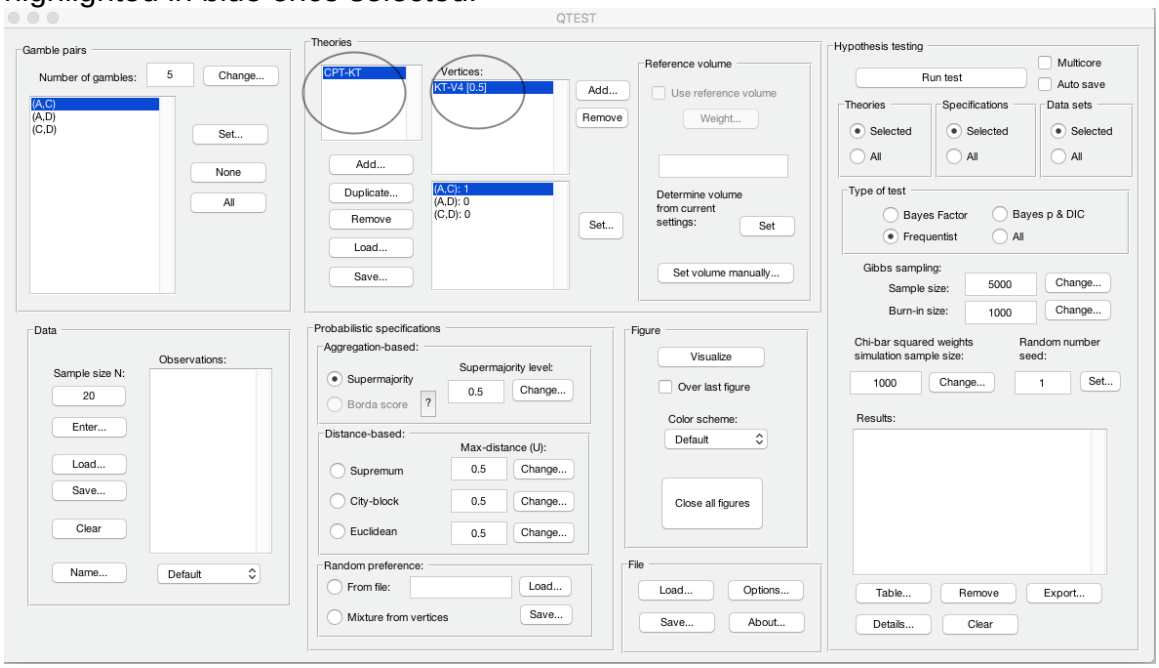


Under “Theories” the QTEST interface shows theory “CPT-KT”. Under “Vertices”, the top half lists vertex, “KT-V4 [0.5]” and the bottom half lists the coordinates (1,0,0).

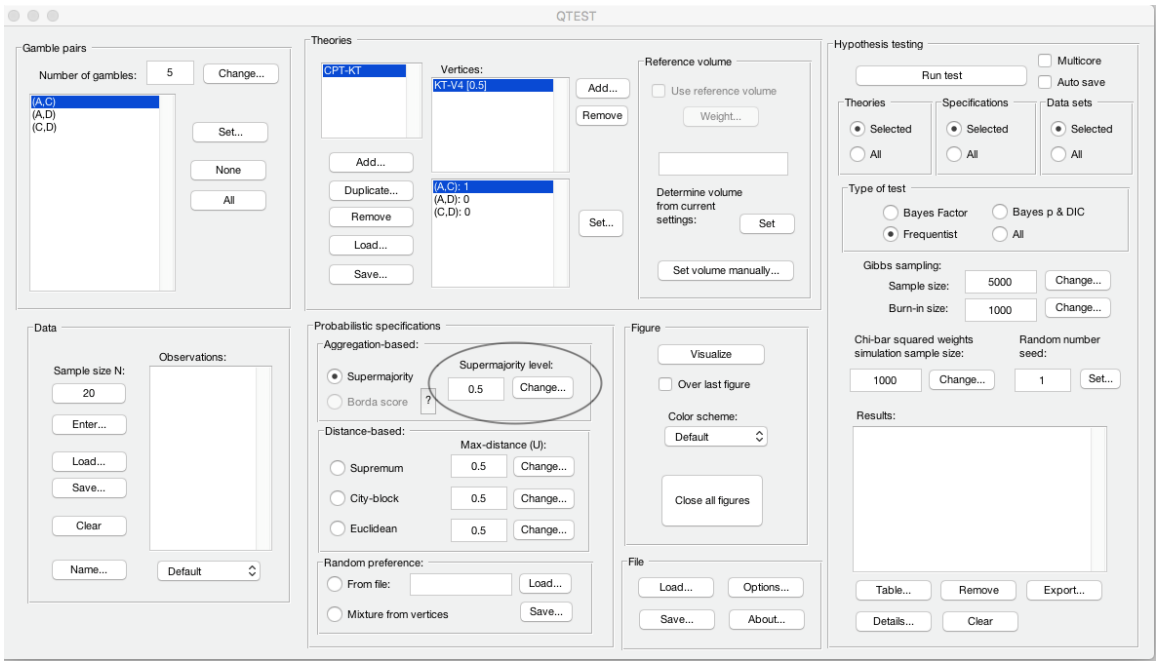


B.4 The 0.50-Majority/modal choice specification of KT-V4 for theory *CPT-KT*

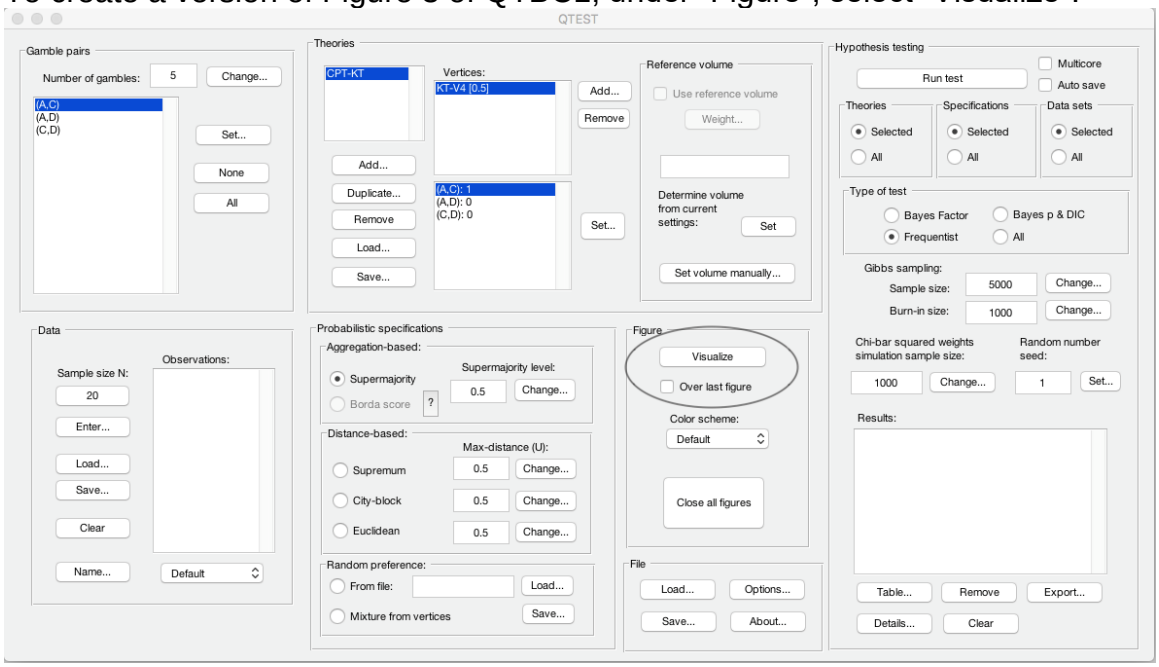
We now use QTEST to construct the 0.50-majority/modal choice specification for KT-V4. First, under "Theories", select "CPT-KT" and "KT-V4". They will be highlighted in blue once selected.



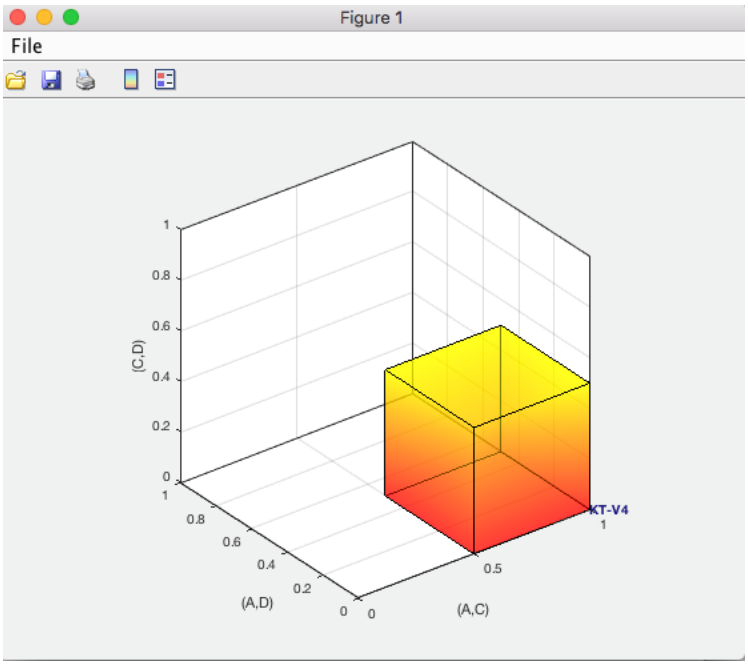
Under "Probabilistic specifications", verify the radio button left of "Supermajority" is checked and that the "Supermajority level:" is set to "0.5".



To create a version of Figure 3 of QTBC1, under “Figure”, select “Visualize”.



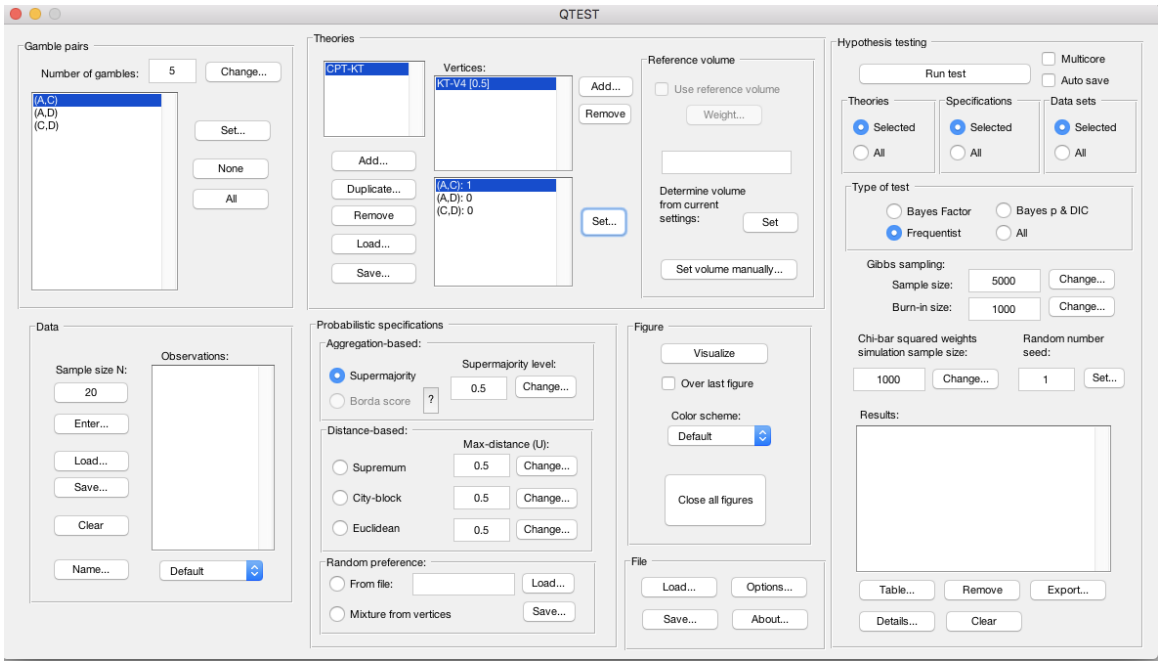
A figure, like the one below, pops up in a separate window. This figure is the leftmost panel in Figure 3 of QTBC1 (without the data points).



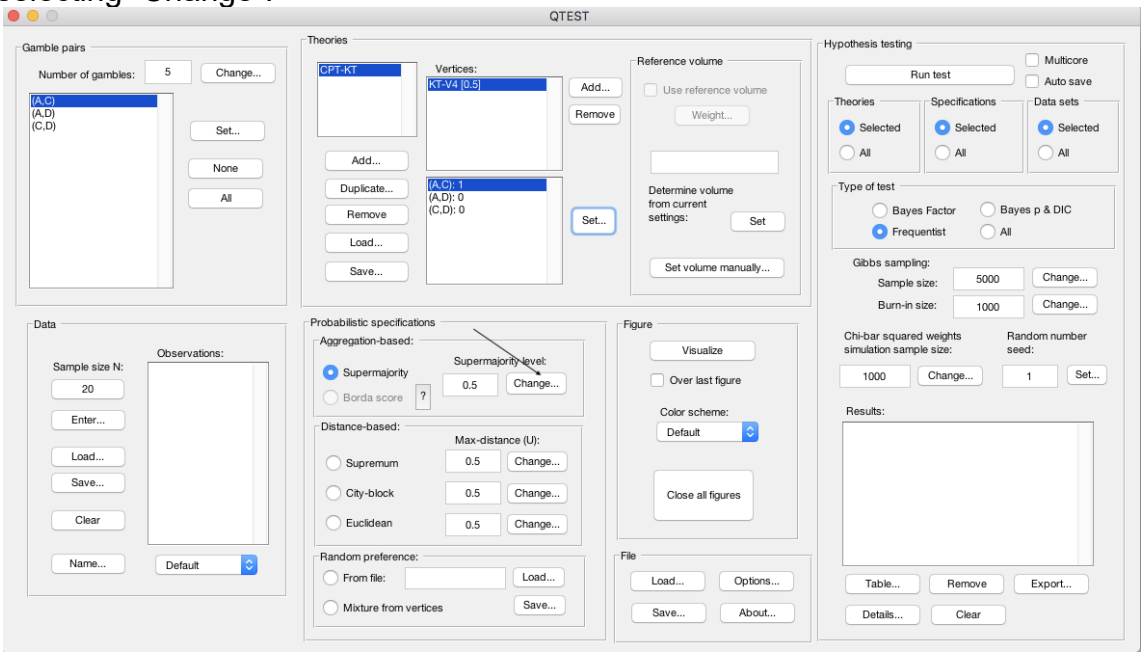
This completes the 0.50-majority specification of KT-V4 for theory *CPT-KT*. QTEST can create more than just a 0.50-majority/modal choice specification. Figure 4 of QTBC1, for instance, depicts the 0.75-supermajority specification of KT-V4 for theory *CPT-KT*. We now show how to create this probabilistic specification in QTEST.

B.5 The 0.75-Supermajority specification of KT-V4 for theory *CPT-KT*

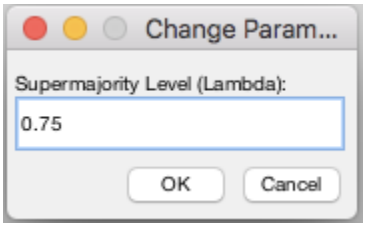
We will now create the 0.75-supermajority probabilistic specification for KT-V4 in Figure 4 of QTBC1. Under "Theories", select "CPT-KT" and "KT-V4" so they are blue highlighted.



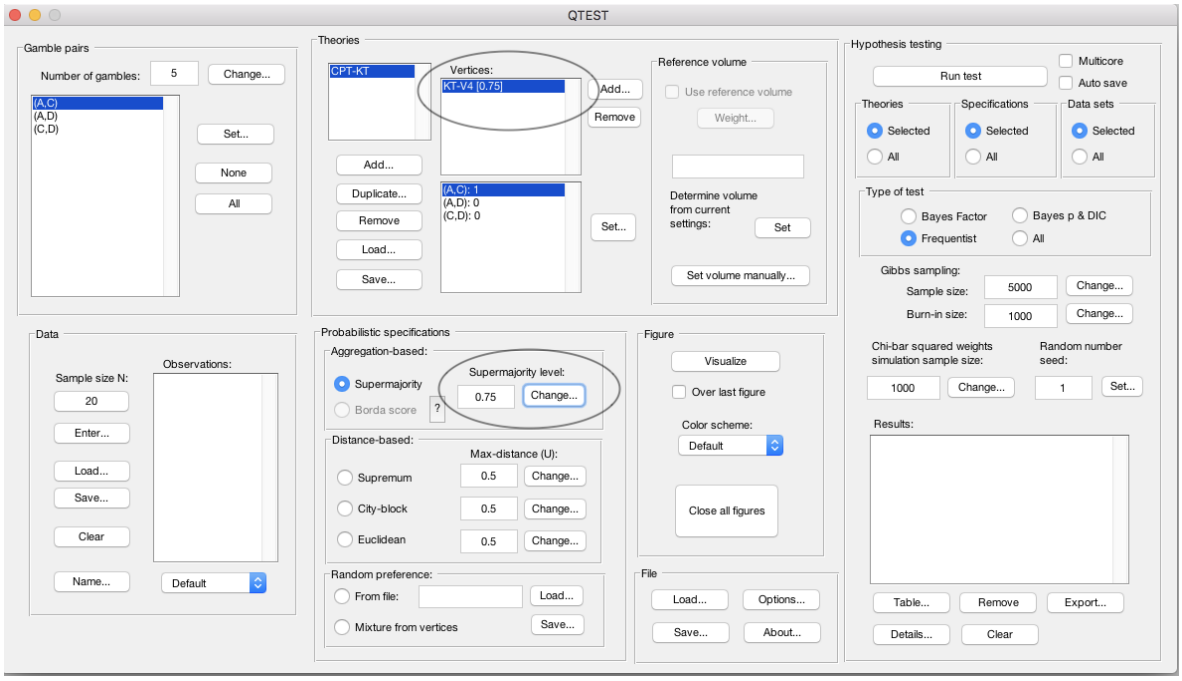
Under “Probabilistic specifications”, under “Aggregation-based:”, verify the radio button left of “Supermajority” is selected. Adjust the “Supermajority level:” by selecting “Change”.



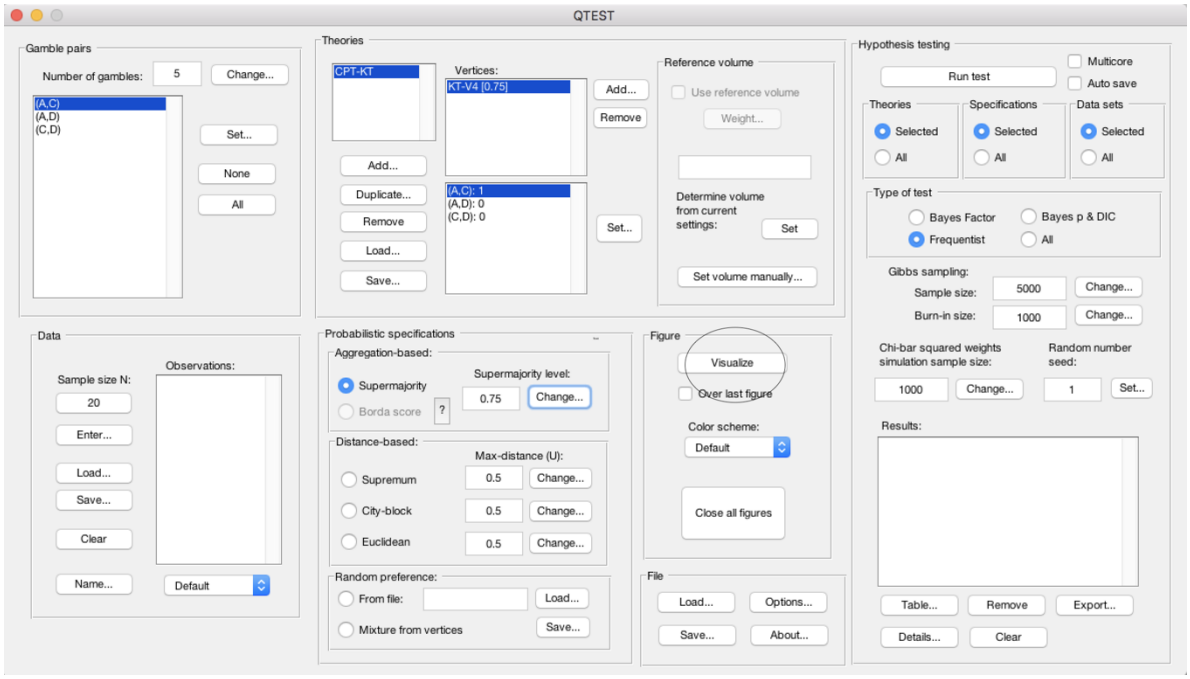
The dialogue box that pops up asks the user to specify the “Supermajority Level (Lambda):”. Enter “.75” into the box. Select “OK”.



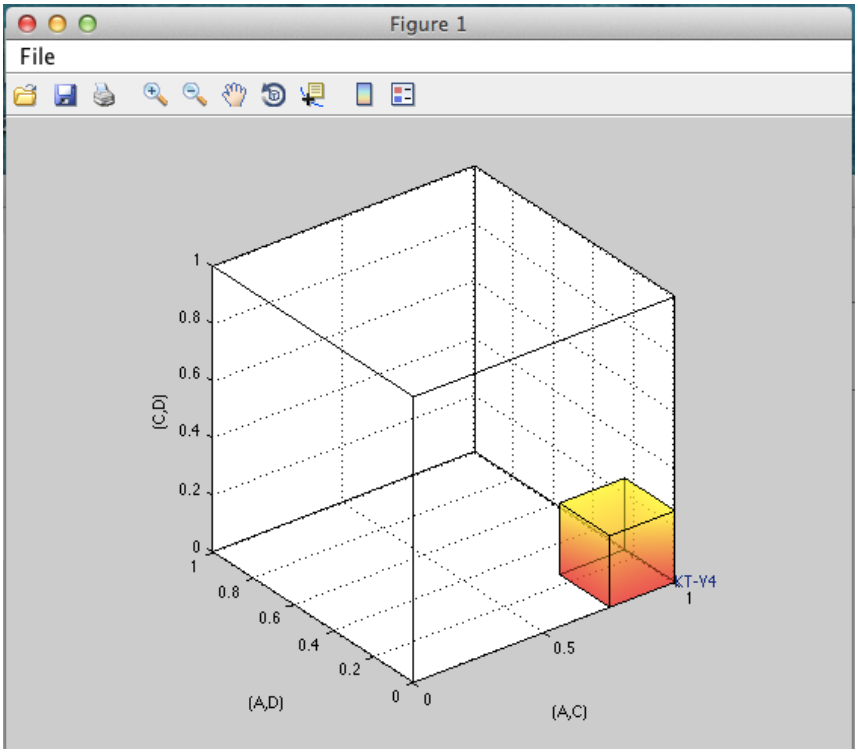
Notice two changes to the QTEST interface. First, under “Theories”, under “Vertices”, the vertex “KT-V4 [0.75]” now has the 0.75-supermajority specification contained in square brackets. Second, the “Supermajority level” under “Probabilistic specifications” has been updated to “0.75”.



To create a version of Figure 4 of QTBC1, press “Visualize” under “Figure”.



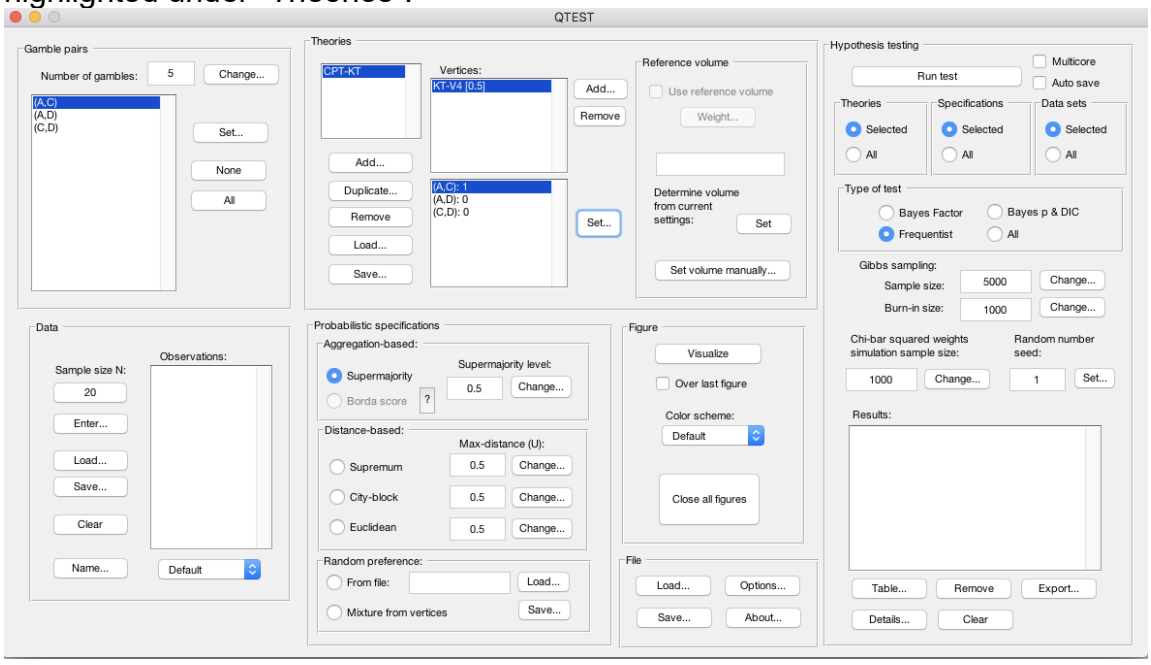
A new figure will pop up in a separate window. In this case the resulting figure is the left panel in Figure 4 of QTBC1 (without the data points).



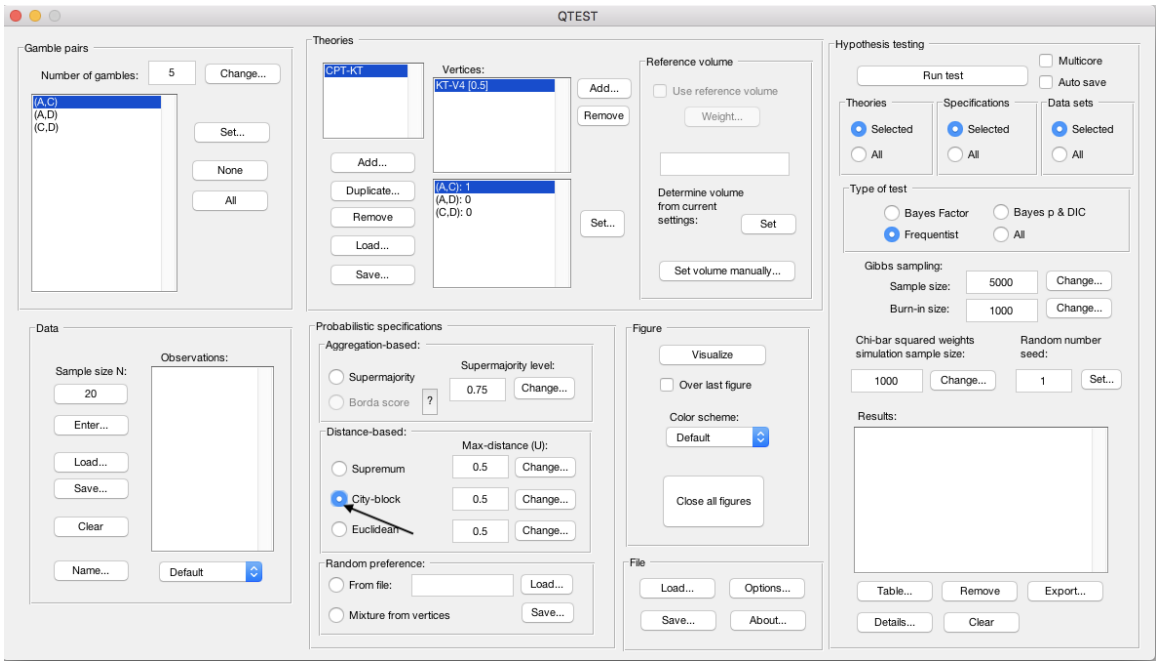
This completes the 0.75-supermajority specification of KT-V4 for theory *CPT-KT*. QTEST can also create distance-based specifications, such as supremum, city-block and Euclidean. Figure 5 of QTBC1 depicts the 0.5-city-block specification of KT-V4 for theory *CPT-KT*. We now show how to create this probabilistic specification in QTEST. (For a formal derivation and fuller treatment of aggregation- and distance-based specifications, we refer the interested reader to Appendix B of QTBC1: Probabilistic Specification.)

B.6 The 0.50-city-block specification of KT-V4 for theory *CPT-KT*

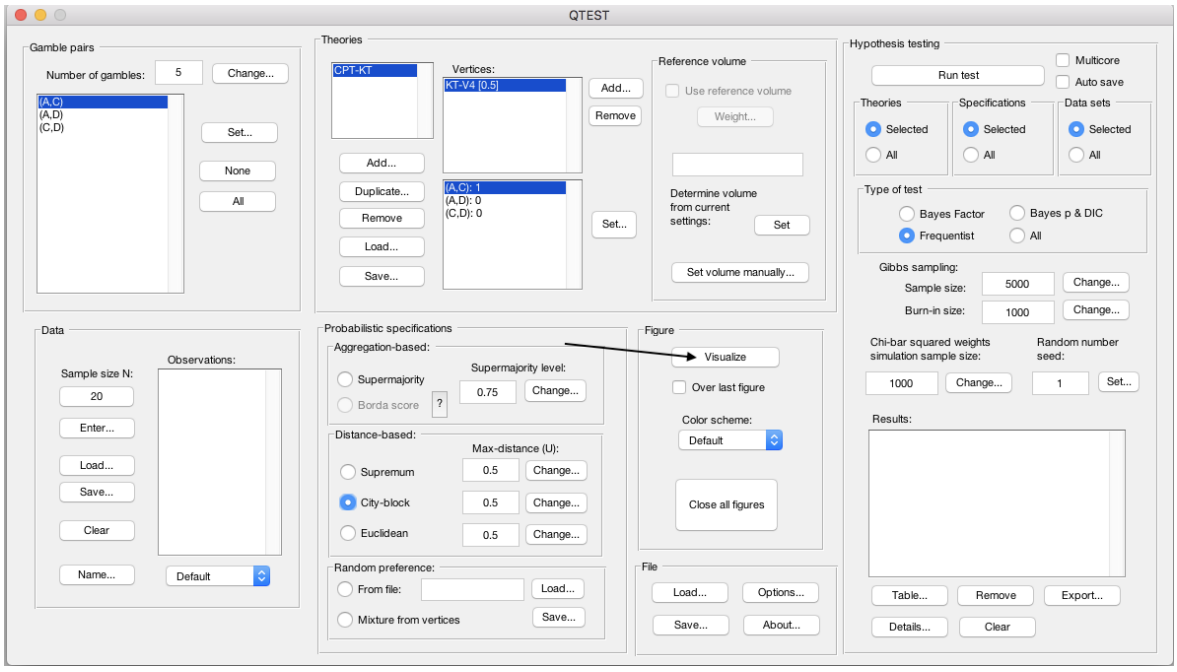
We now create the 0.50-city-block distance-based probabilistic specification for KT-V4 in Figure 5 of QTBC1. First, make sure "CPT-KT" and "KT-V4" are blue highlighted under "Theories".



Under "Probabilistic specifications", under "Distance-based:", the radio button left of "City-block" should be selected. Leave the "Max-distance (U):" set to 0.5, as shown below.



To create a version of Figure 5 of QTBC1, press “Visualize” under “Figure”.



A figure will pop up in a separate window. In this case it is the left panel in Figure 5 of QTBC1 (without the data points). Please note that distance-based specifications with values greater than 0.50 will lead to a warning message, indicating that the regions are overlapping. In this case the user needs to think carefully about how to proceed.

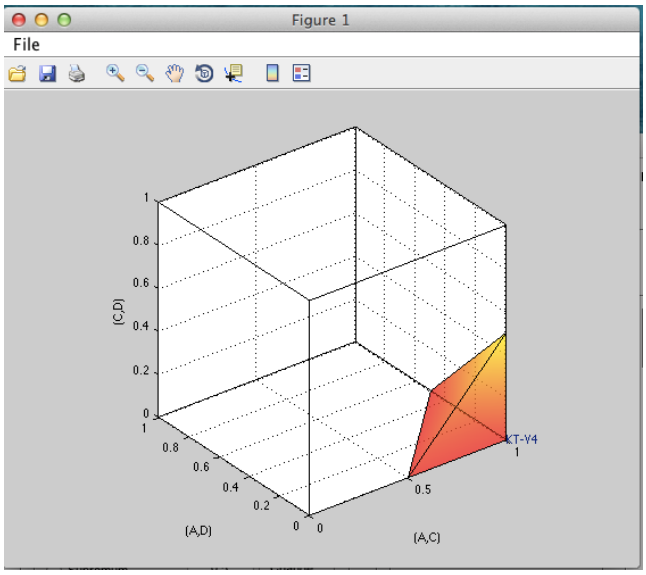


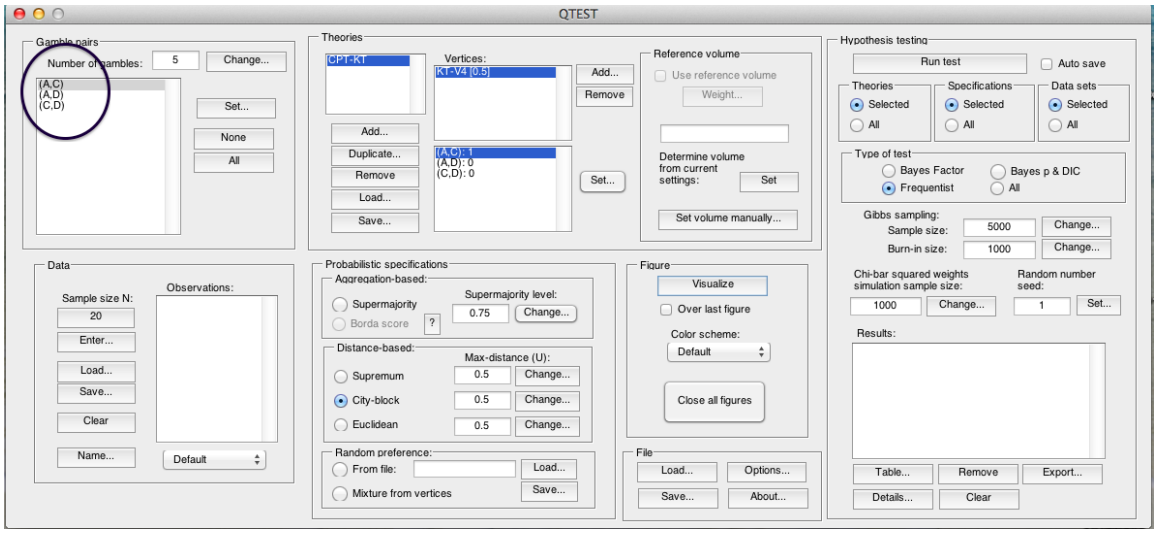
Figure 1
File
(C,D)
1
0.8
0.6
0.4
0.2
0
(A,D)
1
0.8
0.6
0.4
0.2
0
0
0.5
1
(A,C)
XT-V4

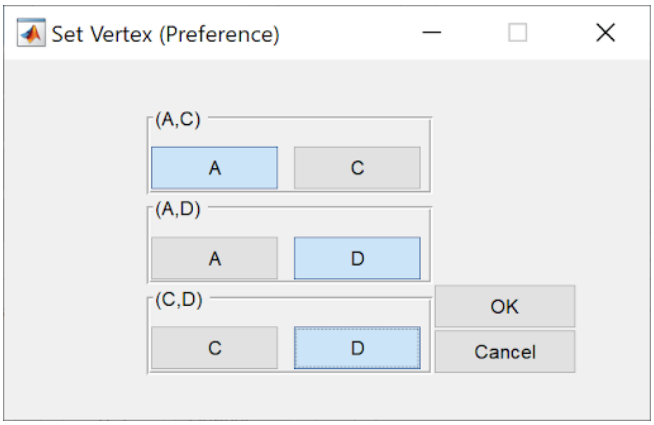
C. KT-V4 vs. $\mathcal{LH}$ (Figure 6 of QTBC1)

We build on Section B by introducing a second theory and demonstrating how the theories compare in the same 3-D geometric space. In Section B.4 we created the 0.50-majority/modal choice specification for $\mathcal{CPT}$-$\mathcal{KT}$ for the vertex KT-V4 for the 3 gambles A, C and D. We use the same 0.50-majority/modal choice specification from B.4. But we also create a specification for the lexicographic heuristic, or $\mathcal{LH}$, in Figure 6 of QTBC1.

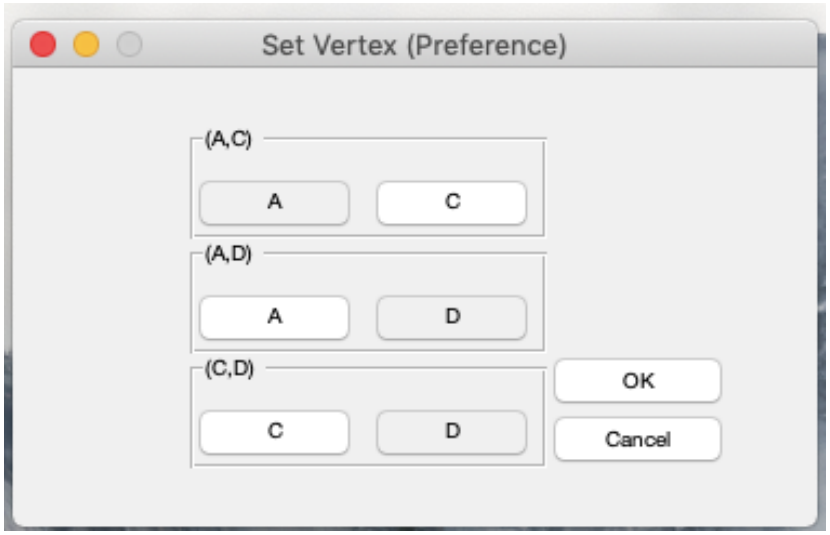
C.1 Create the gamble pairs

If you are continuing from Section B.6 (or starting from a saved session of B.6), your QTEST interface needs to match the following screenshot under "Gamble pairs". Specifically, set the "Number of gambles" to "5". Then verify the 3 gamble pairs "(A,C)", "(A,D)" and "(C,D)" are listed under "Gamble pairs".





Above, the Selection Box appears for **Windows Users** (the selected letters will be blue highlighted, and non-selected letters will appear gray)

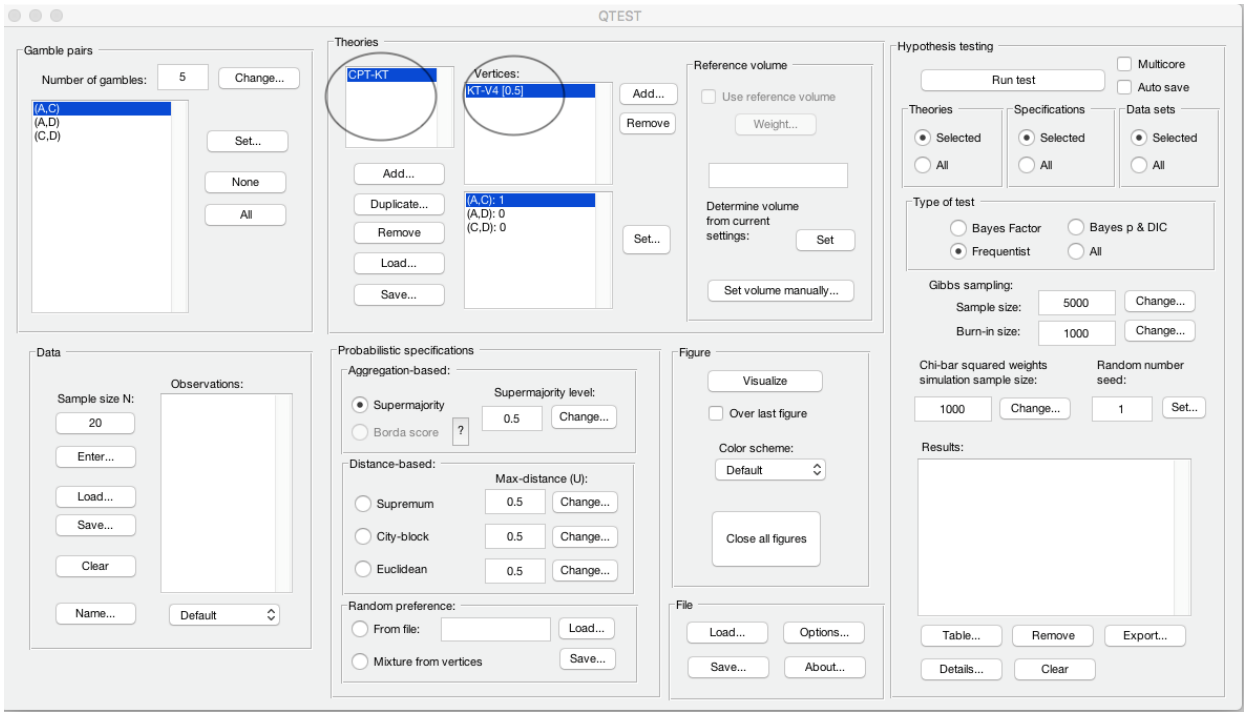


Above, the Selection Box Appears as such for **Mac Users** (the selected letters will remain dark gray, and the non-selected letters become white highlighted)

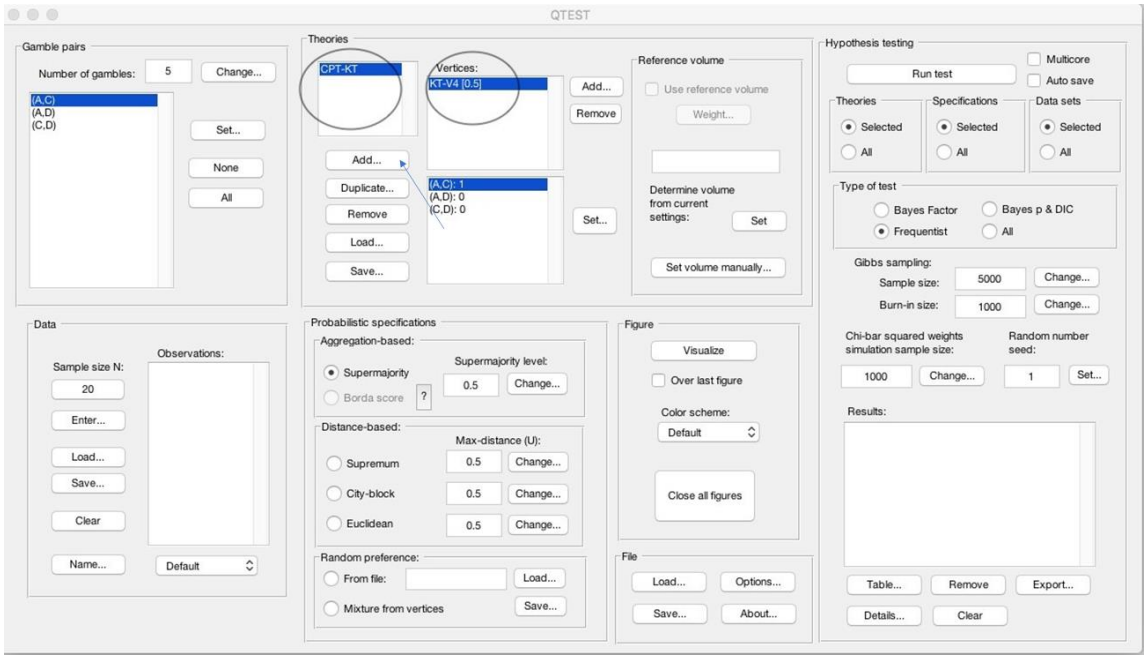
C.2 Define two decision theories, $\mathcal{CPT}$-$\mathcal{KT}$ and $\mathcal{LH}$

Figure 6 of QTBC1 compares two theories: $\mathcal{CPT}$-$\mathcal{KT}$ and $\mathcal{LH}$. We already introduced $\mathcal{CPT}$-$\mathcal{KT}$ in Section B.2. If you are starting a new session of QTEST (or do not have a saved session), please return to Section B.2 and define $\mathcal{CPT}$-

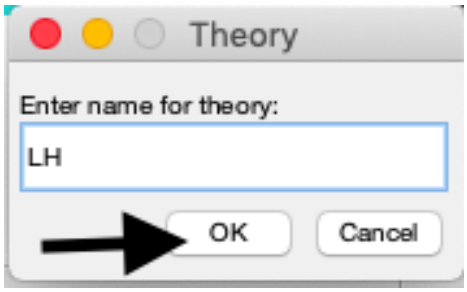
$\mathcal{KT}$ before proceeding. The correct QTEST interface will look like the following. Notice “CPT-KT” is defined under “Theories”.



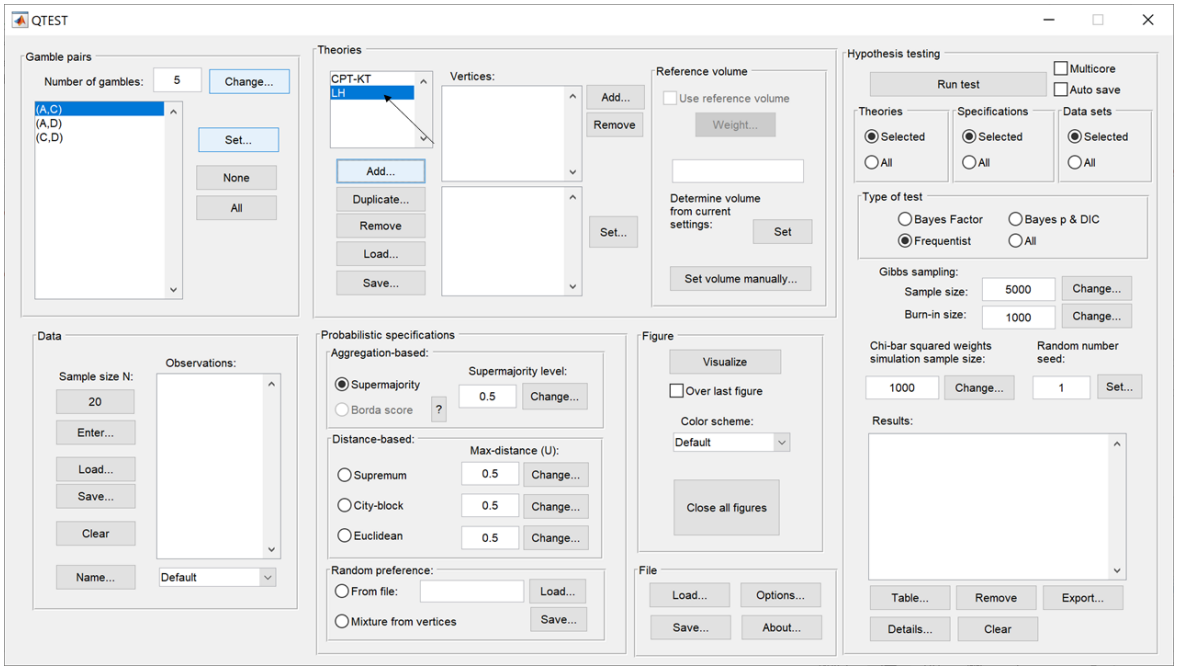
Next add the $\mathcal{LH}$. Under “Theories” select “Add…”.



Enter “LH” in the “Theory” dialogue box that pops up. Then select “OK”.



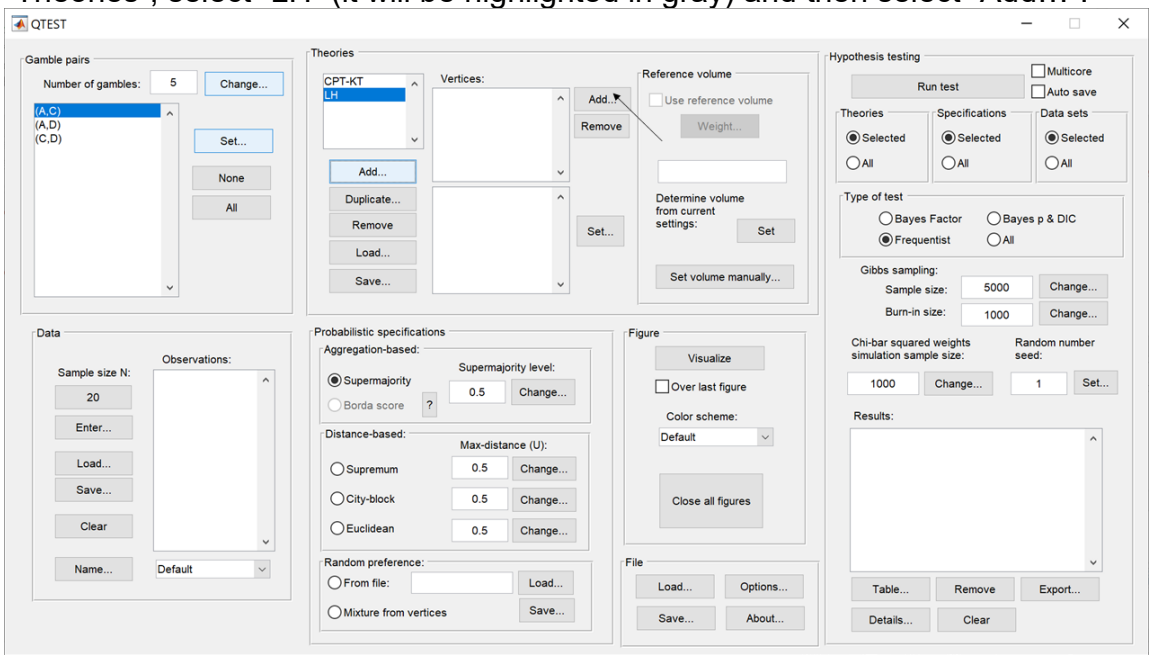
Notice that the updated “Theories” list now contains both “CPT-KT” and “LH”.



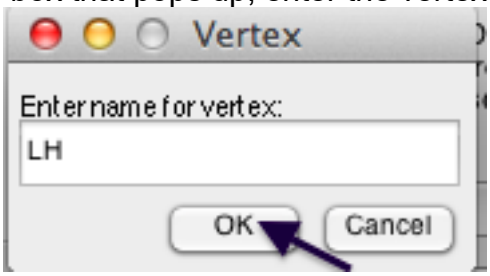
Now we have defined 2 theories in one QTEST session.

C.3 Specify predictions of decision theories $\mathcal{LH}$ and $\mathcal{CPT\text{-}KT}$

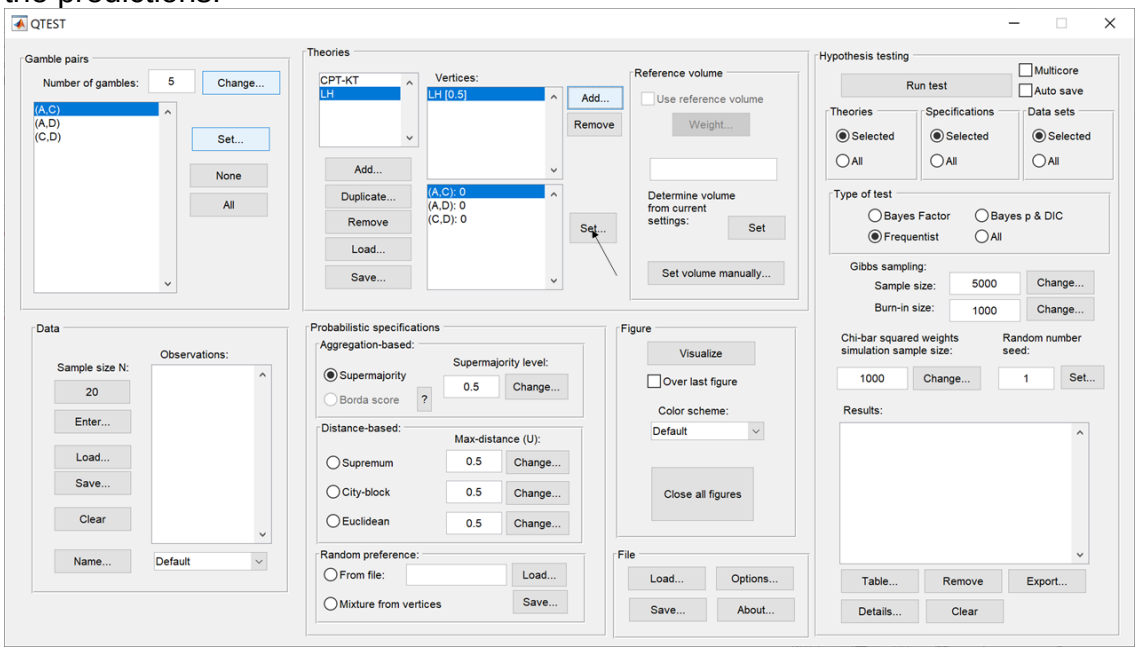
Having defined the theory $\mathcal{LH}$, we now specify its one prediction. Under "Theories", select "LH" (it will be highlighted in gray) and then select "Add…".



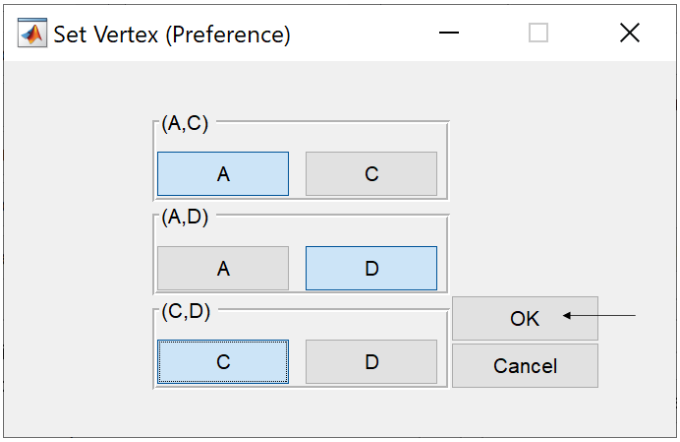
In the "Vertex" dialogue box that pops up, enter the vertex "LH". Select "OK".



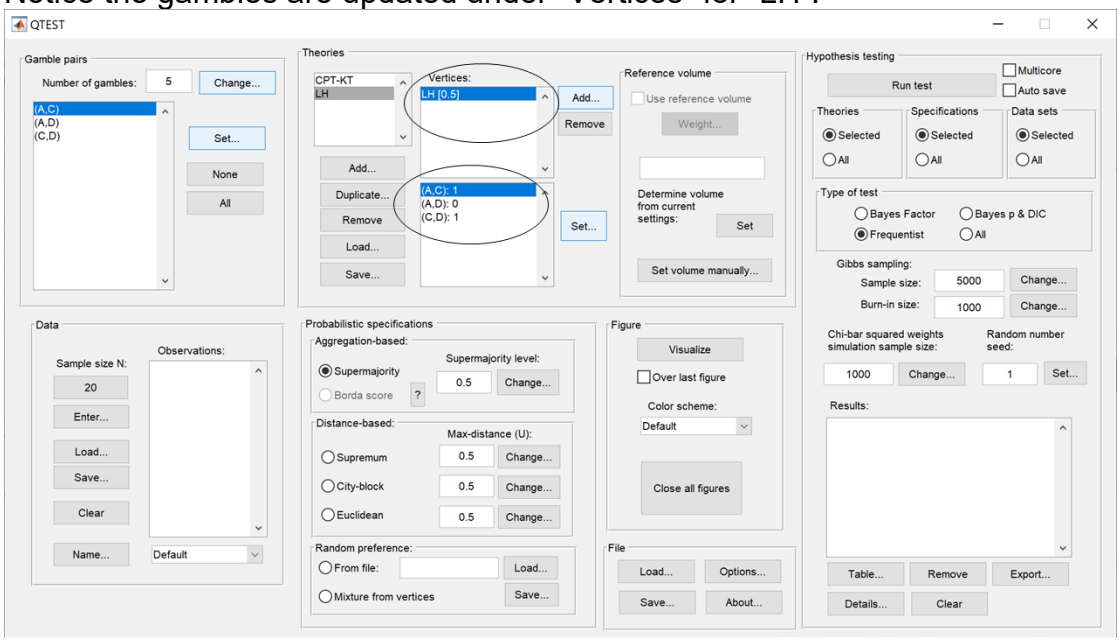
All gamble pairs are set to “0“ by default under “Vertices”. Press “Set” to specify the predictions.



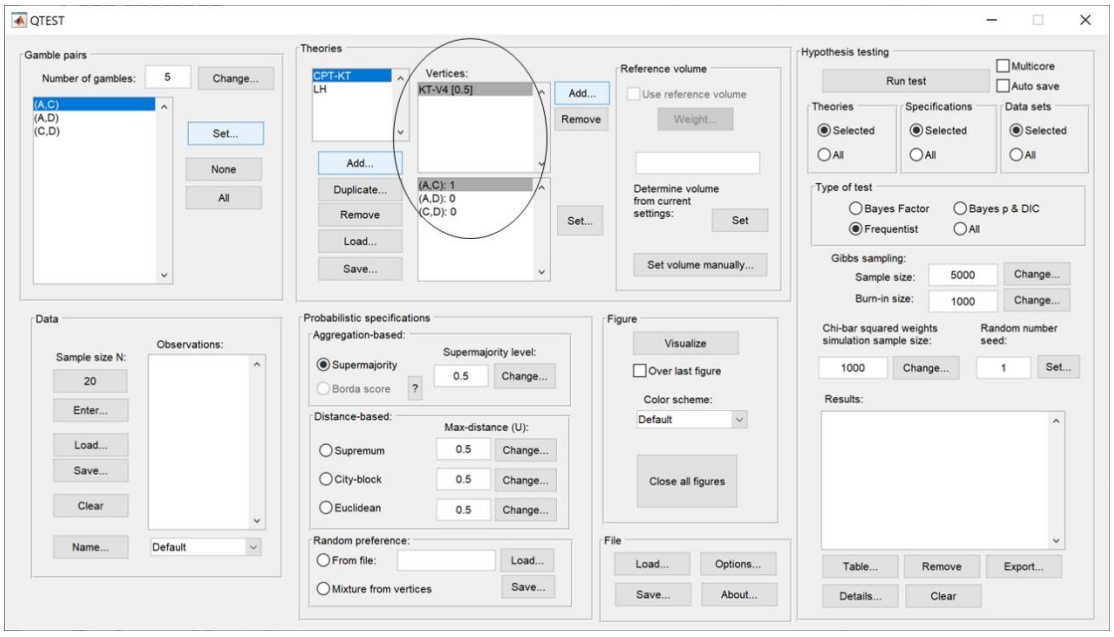
In the “Set Vertex (Preference)” dialogue box that pops up, select “A” from the pair “(A,C)”, “D” from the pair “(A,D)” and “C” from the pair “(C,D)”. Then select “OK”.



Notice the gambles are updated under “Vertices” for “LH”.



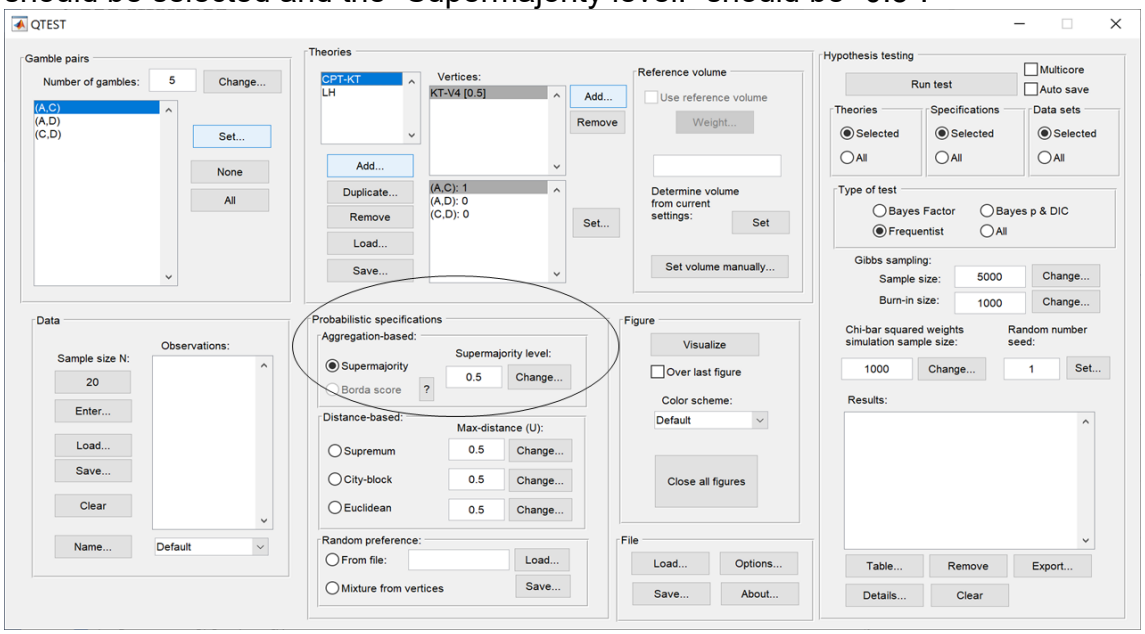
The prediction for LH is now specified. The prediction for CPT-KT should already be set. Check this by clicking once on “CPT-KT” under “Theories”. “CPT-KT” will now be highlighted in blue, “KT-V4” is highlighted in gray under “Vertices” and the gambles are defined as in the following screenshot.



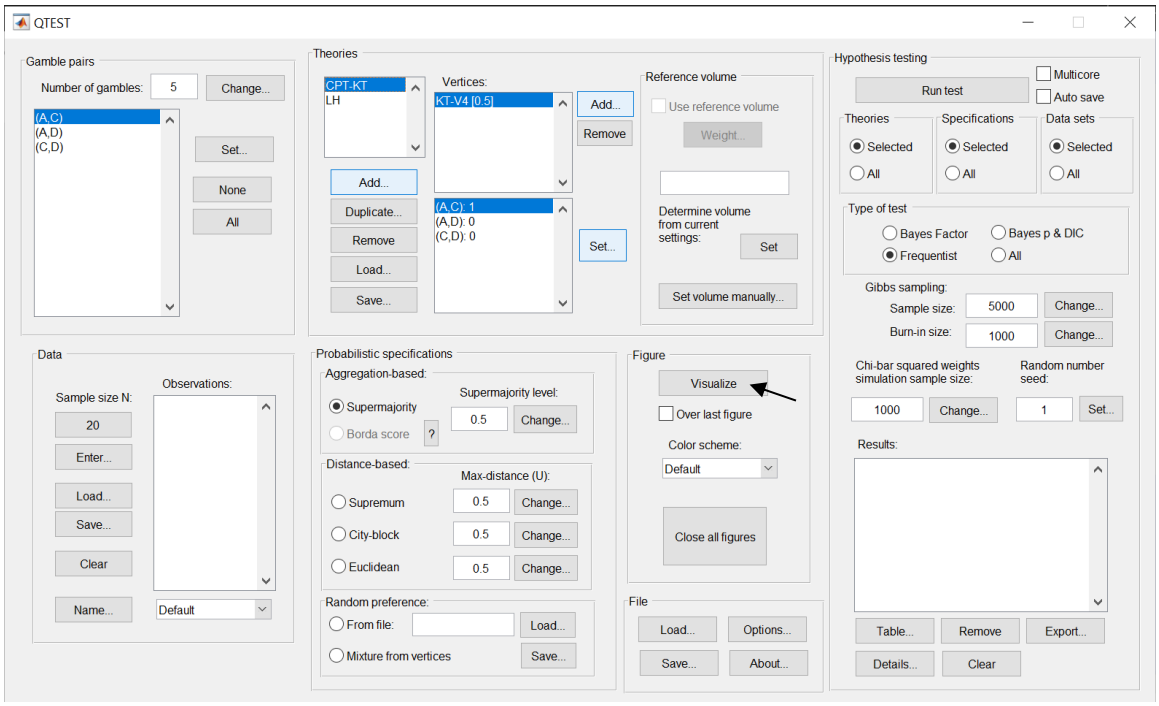
If your session of QTEST does not have the prediction for KT-V4, please see Section B.3.

C.4 The 0.50-Majority specification of KT-V4 (theory *CPT-KT*) and LH (theory *LH*)

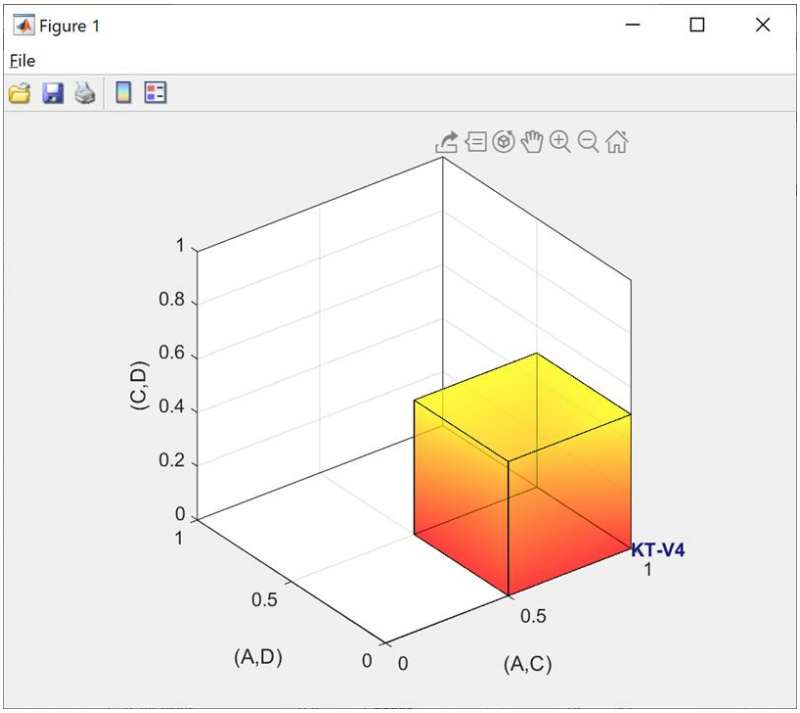
We are now ready to create the 0.50-majority/modal choice specification for both KT-V4 of *CPT-KT* and *LH*. We will specify KT-V4 first. Under "Theories" in the QTEST interface click on "CPT-KT" and "KT-V4" so they are both highlighted in gray. Under "Probabilistic specifications", the radio button left of "Supermajority" should be selected and the "Supermajority level:" should be "0.5".



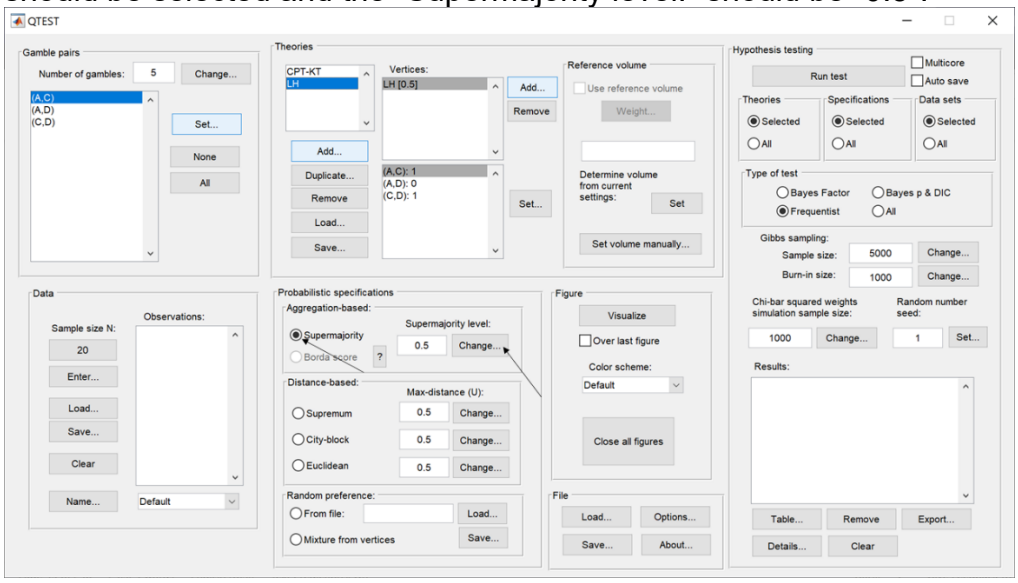
To see this 0.50-majority/modal choice specification in 3-D space, press “Visualize” under “Figure”.



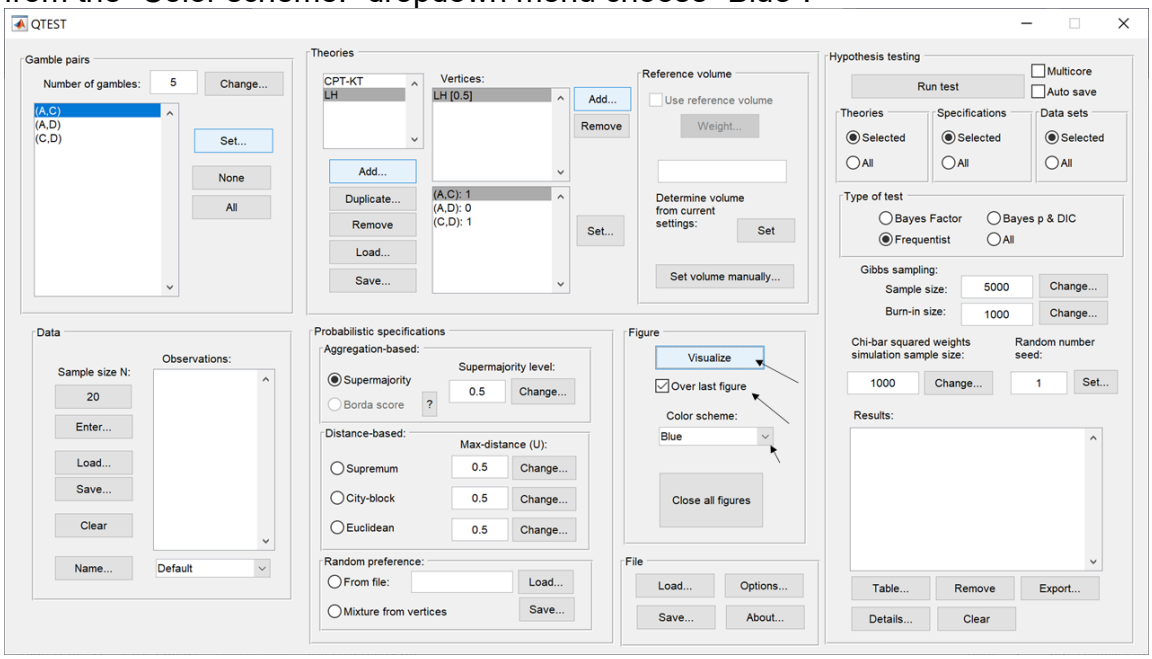
The resulting figure (below) is like Figure 3 of QTBC1 which is also the figure we created in the previous section. Do not close this figure window yet. Minimize or move it to the side, as we will add a second figure to this same window.



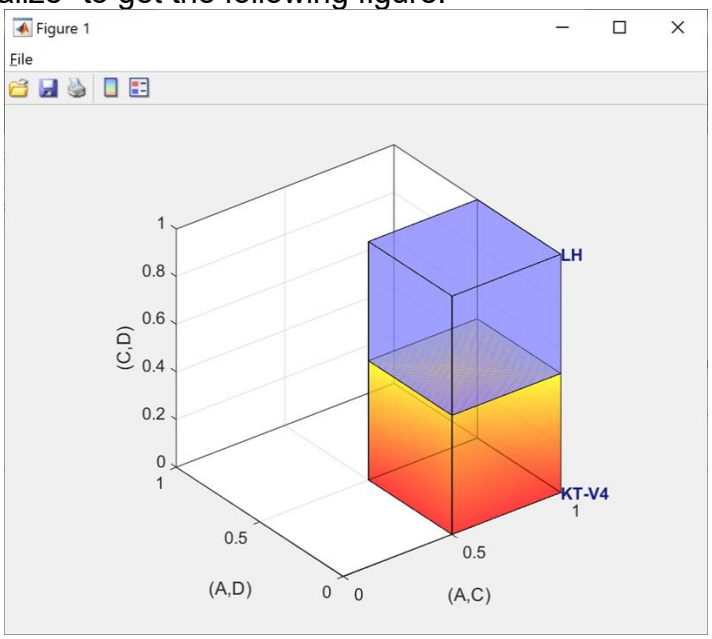
We are now ready to create the 0.50-majority/modal choice specification for LH. Under “Theories” in the QTEST interface click on “LH” and under “Vertices”, make sure “LH[0.5]” is selected. Both should be highlighted in gray. In the “Probabilistic specifications” section, the radio button left of “Supermajority” should be selected and the “Supermajority level:” should be “0.5”.



We want to visualize this figure also. But the procedure is a little different this time. First, in the QTEST interface, under “Figure”, and under “Visualize”, check the box next to “Over last figure”. Second, directly beneath “Over last figure”, from the “Color scheme:” dropdown menu choose “Blue”.



Now click “Visualize” to get the following figure.



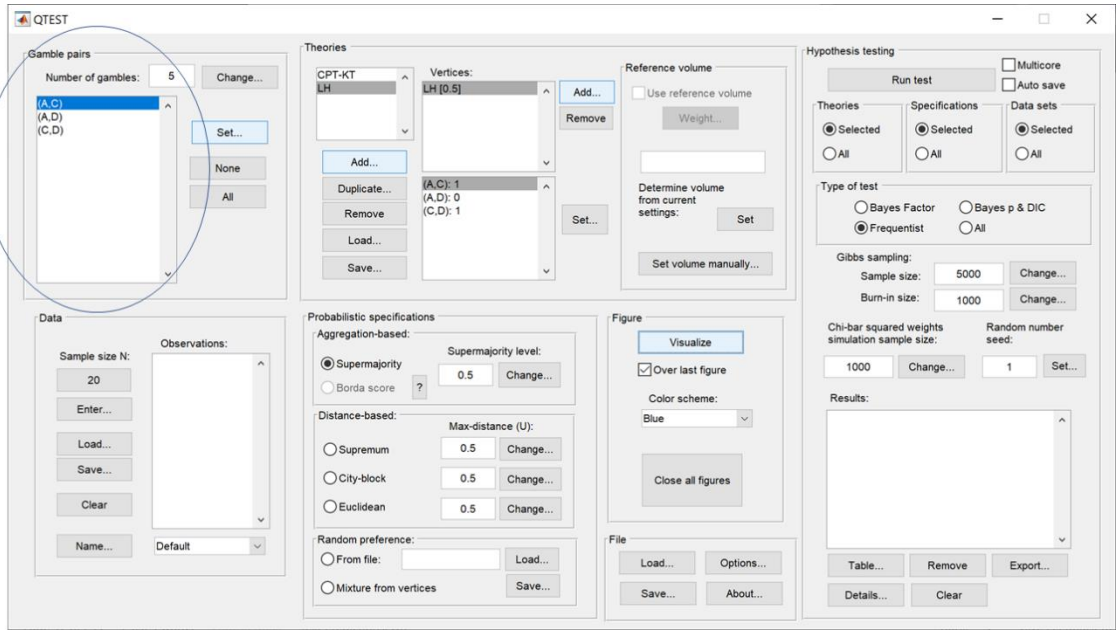
The 0.50-majority/modal choice specification for $\mathcal{LH}$ is created as a blue cube in the same figure window as the figure that QTEST used for the 0.50-majority/modal choice specification of KT-V4 for $\mathcal{CPT}$-$\mathcal{KT}$, which is the orange cube.

D. Linear Orders (Figure 7 of QTBC1)

Section B.1 through Section B.4 defined 3 out of 10 possible gamble pairs, defined one vertex (KT-V4) for $\mathcal{CPT}$-$\mathcal{KT}$ and constructed a single 0.50-majority/modal choice specification for those 3 gamble pairs. In this section, instead of constructing a single 0.50-majority/modal choice specification, we will construct a 0.50-majority/modal choice specification for *each* of the six linear orders on A, C, D, in a single 3-D figure. Once completed, we will have the left panel of Figure 7 of QTBC1.

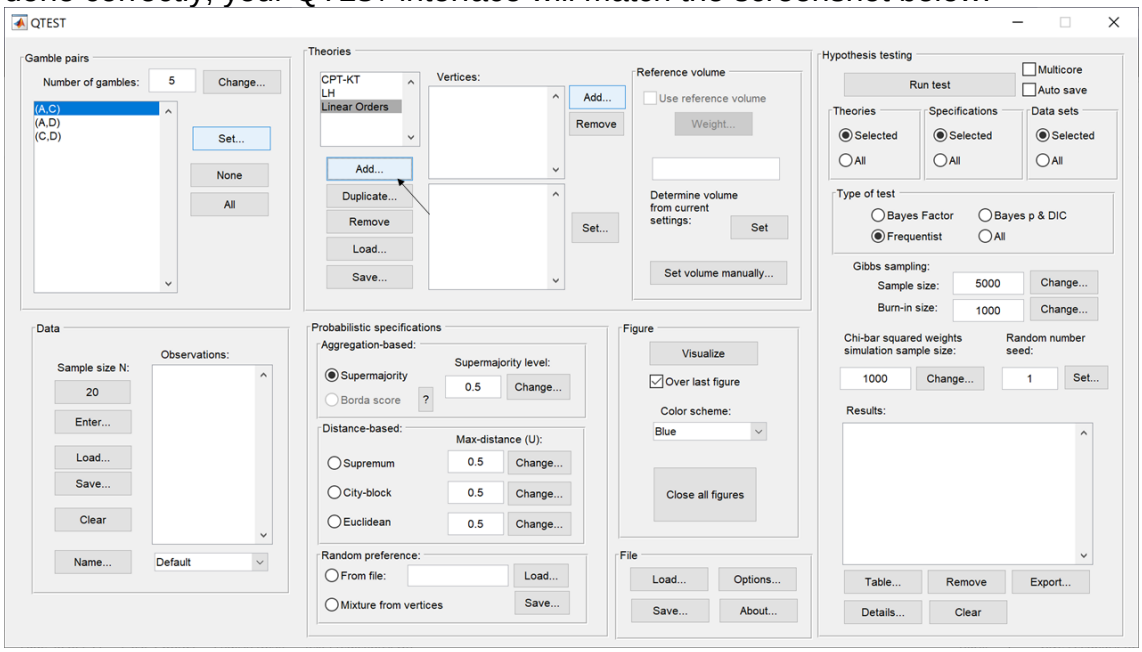
D.1 Create the gamble pairs

We continue our QTEST session from Section C.4. Your session should match the information under "Gamble pairs" in the following screenshot. (If it does not, either load a saved session from C.4 or return to Section B.1 to create the 3 gamble pairs "(A,C)", "(A,D)" and "(C,D)".)



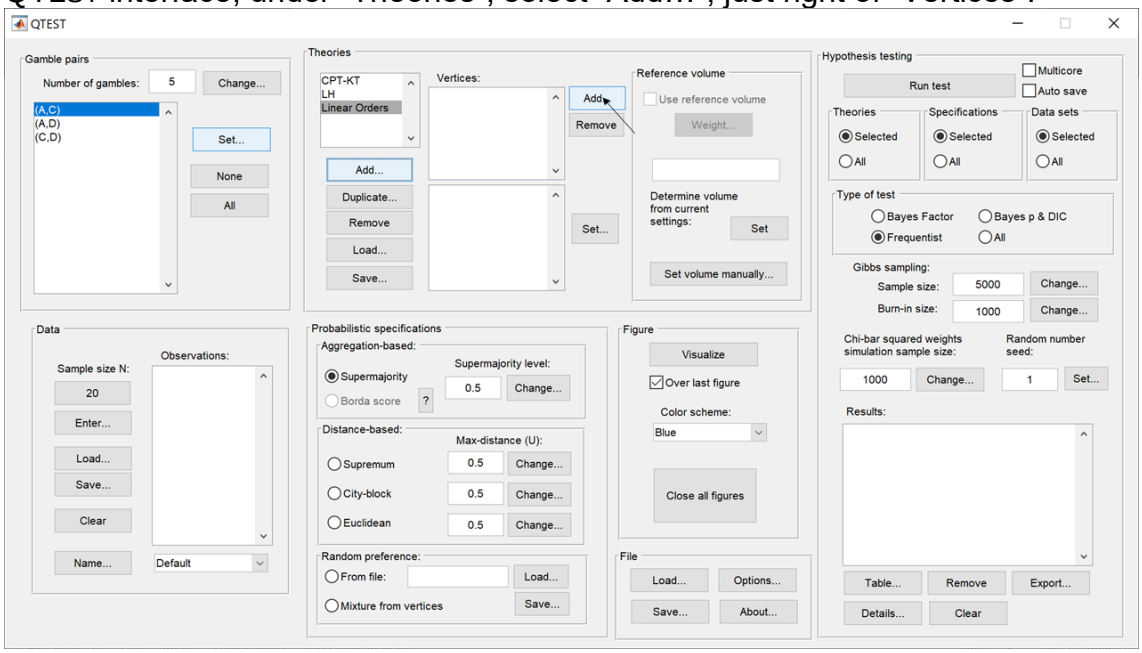
D.2 Define a decision theory, Linear Orders

Now add another theory under “Theories” by selecting “Add…” In the “Theory” dialogue box that pops up, enter “Linear Orders” and then press “OK”. If this is done correctly, your QTEST interface will match the screenshot below.

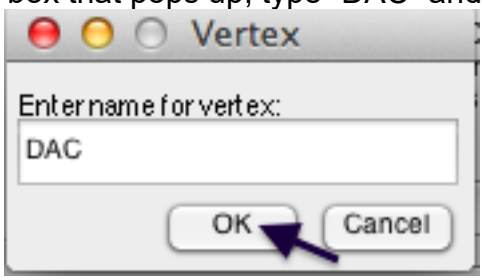


D.3 Specify the predictions of decision theory Linear Orders

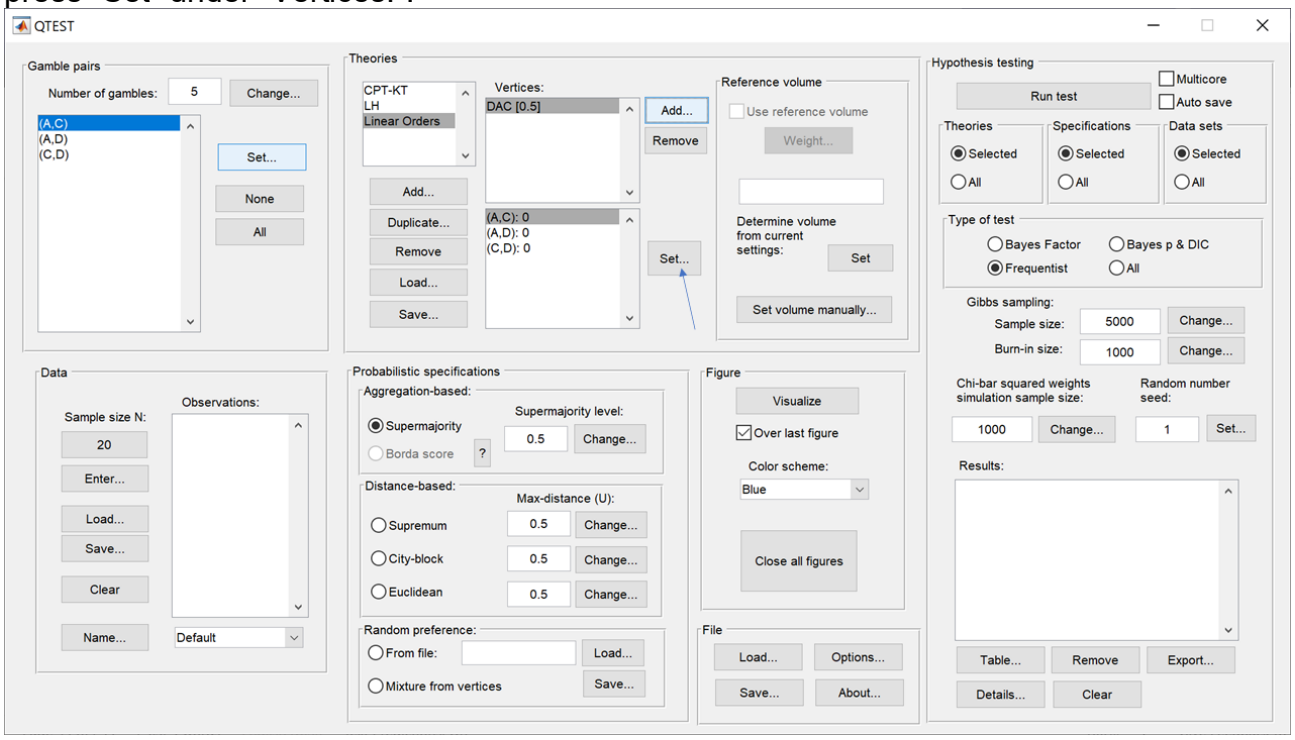
We will first specify the prediction DAC, with 3-D coordinates (1,0,0). In the QTEST interface, under “Theories”, select “Add…”, just right of “Vertices”.



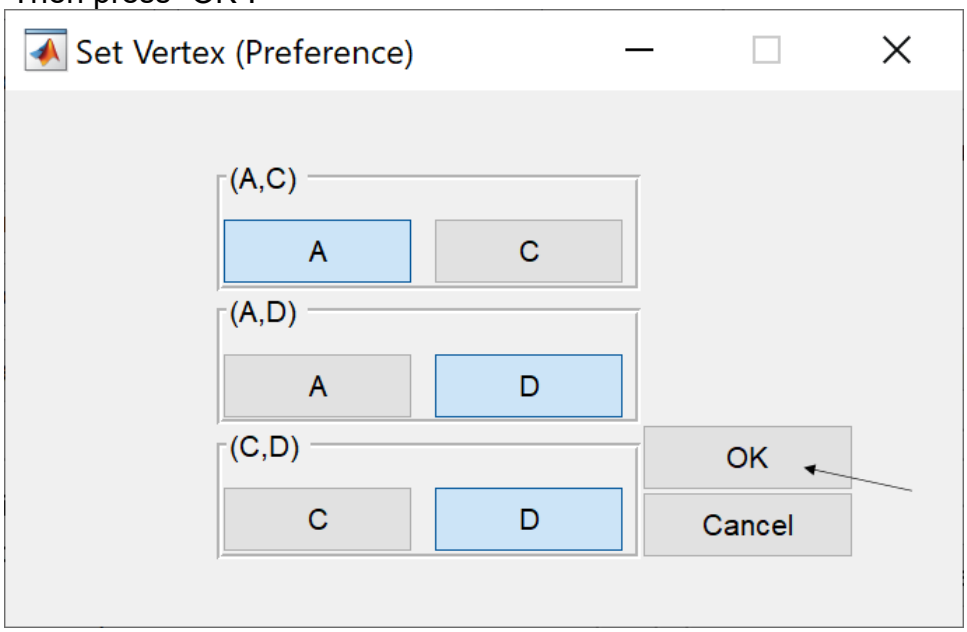
In the “Vertex” dialogue box that pops up, type “DAC” and press “OK”.



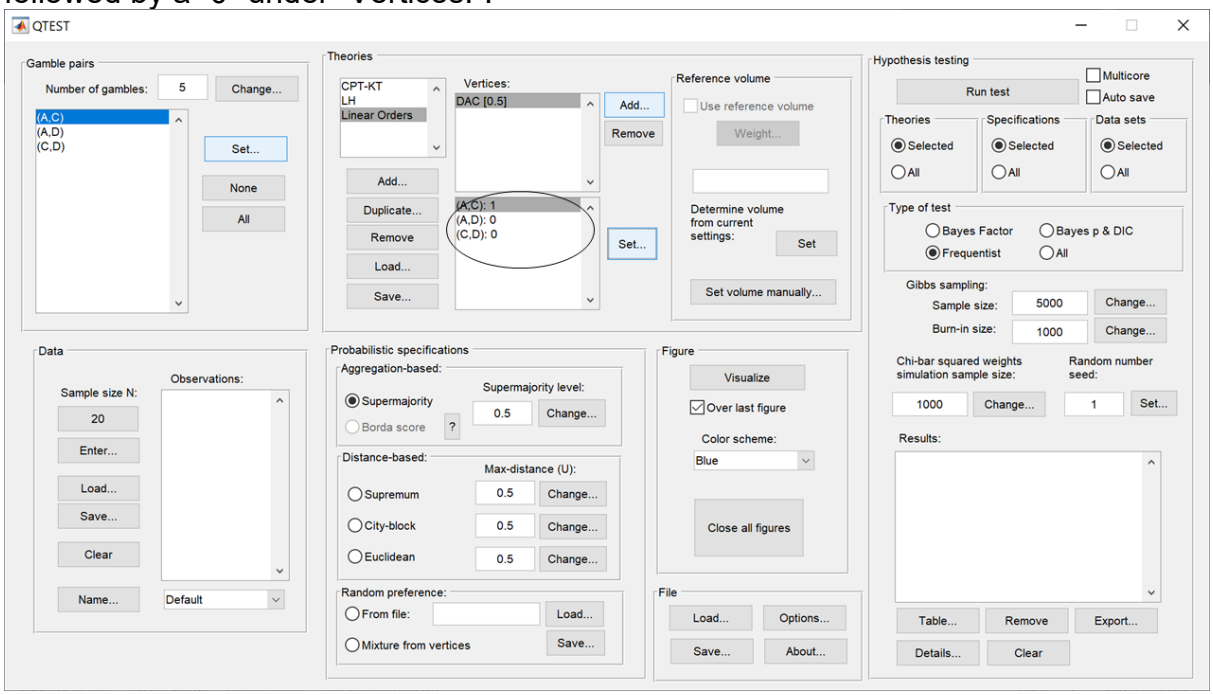
Now “DAC [0.5]” appears in the list of “Vertices” under “Theories” in the QTEST interface. Notice that the 3 gamble pairs, (A,C), (A,D) and (C,D) are all followed by a “0” under “Theories”. This is the default. To specify the prediction for DAC, press “Set” under “Vertices:”.



In the “Set Vertex (Preference)” dialogue box that pops up, select A from the gamble pair (A,C), D from the gamble pair (A,D) and D from the gamble pair (C,D). Then press “OK”.



The QTEST interface should match the following screenshot. Note that there is now a “1” following the gamble pair “(A,C)” while “(A,D)” and “(C,D)” are both followed by a “0” under “Vertices:”.



This completes the first prediction. Creating the remaining 5 rankings follows the same procedures as the first. We only provide a verbal description of the rankings, leaving it to the reader to make the changes in QTEST.

Select “Add” just right of “Vertices” in QTEST. In the “Vertex” dialogue box that pops up enter “DCA” and then press “OK”. Make sure “DCA” is highlighted in gray under “Vertices” in the QTEST interface and then press “Set”. In the “Set Vertex (Preference)” dialogue box that pops up, make sure “C” from gamble pair “(A,C)” is selected, “D” from gamble pair “(A,D)” is selected and “D” from gamble pair “(C,D)” is selected. Then select “OK”.

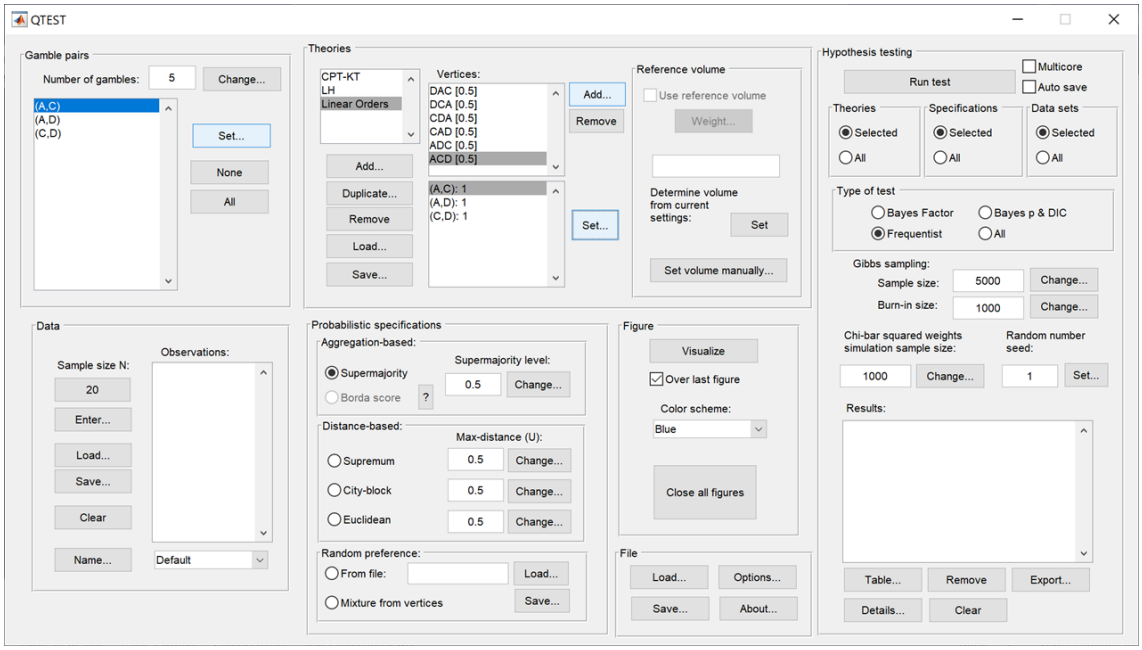
Select “Add” just right of “Vertices” in QTEST. In the “Vertex” dialogue box that pops up enter “CDA” and then press “OK”. Make sure “CDA” is highlighted in gray under “Vertices” in the QTEST interface and then press “Set”. In the “Set Vertex (Preference)” dialogue box that pops up, make sure “C” from gamble pair “(A,C)” is selected, “D” from gamble pair “(A,D)” is selected and “C” from gamble pair “(C,D)” is selected. Then select “OK”.

Select “Add” just right of “Vertices” in QTEST. In the “Vertex” dialogue box that pops up enter “CAD” and then press “OK”. Make sure “CAD” is highlighted in gray under “Vertices” in the QTEST interface and then press “Set”. In the “Set Vertex (Preference)” dialogue box select “C” from gamble pair “(A,C)”, “A” from gamble pair “(A,D)” and “C” from gamble pair “(C,D)”. Then select “OK”.

Select “Add” just right of “Vertices” in QTEST. In the “Vertex” dialogue box that pops up enter “ADC” and then press “OK”. Make sure “ADC” is highlighted in gray under “Vertices” in the QTEST interface and then press “Set”. In the “Set Vertex (Preference)” dialogue box, select “A” from gamble pair “(A,C)”, “A” from gamble pair “(A,D)” and “D” from gamble pair “(C,D)”.

Select “Add” just right of “Vertices” in QTEST. In the “Vertex” dialogue box that pops up enter “ACD” and then press “OK”. Make sure “ACD” is highlighted in gray under “Vertices” in the QTEST interface and then press “Set”. In the “Set Vertex (Preference)” dialogue box select “A” from gamble pair “(A,C)”, “A” from gamble pair “(A,D)” and “C” from gamble pair “(C,D)”.

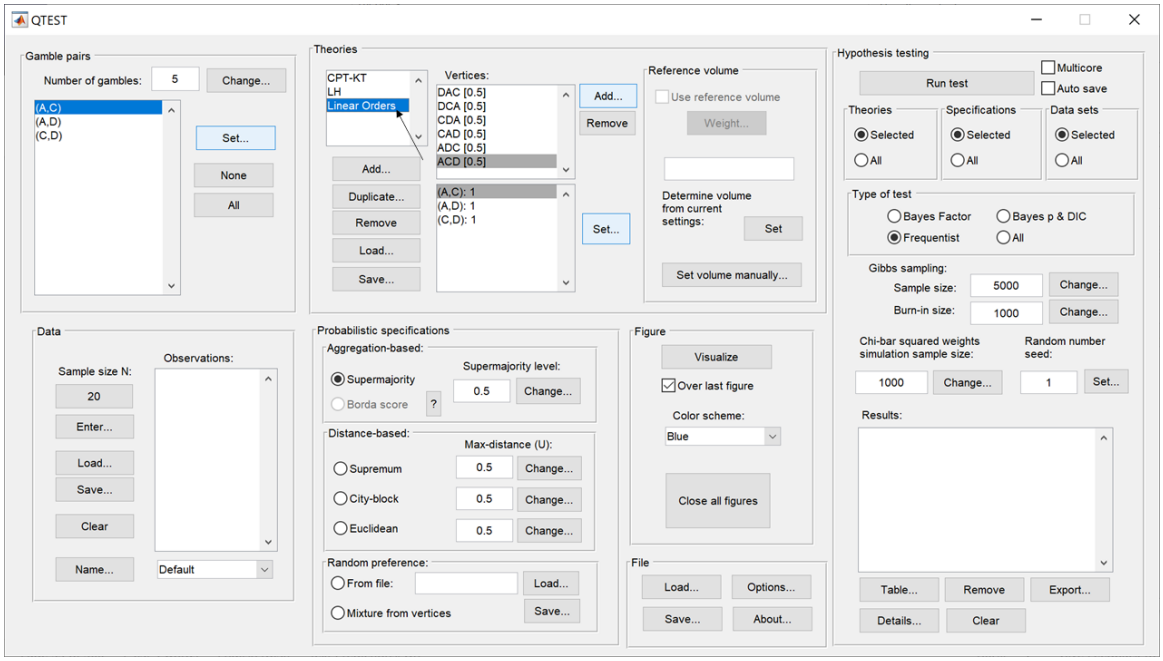
The QTEST interface should now match the following screenshot. Note the list of “Vertices” contains “DAC [0.5]”, “DCA [0.5]”, “CDA [0.5]”, “CAD [0.5]”, “ADC [0.5]” and “ACD [0.5]”. By selecting one of these vertices (it will be highlighted) the gambles specified by that vertex are shown in the box directly beneath the list of “Vertices:”.



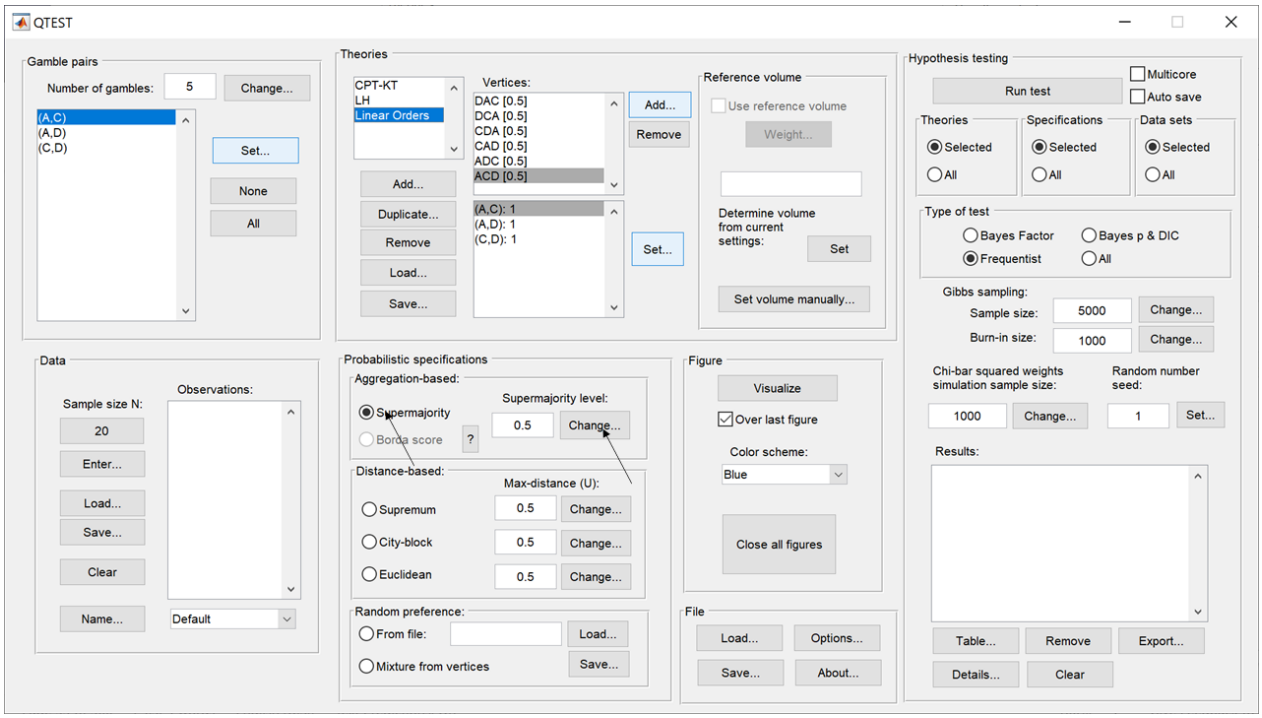
Now that the 6 predictions, or vertices, of Figure 7 of QTBC1 have been defined, we can create the 0.50-majority/modal choice specification for each of these 6 predictions.

D.4 The 0.50-Majority specification of 6 predictions for theory Linear Orders

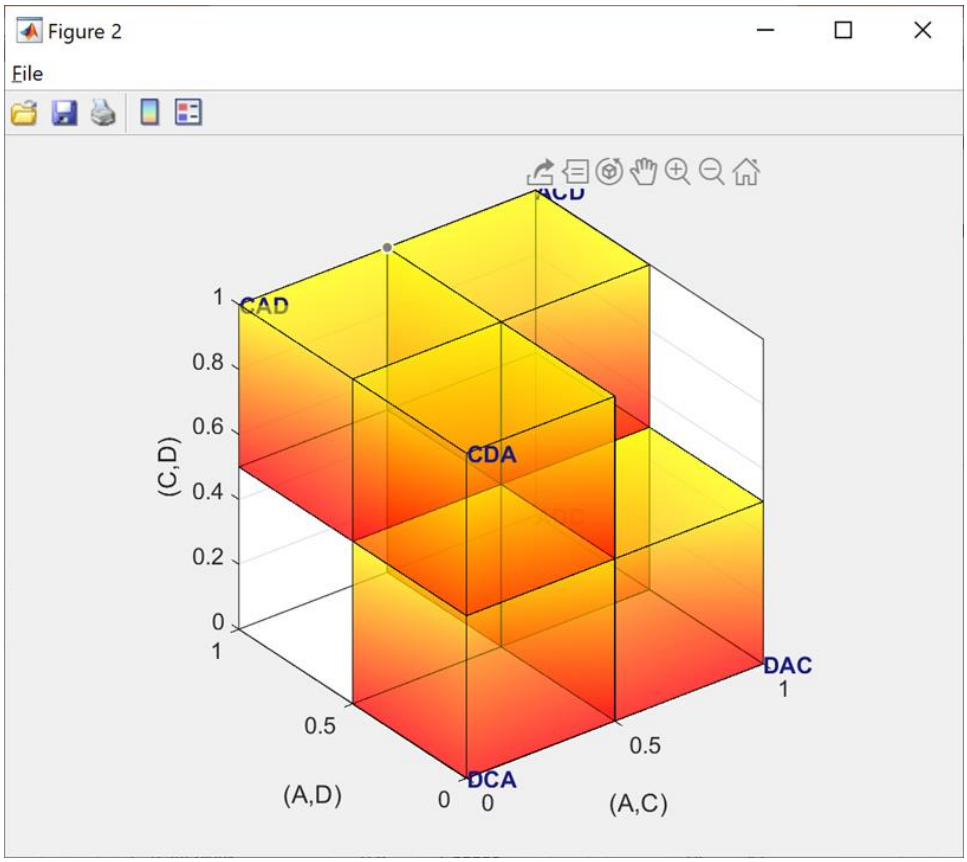
Under “Theories” make sure “Linear Orders” is selected--it will be highlighted in blue.



Under “Probabilistic specifications”, verify that the “Supermajority” radio button is selected and that the “Supermajority level:” is set to “0.5”.



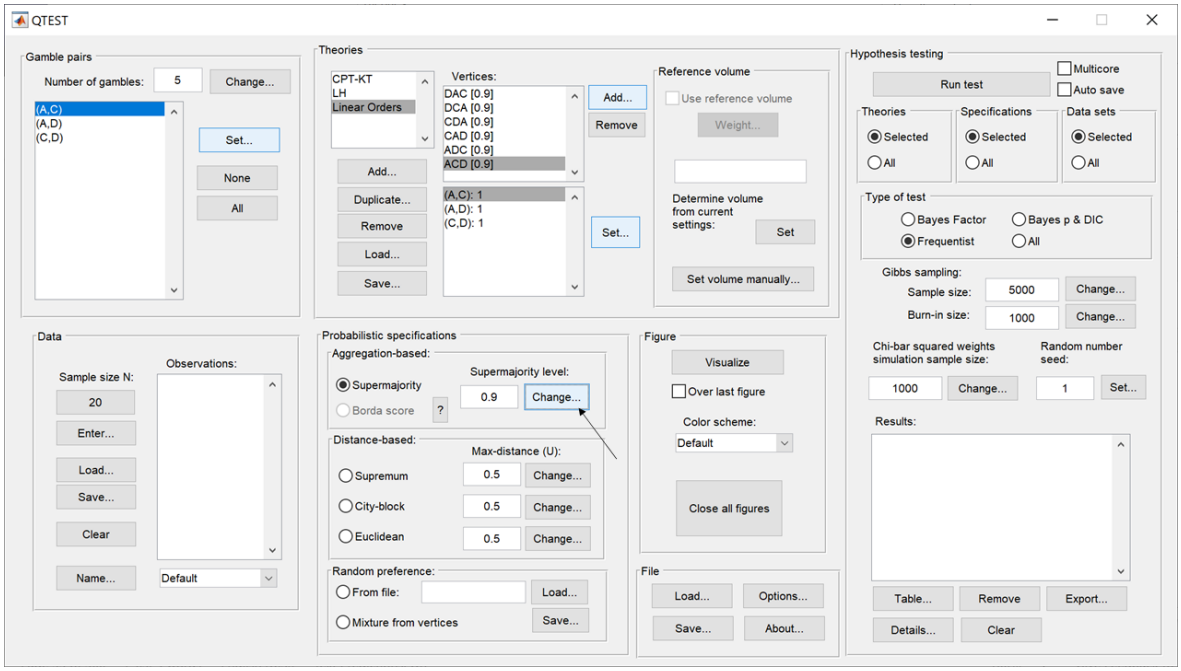
Now, under “Figure” in the QTEST interface, press “Visualize” once. The resulting figure is a version of the left-hand side of Figure 7 of QTBC1.



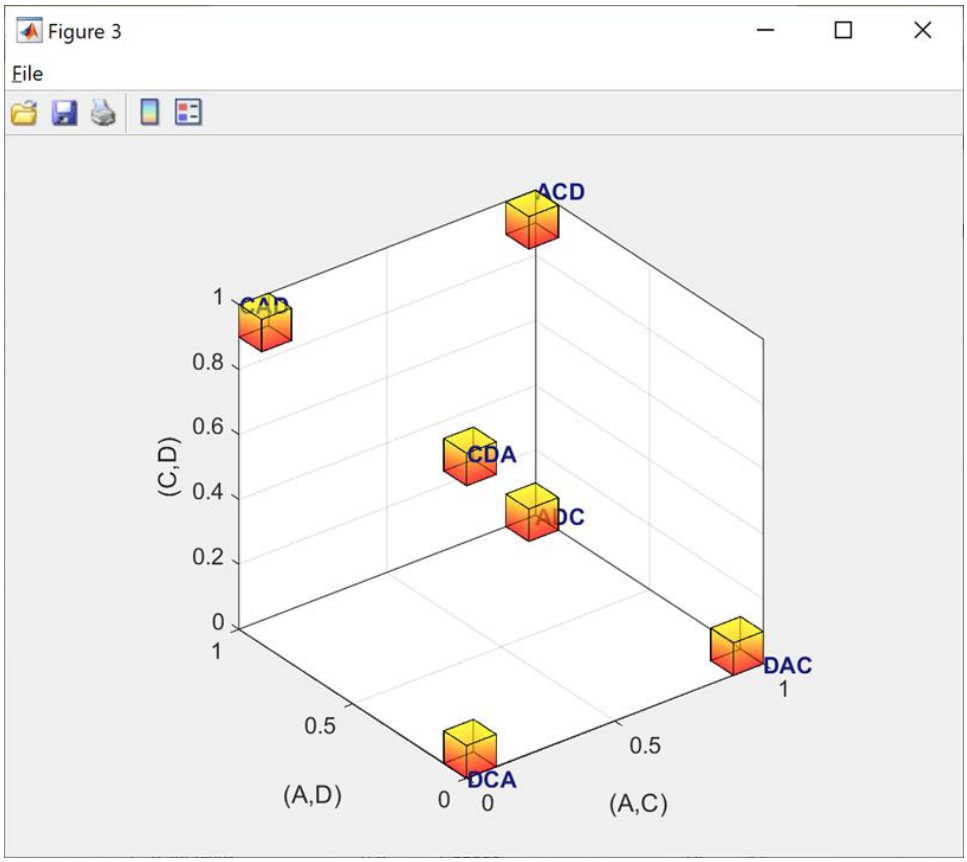
How can we create the right-hand side of Figure 7 of QTBC1? The gamble pairs, theories and vertices are identical for the two figures. The only difference between the left- and right-hand sides of Figure 7 of QTBC1 is the supermajority specification. In the left-hand side the supermajority specification is 0.5 whereas in the right-hand side the supermajority specification is 0.90. We can create this specification by making one change in the QTEST interface.

D.5 The 0.90-Supermajority specification of 6 predictions for Linear Orders

In the QTEST interface, select “Change” under “Probabilistic specifications”. In the dialogue box that pops up, enter “0.9” for the “Supermajority Level (Lambda)”. Then press “OK”. The interface will then look like the following screenshot.



Press “Visualize” once under “Figure” in the QTEST to get the following figure, which is a version of the right-hand side of Figure 7 of QTBC1.



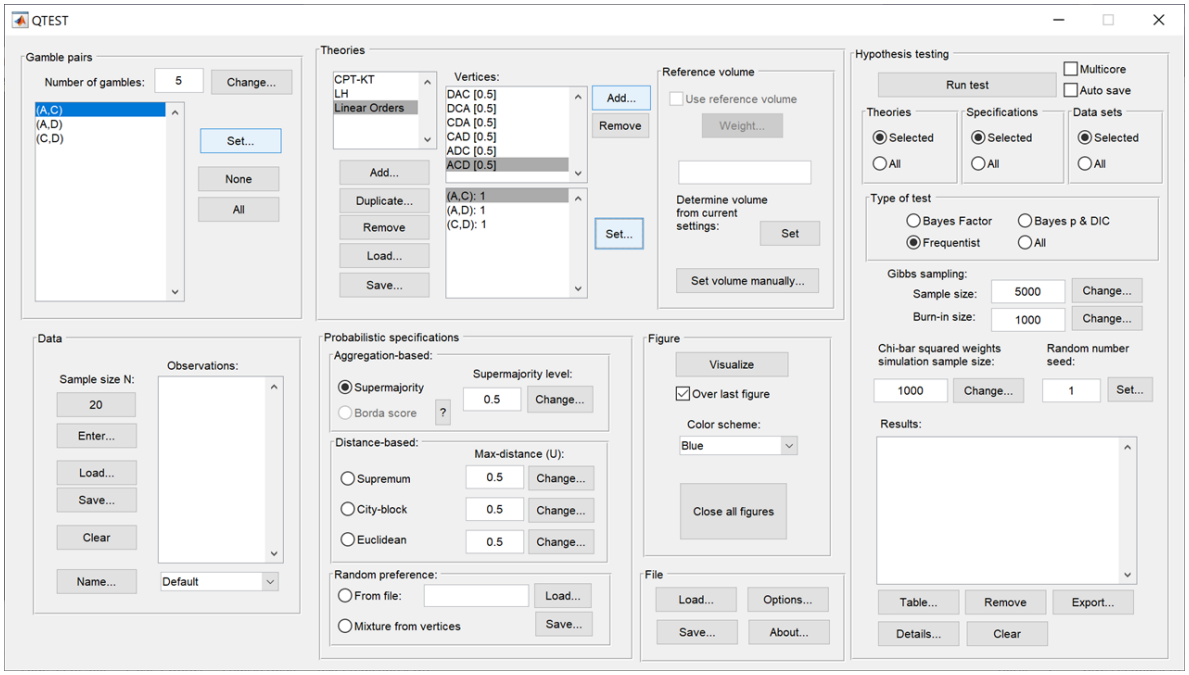
This completes the section for defining one theory, Linear Orders, with multiple predictions and with a separate probabilistic specification for each prediction.

E. $\mathcal{CPT}$-$\mathcal{KT}$ vs. $\mathcal{LH}$ (Figure 8 of QTBC1)

In this section, we will build on our knowledge from Sections D.1 through D.4 that compared one prediction for $\mathcal{CPT}$-$\mathcal{KT}$ and one prediction for $\mathcal{LH}$. Here, we compare these theories again. But this time we consider all predictions for $\mathcal{CPT}$-$\mathcal{KT}$ rather than just one. Once we complete this section, we will have replicated a version of Figure 8 of QTBC1.

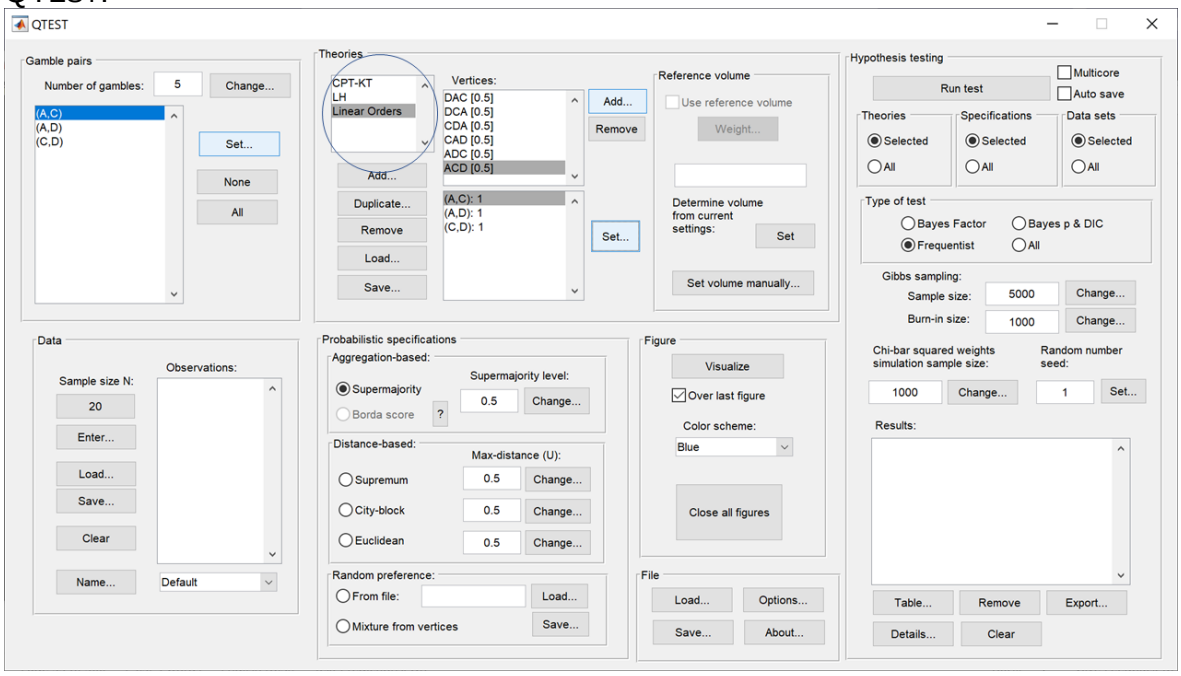
E.1 Create the gamble pairs

If you are continuing from Section D.5, or loading Section D.5 from a saved session, your QTEST session, under "Gamble pairs" should match the screenshot below. (If you need to create these gamble pairs, please go to Section D.1 above.)

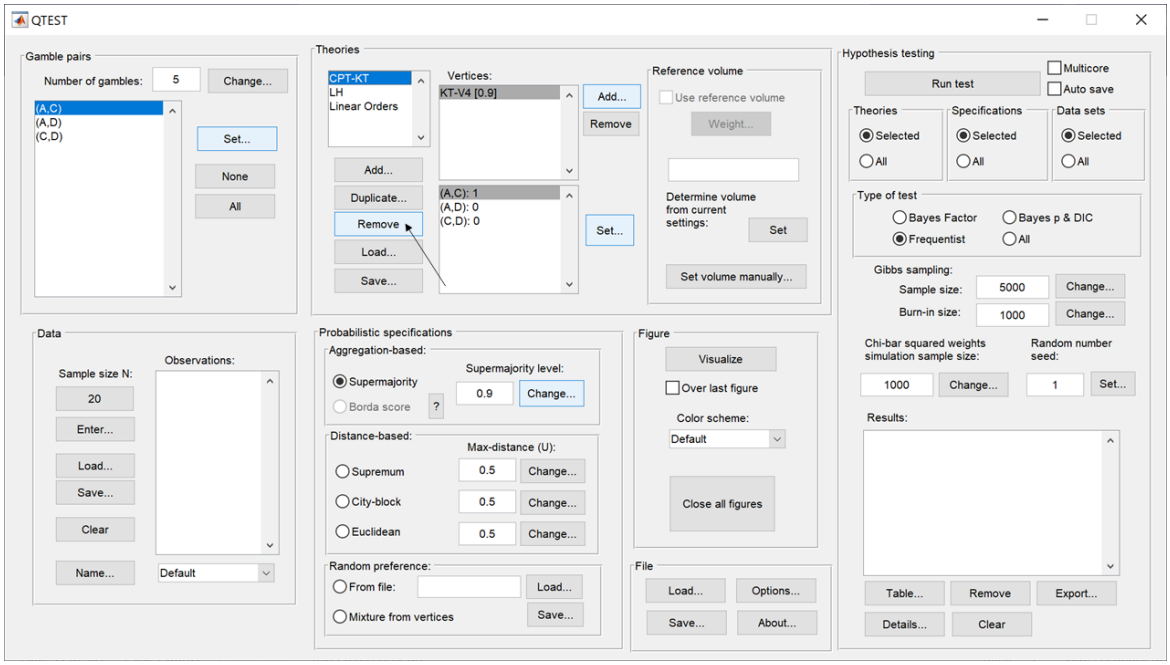


E.2 Define two decision theories, *CPT-KT* and *LH*

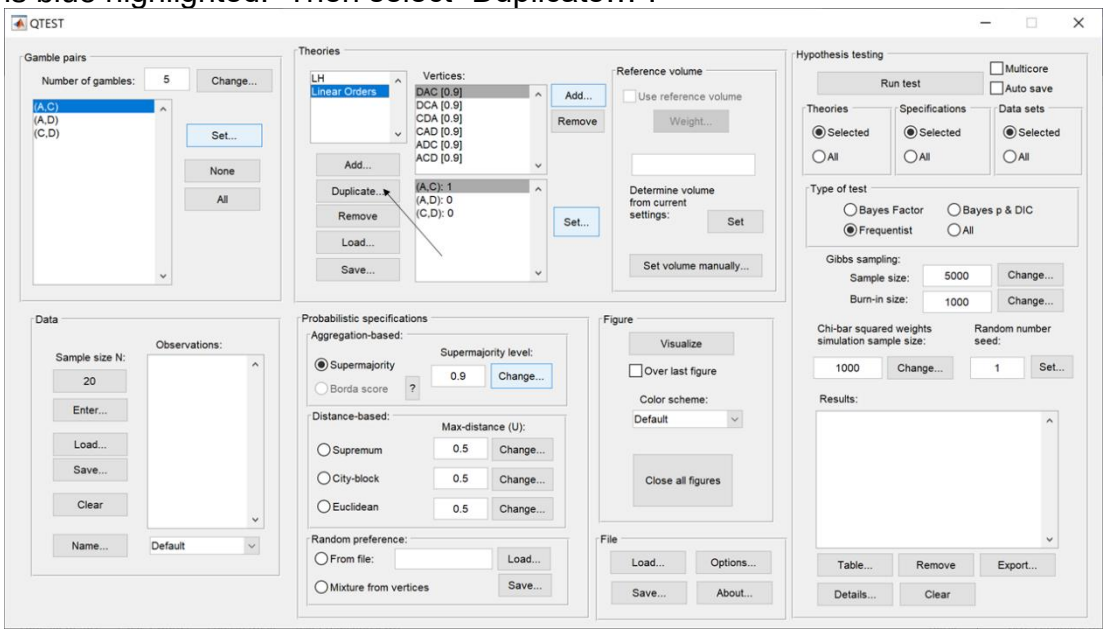
Under “Theories”, “CPT-KT”, “LH” and “Linear Orders” are listed. If you do not see “CPT-KT” and “LH” listed, return to Section C.2 to define these theories in QTEST.



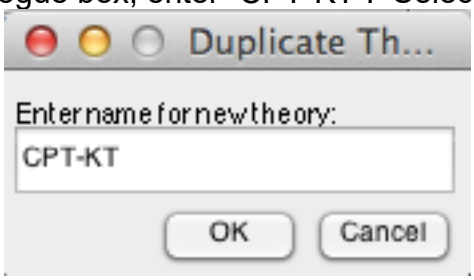
Under “Theories”, select “CPT-KT” so it is blue highlighted and then select “Remove”.



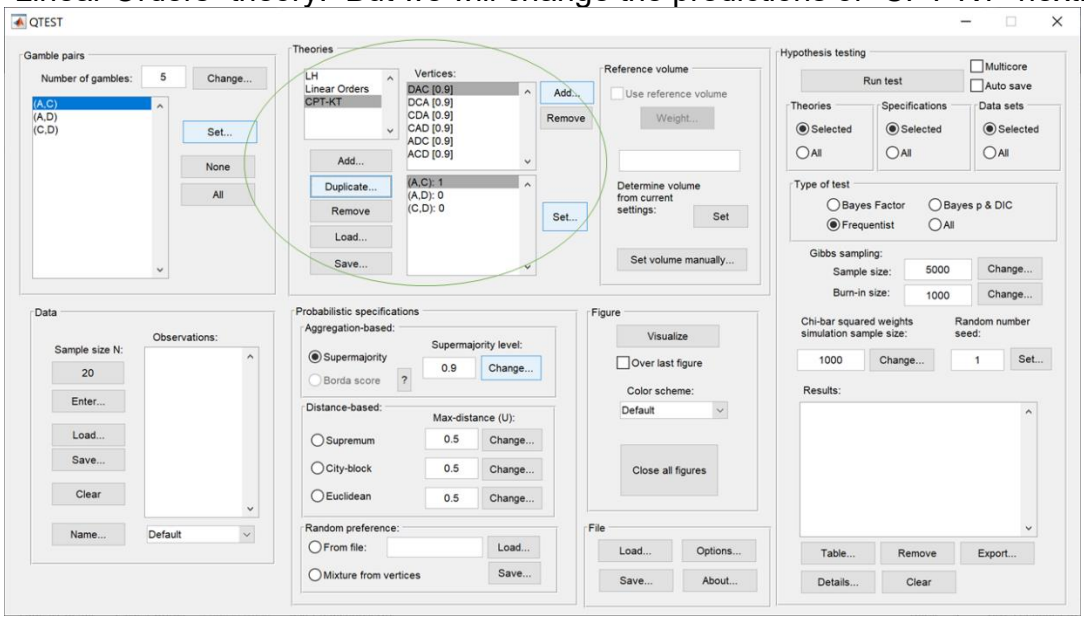
Only two theories remain, “LH” and “Linear Orders”. Select “Linear Orders” so it is blue highlighted. Then select “Duplicate…”.



In the “Duplicate…” dialogue box, enter “CPT-KT”. Select “OK”.

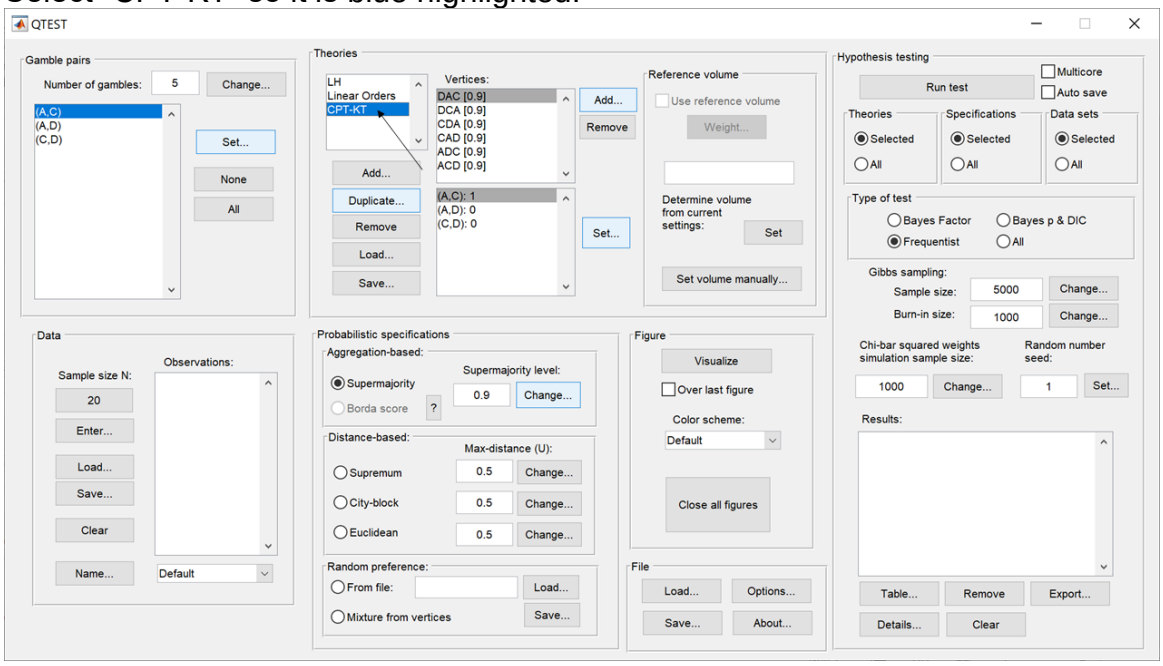


“CPT-KT” is listed under “Theories” but now it has identical “Vertices:” as the “Linear Orders” theory. But we will change the predictions of “CPT-KT” next.

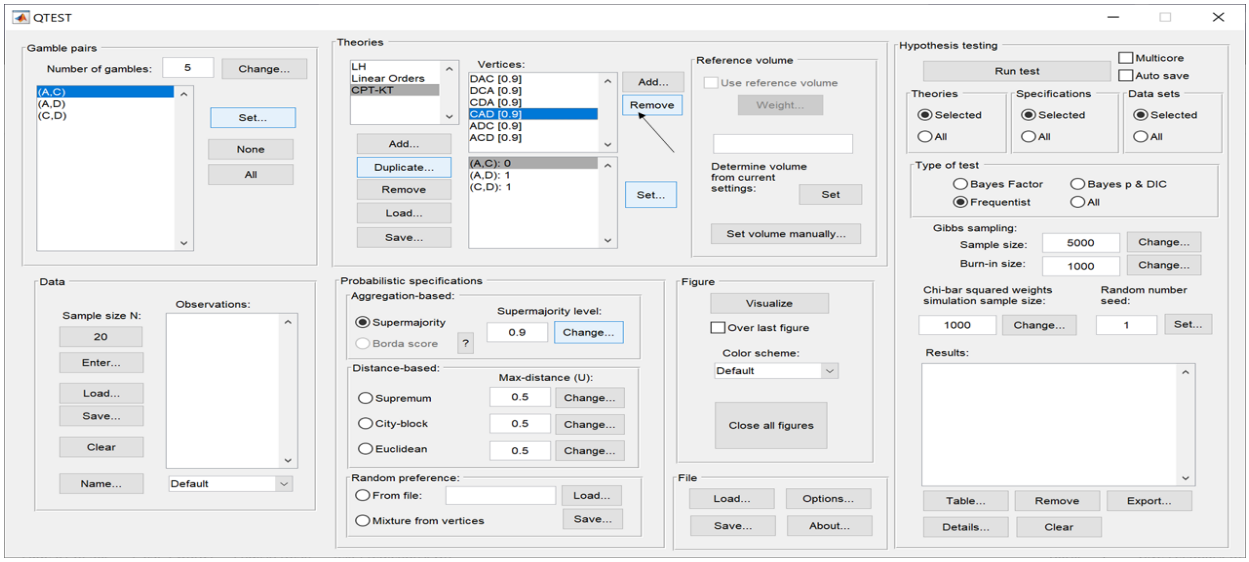


E.3 Specify the predictions of decision theories *LH* and *CPT-KT*

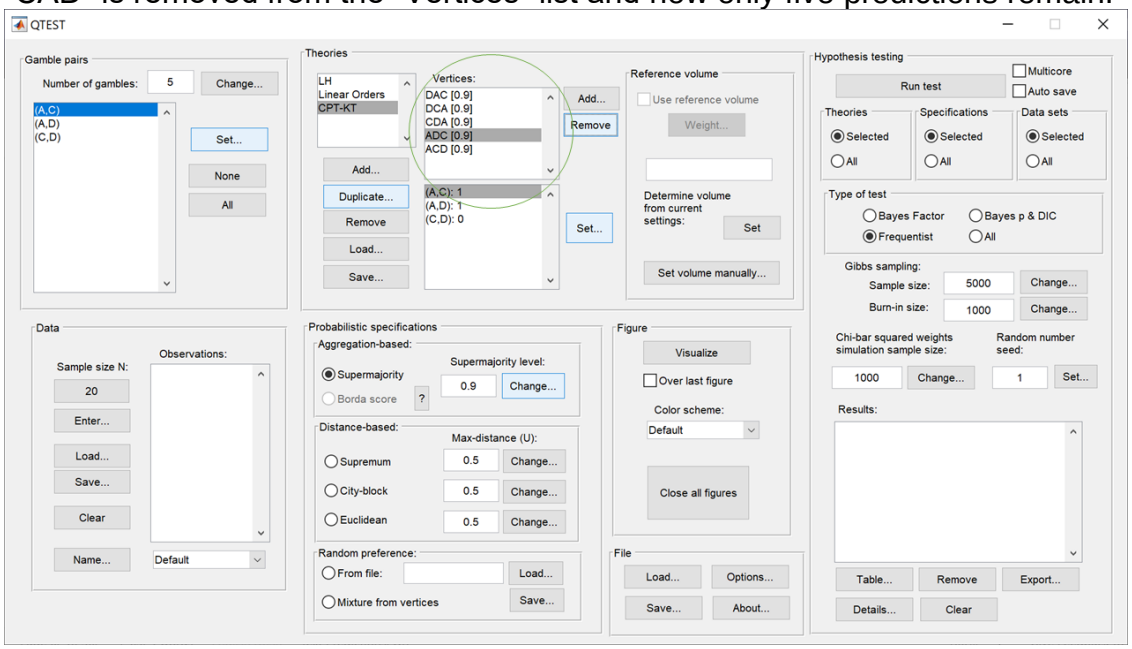
Select “CPT-KT” so it is blue highlighted.



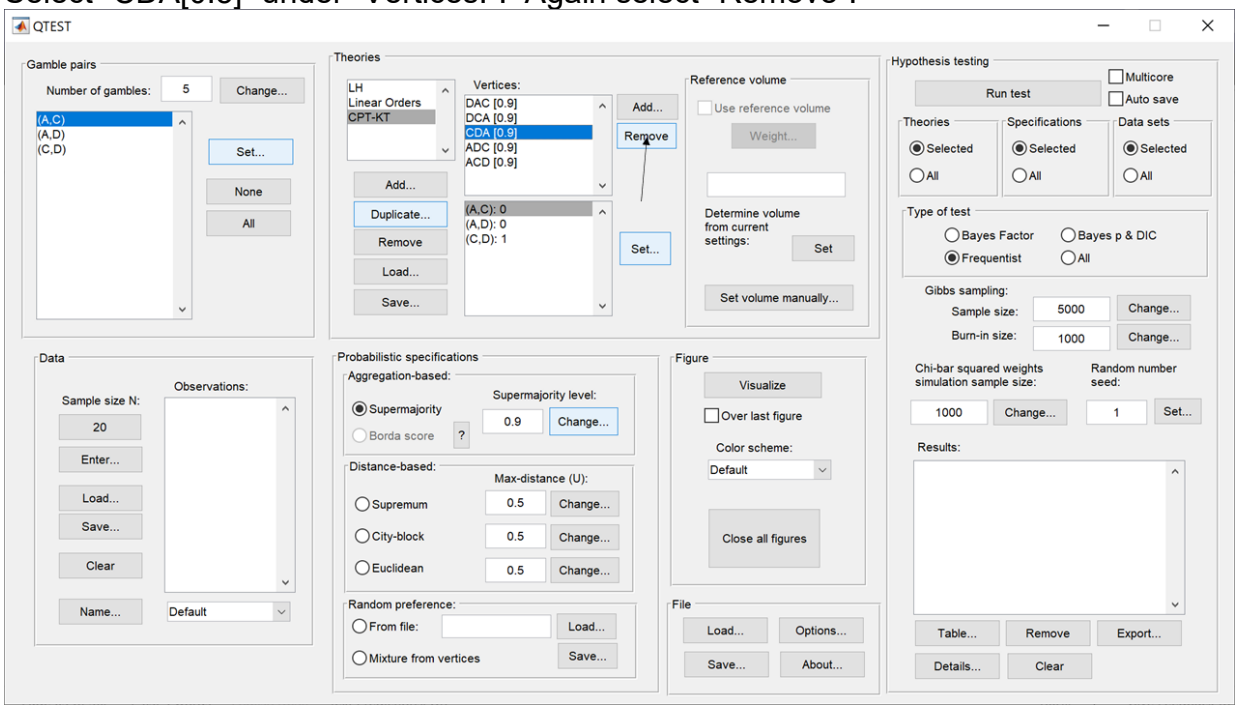
Under “Vertices:”, select “CAD[0.5]” so it is blue highlighted. Then select “Remove”.



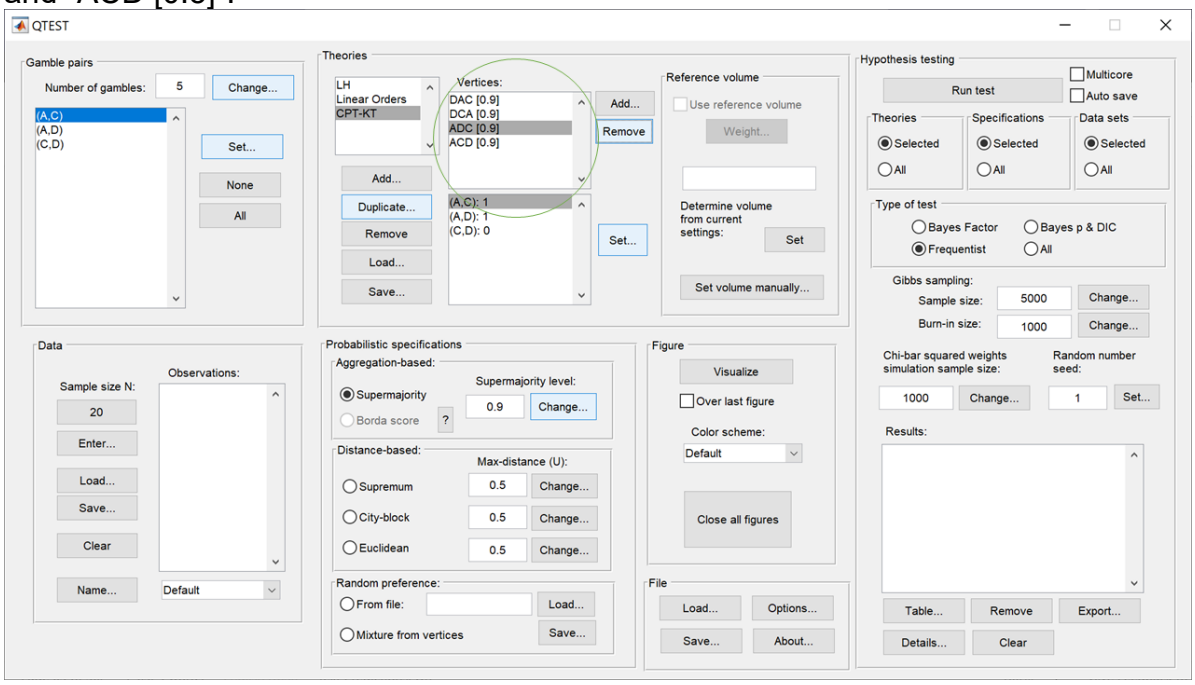
“CAD” is removed from the “Vertices” list and now only five predictions remain.



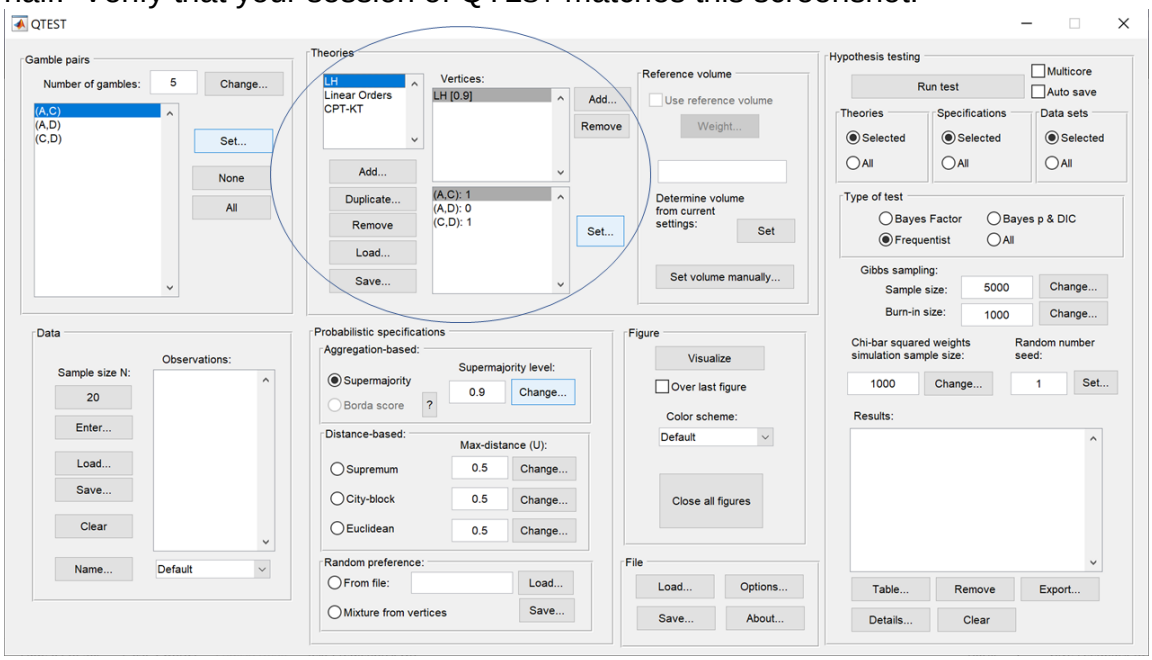
Select “CDA[0.5]” under “Vertices:”. Again select “Remove”.



The QTEST interface will now match the following screenshot. The list of "Vertices:" only contains the four predictions "DAC [0.5]", "DCA [0.5]", "ADC [0.5]" and "ACD [0.5]".

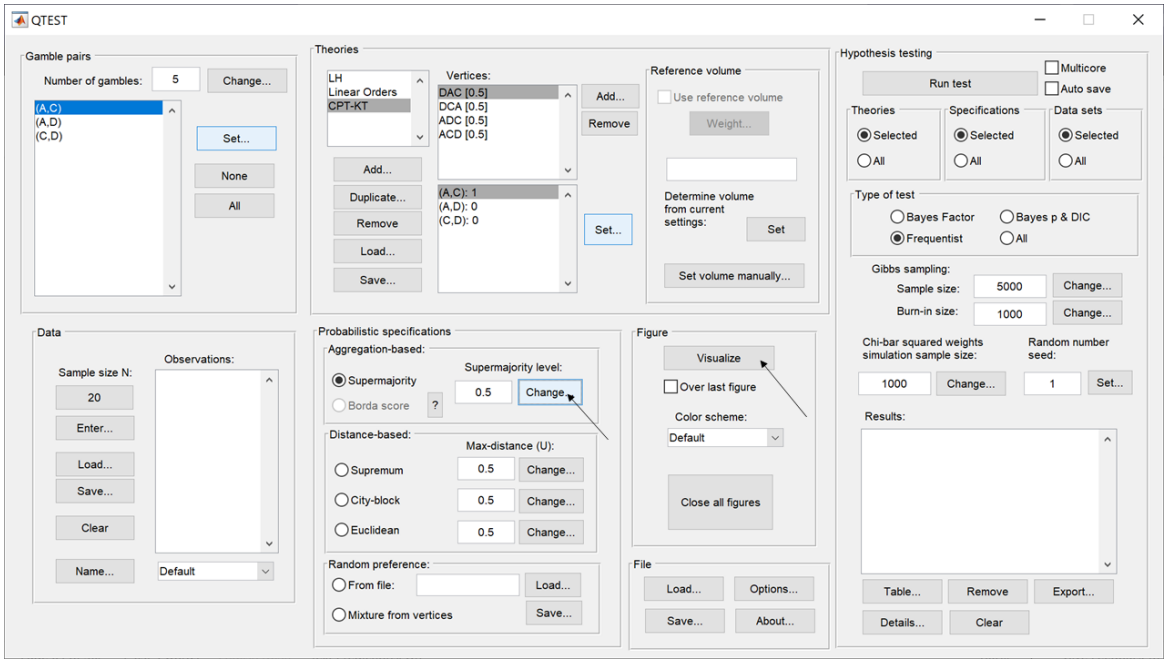


Select "LH" so it is blue highlighted. After highlighting "LH", under "Vertices", "LH" is listed in the top half and the coordinates for its vertex are listed in the bottom half. Verify that your session of QTEST matches this screenshot.

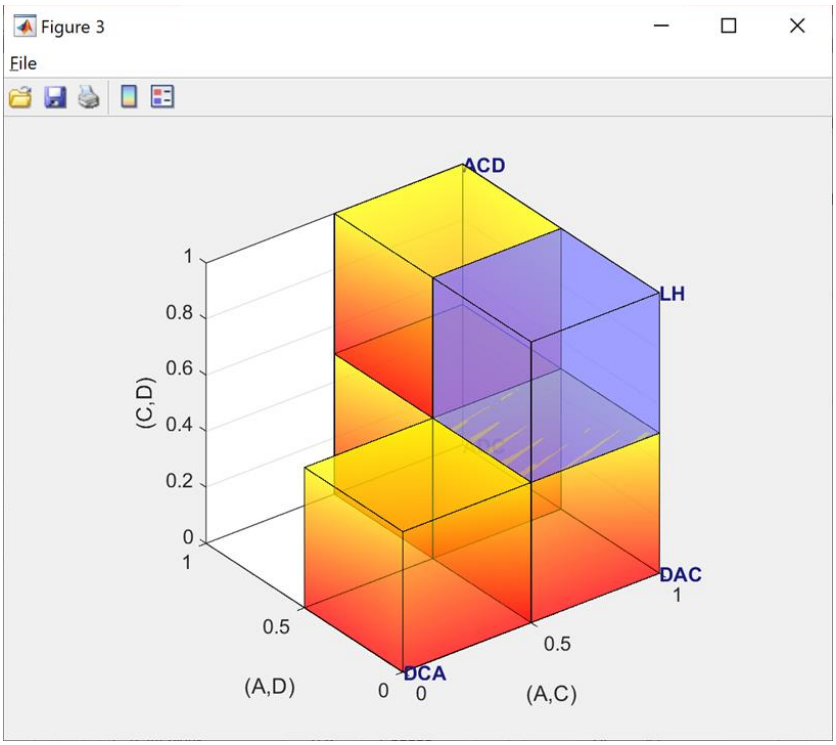


E.4 The 0.50-Majority specification of $\mathcal{CPT}$-$\mathcal{KT}$ and $\mathcal{LH}$

We are now ready to create the 0.50-majority/modal choice specification for both $\mathcal{CPT}$-$\mathcal{KT}$ and $\mathcal{LH}$. Under "Theories" in the QTEST interface click on "CPT-KT" so it is highlighted in gray. Under "Probabilistic specifications", the radio button left of "Supermajority" should be selected and the "Supermajority level:" should be changed or set to "0.5". Under "Theories, select "CPT-KT" and under "Figure" change "Color scheme" to "Default" and uncheck "Over last Figure" (if it is not already unchecked). Then select "Visualize".

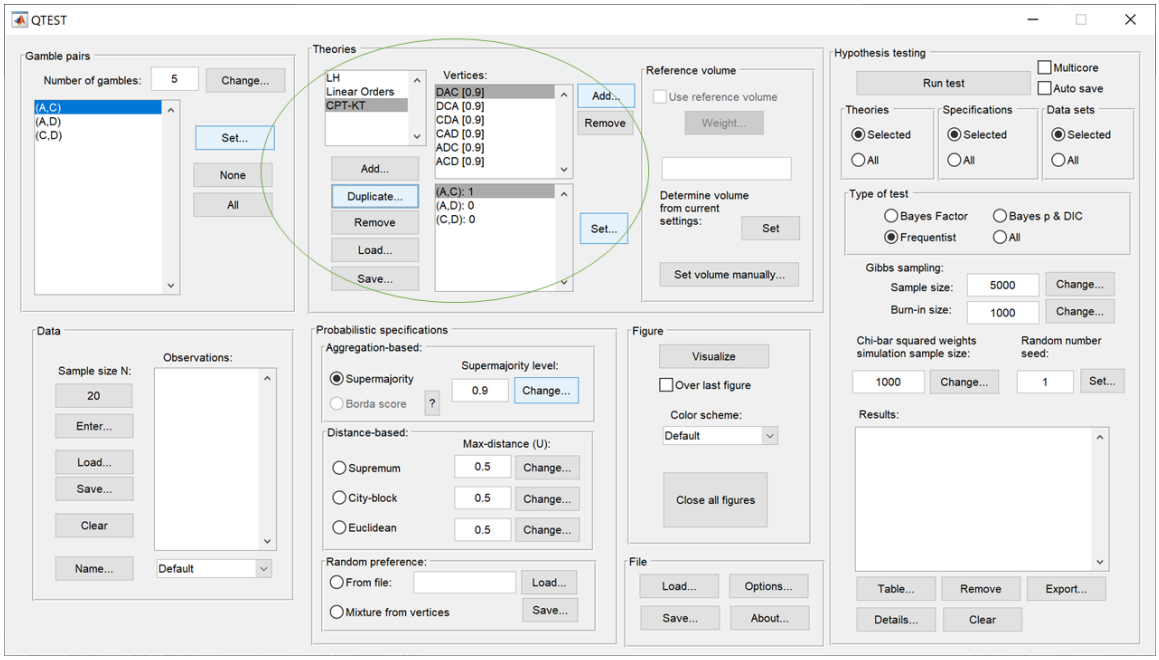


Once this figure has been created, do not close it. Instead, select “LH” under “Theories”. Then check “Over last figure” under “Figure”. Change “Color scheme” to “Blue”. Then select “Visualize”, which should give the following figure, which is a version of the left-hand side of Figure 8 of QTBC1.

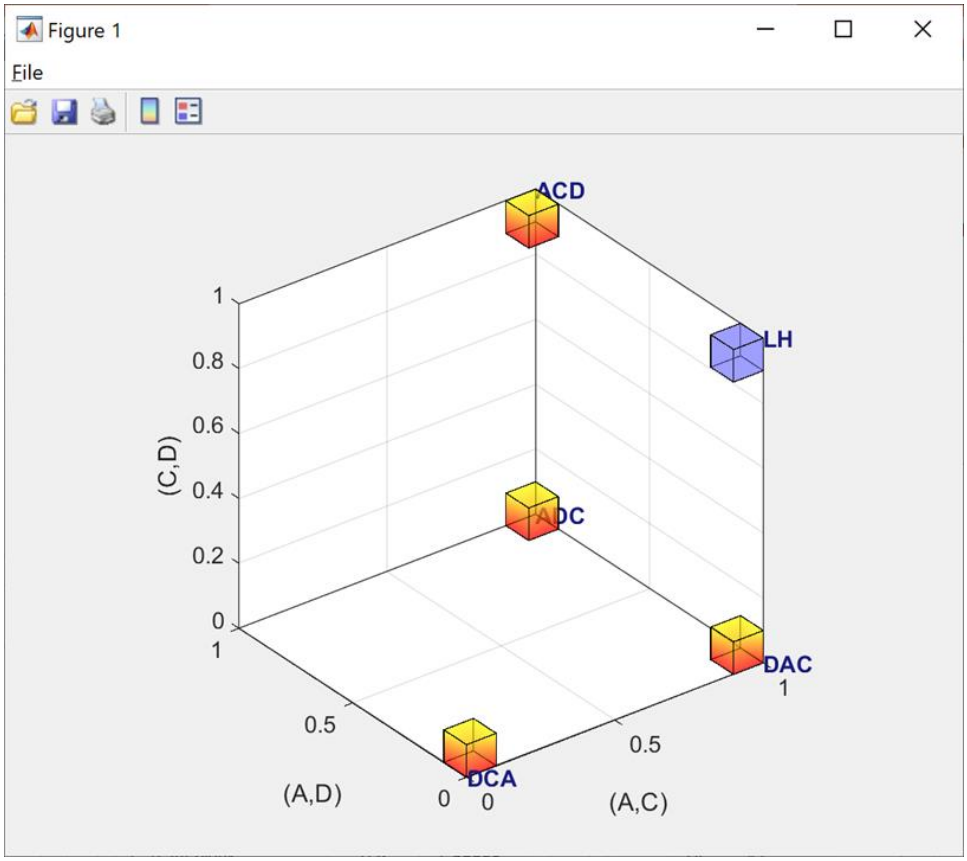


E.5 The 0.90-supermajority specification of KT-V4 (theory *CPT-KT*) and *LH* (theory *LH*)

We repeat the same procedure as E.4 but now create a 0.90-supermajority specification. Under “Probabilistic specifications”, the radio button left of “Supermajority” should be selected and the “Supermajority level:” should be set to “0.9”.



Under “Theories, select “CPT-KT” and under “Figure” change “Color scheme” to “Default” and, if it is checked, uncheck “Over last Figure”. Then, under “Figure” select “Visualize”. Once this figure has been created, do not close it. Instead, select “LH” under “Theories”. Then check “Over last figure” under “Figure”. Change “Color scheme” to “Blue”. Then select “Visualize”, which should give the following figure, which is a version of the right-hand side of Figure 8 of QTBC1.

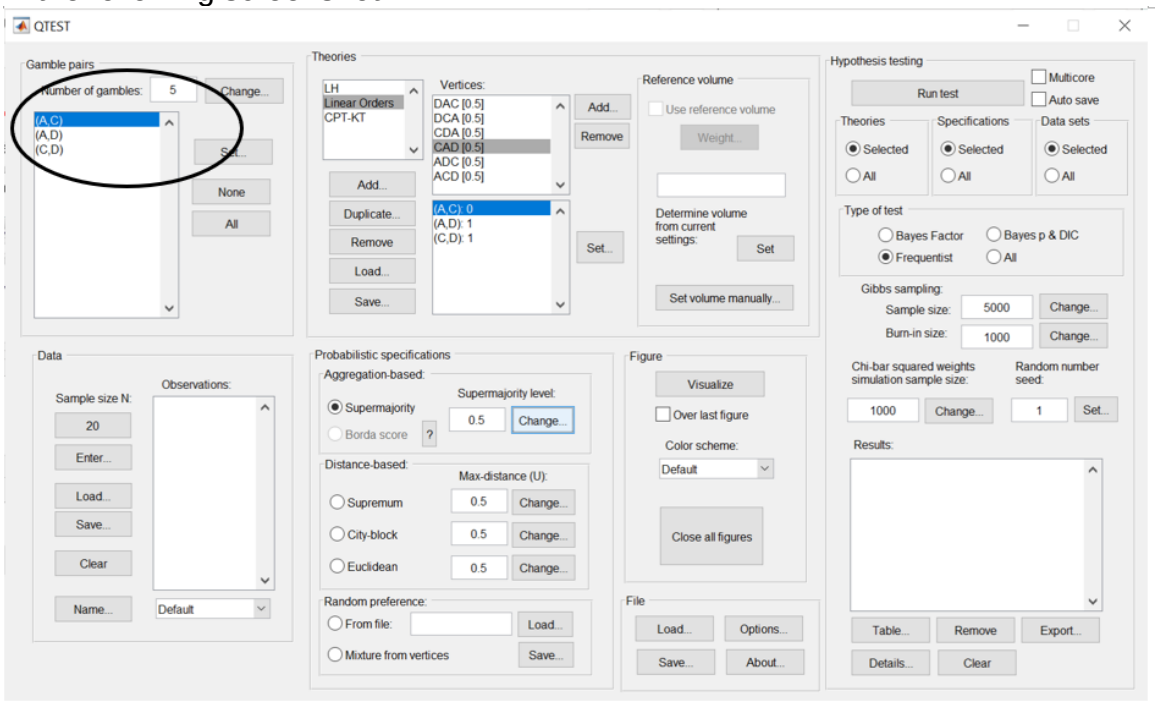


F. Mixture Models (Figure 9 of QTBC1, Figure 2 of Online Supplement 1, and Figure 4 of QTBC2)

Figure 9 of QTBC1 creates a fundamentally different type of probabilistic specification. The method for specifying these mixture models is different than the one used for the distance-based probabilistic specifications, which comprise all previous sections of the tutorial (Sections A-E). Due to the mathematical aspects involved in specifying these models, the process is not nearly as automated in QTEST as are the models we have considered so far.

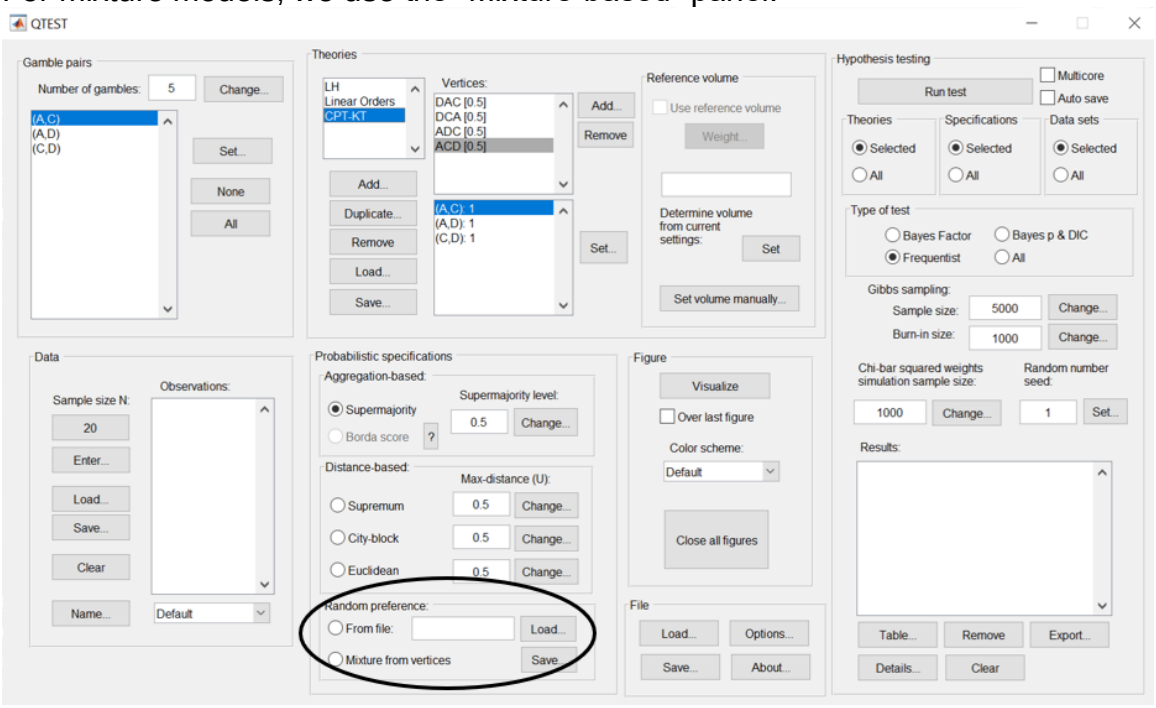
F.1.1 Create the gamble pairs for Figure 9 of QTBC1 and Figure 2 of Online Supplement 1

We will use the same gamble pairs as in our QTEST session from Section E. If you are loading a saved session, loading the session from Section D will be most helpful. Your session should match the circled information, under “Gamble pairs”, in the following screenshot.



F.1.2 Define one decision theory, Random *CPT-KT* for Figure 9 of QTBC1 and Figure 2 of Online Supplement 1

For mixture models, we use the “Mixture-based” panel.



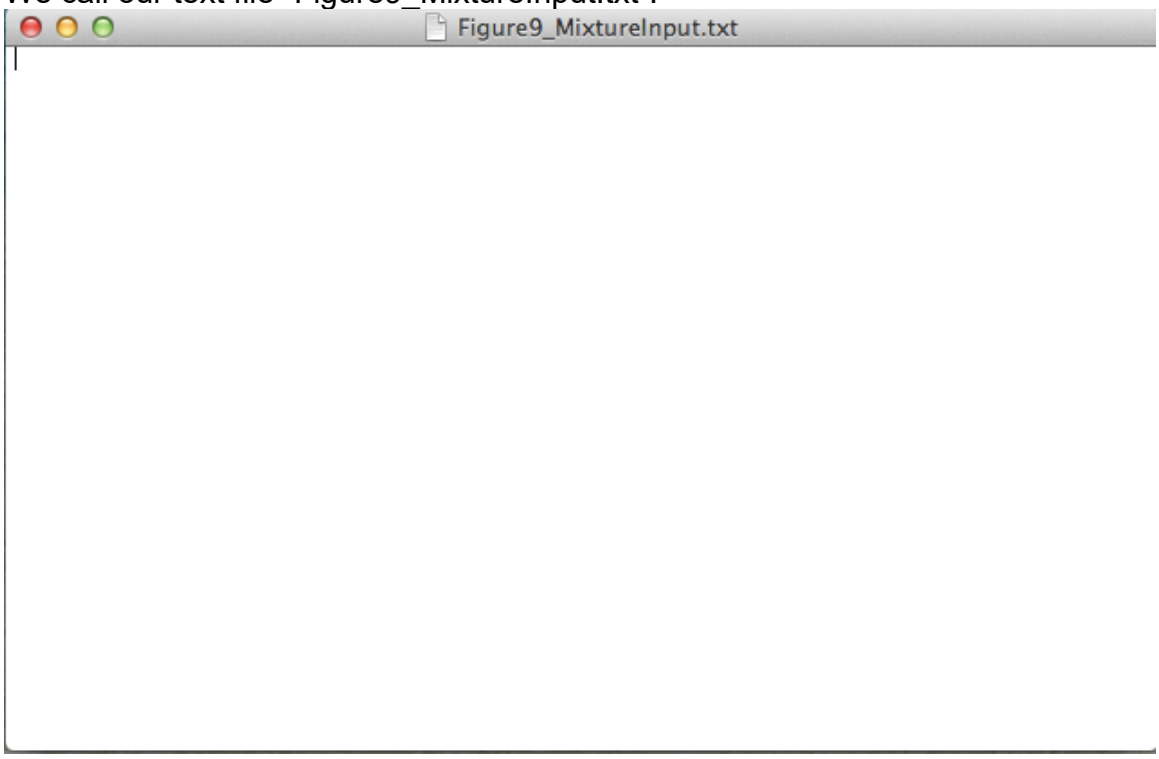
F.1.3 Mixture model specification of *CPT-KT* for Figure 9 of QTBC1 and Figure 2 of Online Supplement 1

The mixture model specification of *CPT-KT* can be generated in two different ways. These methods are now described in more detail.

Method 1: generating the mixture model specification of *CPT-KT* if using PORTA directly

The vertices for the mixture model are defined differently than for all previous sections of the tutorial. We need to create a special text file (with a .txt extension), which contains information that QTEST reads. We will now look at the specific requirements of this text file. Specifying and testing a mixture model is recommended for more advanced users, e.g., because it requires that the user first solves the relevant mathematics problems to determine the facet structure of the polytope that characterizes the mixture model.

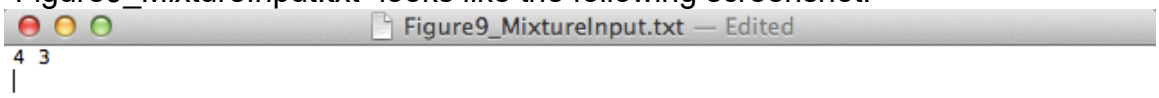
We call our text file “Figure9_MixtureInput.txt”.



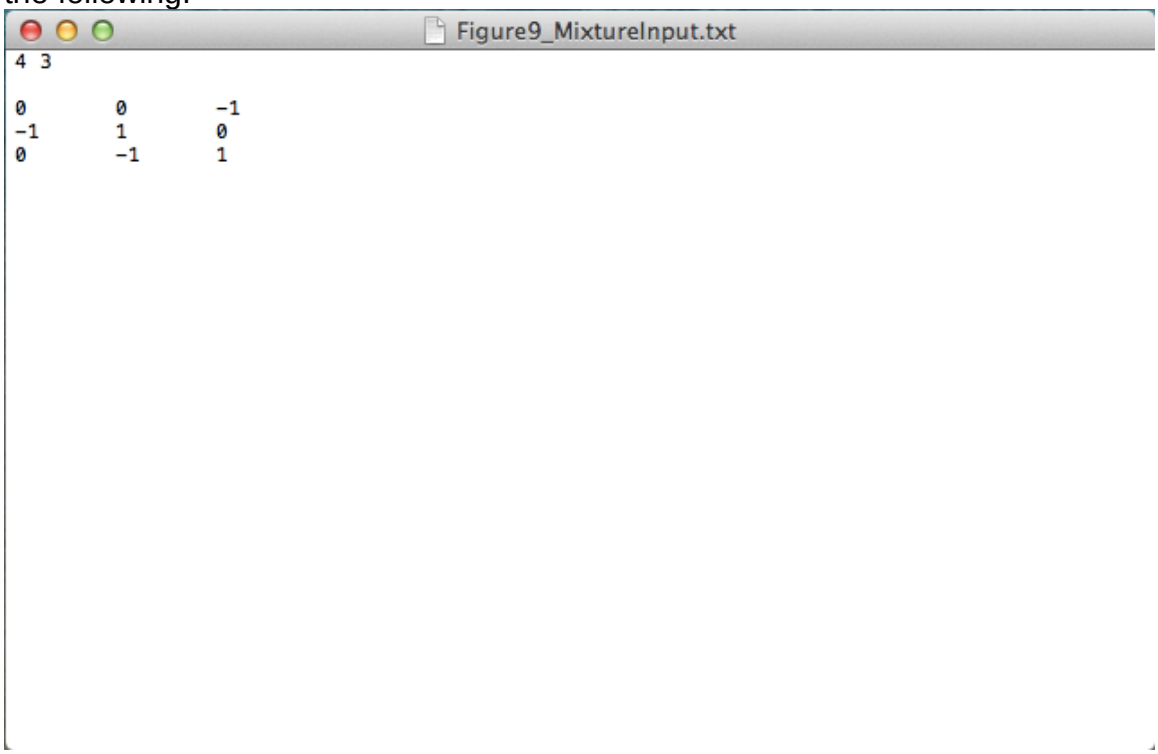
The first line of “Figure9_MixtureInput.txt” must contain two numbers, separated by a space. The first number represents the number of linear inequalities while the second number represents the number of gambles under consideration. To obtain the system of facet defining inequalities, one must use software like PORTA which is discussed in QTBC1 under the section ‘Random Preference and Random Utility Models’ and in Online Supplement 1 to QTEST. After entering the vertices “ACD”, “ADC”, “DAC” and “DCA” (or the 3-D coordinates 111, 110, 100 and 000) into PORTA, one will obtain the following system of 4 linear inequalities:

$$
\begin{aligned}
0 * P_{AC} + \ 0 * P_{AD} - \ 1 * P_{CD} \ &\leq 0 \\
-1 * P_{AC} + \ 1 * P_{AD} + \ 0 * P_{CD} \ &\leq 0 \\
0 * P_{AC} + \ -1 * P_{AD} + \ 1 * P_{CD} \ &\leq 0 \\
1 * P_{AC} + \ 0 * P_{AD} + \ 0 * P_{CD} \ &\leq 1
\end{aligned}
$$

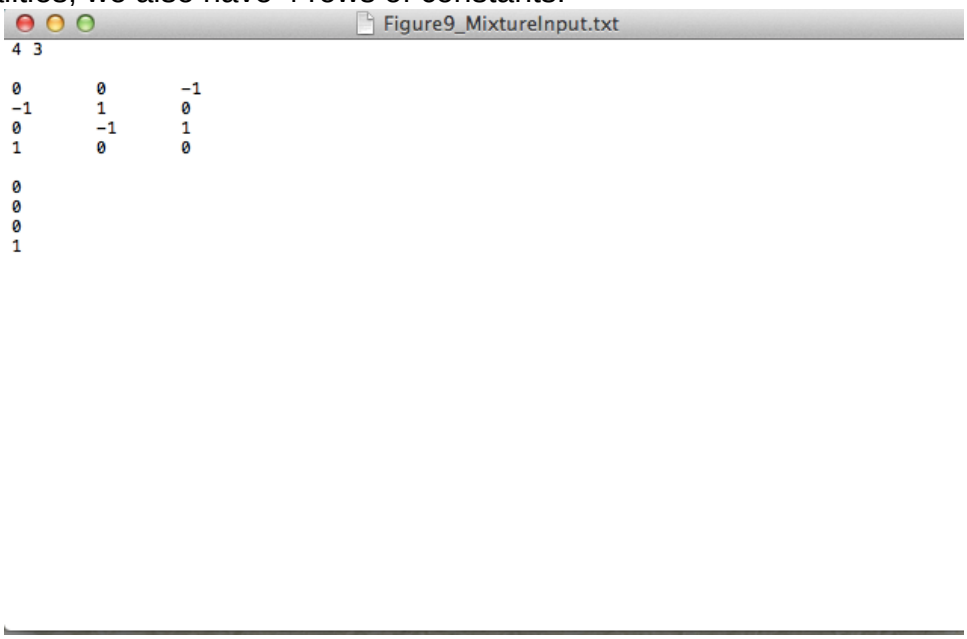
We now have 4 linear inequalities (where each row is 1 linear inequality). So, the first number of the first row of the input file is 4, to denote the number of linear inequalities. The second number, determined by the number of gambles (recall we have 3 in Figure 9: A, D and C), is 3. The first line of "Figure9_MixtureInput.txt" looks like the following screenshot.



The next row is an optional blank row. The row after contains the coefficients of everything to the left of the inequality signs in the system of linear inequalities provided above, with each column separated by a tab (or a single space). The inequalities must be formulated precisely as above, with the ≤ sign and the constant on the right-hand side of the inequality. Since there are 4 rows of inequalities, we have 4 rows of coefficients. Be sure to include any 0 coefficients. Adding these coefficients to the "Figure9_MixtureInput.txt" file yields the following.

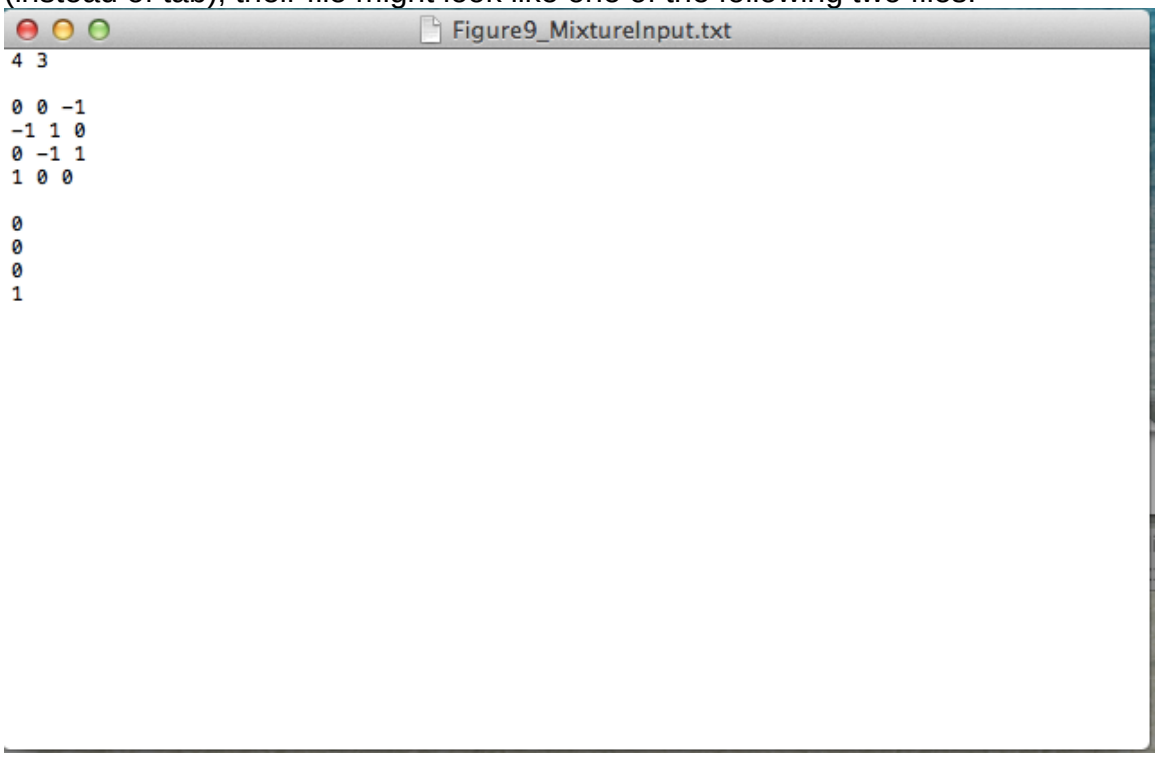


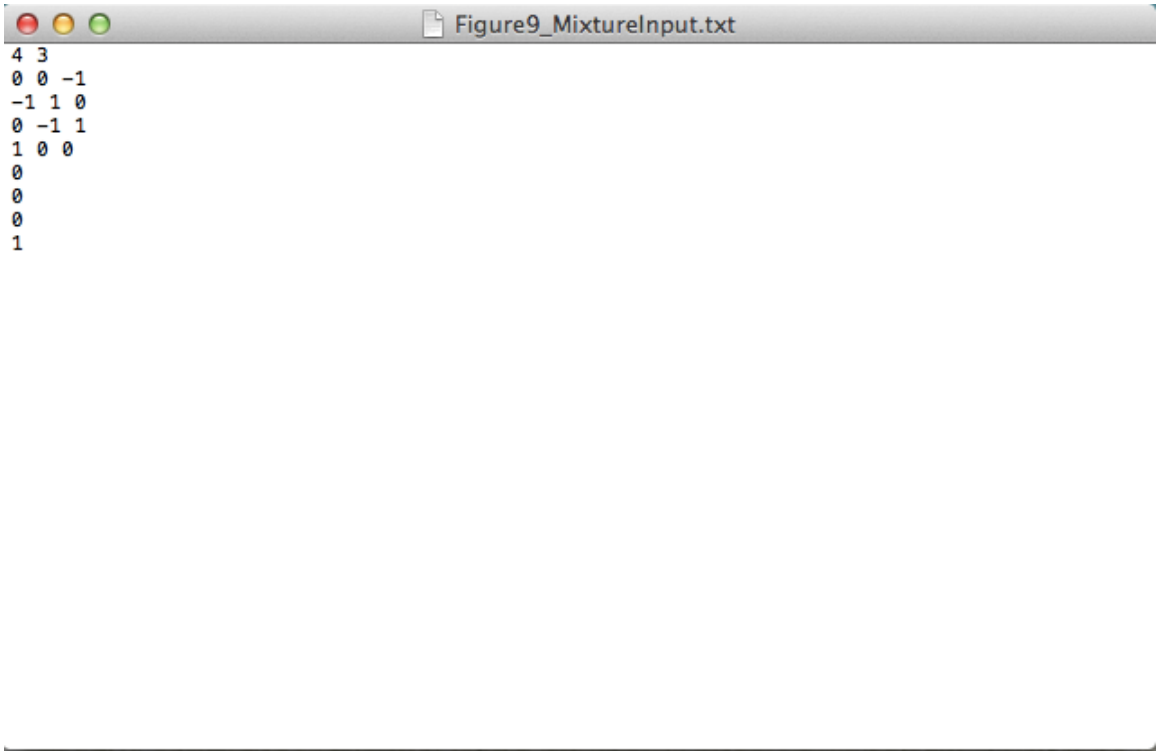
Again, the next row is an optional blank row. Then the constants of the system of linear inequalities (i.e. everything to the right of the ≤ operator in the system of inequalities above) are listed, one per row. (NOTE: The order of the constants must have the correct sign (positive or negative.) Since we have 4 rows of inequalities, we also have 4 rows of constants.



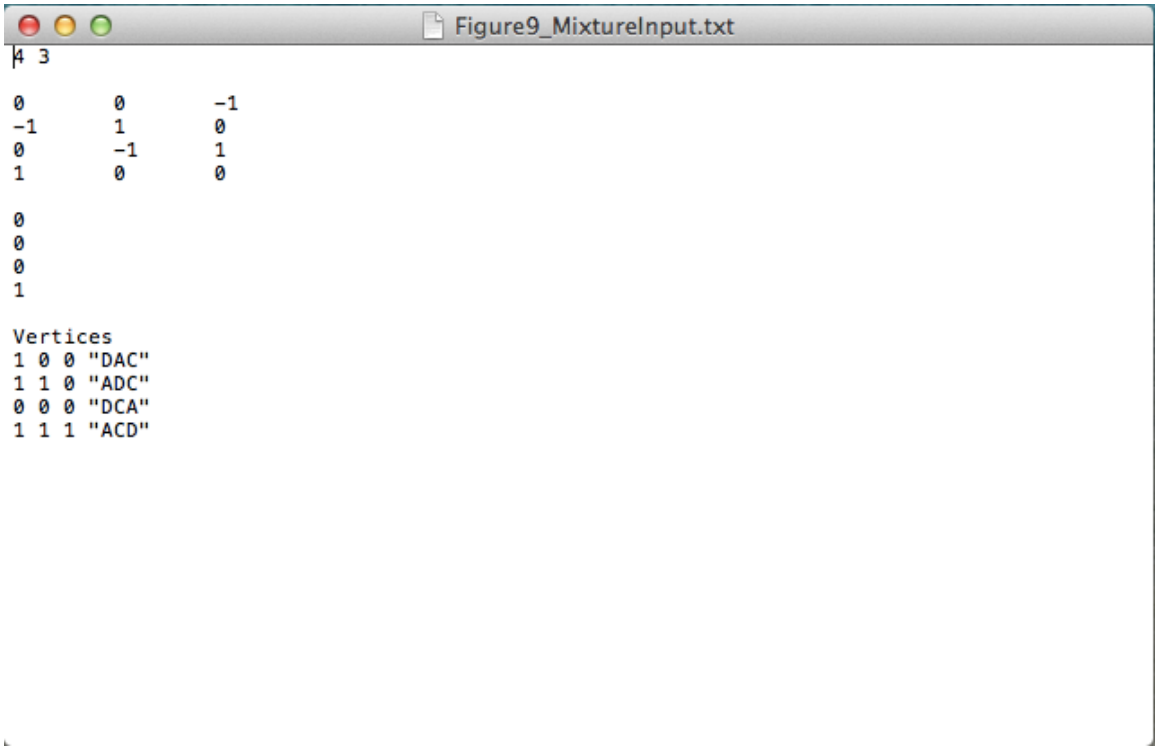
This file contains all the required information QTEST needs to analyze a mixture model. Alternatively, the file might look like the following, which does not have the optional spaces between rows.

Or if one used spaces in between the coefficients of the linear inequalities (instead of tab), their file might look like one of the following two files.





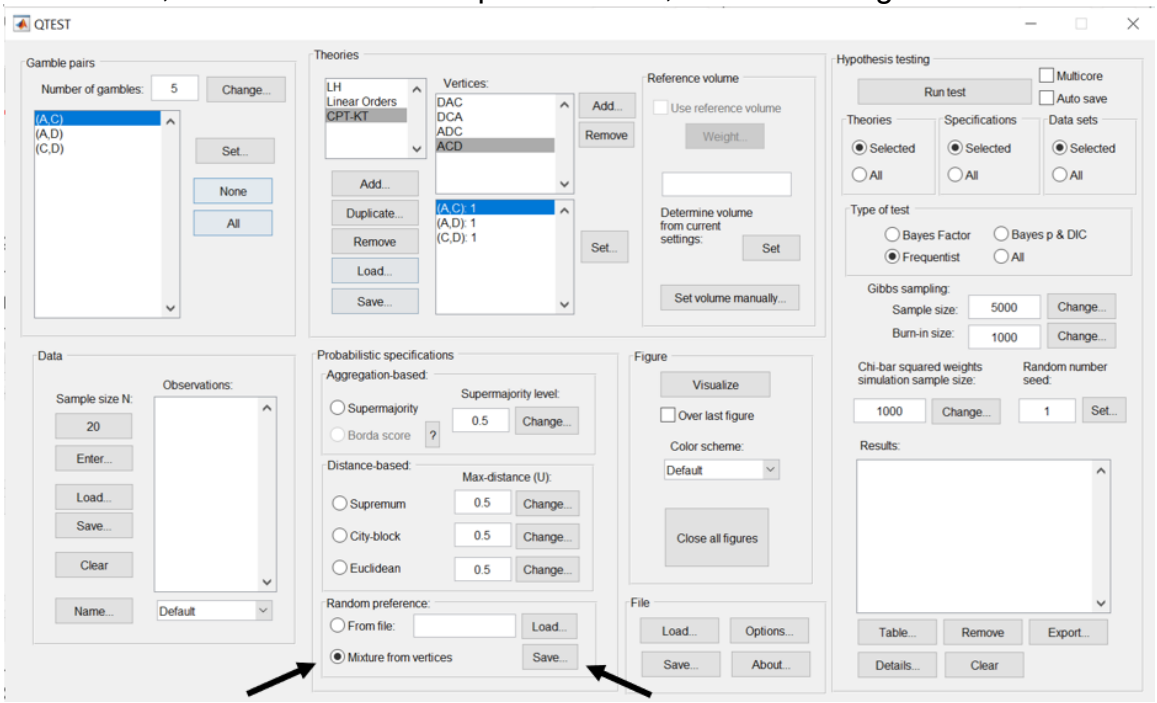
Finally, while not necessary for QTEST to do the analysis, it can be helpful to have more informative labels than the generic ones that QTEST will generate. After the last constant from the last inequality, (with an optional blank row), one can include the optional name “Vertices”, the coordinate and/or even the labels (in double quotes) for each vertex name. Once again, none of this information is required by QTEST—they are useful primarily for purposes of documentation and for 3-D visualizations.



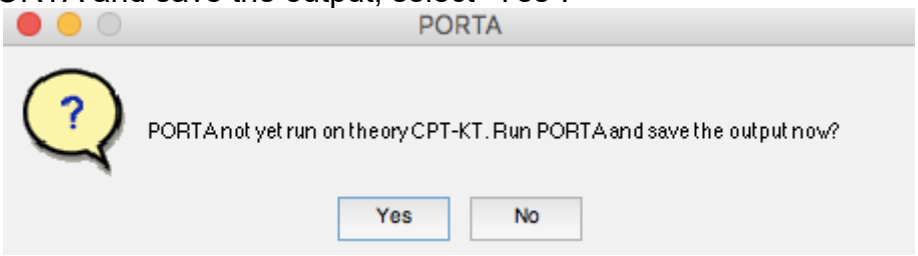
In this method, this is all the information QTEST needs to analyze a mixture model. Save this “Figure9_MixtureInput.txt” file. In the following section we will use this file to complete the analysis of the mixture model in the QTEST interface.

Method 2: generating the mixture model specification of $\mathcal{CPT}$-$\mathcal{KT}$ if using the QTEST interface to access PORTA

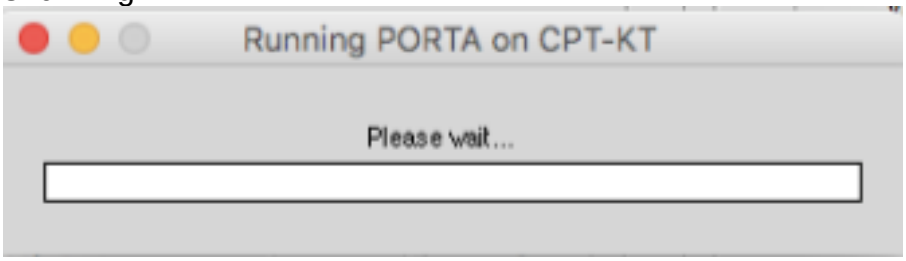
Under “Probabilistic specifications”, select the radio button left of “Mixture from vertices”. Then under “Probabilistic specifications”, select “Save…” and save this file as “Figure9_MixtureInput.mat”. Your session should match the circled information, under “Probabilistic specifications”, in the following screenshot.



A window matching the following screenshot will appear, asking if you would like to run PORTA and save the output; select “Yes”.



Another window matching the following screenshot will appear showing that PORTA is running.



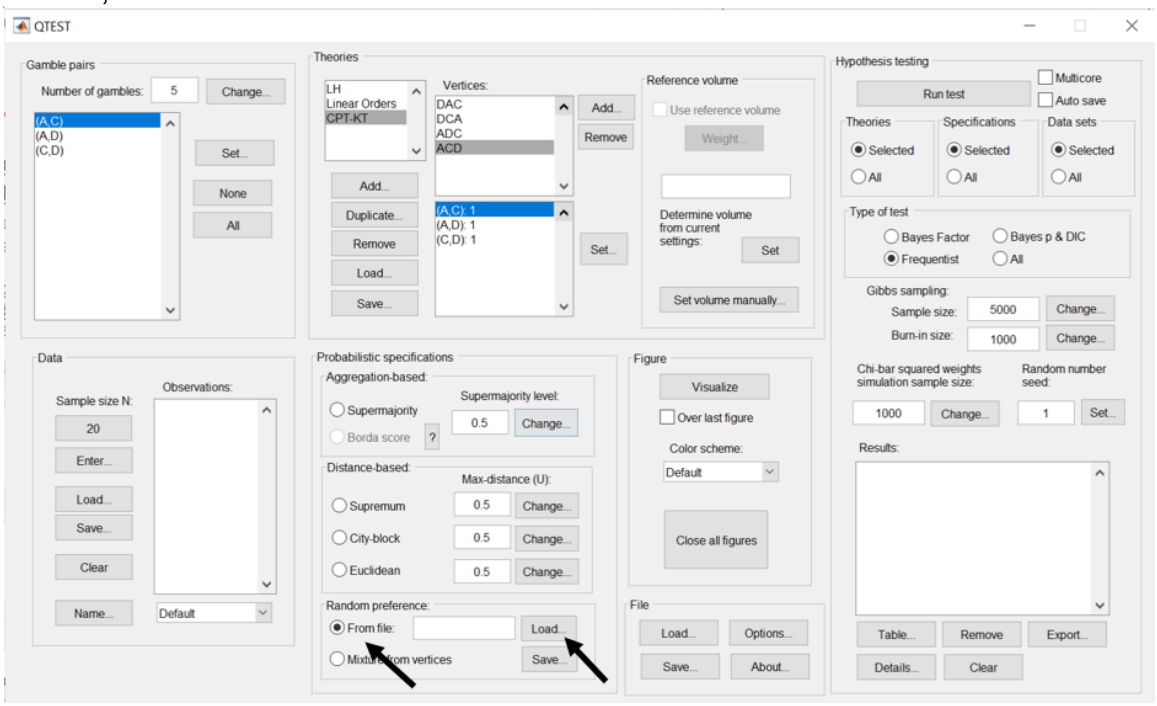
In the following section we will show how to complete the analysis of the mixture model in the QTEST interface.

F.1.4 Mixture model analysis of Random $\mathcal{CPT}$-$\mathcal{KT}$ for Figure 9 of QTBC1 and Figure 2 of Online Supplement 1

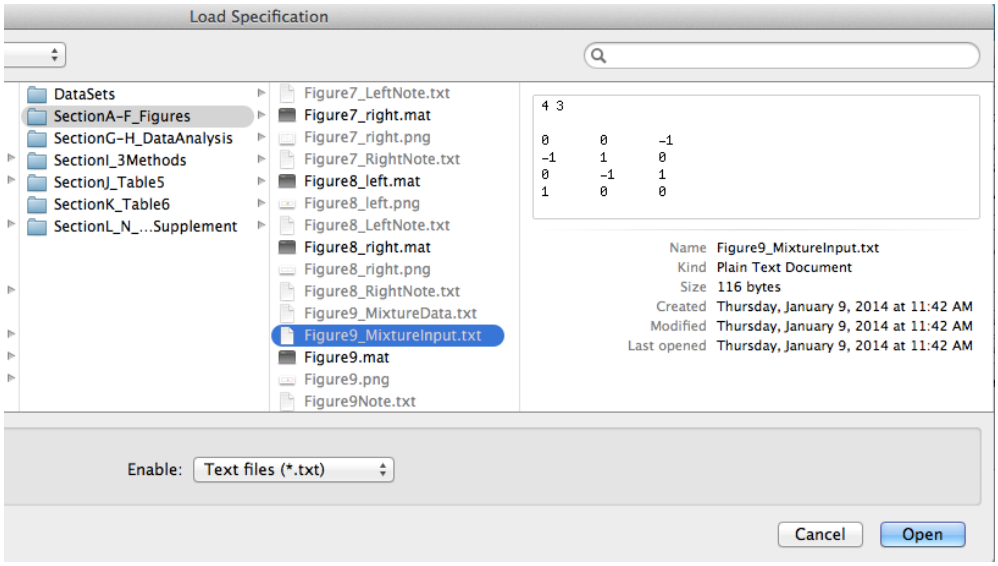
The mixture model analysis of Random $\mathcal{CPT}$-$\mathcal{KT}$ can be generated in two different ways. These methods are now described in more detail.

Method 1: generating the mixture model analysis of Random $\mathcal{CPT}$-$\mathcal{KT}$ if PORTA was used directly in the previous section

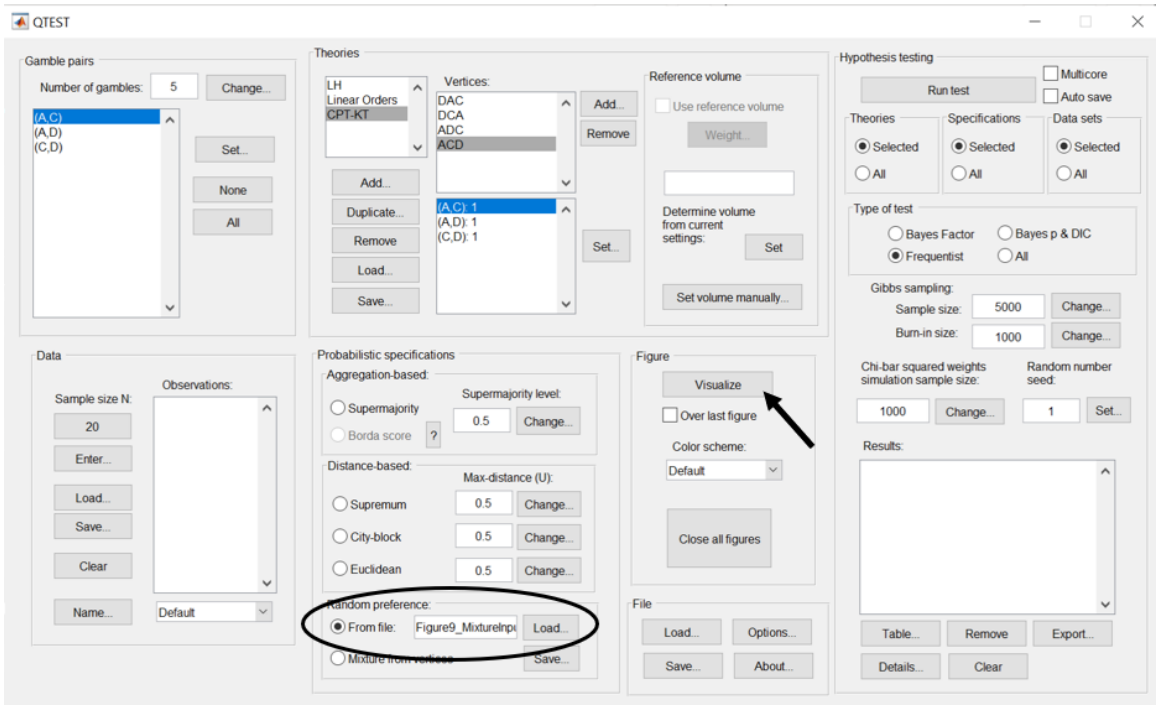
In the QTEST interface, under “Probabilistic specifications”, under “Mixture-based”, select the radio button next to “From file:”. Then select “Load…”.



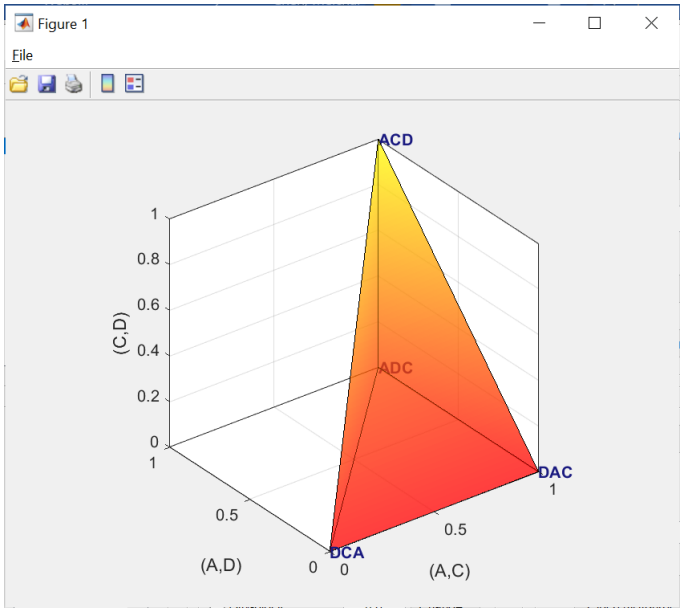
In the “Load Specification” dialogue box that pops up, change the “Files of type:” to “Text files (*.txt)” and then navigate to the location of the “Figure9_MixtureInput.txt” file. Then select “Open”.



Now “Figure9_MixtureInput.txt” appears under “Mixture-based”. Under “Figure”, select “Visualize”.

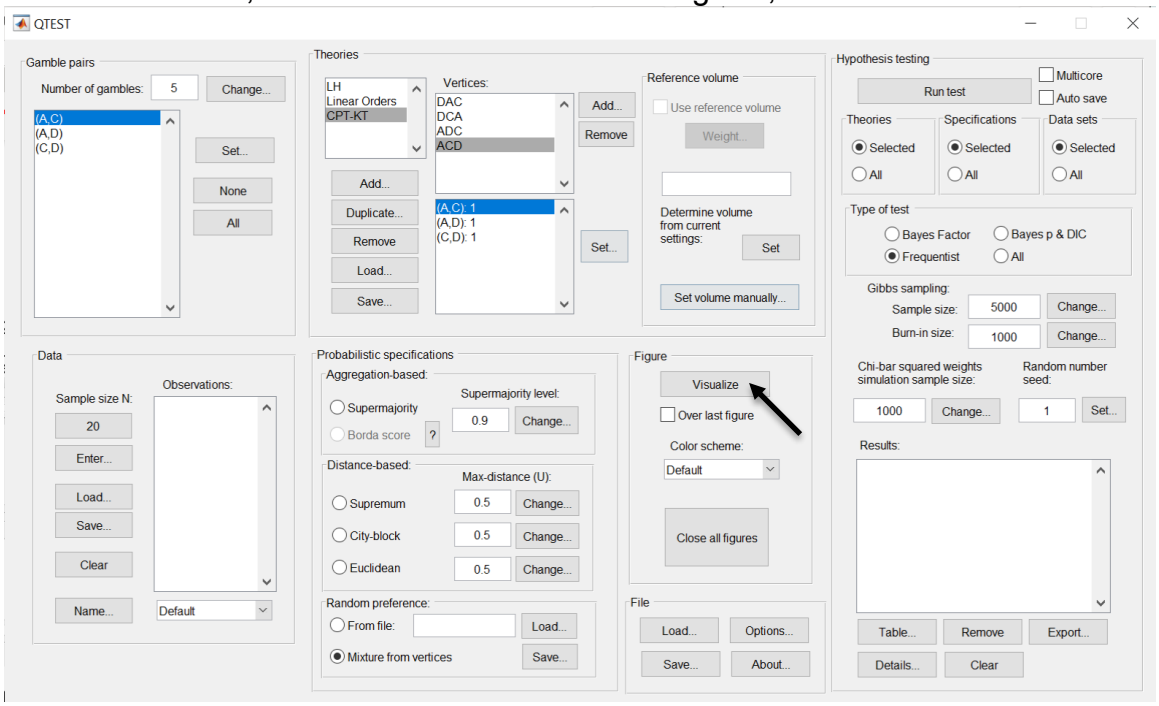


The figure that pops up is a version of Figure 9 of QTBC1.

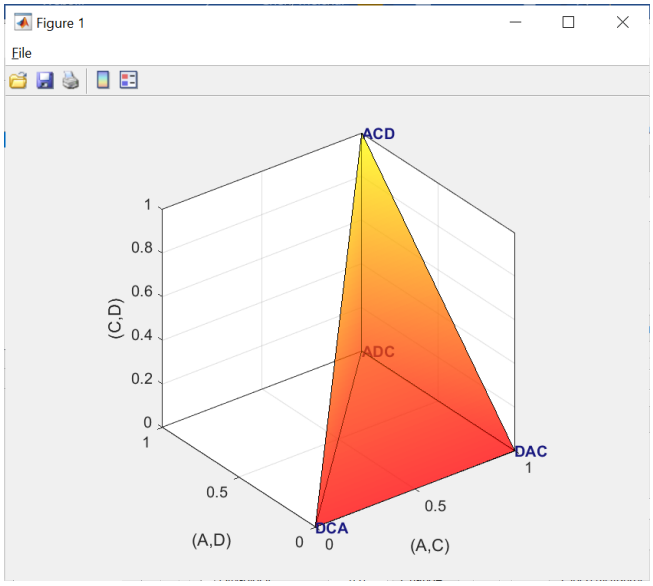


Method 2: generating the mixture model analysis of Random $CPT\text{-}KT$ if the QTEST interface was used to access PORTA in the previous section

Under “Theories”, select “CPT-KT” and under “Figure”, select “Visualize”.



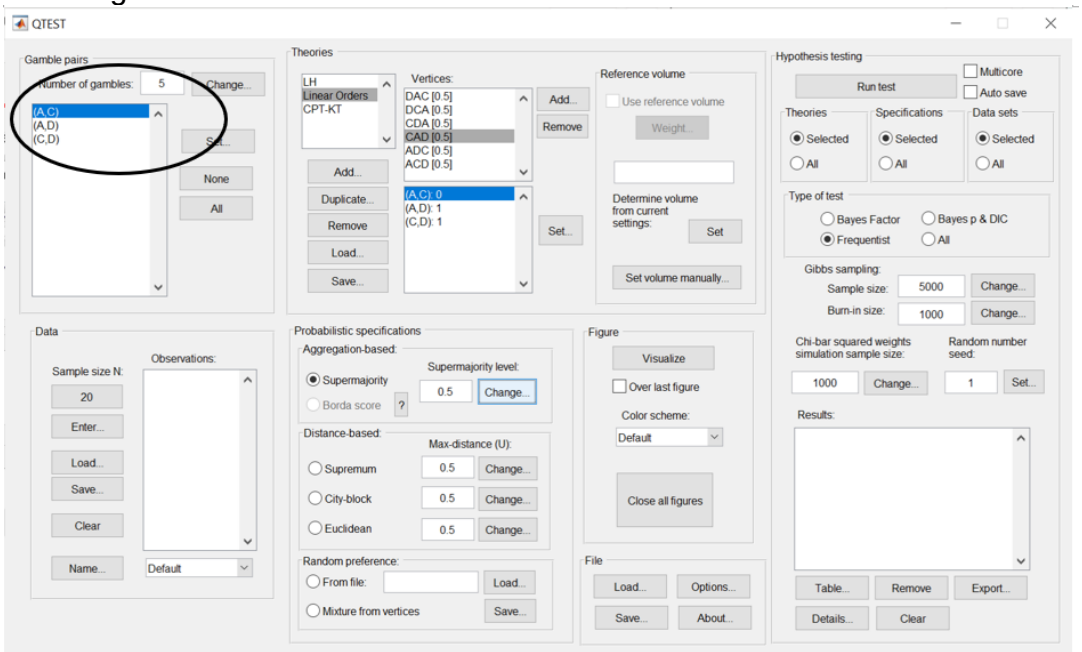
The figure that pops up is a version of Figure 9 of QTBC1.



This completes the 3-D example for the mixture model specification for Figure 9 of QTBC1, and is the last figure of QTBC1.

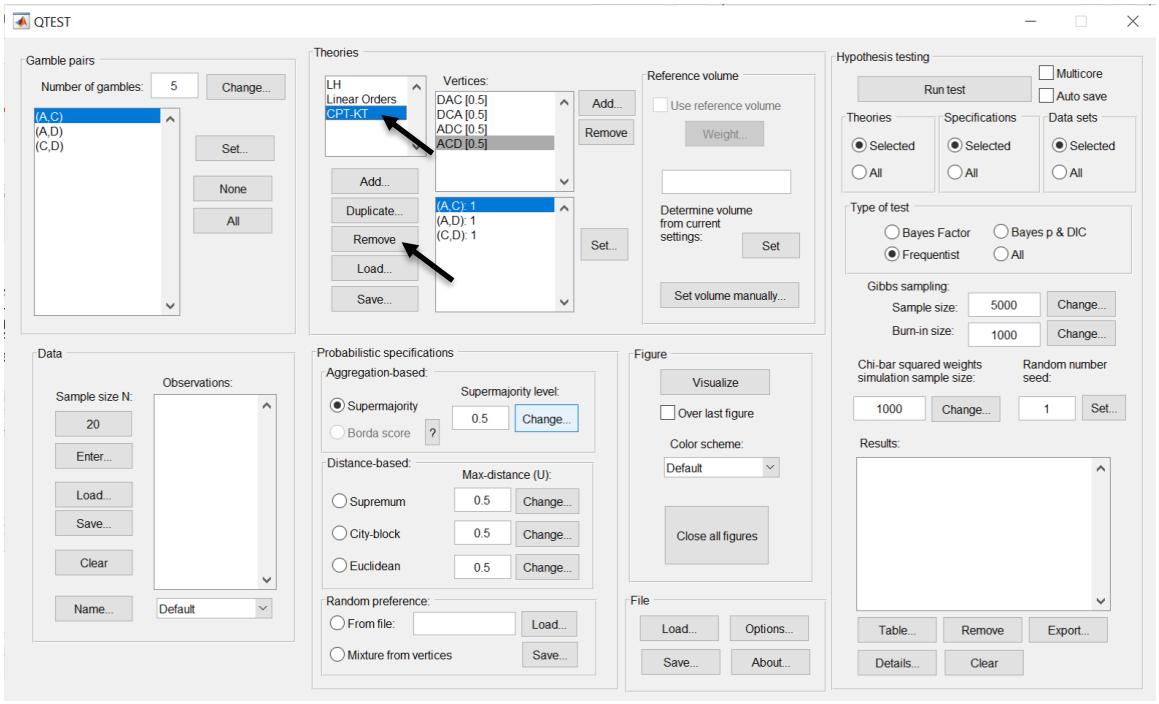
F.2.1 Create the gamble pairs for Figure 4 of QTBC2

We will use a modification of the gamble pairs as in our QTEST session from Section E to create the gamble pairs for Figure 4 of QTBC2. If you are loading a saved session, loading the session from Section D will be most helpful. Your session should match the circled information, under “Gamble pairs”, in the following screenshot.

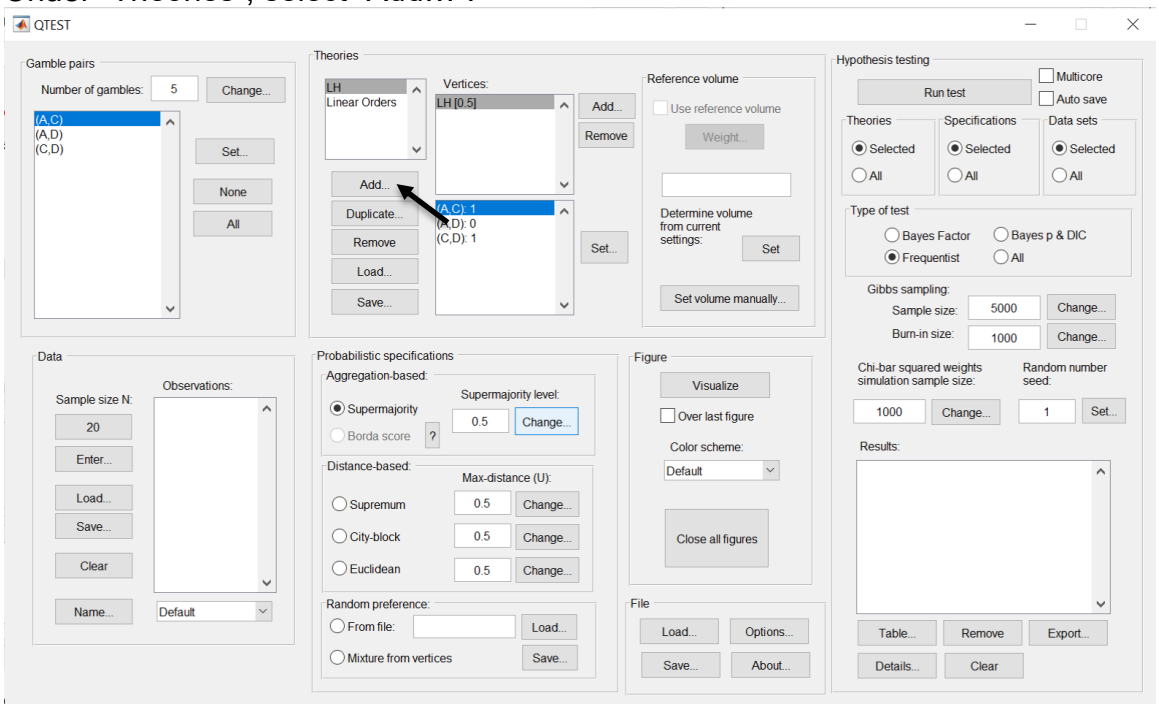


F.2.2 Define one decision theory, Random *CPT-KT* for Figure 4 of QTBC2

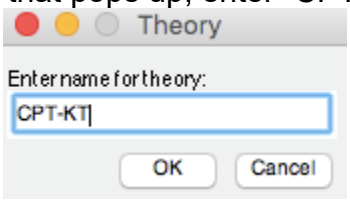
Under “Theories”, select “CPT-KT” so it is blue highlighted. Then select “Remove”. We will create a new random *CPT-KT* in this section.



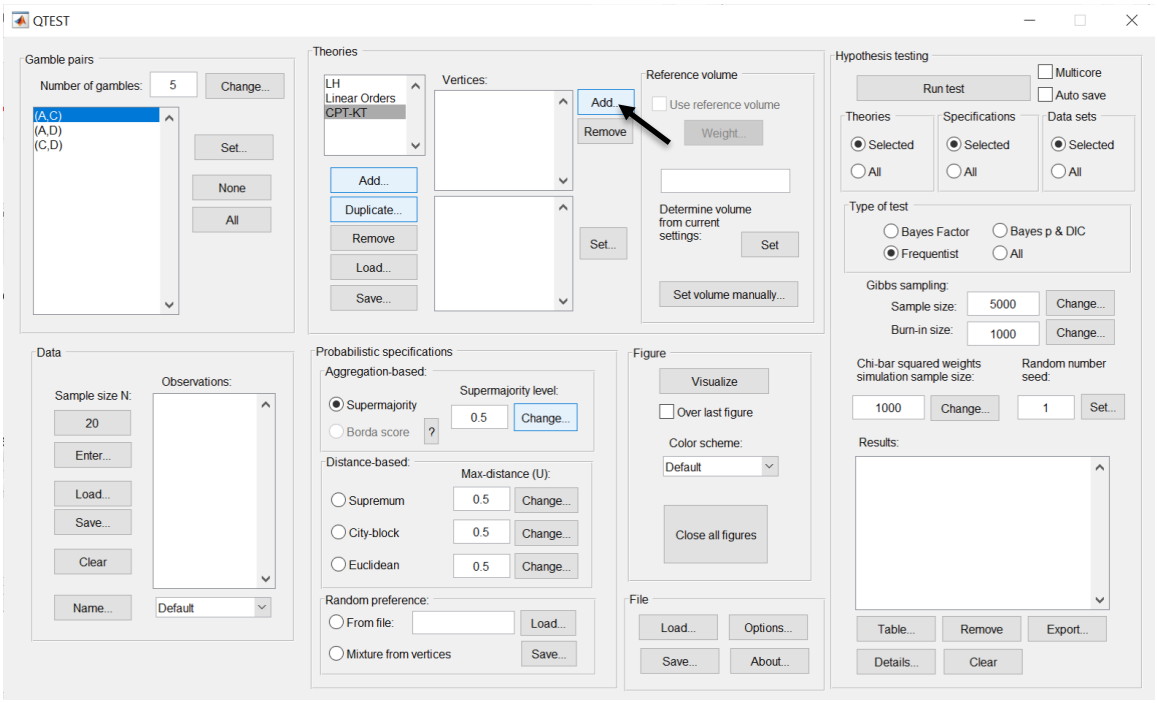
Under “Theories”, select “Add…”.



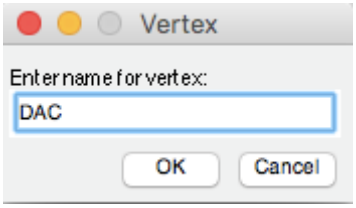
In the “Theory” dialogue box that pops up, enter “CPT-KT”. Select “OK”.



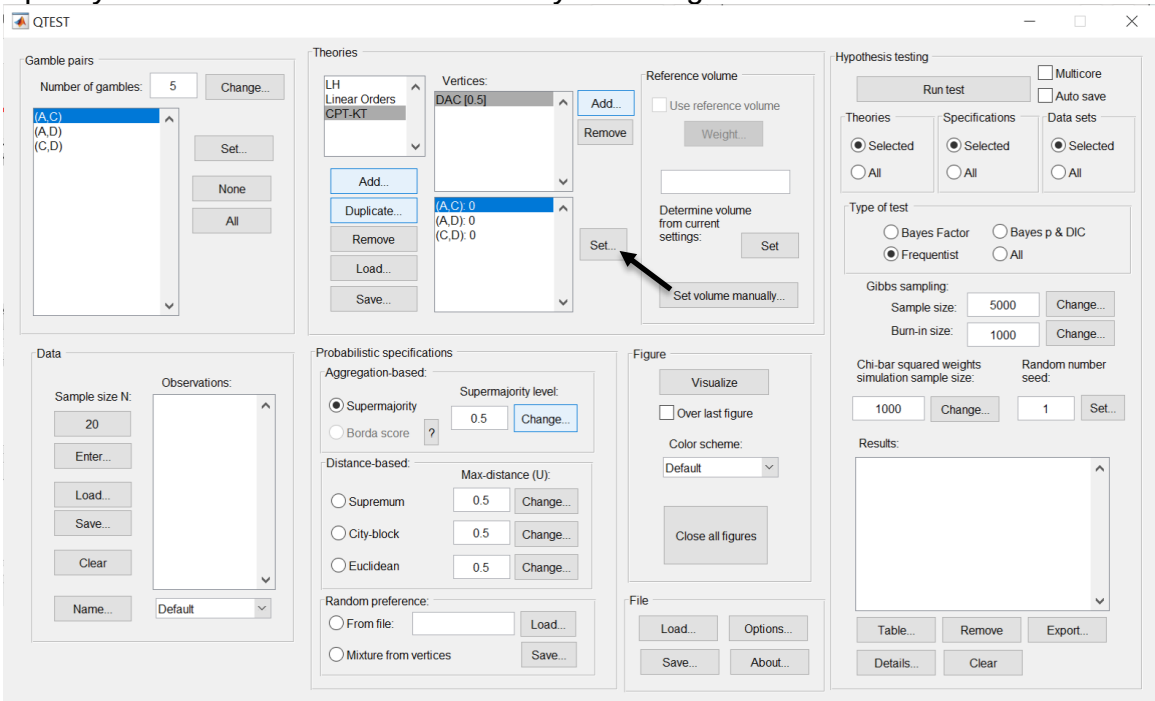
Under “Theories”, select “Add…”, just right of “Vertices:”.



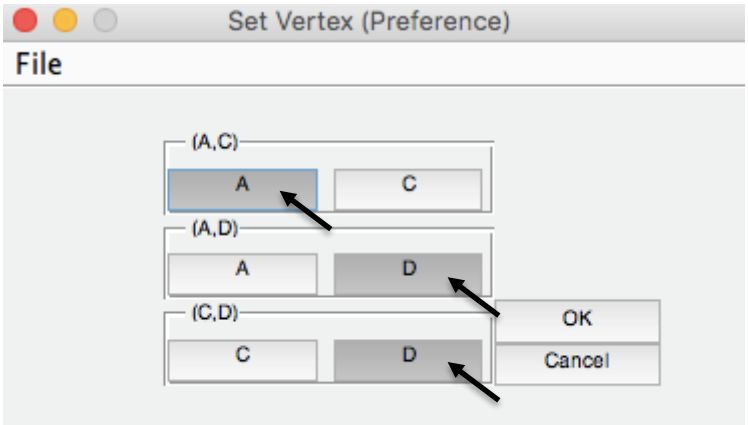
Enter “DAC”, as a name for the ranking DAC, in the “Vertex” dialogue box that pops up. Then select “OK”.



Specify the coordinates of this vertex by selecting “Set…”.



The “Set Vertex (Preference)” window pops up. For each gamble pair, select the gamble preferred under the ranking DAC. Since D is preferred to A in pair (A,D), select “D”. Likewise, A is preferred to C in pair (A,C), so select “A”. Finally, D is preferred to C in pair (D,C) so select “D”. And then select “OK”.

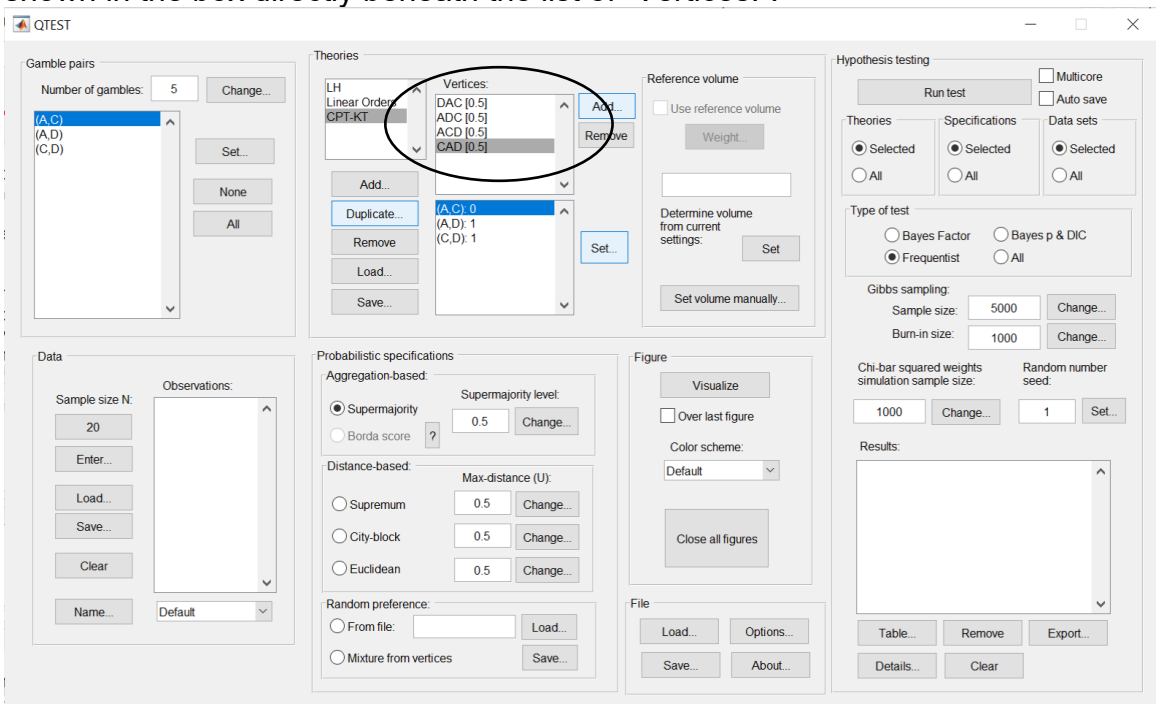


Select “Add” just right of “Vertices” in QTEST. In the “Vertex” dialogue box that pops up enter “ADC” and then press “OK”. Make sure “ADC” is highlighted in gray under “Vertices” in the QTEST interface and then press “Set”. In the “Set Vertex (Preference)” dialogue box, select “A” from gamble pair “(A,C)”, “A” from gamble pair “(A,D)” and “D” from gamble pair “(C,D)”.

Select “Add” just right of “Vertices” in QTEST. In the “Vertex” dialogue box that pops up enter “ACD” and then press “OK”. Make sure “ACD” is highlighted in gray under “Vertices” in the QTEST interface and then press “Set”. In the “Set Vertex (Preference)” dialogue box select “A” from gamble pair “(A,C)”, “A” from gamble pair “(A,D)” and “C” from gamble pair “(C,D)”.

Select “Add” just right of “Vertices” in QTEST. In the “Vertex” dialogue box that pops up enter “CAD” and then press “OK”. Make sure “CAD” is highlighted in gray under “Vertices” in the QTEST interface and then press “Set”. In the “Set Vertex (Preference)” dialogue box select “C” from gamble pair “(A,C)”, “A” from gamble pair “(A,D)” and “C” from gamble pair “(C,D)”. Then select “OK”.

The QTEST interface should now match the following screenshot. Note the list of “Vertices” contains “DAC”, “ADC”, “ACD”, and “CAD”. By selecting one of these vertices (it will be gray highlighted) the gambles specified by that vertex are shown in the box directly beneath the list of “Vertices:”.

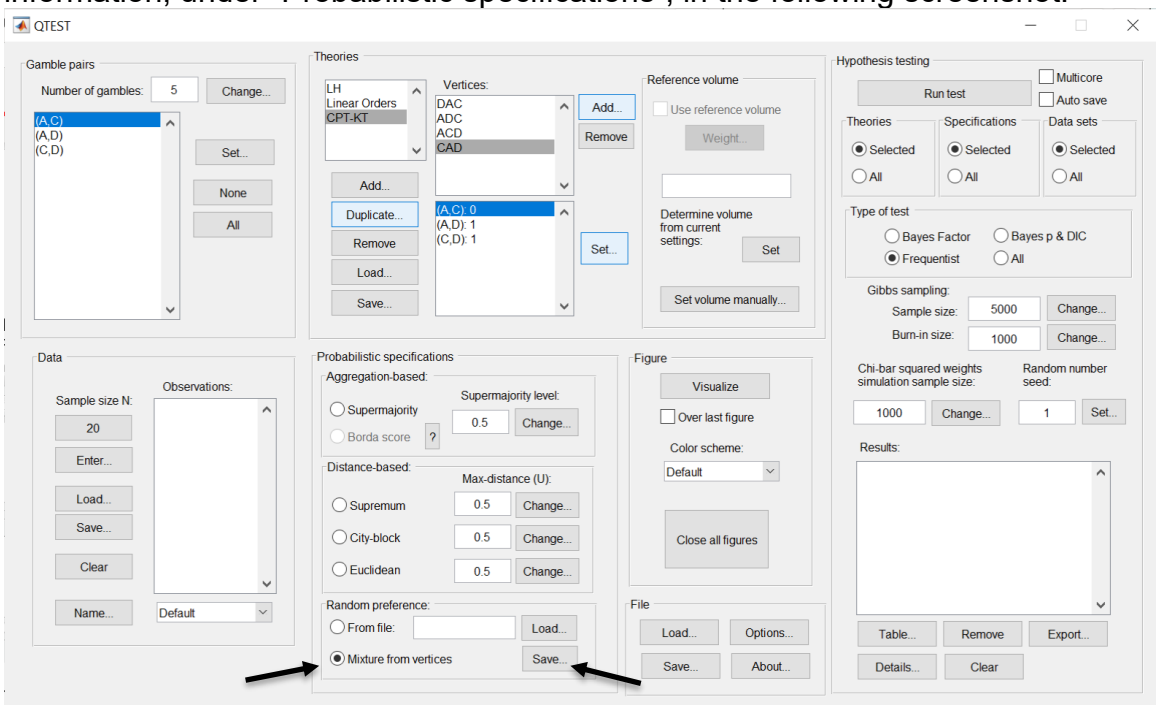


Now that the 4 predictions, or vertices, of Figure 4 of QTBC2 have been defined, we can create the mixture model specification of $\mathcal{CPT}$-$\mathcal{KT}$.

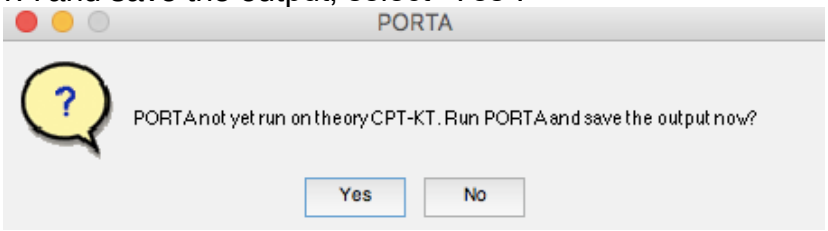
F.2.3 Mixture model specification of $\mathcal{CPT}$-$\mathcal{KT}$ for Figure 4 of QTBC2

The mixture model specification of $\mathcal{CPT}$-$\mathcal{KT}$ will now be generated using the QTEST interface to access PORTA.

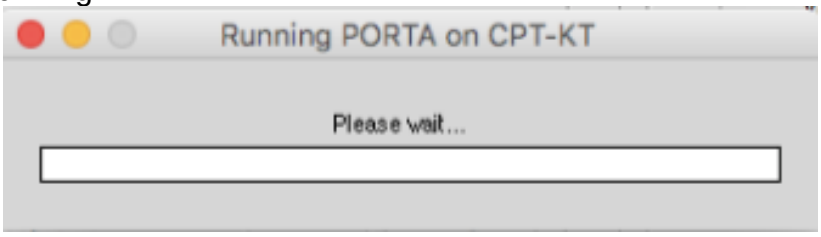
Under “Probabilistic specifications”, select the radio button left of “Mixture from vertices”. Then under “Probabilistic specifications”, select “Save…” and save this file as “2.0Figure4_MixtureInput.mat”. Your session should match the circled information, under “Probabilistic specifications”, in the following screenshot.



A window matching the following screenshot will appear, asking if you would like to run PORTA and save the output; select “Yes”.



Another window matching the following screenshot will appear showing that PORTA is running.



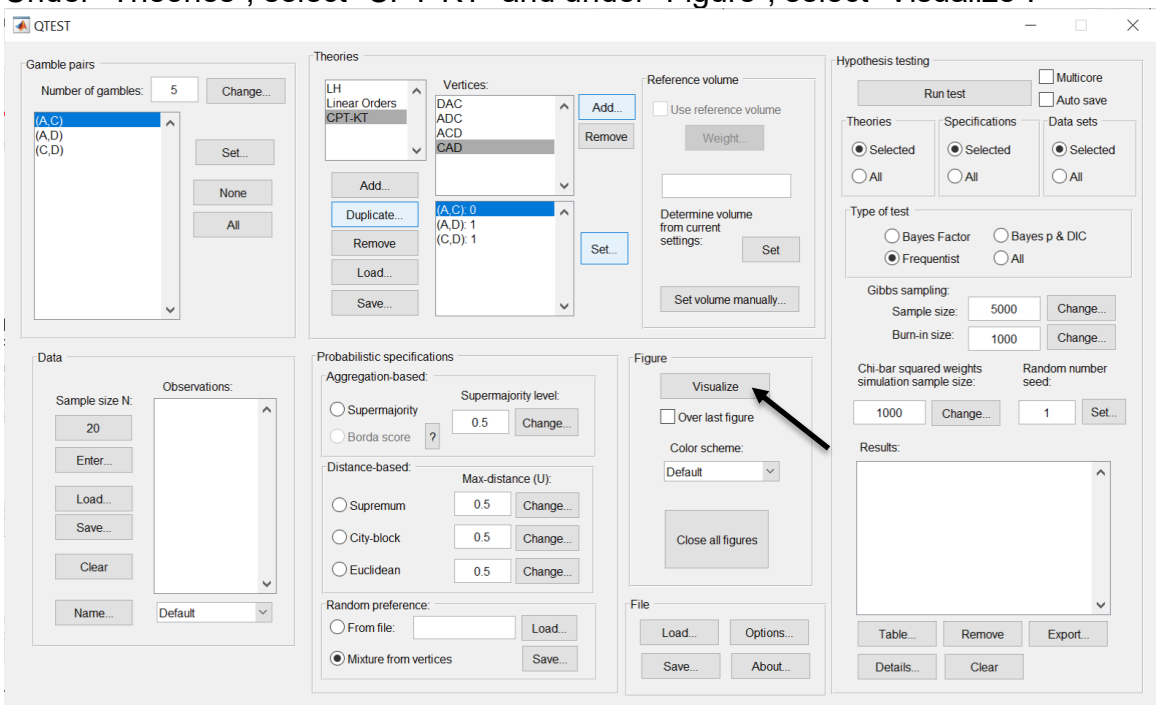
In the following section we will show how to complete the analysis of the mixture model in the QTEST interface.

F.2.4 Mixture model analysis of Random $\mathcal{CPT}$-$\mathcal{KT}$ for Figure 4 of QTBC2

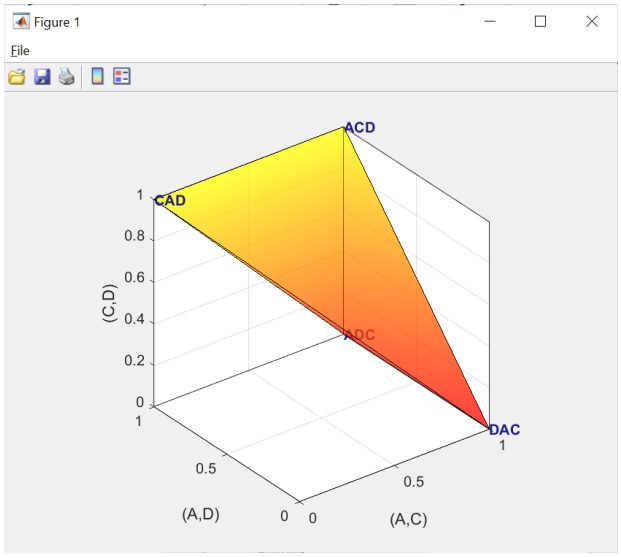
The mixture model analysis of Random $\mathcal{CPT}$-$\mathcal{KT}$ will now be generated using the QTEST interface to access PORTA.

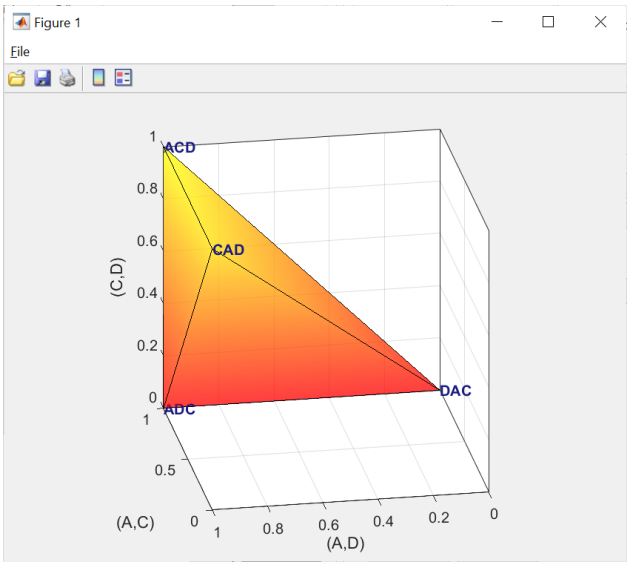
Method 2: generating the mixture model analysis of Random $\mathcal{CPT}$-$\mathcal{KT}$ if the QTEST interface was used to access PORTA in the previous section

Under “Theories”, select “CPT-KT” and under “Figure”, select “Visualize”.



After rotating, the figure that pops up is a version of Figure 4 of QTBC2.





This completes the 3-D example for the mixture model specification for Figure 4 of QTBC2.

PART III: Data Analysis

Part II of the tutorial exclusively dealt with 5 parts of the QTEST interface: "Gamble Pairs", "Theories", "Probabilistic Specifications", "Figure" and "File". In this last part of the tutorial, we build on this knowledge and learn how to use the "Data" and "Hypothesis Testing" parts of the QTEST interface to test theories on data.

Part II of the tutorial analyzed part of the data set called Cash II to generate the Figures. Part III of the tutorial analyzes the entire datasets for both Cash I and Cash II.

The objective of this Data Analysis section is to allow a user of QTEST to recreate the results shown in Tables 5 and 6 of the paper *QTEST: Quantitative Testing of Theories of Binary Choice* made accessible and Tables 1, 2, and 3 of *QTEST 2.0: Quantitative Testing of Theories of Binary Choice Using Bayesian Inference.* Just as Part II of the tutorial was organized around the creation of each Figure of QTBC1 and Figure 4 of QTBC2, so Part III is organized around the generation of each Table of QTBC1 and QTBC2.

In Part II of the tutorial, it was reasonable to manually enter all the information needed to generate the Figures of QTBC1 and Figure 4 of QTBC2 because we only used 3 gamble pairs. In Part III, the data analysis requires 10 gamble pairs, necessarily increasing the amount of information QTEST needs to run analyses. While it is certainly possible to enter all this information manually, that process becomes laborious and error-prone. To circumvent this problem, and approximate research settings (which often have lots of gamble pairs and large data sets), most of the analyses that follow require loading an appropriate input file provided with this tutorial. We will show how one can enter the required information into the QTEST interface manually and, thereafter, will show how to use the input files. Moreover, a set of corresponding output files is also provided so the user of this tutorial can match their work with these files.

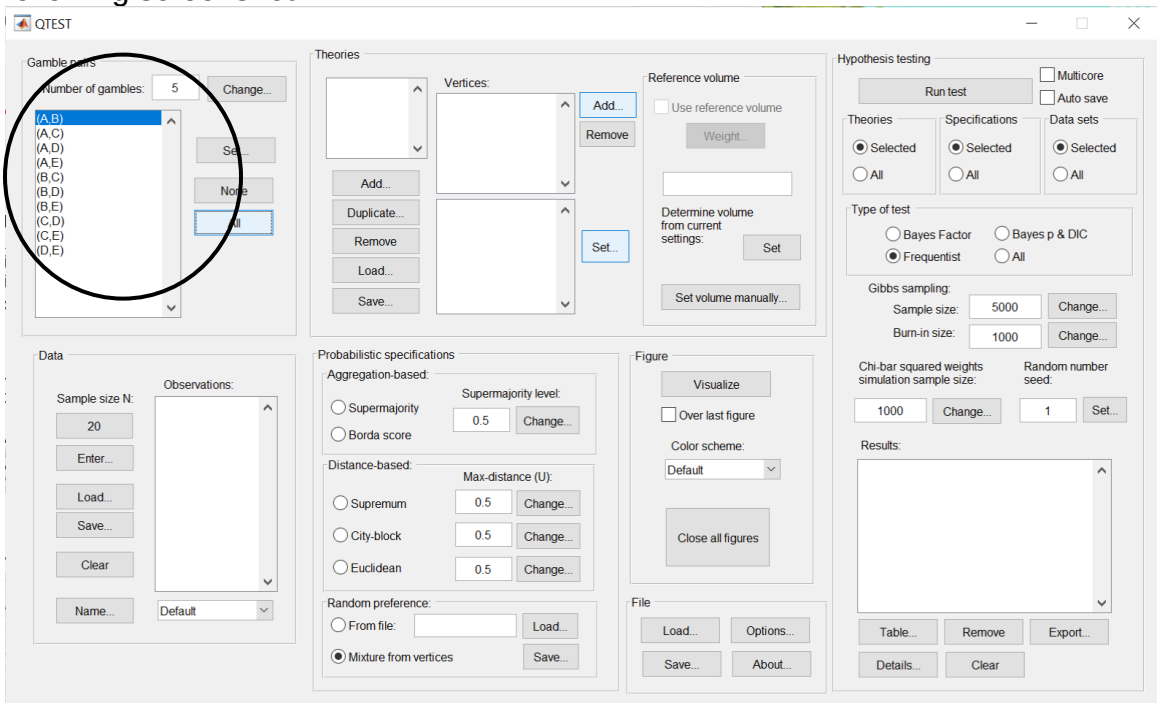
Part III of the tutorial encompasses Sections G through K. Sections G and H present detailed examples of data analysis. Section I provides some general guidelines on file nomenclature and different ways to replicate the tables of QTBC1. Sections J and K allow a user of QTEST to reproduce Tables 5 and 6 of QTBC1. Sections L and M allow a user of QTEST to reproduce Tables 1, 2, and 3 of QTBC2.

G. Data analysis of one theory with one vertex

All files needed for Section G can be found within the folder "SectionG-H_DataAnalysis", which is downloadable from the QTEST website. If one loads the file "LH_.5_Maj.mat" into QTEST then it will contain all the steps of Section G of this tutorial. We begin with the upper half of Table 5, which is the 0.50-majority/modal choice specification and we analyze $\mathcal{LH}$ first.

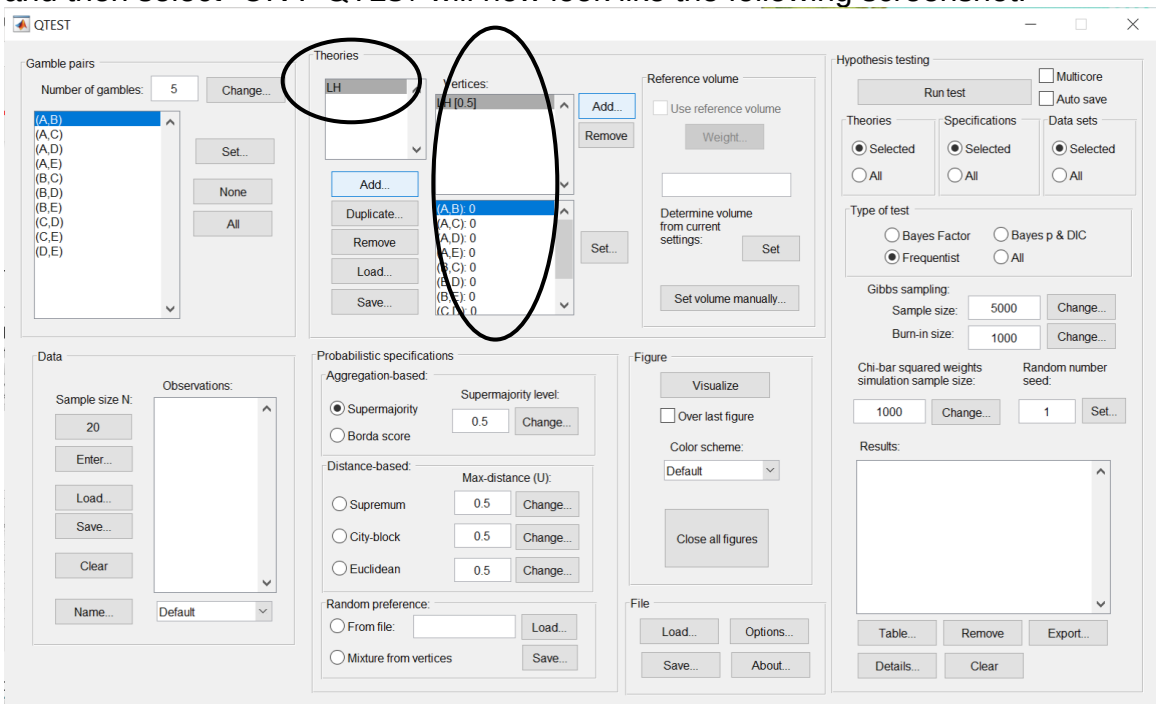
G.1 Gamble pairs

Starting with a clear (or new) QTEST interface, under "Gamble pairs", "Change" the "Number of gambles:" to "5" and then select "All". QTEST should look like the following screenshot.

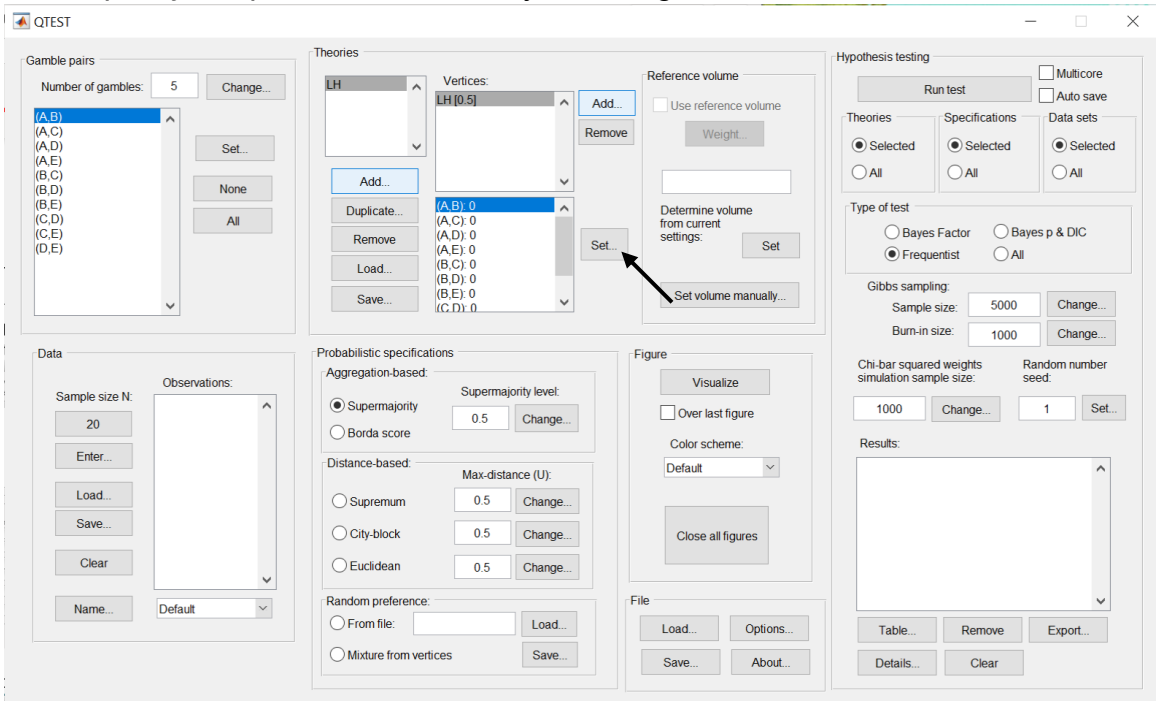


G.2 Theory and vertex

Now we need to define the vertices for $\mathcal{LH}$. Under "Theories", select "Add…". In the "Theory" dialogue box that pops up, enter "LH". Then select "OK". Under "Vertices:", select "Add…". In the "Vertex" dialogue box that pops up, enter "LH" and then select "OK". QTEST will now look like the following screenshot.



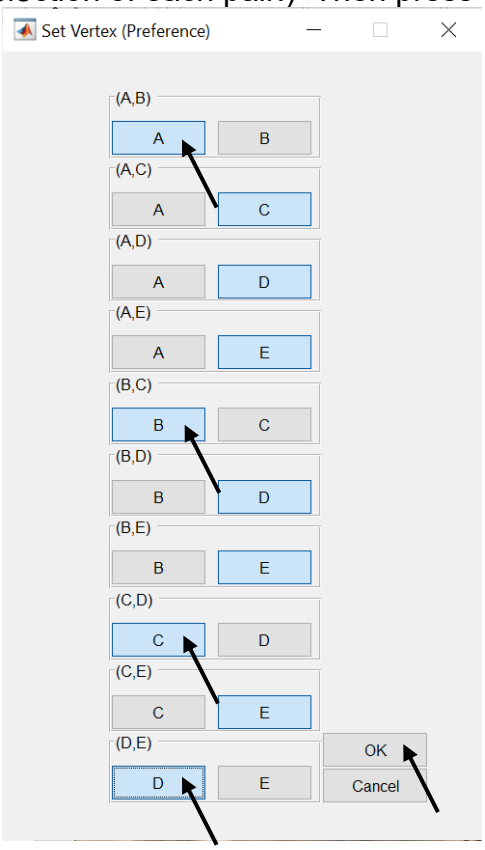
Next, specify the predictions of $\mathcal{LH}$ by selecting "Set…" under "Vertices:".



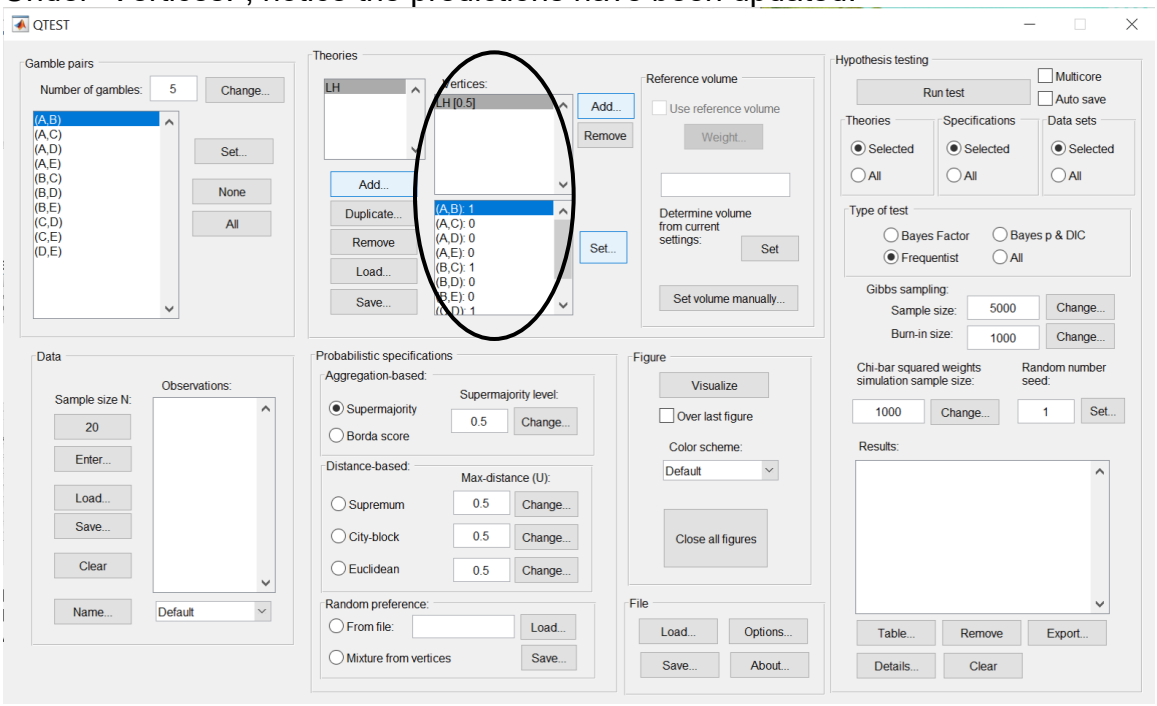
From QTBC1, if a decision maker follows $\mathcal{LH}$, they will prefer the first gamble in pairs (A,B), (B,C), (C,D) and (D,E). In the coding of 1's and 0's, the decision maker would have a 1 for these four pairs. The decision maker would prefer the second gamble in pairs (A,C), (A,D), (A,E), (B,D), (B,E) and (C,E), which would be coded as a 0 for these 6 pairs. We now translate this logic into QTEST. In the "Set Vertex (Preference)" dialogue box that popped up (after pressing "Set…" under "Vertices:"), select the following gambles from each pair in the window. You should only have to change 4 of the 10 gambles from their default selections:

"A" in pair "(A,B)"
"B" in pair "(A,C)" (default selection)
"D" in pair "(A,D)" (default selection)
"E" in pair "(A,E)" (default selection)
"B" in pair "(B,C)"
"D" in pair "(B,D)" (default selection)
"E" in pair "(B,E)" (default selection)
"C" in pair "(C,D)"
"E" in pair "(C,E)" (default selection)
"D" in pair "(D,E)"

If you have done this correctly, the pop up window should look like the following screenshot. (An arrow is only shown on the screenshot where it was necessary to change the default selection of each pair.) Then press "OK".



Under “Vertices:”, notice the predictions have been updated.



To check if these predictions are correctly defined, the number following each gamble pair in the bottom half of the “Vertices:” section should match the following vector of 1’s and 0’s:

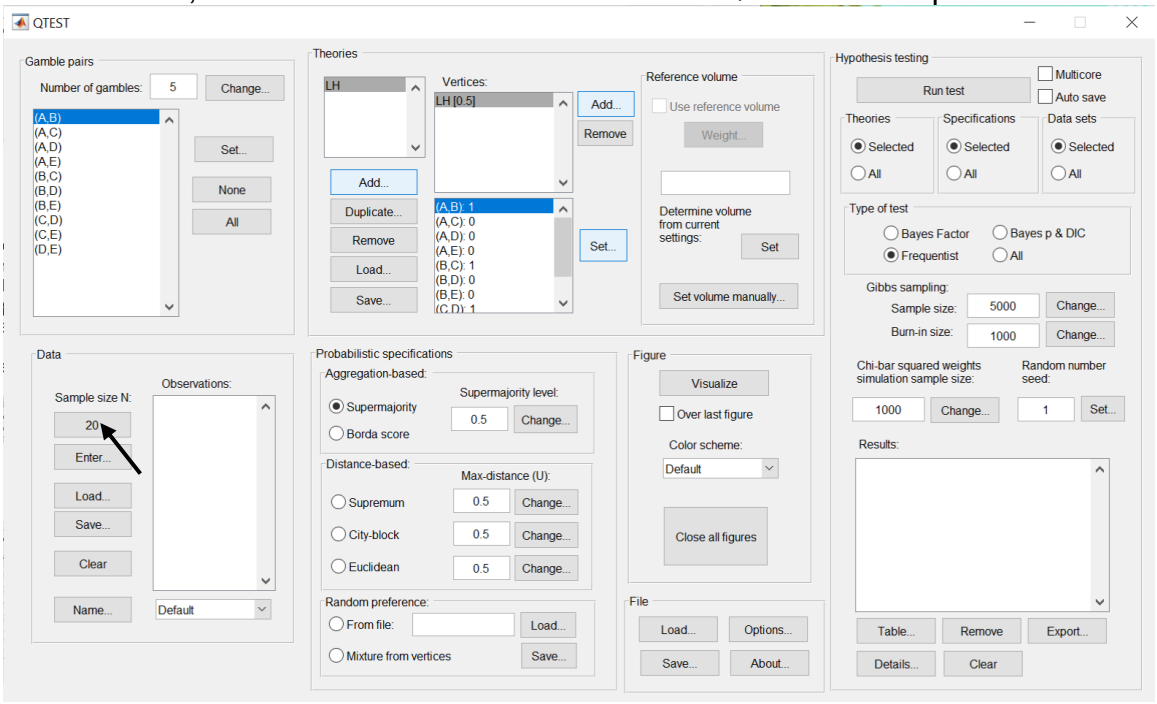
(A,B): 1
(A,C): 0
(A,D): 0
(A,E): 0
(B,C): 1
(B,D): 0
(B,E): 0
(C,D): 1
(C,E): 0
(D,E): 1

G.3 Data

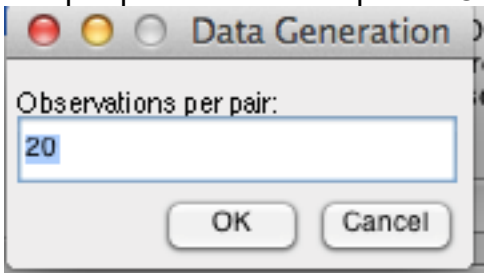
Now that we have defined the gamble pairs and the vertex for $L\mathcal{H}$, we need to enter data, under “Data” in the QTEST interface. For this step, we will briefly overview how one would enter data manually into QTEST using the data from Decision Maker 1 (DM1) and Decision Maker 13 (DM13) of Table 2 of QTBC1. We will load the data from a file for our analysis of Table 5 of QTBC1, however, because, with 18 participants and 10 gamble pairs for both Cash I and Cash II data sets, individual data entry would take much time and lead to an increased chance of making an error.

At this point we recommend that *at least* 20 observations per gamble pair, per person be used in a QTEST analysis. This ensures the assumptions of the asymptotic distributions are reasonably met. Of course, one may use more than 20 observations. But with less than 20 observations the results may be compromised. However, there are exceptions—see Online Supplement 1 for more details.

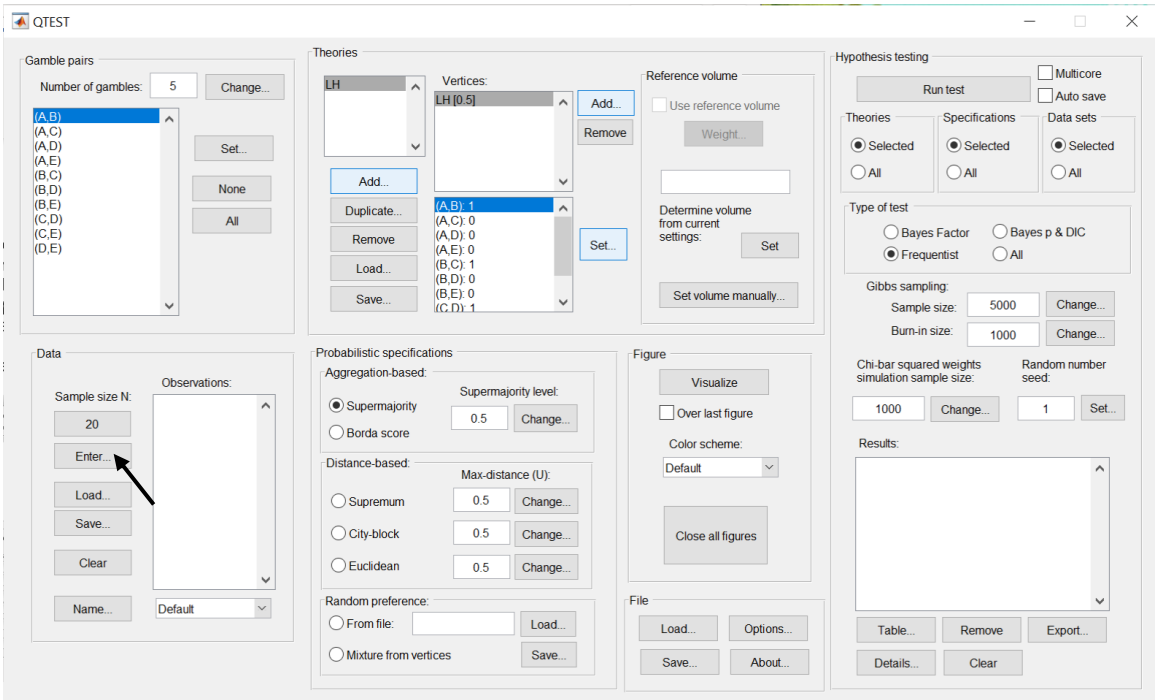
Under “Data”, the first selection listed for a user of QTEST is “Sample size N:”.



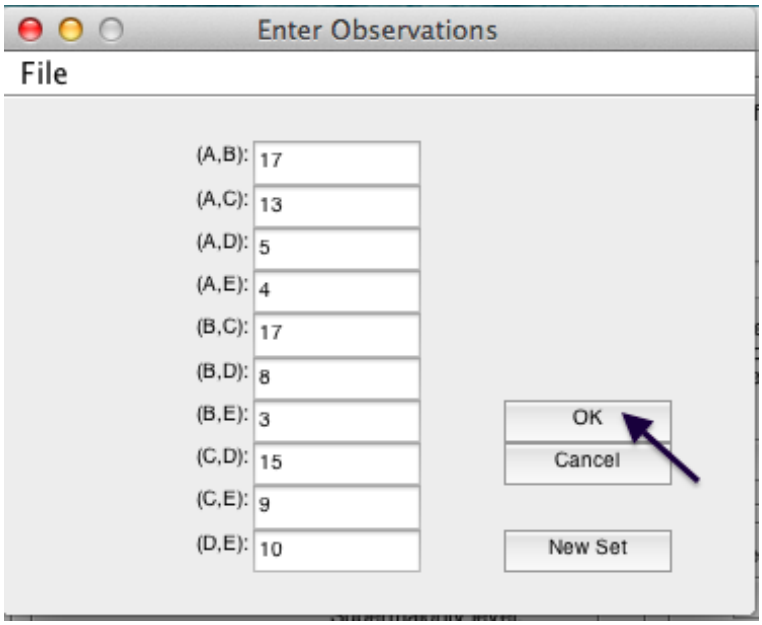
This “Sample size N:” represents the number of decisions *each* participant made on *each* gamble pair in the entire experiment. The default sample size is “20”. To change the sample size, simply select “20” and in the dialogue box that pops up, enter the “Observations per pair:”. And then press “OK” when finished.



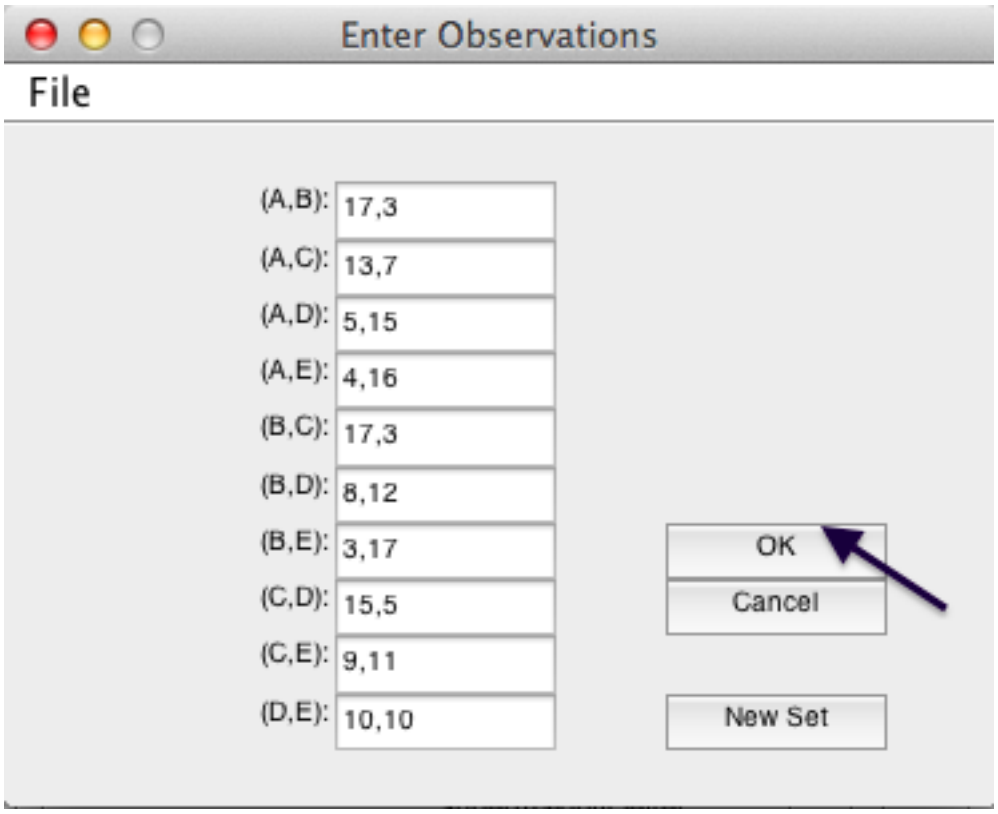
The next button, “Enter…” allows the user to specify the number of times the *first* gamble (i.e., the gamble “coded as Gamble 1” in Table 2 of QTBC1) in the gamble pair was selected.



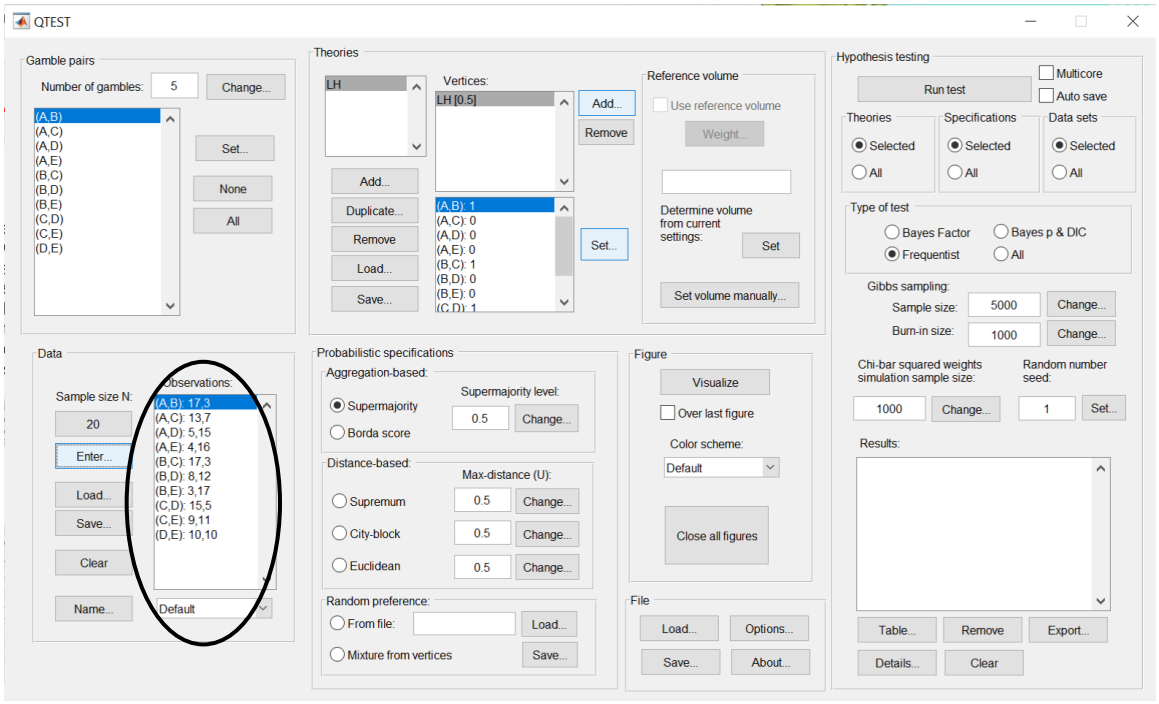
In the “Enter Observations” dialogue box that pops up, there are two choices for entering the data. Option one requires entering the number of times the first gamble was chosen for each gamble pair. We start with DM1 of QTBC1. Use the 2nd to last column from Table 2 of QTBC1 to get the following. Then press “OK”.



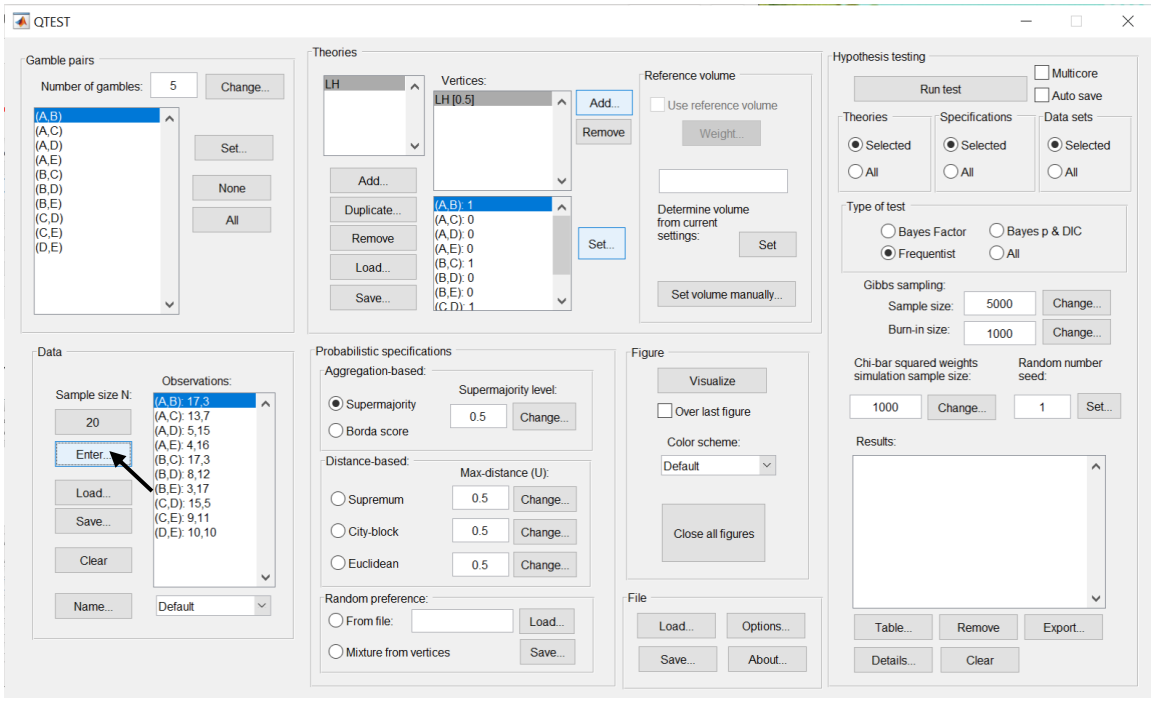
Option two for data entry is to enter the number of times the first gamble was chosen, enter a comma and then enter the number of times the second gamble (i.e., the gamble “coded as Gamble 0” in Table 1 of QTBC1) was chosen. Here is a different screenshot for the same data as the previous screenshot, but entered in this different format:



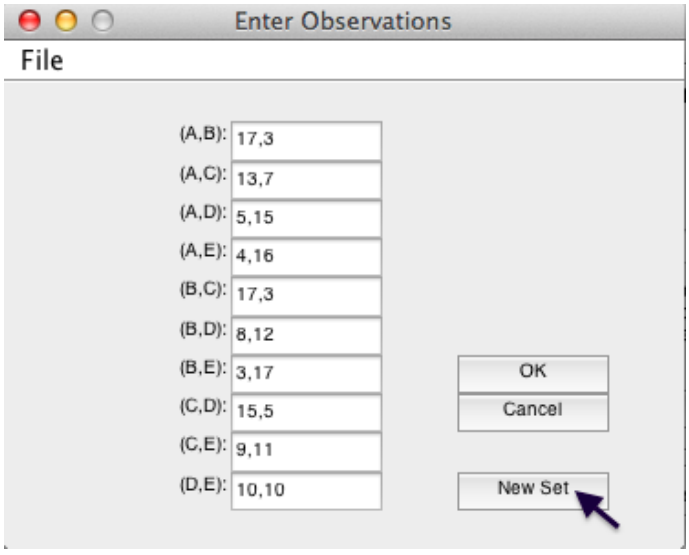
Under “Data”, under “Observations:”, notice that each pair of gambles is followed by two values separated by a comma. The first number (before the comma) represents the number of times the first gamble was selected (in this case 17 times out of 20) and the second number (after the comma) represents the number of times the second gamble was selected by the participant. Also notice that the “Name…” is set to “Default”. Select “Name…” and in the “Data Set” dialogue box that pops up, enter an appropriate name for this data set. Then press “OK”.



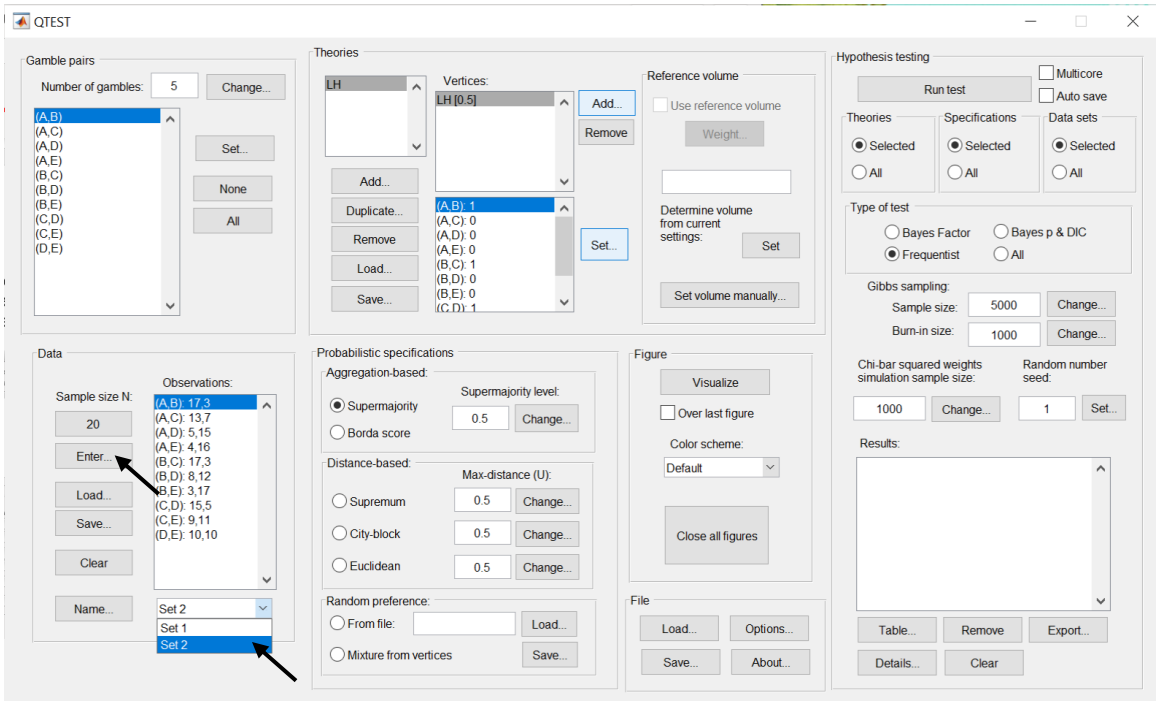
Now we enter the data for DM13 from Table 2 of QTBC1, which is the last column of that table. Select “Enter…” again.



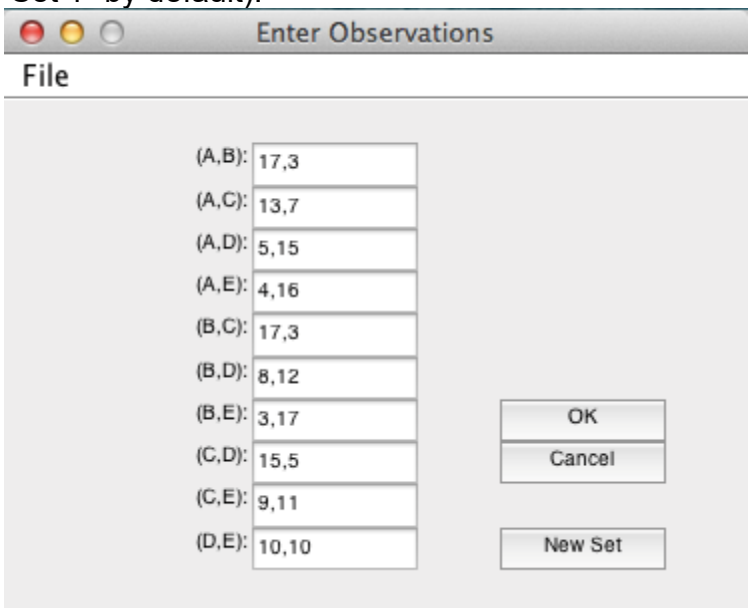
In the “Enter Observations” dialogue box that pops up, you will see the data from the previous entry, DM1. Select “New Set”. (If the user selects “OK” in this dialogue box, it will overwrite the previously entered data set.)



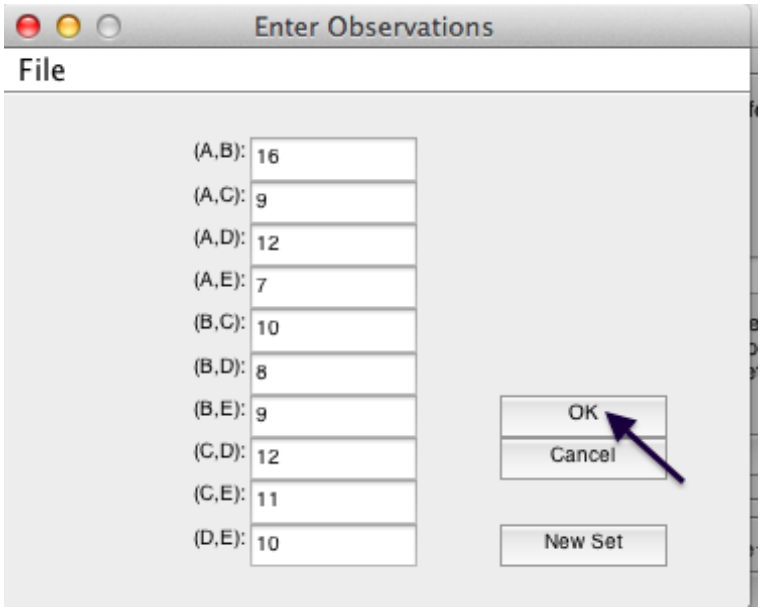
In the QTEST interface, under “Data”, notice in the dropdown menu that there are 2 identical data sets. Select “Set 2” so that it is highlighted. Then select “Enter…”.



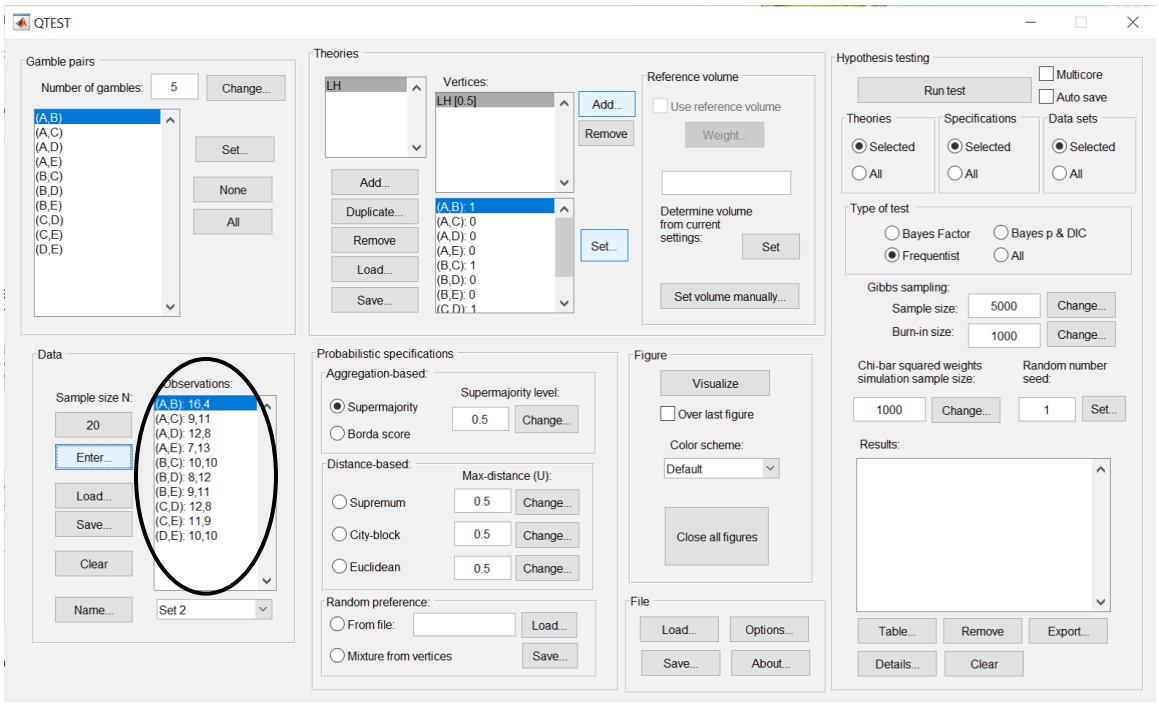
The “Enter Observations” dialogue box initially contains the gambles chosen by DM1 (labeled “Set 1” by default).



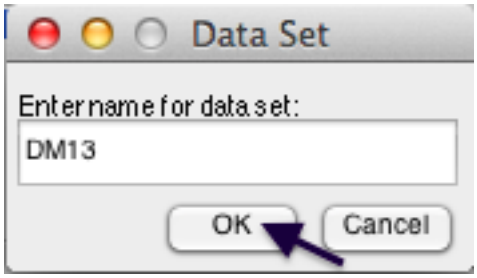
Replace all the entries of this dialogue box with the values for DM13, which can be found in the last column of Table 2 of QTBC1. When finished, it should look like the following screenshot. Then select “OK”.



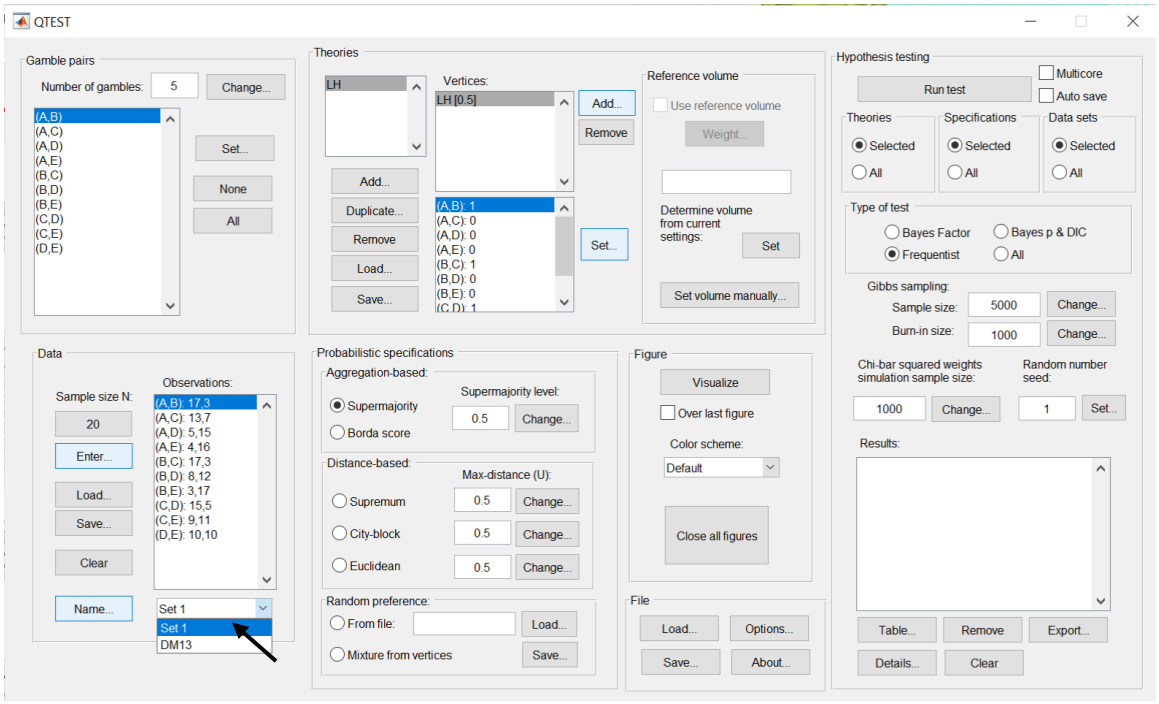
Under “Observations:”, “Set 2” lists the choices of DM13. Replace “Set 2” with “DM13” by selecting “Name…”.



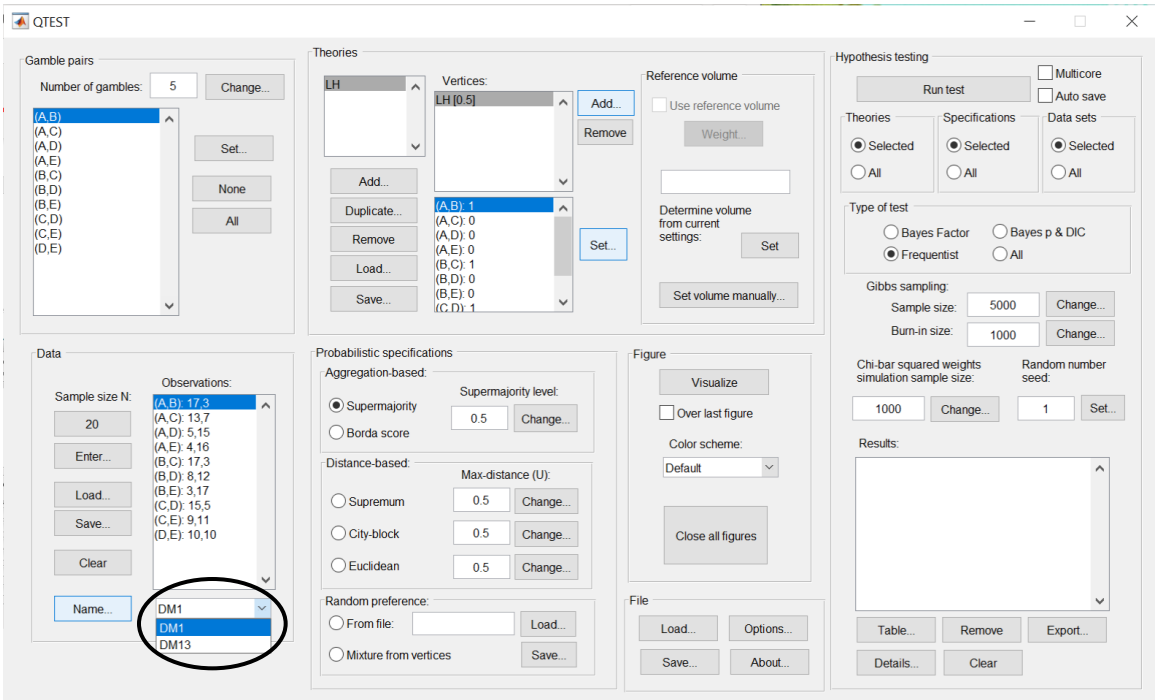
In the “Data Set” dialogue box, enter “DM13”. Then select “OK”.



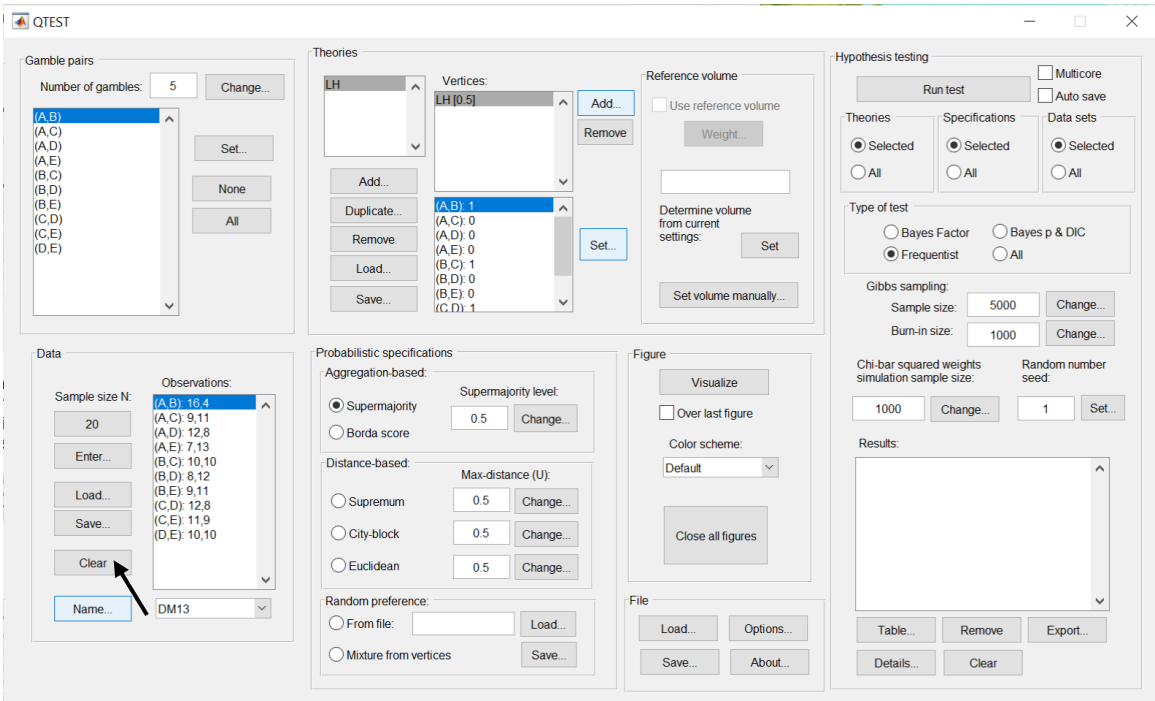
Rename “Set 1” by selecting it from the dropdown menu, select “Name…” and then entering “DM1” in the dialogue box.



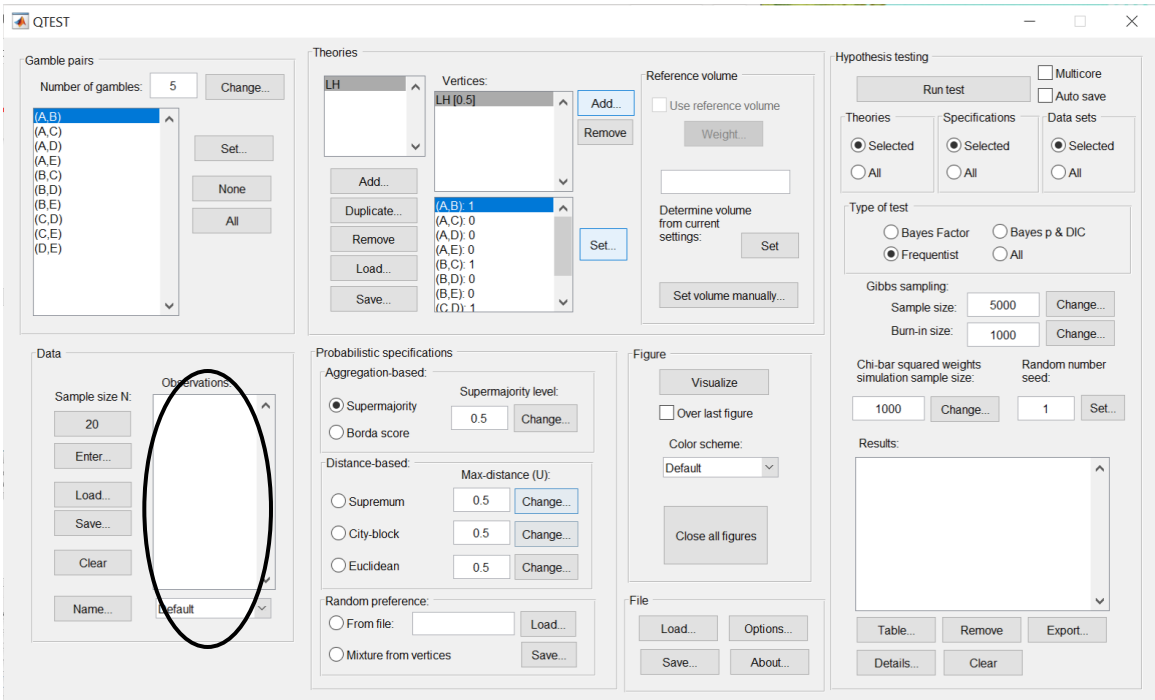
When finished renaming the 2 data sets, they will look like the following.



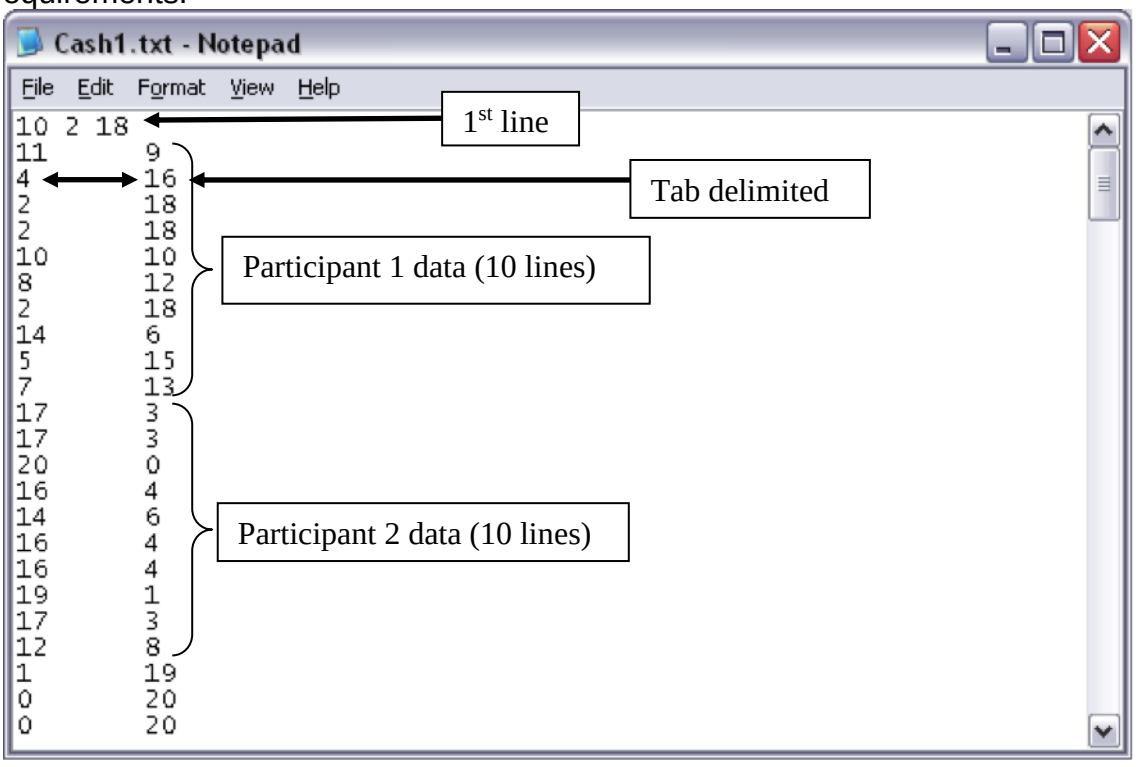
Data from DM1 and DM13 are 2 of the 18 decision makers that comprise the Cash I and Cash II data. We will analyze both Cash I and Cash II in the entirety, starting with Cash I. So, we now want to load the Cash I data. Under “Data”, first select “Clear”.



The QTEST interface should now look like the following:



Now we are ready to enter the Cash I data. But before bringing these data into QTEST, we will first examine the specific requirements for this data file. Below is a screenshot of the data file "Cash1.txt", which we will use to illustrate those requirements.

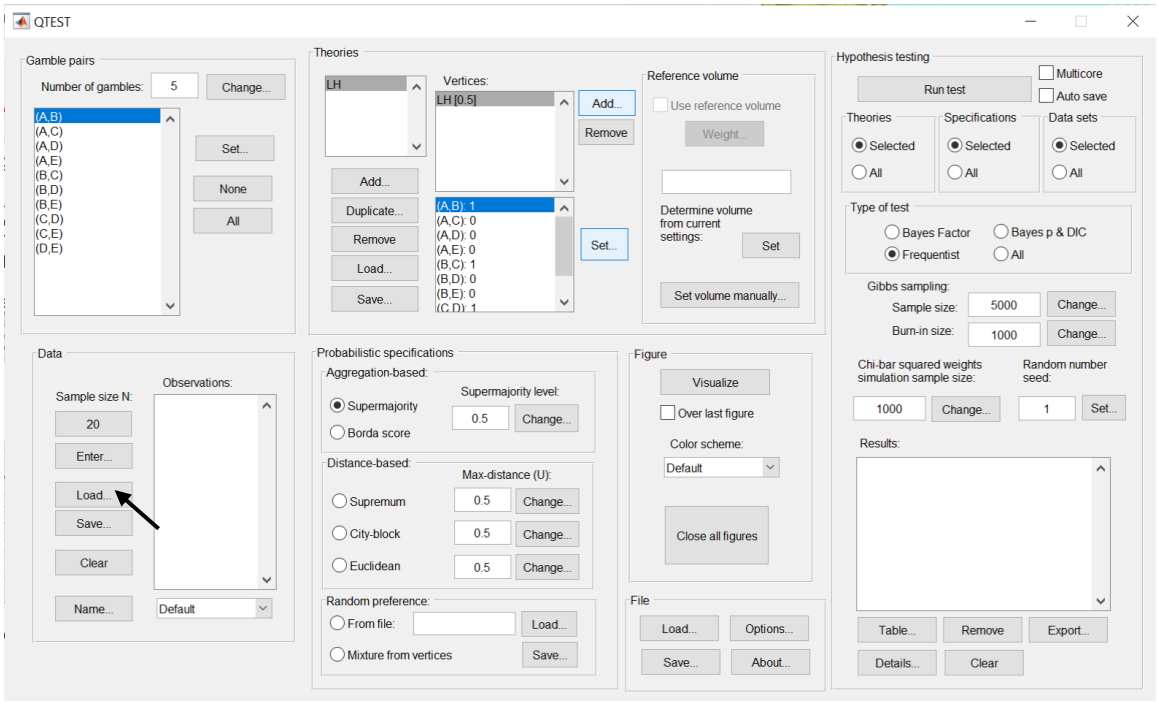


The first line of the data input file must contain 3 values, with a single space between the 1st and 2nd, as well as between the 2nd and 3rd values. Here, the first number of the first line is “10”, which represents the number of gamble pairs. The second number of the first line is “2” which represents the 2-column format of the data that follow. The third number of the first line is “18”, denoting the number of participants.

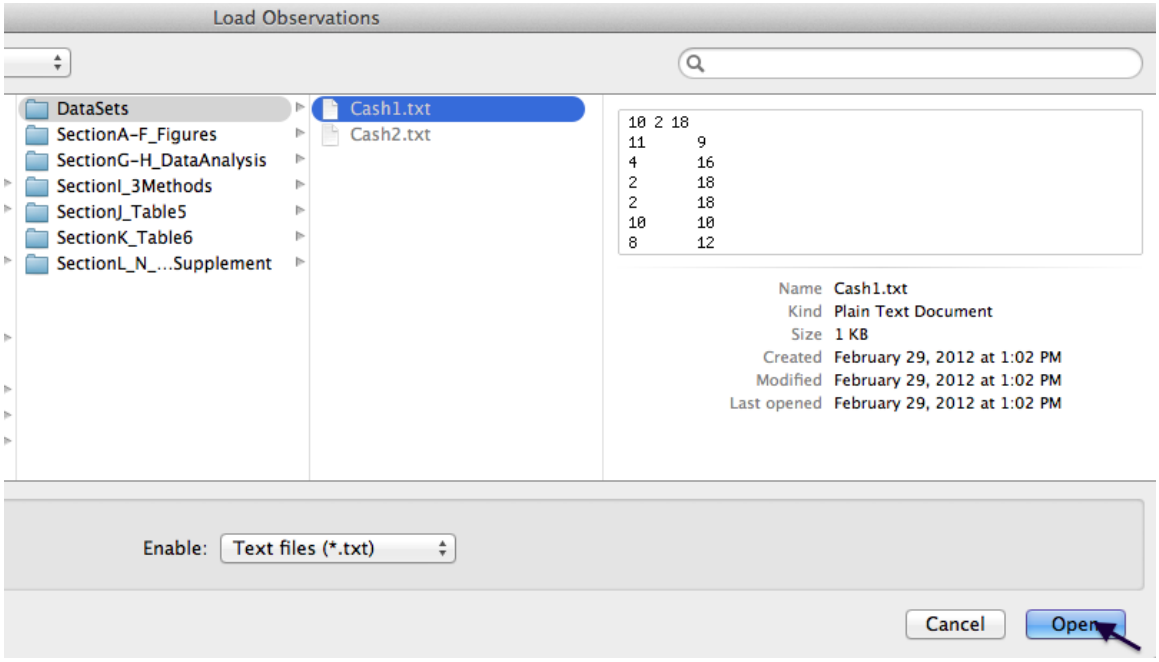
The data for the 1st participant begin on the second line. The structure of these data must have the number of times the first gamble was chosen as the first entry (left column) and the number of times the second gamble was chosen as the second entry (right column). Here, these two entries are separated by a tab delimiter; but a single space delimiter will also work.

The data for participant 1 encompass lines 2 through 11, for a total of 10 lines. This is because the participant made decisions on all 10 gamble pairs among the five gambles. The data for the Participant 2 begin immediately on the next line after the end of the data for Participant 1. Participant 2 has their data in lines 12 through 21. And, while not shown in this screenshot, the remaining 16 participants in this Cash I data set are also included in the “Cash1.txt file”. (NOTE: optionally, one may separate data sets for each participant with a single blank line, to possibly improve readability.) We now load this file into QTEST.

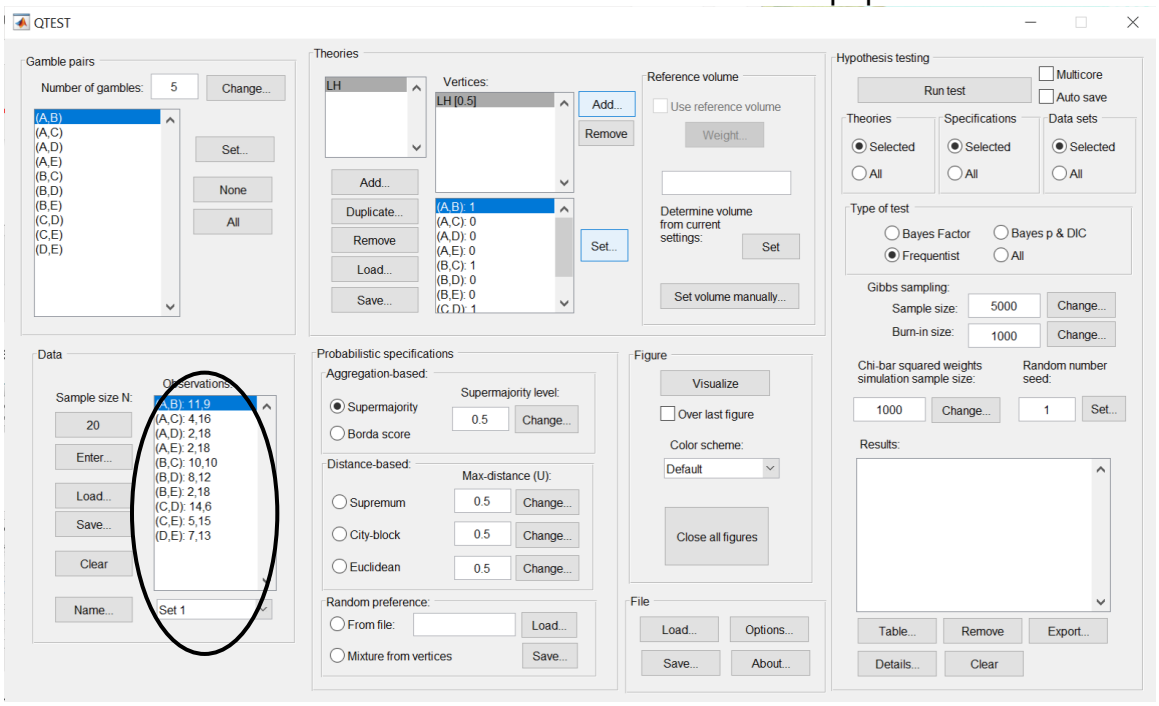
Under “Data” select “Load…”.



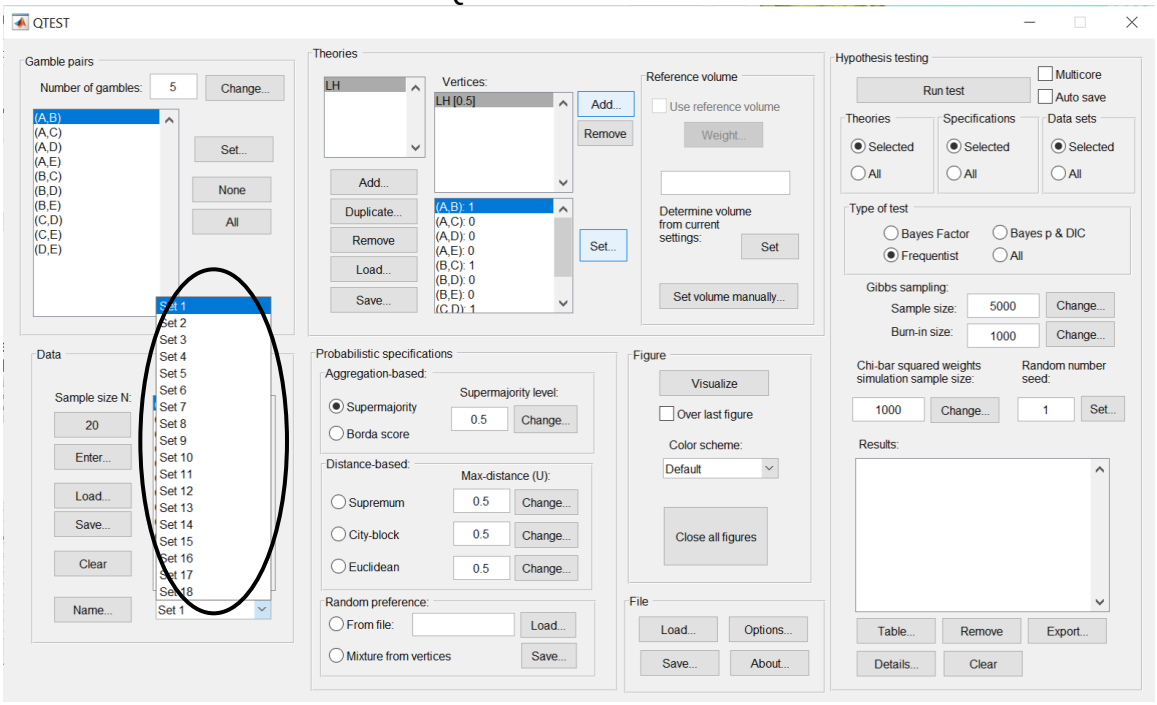
In the “Load Observations” dialogue box that pops up, navigate to the “Cash1.txt” data input file. Then select “Open”.



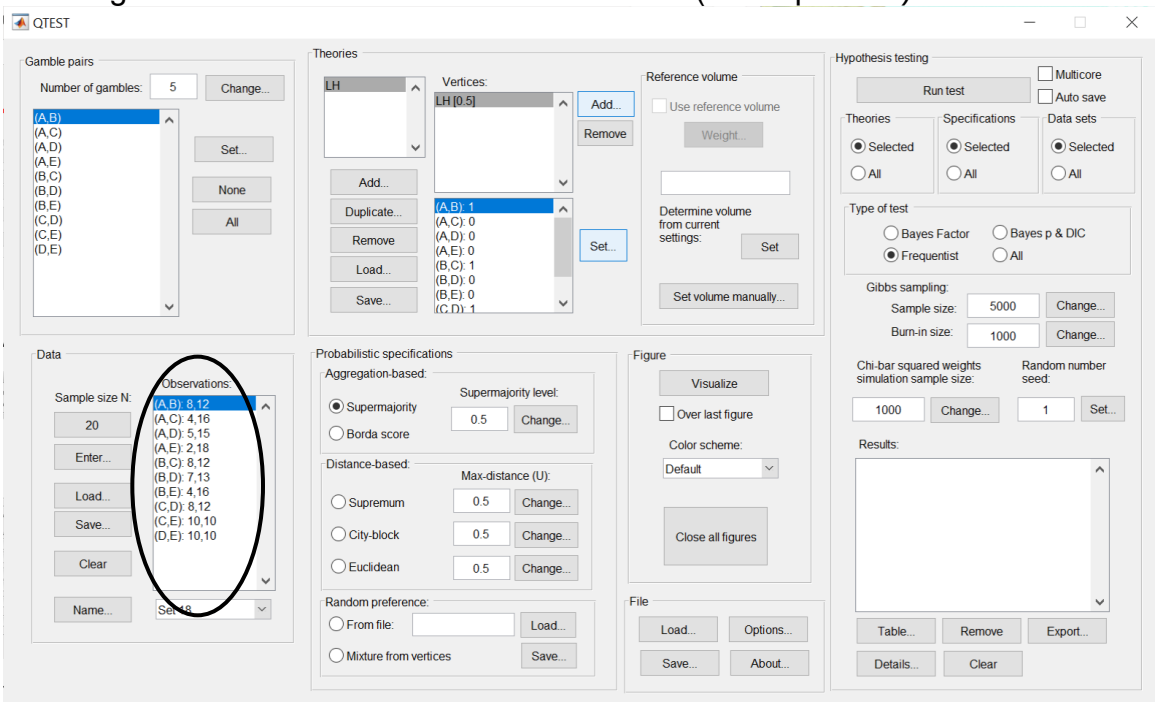
Under “Data” notice the “Observations:” list has now been populated:



Under “Data”, select the dropdown menu next to “Name…” to see all 18 data sets that have been loaded into the QTEST interface.



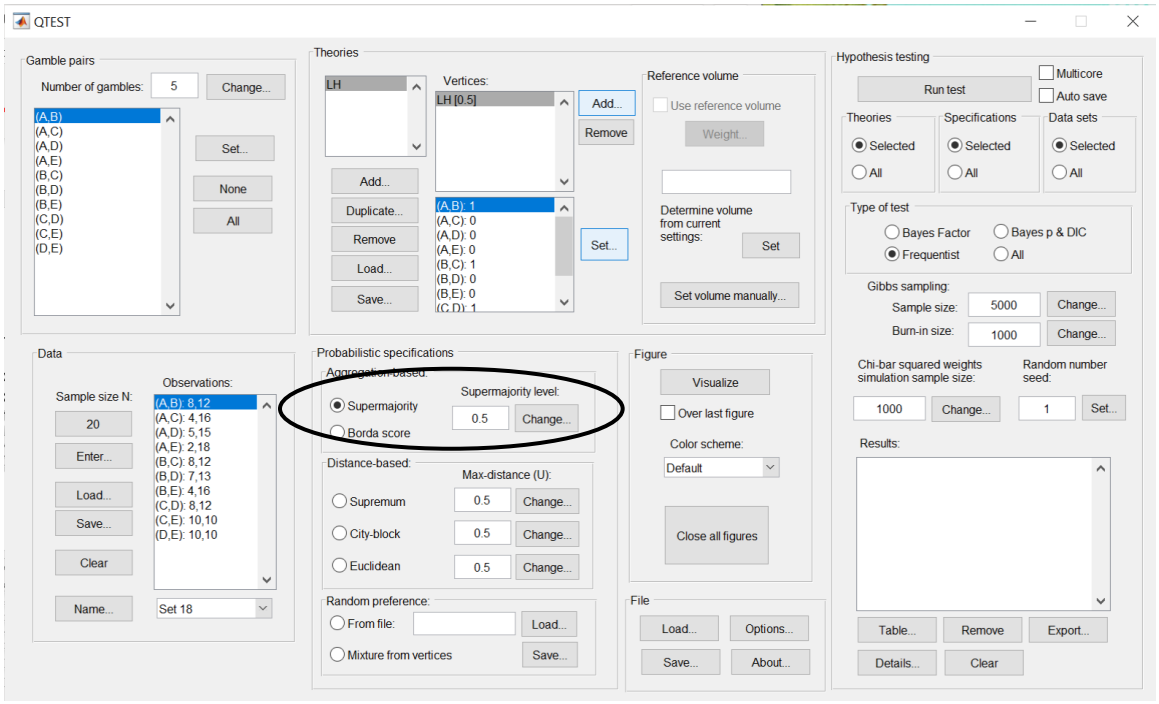
Select any set (it will be blue highlighted) to see the data for that participant. The following screenshot shows the data for “Set 18” (Participant 18).



We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

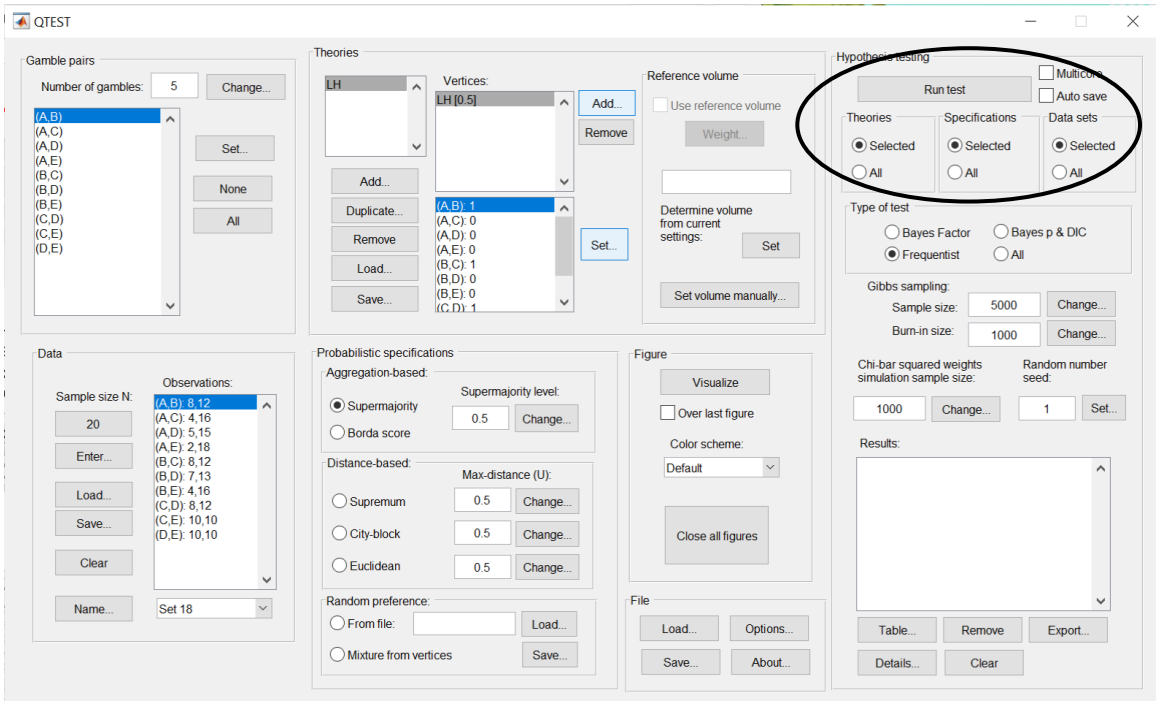
G.4 Probabilistic specification

The results of the top-half of Table 5 of QTBC1 are based upon a 0.50-majority/modal choice specification. To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected and that the “Supermajority level:” is set to “0.5”.

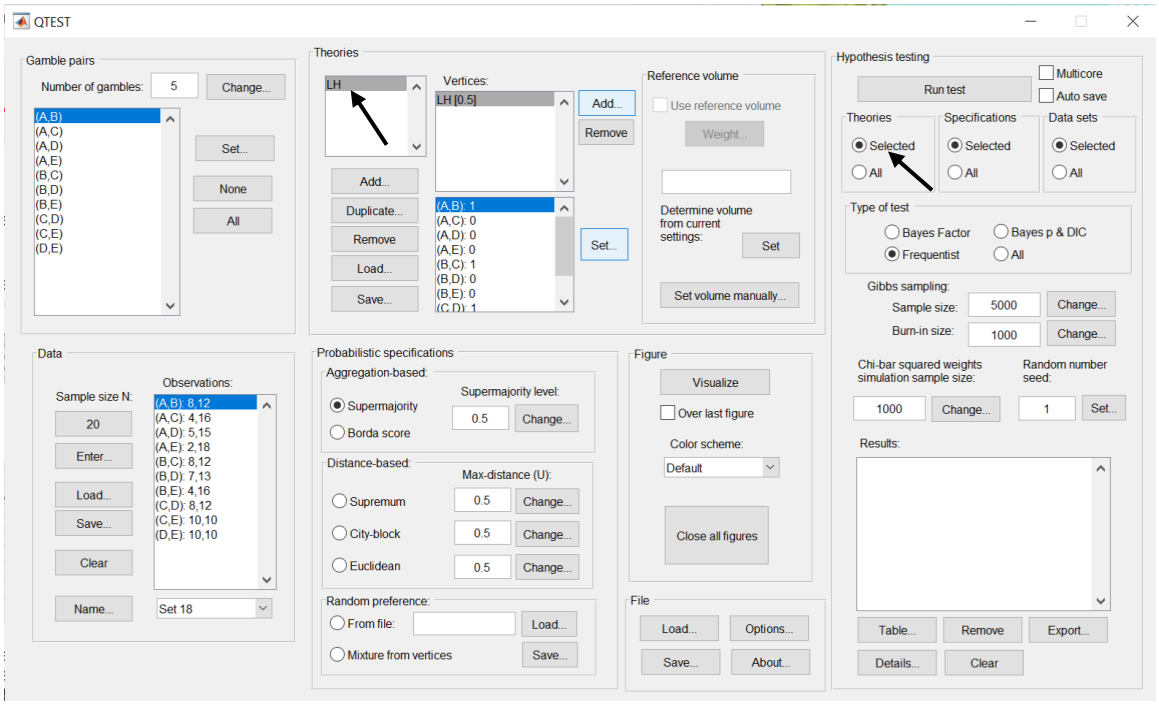


G.5 Hypothesis testing

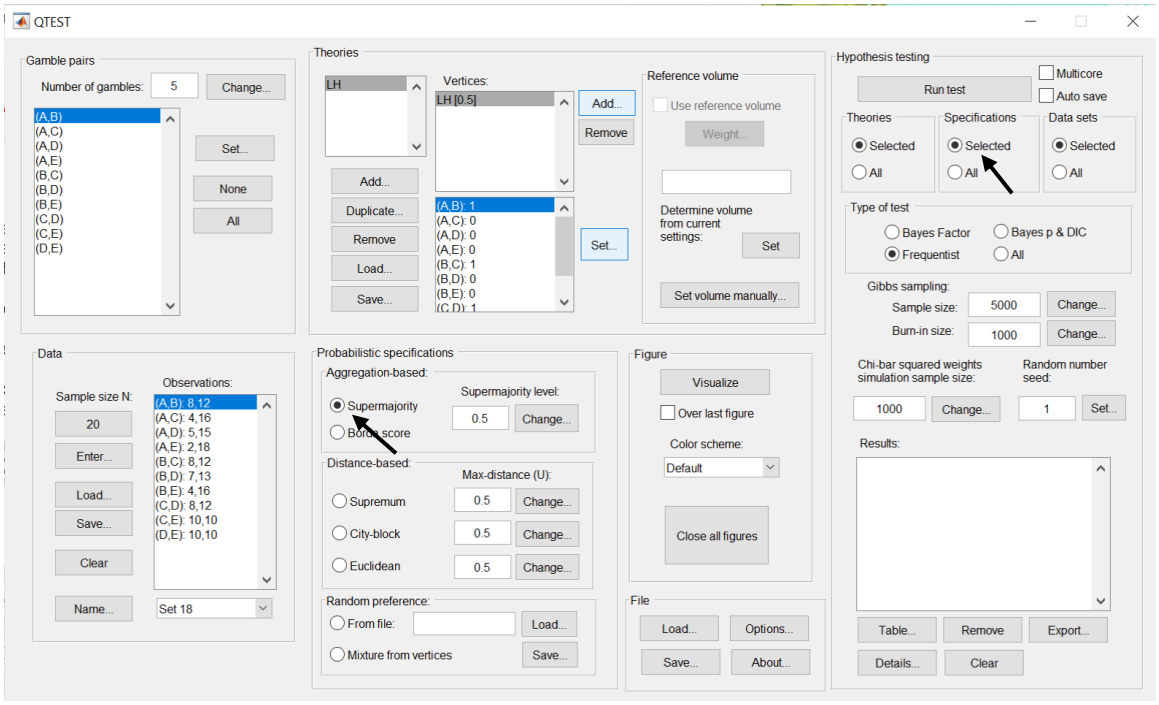
We are now ready for the goodness-of-fit test of $L\mathcal{H}$ for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under "Hypothesis testing", under the "Run test" button, there are 3 columns: "Theories", "Specifications" and "Data sets". For each of these, the user must choose the radio button next to either "Selected" or "All".



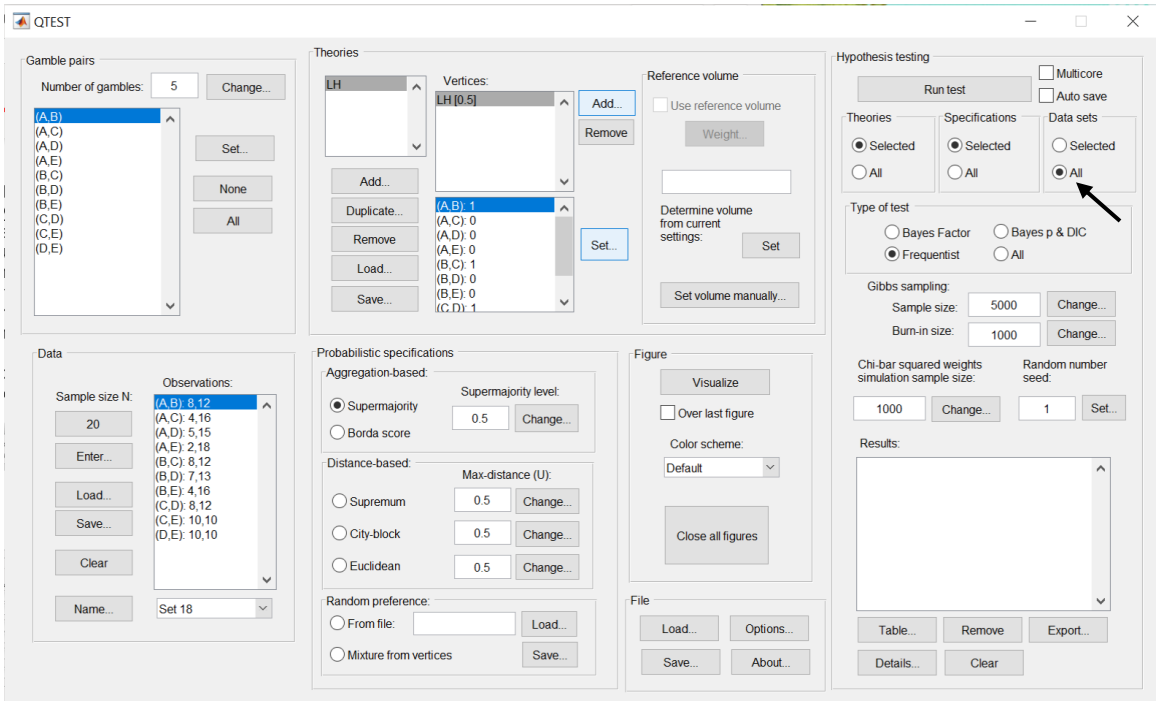
If the radio button for “Theories” under “Hypothesis testing” is set to “Selected”, then the analysis will only include the theory highlighted in gray in the “Theories” section. For $\mathcal{LH}$, there is only one theory, so this radio button is set to “Selected”. (If the radio button were set to “All”, then all theories under “Theories” would be analyzed).



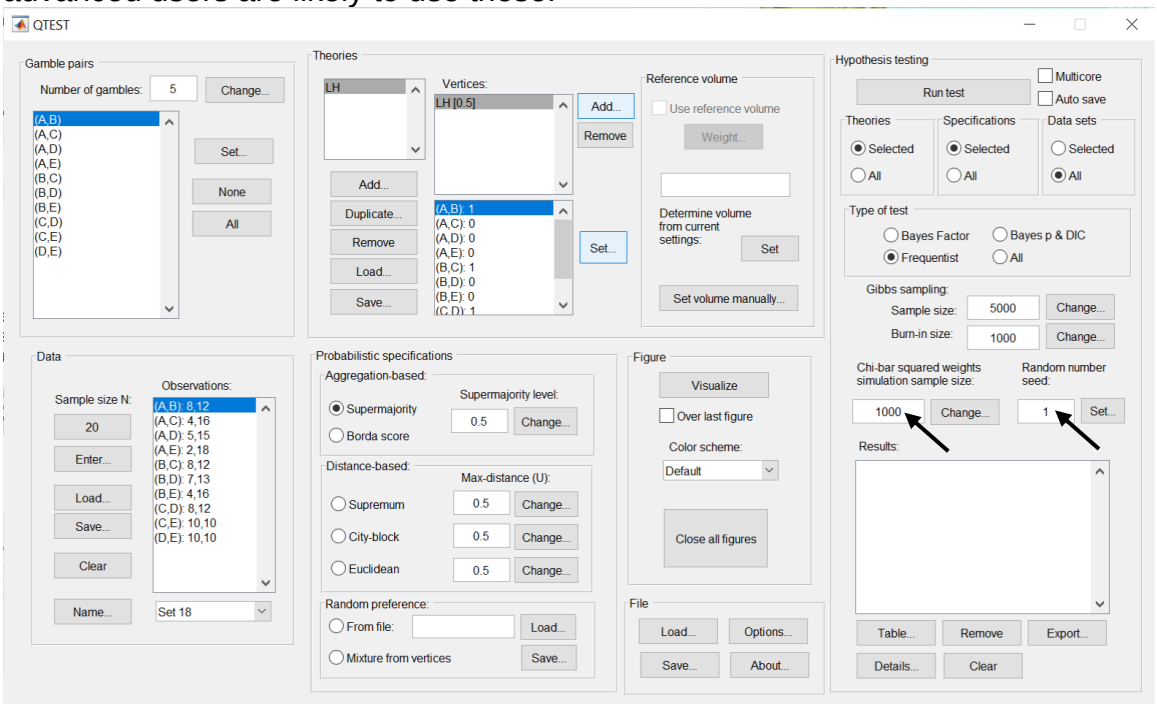
If the radio button for “Specifications” under “Hypothesis testing” is set to “Selected”, then the analysis will only include the selected specification under “Probabilistic specifications” where the radio button is selected. In this case, we only want a 0.50-majority/modal choice specification so “Selected” under “Hypothesis testing” is chosen. (If a user wanted to do “All” the specifications, it would be necessary to first set the level of the specification for all “Aggregation-based” and “Distance-based” under “Probabilistic specifications”. Even though only one radio button at a time can be selected under “Probabilistic specifications”, once a change has been made for a specification it will continue to be set to that value and used in the analysis.)



Finally, under “Hypothesis testing”, we can analyze data sets individually or analyze the data all at one time. For instance, since we have 18 data sets, if we ran each of these 18 data sets individually, that would require selecting a data set under “Data” each time (from the dropdown menu next to “Name…”) and then “Run test” under “Hypothesis testing” 18 separate times, one for each data set. But if the radio button next to “All” is chosen under “Data sets” under “Hypothesis testing”, then 18 analyses are run all together. But it is important to note that, even when “All” is selected under “Data sets”, data are never aggregated. Each data set is always analyzed on its own and never combined, no matter which radio button is selected. In this case, since we want to analyze the data for all 18 participants, change the radio button selection to “All” under “Data sets”:



Under “Hypothesis testing” there are two more inputs the user may specify: “Chi-bar squared weights simulation sample size” and “Random number seed”. Only advanced users are likely to use these.

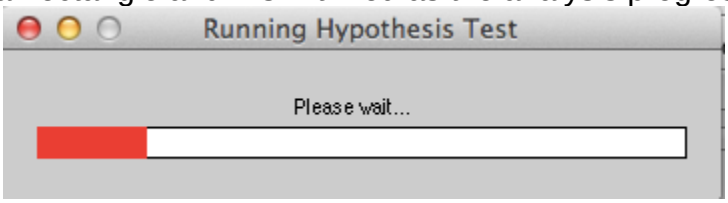


The appropriate “Chi-bar squared weights” in the underlying “order-constrained inference” engine that operates ‘under the hood’ of QTEST are determined based on certain numerical simulations. The simulations use a random sampling process. The larger the sample size, the more accurate the resulting weights, and therefore a more accurate p-value will be computed. Increased accuracy comes at the cost of more computation to reach a result.

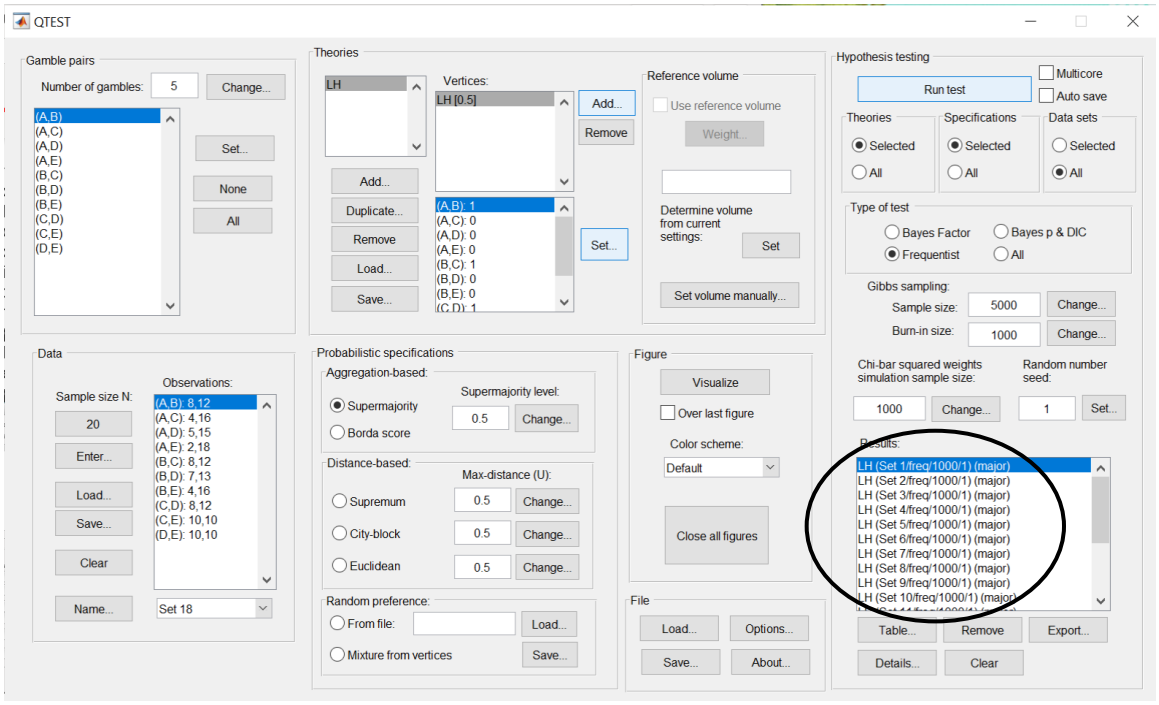
If a hypothesis test is repeated on the same data, QTEST produces the exact same chi-bar squared weights because the “random” samples are simulated, based on a seed. To produce another, independent, computation of a hypothesis test, choose a different “Random number seed” under “Hypothesis testing”.

For all results in Tables 4 and 5, the default values of both “Chi-bar squared weights” and “Random number seed” are used.

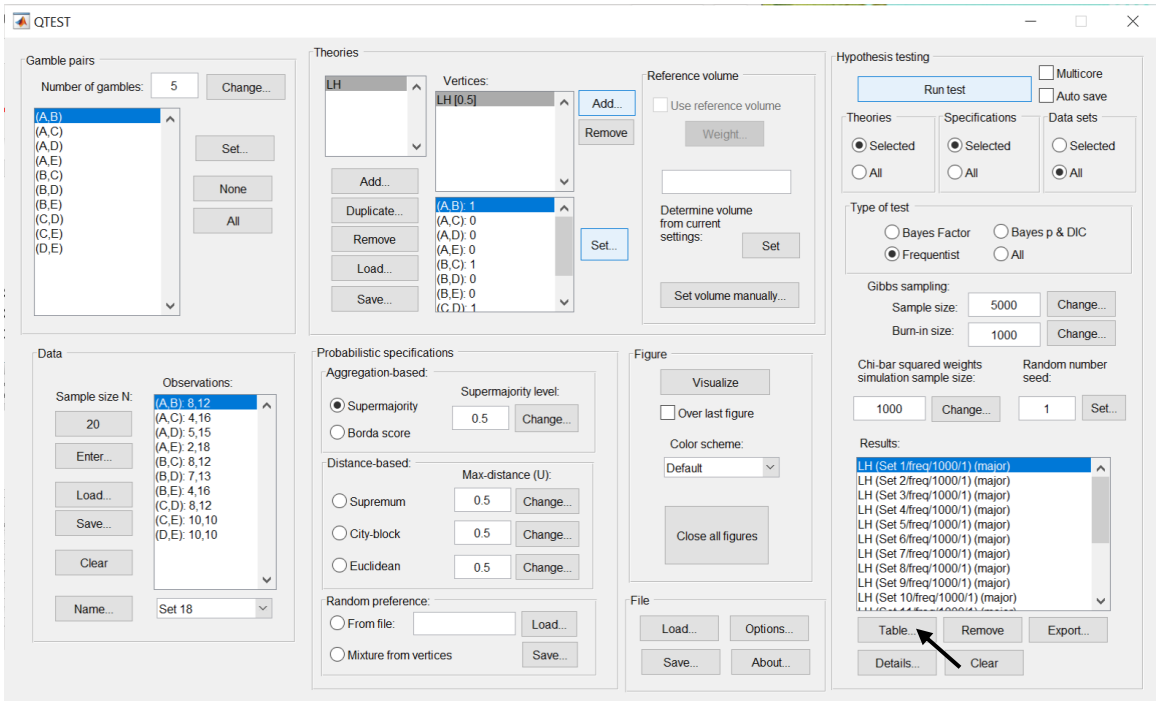
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



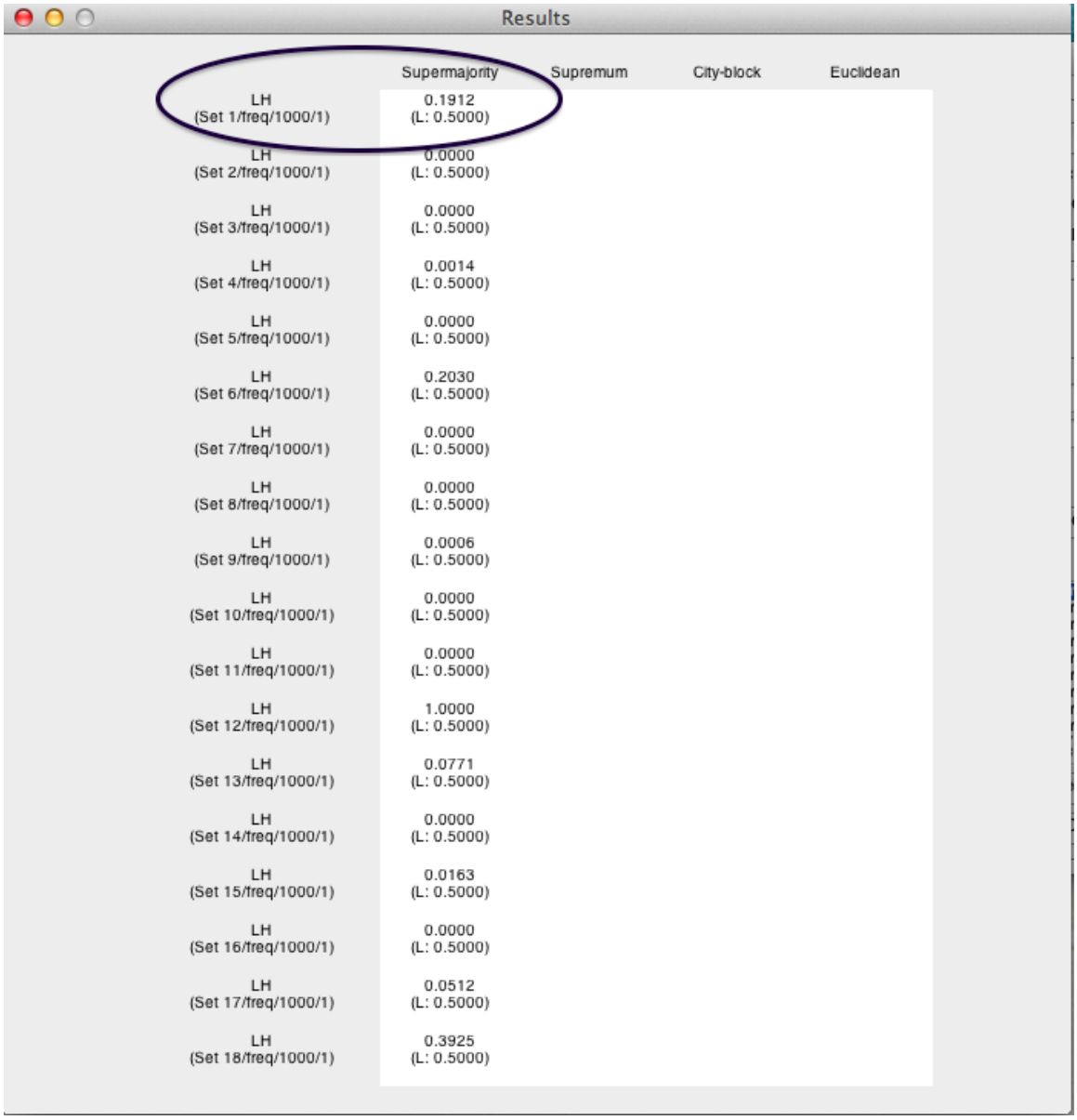
The time for the analysis to complete can vary widely. It depends on many factors: the computer running the analysis, the number of data sets, the type and number of probabilistic specifications, the number of theories, the number of vertices for each theory, the number of simulation sample weights and other factors. (It can be a good idea to just run the hypothesis test for a single data set the first time an analysis is executed to get an approximate baseline expectation of how long QTEST may need to complete the entire analyses for all data sets. Such a baseline computation may sometimes not be representative of other computations, however, if data or theories vary widely from one analysis to another.) Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.



QTEST offers several tools for working with, and examining, the results when the hypothesis testing has completed. Under “Hypothesis testing”, under “Results:”, select “Table…”.



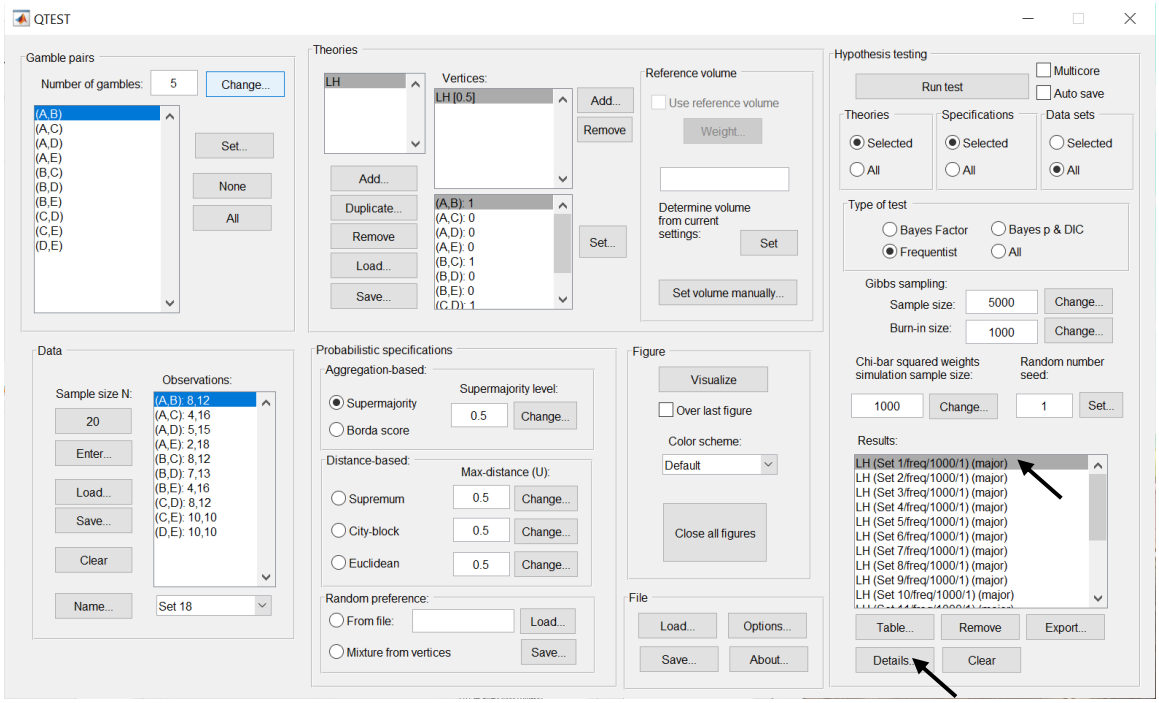
A “Results” window pops up that looks like the following screenshot.



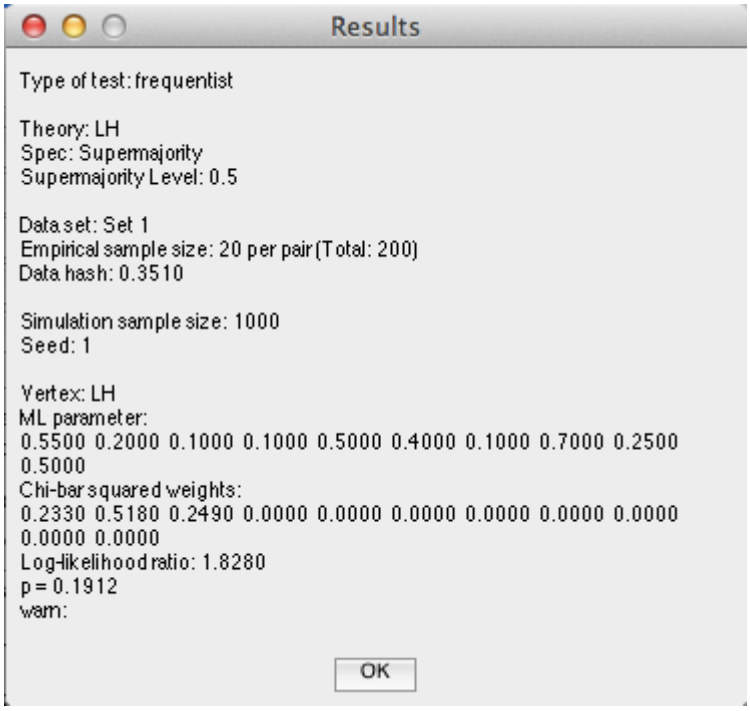
Column headers are the probabilistic specifications “Supermajority”, “Supremum”, “City-block” and “Euclidean”. Each row header contains two lines. The first line denotes the theory name, in this case “LH”. The second line “(Set 1/1000/1)” provides the data set (“Set 1”), the number of simulation samples (“1000”) and the random seed number (“1”). An entry within the table, at the intersection of each row and column header, will provide the p-value, which is the first line and for the circled entry in the screenshot above, that value is “0.1912”. The second line within the table provides the supermajority level. In this case we set it to 0.50 and that is why we see “(L: 0.5000)” in the first cell of the table. (The “L” stands for lambda.)

If the same session of QTEST is used for further analyses, these results will stay in this table. If further results include the same theory and data, but a different probabilistic specification, the appropriate column would be filled in. But if a new theory is used, then the results from this new theory would be appended to the current table.

If a user needs more information, they can select the result for which they wish to see more detail from the “Results:” list and then select “Details…”, as shown in the screenshot below.



A different “Results” window pops up.



The “Results” window that pops up gives more of the results from the order-constrained inference algorithm developed in Davis-Stober (2009).

The first 4 lines of text, and the 7th and 8th lines of text, give equivalent information to that already discussed in the earlier table format.

The 5th line of text “Empirical sample size: 20 per pair (Total: 200)” simply provides the number of observations for each gamble pair, which was set in “Data”.

The 6th line of text, “Data hash: 0.3510”, is an identifier of the data used in this test. It helps identify different data sets in the results table (unless names have been assigned to individual data sets).

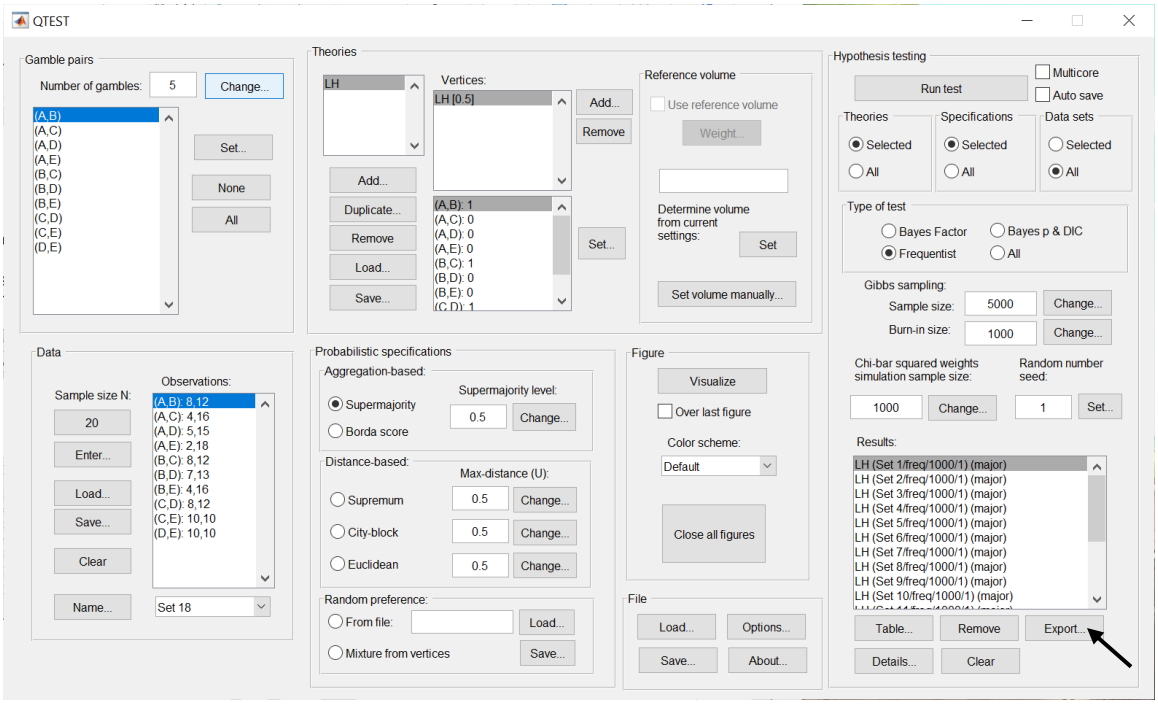
The 9th line of text, “Vertex: LH” specifies which vertex was analyzed. In this case, there was only one vertex. But in the event of multiple vertices, there will be a unique set of results for each vertex.

The line of text starting with “ML parameter” contains the maximum likelihood estimates. At least one of these values lies on one of the faces of the supermajority cube that represents the 0.50 supermajority specification. So, here, two best-fitting binary choice probabilities are 0.50. In situations like this, where the point estimates are on the boundary of the parameter space, the log-likelihood statistic does not have a Chi-squared distribution. Rather the statistic

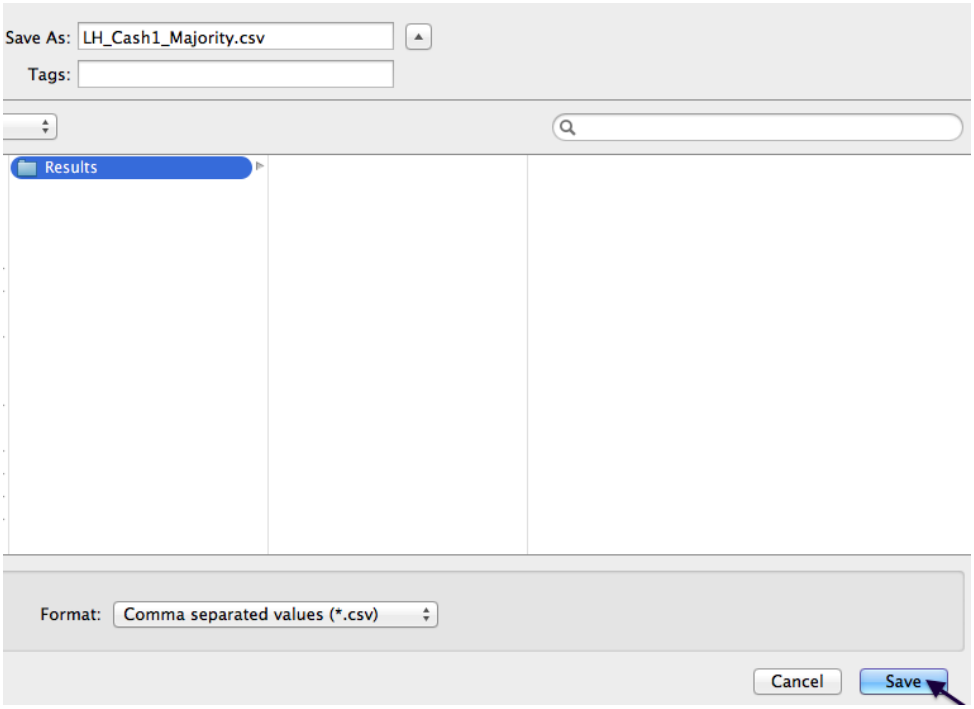
developed by Davis-Stober follows a Chi-bar squared distribution, which is a mixture of Chi-square distributions (2009). Here, QTEST has determined the weights of this mixture with the results in the line starting with “Chi-bar squared weights:”

The second to last line of text contains the log-Likelihood ratio: “1.8280”. In the appropriate Chi-bar squared distribution, which is the last line of the output, a log-likelihood ratio value of 1.8280 has a p-value of 0.1912. This represents a non-significant violation. Note that log-likelihood ratio values of different respondents are not directly comparable in a meaningful way because each case is typically modeled by a different Chi-bar squared distribution. Hence, a larger log-likelihood value need not translate into a poorer fit, when comparing two data sets.

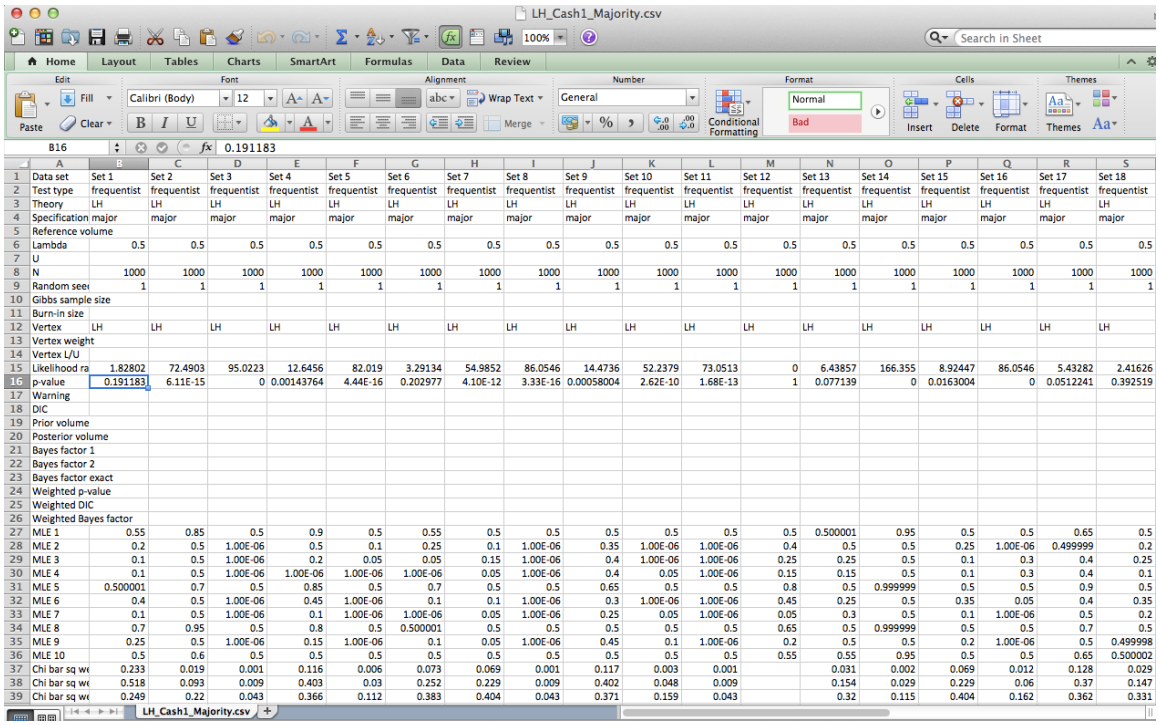
Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory, especially when the number of vertices or data sets, or both, are large. Therefore, QTEST can export the results to a spreadsheet format. Under “Hypothesis testing”, under “Results:”, select “Export…”.



An “Export Results As” window pops up. Navigate to the location to save the file. Here we name the file “LH_Cash1_Majority” and save it as a .csv file. Select “Save”.



The following screenshot shows the “LH_Cash1_Majority.csv” file. In this case, each column is a different participant, labeled “Set 1” through “Set 18” in columns “B” through “S” of the spreadsheet. All the information in this spreadsheet is identical to what one would see if they selected “Details…” for each participant. The layout is a little different, however.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist
3	Theory	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
4	Specification	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference volume																		
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																		
8	N	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
9	Random seed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sample size																		
11	Burn-in size																		
12	Vertex	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ra	1.82802	72.4903	95.0223	12.6456	82.019	3.29134	54.9852	86.0546	14.4736	52.2379	73.0513	0	6.43857	166.355	8.92447	86.0546	5.43282	2.41626
16	p-value	0.191183	6.11E-15	0	0.00143764	4.44E-16	0.202977	4.10E-12	3.33E-16	0.00058004	2.62E-10	1.68E-13	1	0.077139	0	0.0163004	0	0.0512241	0.392519
17	Warning																		
18	DIC																		
19	Prior volume																		
20	Posterior volume																		
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor exact																		
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Bayes factor																		
27	MLE 1	0.55	0.85	0.5	0.9	0.5	0.55	0.5	0.5	0.5	0.5	0.5	0.5	0.500001	0.95	0.5	0.5	0.65	0.5
28	MLE 2	0.2	0.5	1.00E-06	0.5	0.1	0.25	0.1	1.00E-06	0.35	1.00E-06	1.00E-06	0.4	0.5	0.5	0.25	1.00E-06	0.499999	0.2
29	MLE 3	0.1	0.5	1.00E-06	0.2	0.05	0.05	0.15	1.00E-06	0.4	1.00E-06	1.00E-06	0.25	0.25	0.5	0.1	0.3	0.4	0.25
30	MLE 4	0.1	0.5	1.00E-06	1.00E-06	1.00E-06	1.00E-06	0.05	1.00E-06	0.4	0.05	1.00E-06	0.15	0.15	0.5	0.1	0.3	0.4	0.1
31	MLE 5	0.500001	0.7	0.5	0.85	0.5	0.7	0.5	0.5	0.65	0.5	0.5	0.8	0.5	0.999999	0.5	0.5	0.9	0.5
32	MLE 6	0.4	0.5	1.00E-06	0.45	1.00E-06	0.1	0.1	1.00E-06	0.3	1.00E-06	1.00E-06	0.45	0.25	0.5	0.35	0.05	0.4	0.35
33	MLE 7	0.1	0.5	1.00E-06	0.1	1.00E-06	1.00E-06	0.05	1.00E-06	0.25	0.05	1.00E-06	0.05	0.3	0.5	0.1	1.00E-06	0.5	0.2
34	MLE 8	0.7	0.95	0.5	0.8	0.5	0.500001	0.5	0.5	0.5	0.5	0.5	0.65	0.5	0.999999	0.5	0.5	0.7	0.5
35	MLE 9	0.25	0.5	1.00E-06	0.15	1.00E-06	0.1	0.05	1.00E-06	0.45	0.1	1.00E-06	0.2	0.5	0.5	0.2	1.00E-06	0.5	0.499998
36	MLE 10	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.55	0.95	0.5	0.5	0.65	0.500002
37	Chi bar sq we	0.233	0.019	0.001	0.116	0.006	0.073	0.069	0.001	0.117	0.003	0.001		0.031	0.002	0.069	0.012	0.128	0.029
38	Chi bar sq we	0.518	0.093	0.009	0.403	0.03	0.252	0.229	0.009	0.402	0.048	0.009		0.154	0.029	0.229	0.06	0.37	0.147
39	Chi bar sq we	0.249	0.22	0.043	0.366	0.112	0.383	0.404	0.043	0.371	0.159	0.043		0.32	0.115	0.404	0.162	0.362	0.331

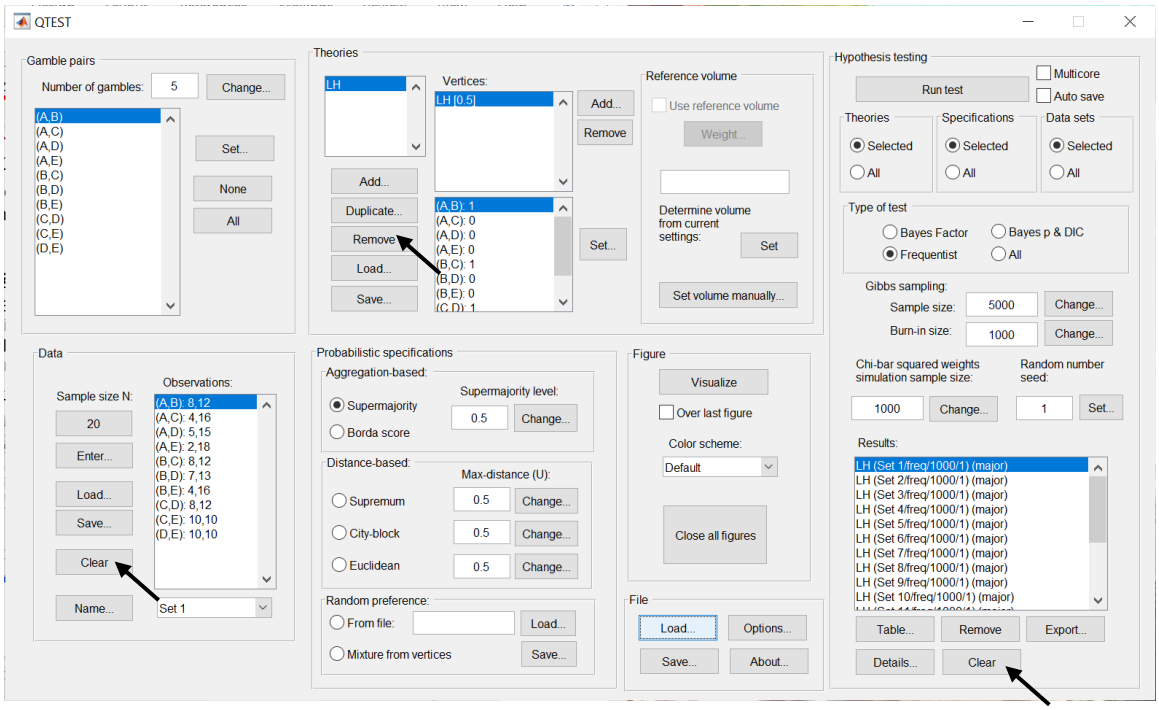
This completes the analysis for Cash I data for $\mathcal{LH}$, which only has 1 vertex. We now consider $\mathcal{CPT}$-$\mathcal{GE}$ for the Cash I data, which has 11 vertices.

H. Data analysis of one theory with multiple vertices

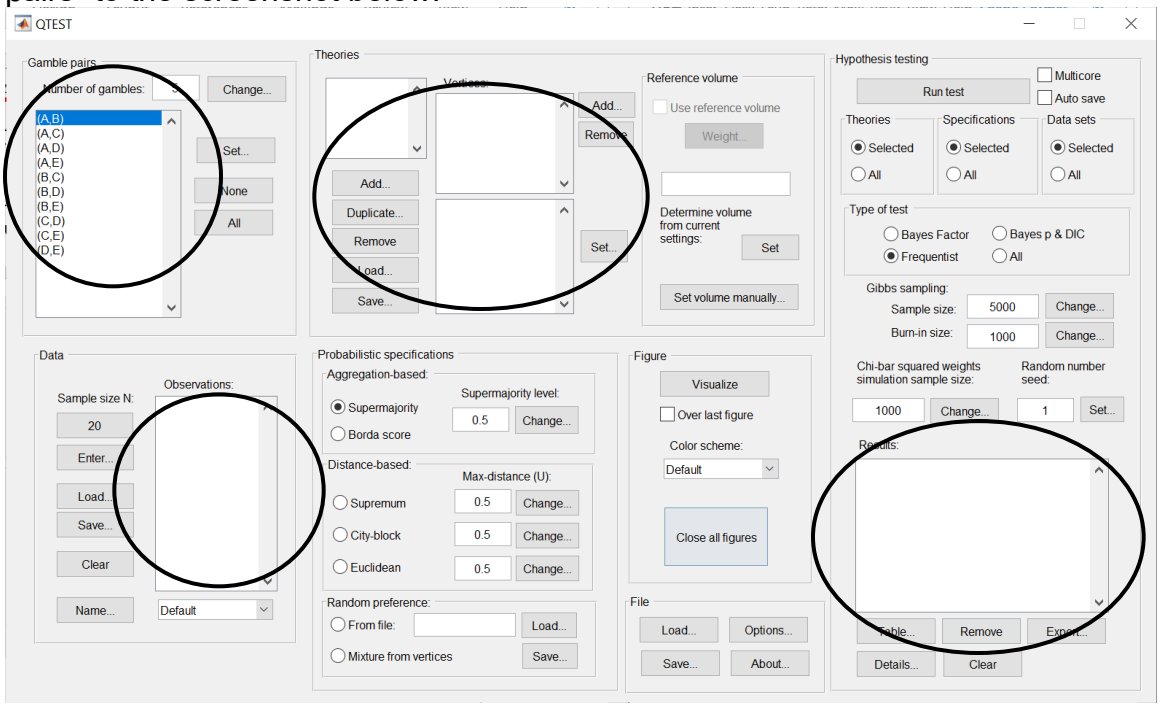
There are only two differences between Section G and H. In Section G, we showed how to enter the theory, vertices and data manually. In Section H we show how to load all of this from files, greatly expediting the analysis. The second difference concerns the output. In Section G there was one vertex so there was only one set of results for each experimental data set. But in Section H we have 11 vertices. The structure of these results is different, and we will explore those differences. All files needed for Section H can be found in the folder "SectionG_H_DataAnalysis". Loading the file "Complete_CPT_GE_Cash1_.5M.mat" will give identical results as following all steps in Section H. To illustrate how to load files into QTEST and interpret results with multiple vertices, we will analyze the Cash I data for $\mathcal{CPT}$-$\mathcal{GE}$ with a 0.50-majority/modal choice specification.

H.1 Gamble pairs

Even though QTEST is designed to store multiple theories, each with their own predictions, we will clear everything from QTEST except the "Gamble pairs" to keep the screenshots easier to follow. The following screenshot shows the 3 selections to clear the interface. Select "Clear" under "Data"; under "Hypothesis testing", under "Results:", select "Clear"; and under "Theories", select "Remove" to remove "LH". This will also automatically clear the associated vertex.

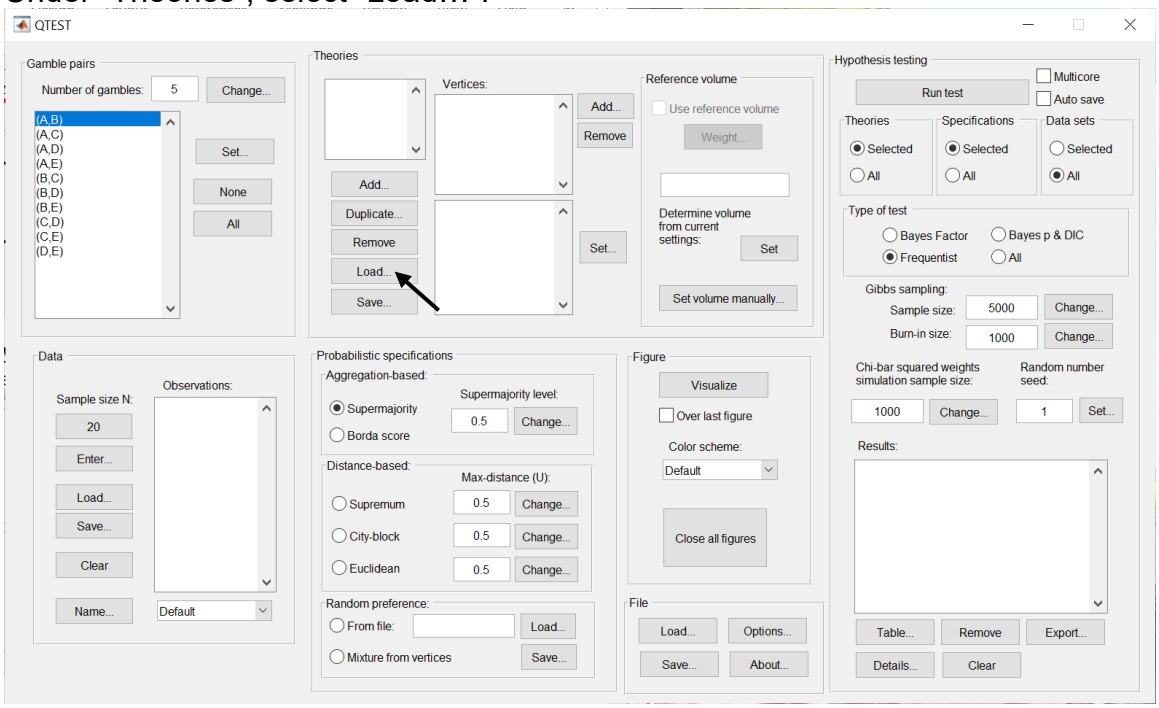


The QTEST interface looks like the following screenshot. We only retain the "Gamble pairs". If you are starting a new session of QTEST, match the "Gamble pairs" to the screenshot below.

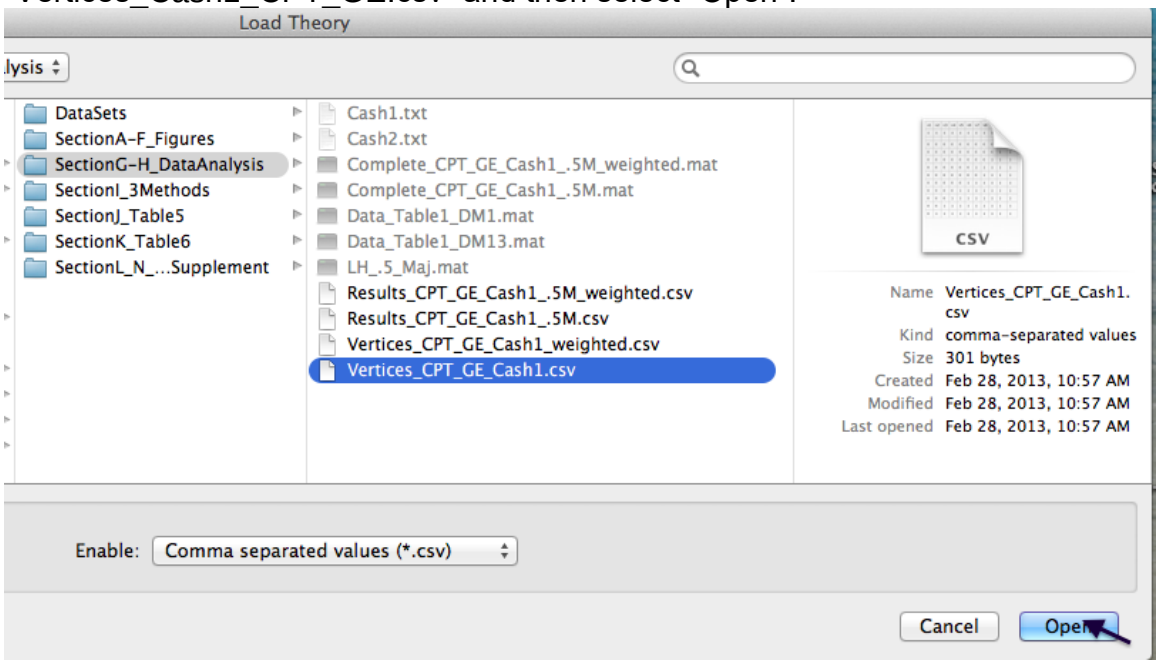


H.2 Theory and vertices

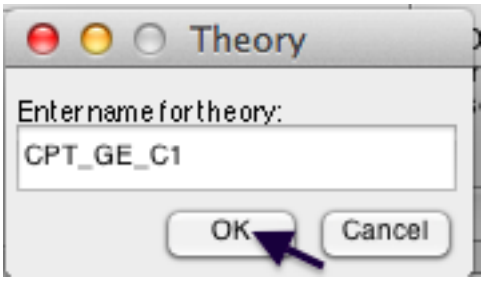
Under "Theories", select "Load…".



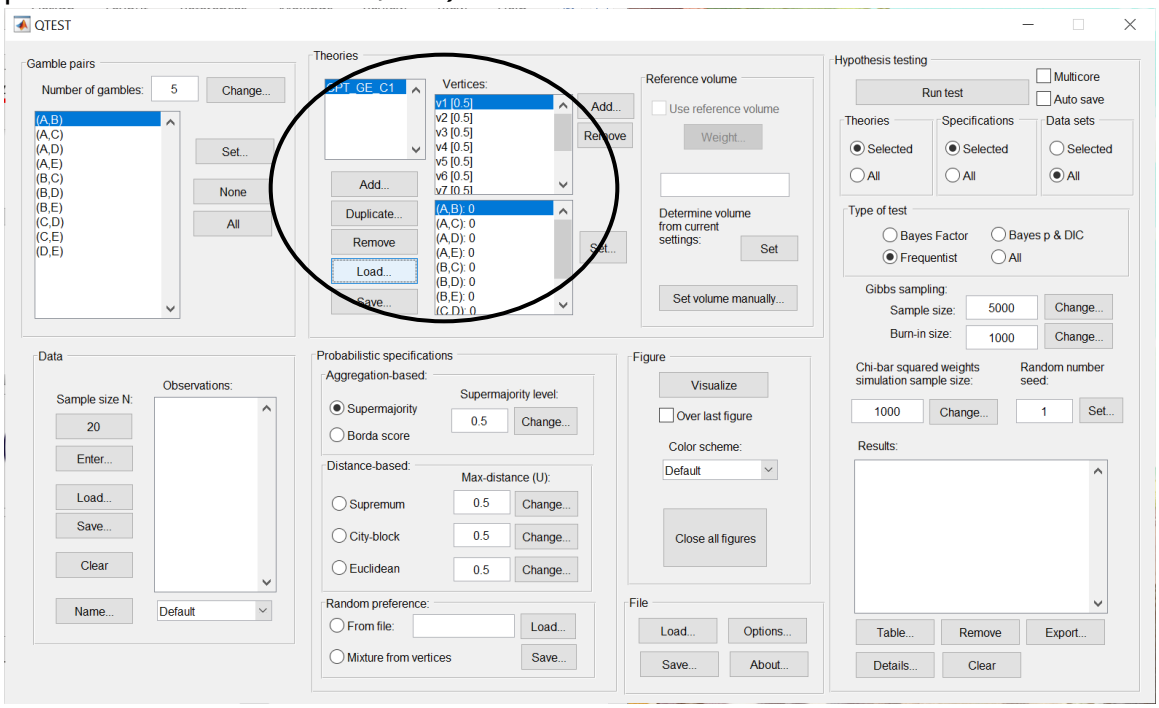
In the “Load Theory” dialogue window that opens, navigate to the file “Vertices_Cash1_CPT_GE.csv” and then select “Open”.



Then a “Theory” dialogue box pops up. Enter “CPT_GE_C1”, where “C1” stands for Cash I. Select “OK”.

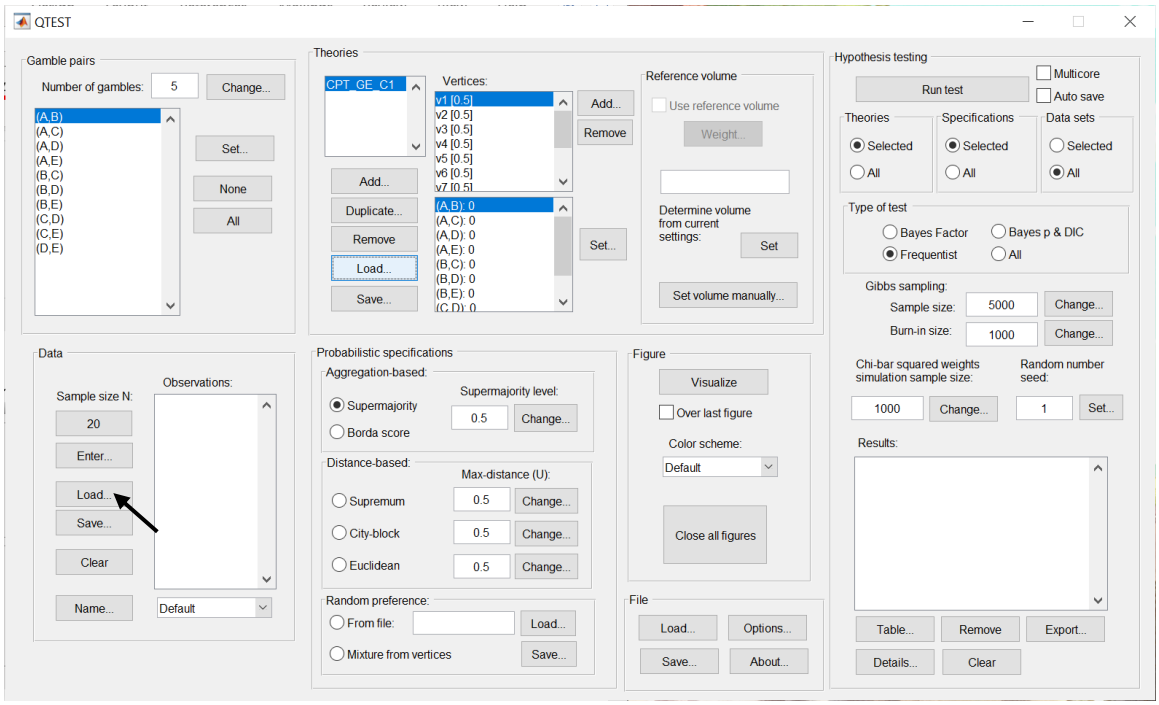


The “Theories” list now contains “CPT_GE_C1” and “Vertices:” lists the 11 predictions of Cash I for *CPT-GE*.

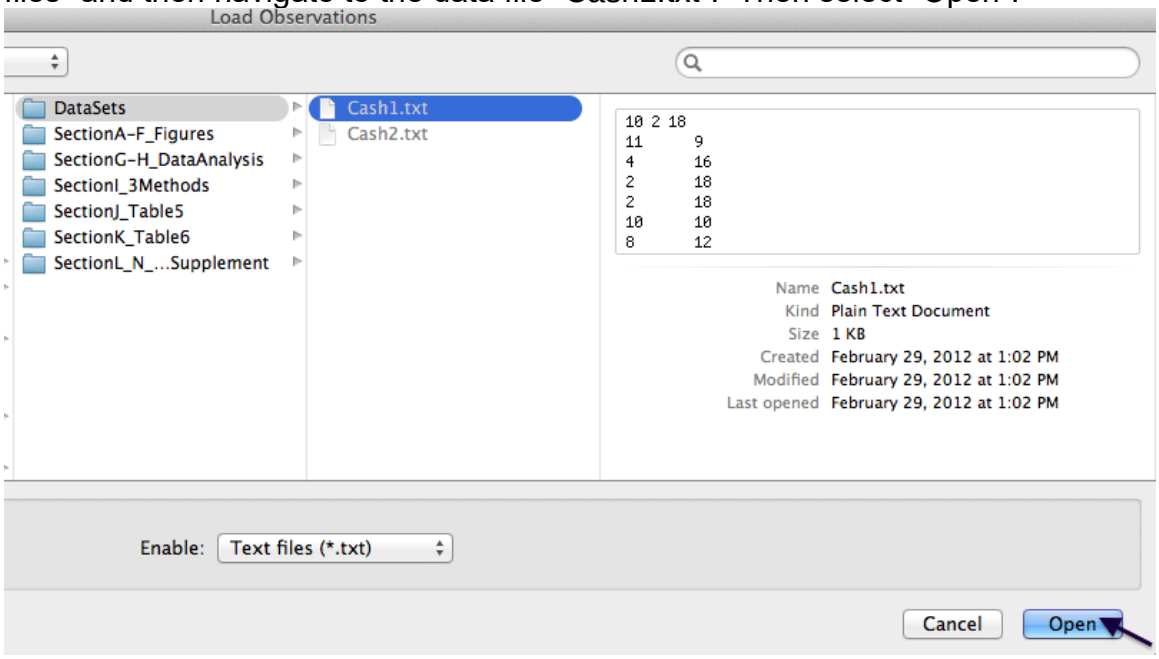


H.3 Data

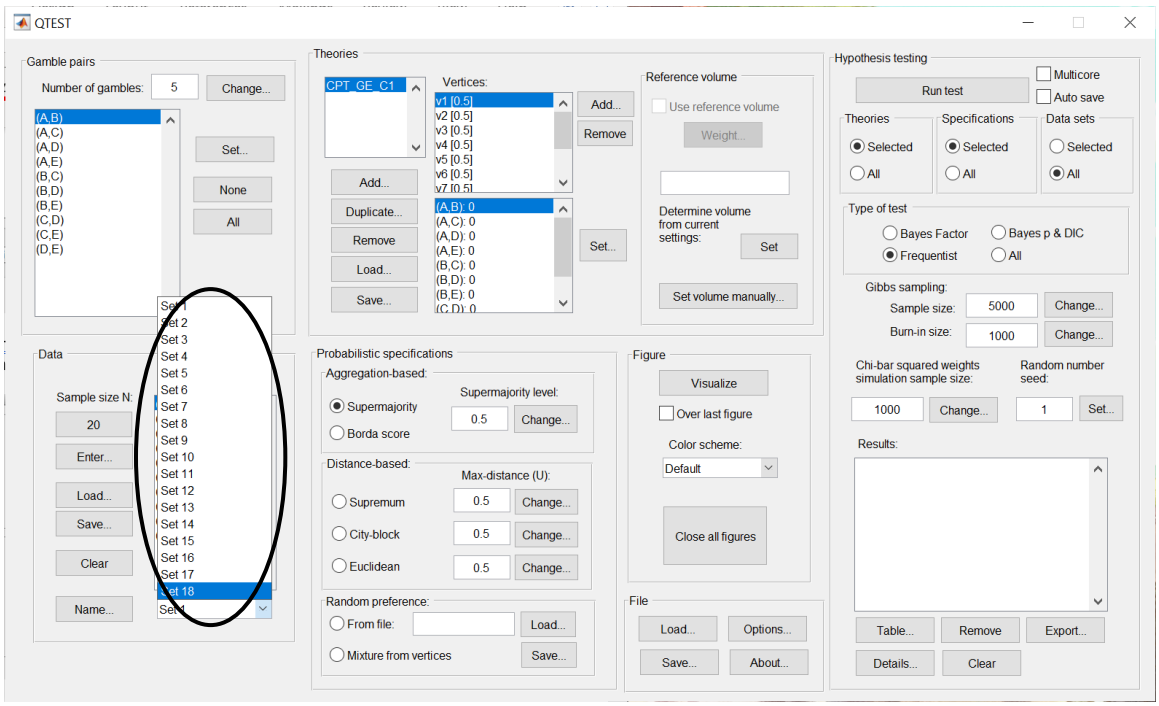
Next, we will enter the Cash I data. Under “Data” select “Load”.



In the “Load Observations” window that pops up, change “Files of type:” to “Text files” and then navigate to the data file “Cash1.txt”. Then select “Open”.

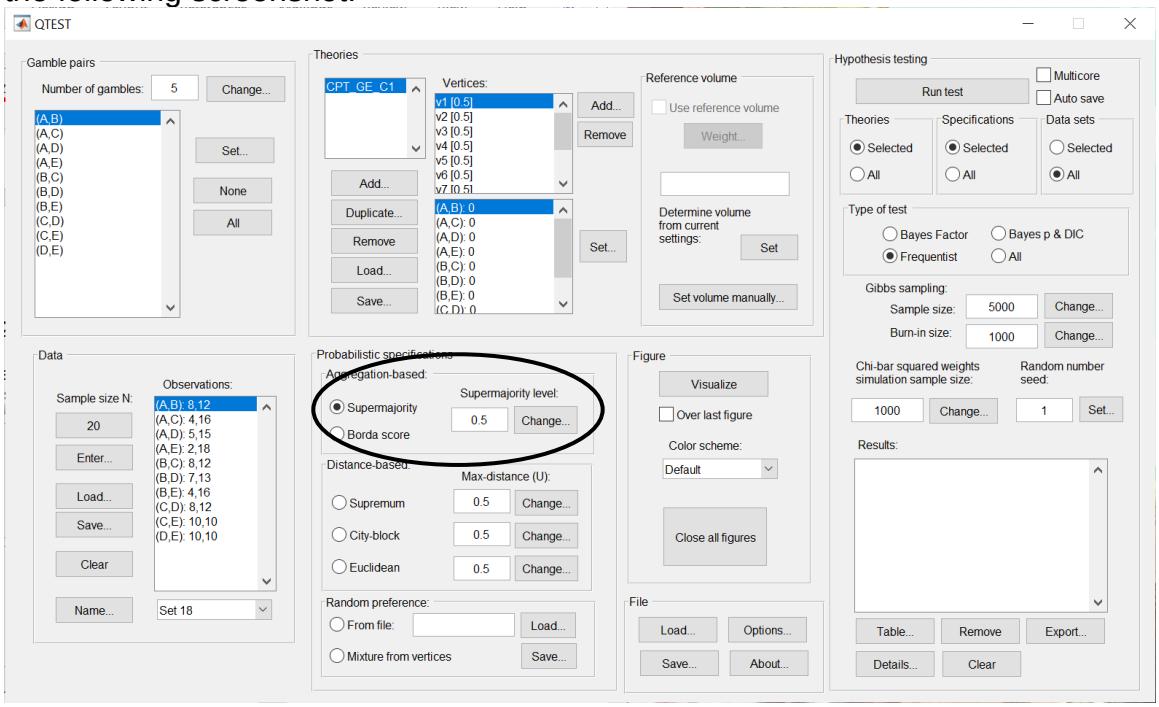


To verify all 18 Cash I data sets loaded properly, under “Data”, next to “Name…” select the dropdown menu. If they loaded, the dropdown menu will list “Set 1”-“Set 18”.



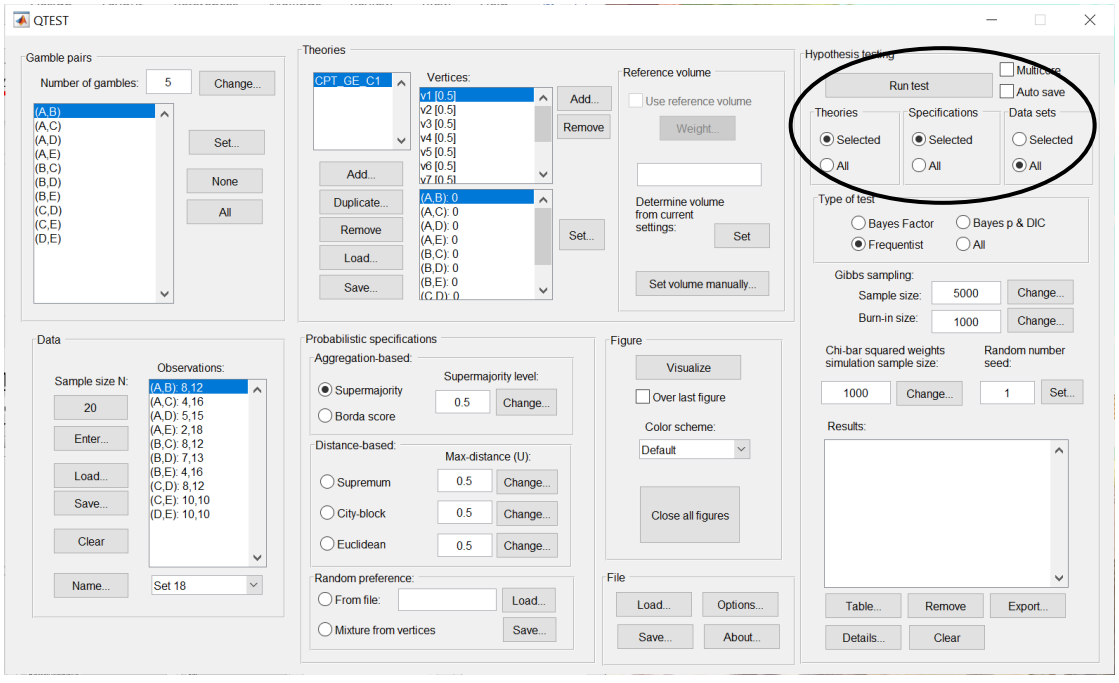
H.4 Probabilistic specification

Under “Probabilistic specifications”, verify that the radio button next to “Supermajority” is selected and that the “Supermajority level:” is set to “0.5”, as in the following screenshot.

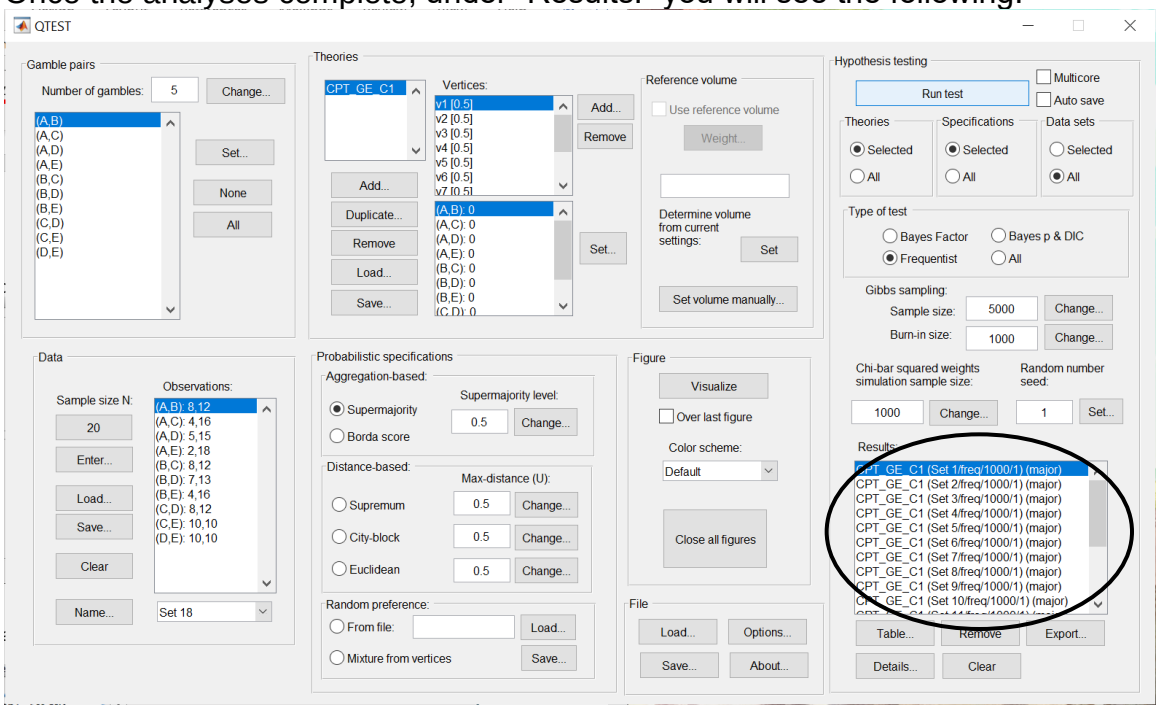


H.5 Hypothesis Testing

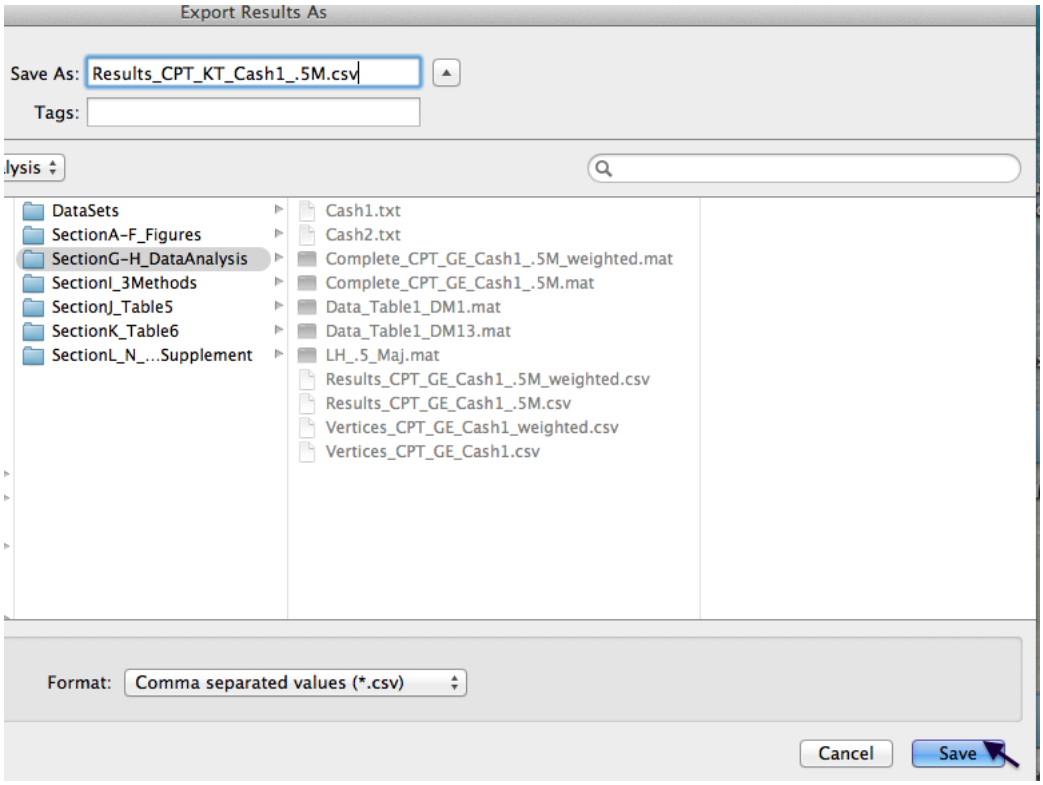
Under “Hypothesis testing” verify that the radio button next to “All” under “Data sets” is selected. Then select “Run test”.



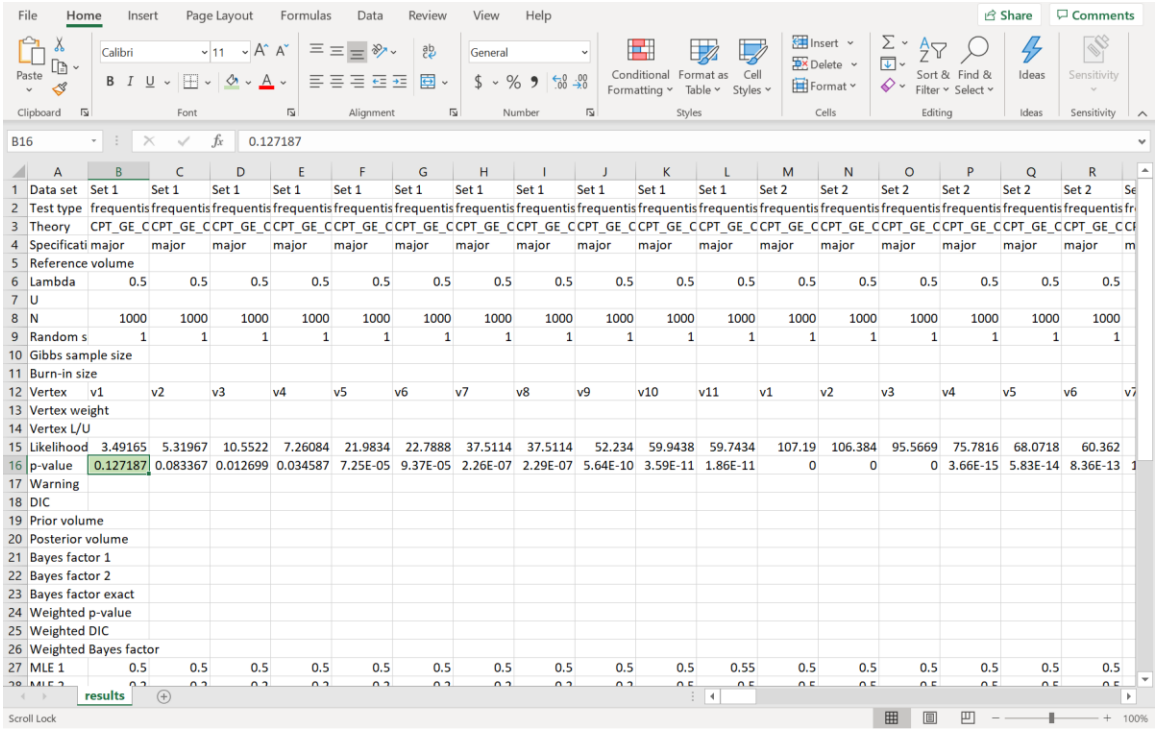
Once the analyses complete, under “Results:” you will see the following.



To save the results, under “Results:”, select “Export…”. An “Export Results As” window pops up. Save the file as “Results_CPT_GE_Cash1_.5M.csv”. Select “Save”.



Now open the “Results_CPT_GE_Cash1_.5SM.csv” file we just saved. (Or open the file in the folder “SectionI-K_DataAnalysis” downloaded from the website.) A screenshot of part of the file is provided below. We have added all the highlighting here. The spreadsheet will not contain highlighted cells. First, notice that for Set 1, there are now 11 columns of results, one column for each vertex, as highlighted in yellow. Second, to identify the best fitting vertex for this decision-maker under a 0.50-majority/modal choice specification for the Cash I data, look at the p-values in row 16. Highlighted in green is the p-value of “0.127187”, which is the largest p-value for this participant. Third, each column contains the maximum likelihood estimates for the 10 gamble pairs for this decision maker for each vertex. In order-constrained inference, the best fitting vertex is the one with the largest p-value. The overall p-value of the model is that largest p-value, in the case of Set 1, it is vertex one which has a p-value of 0.127187.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2
2	Test type	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis	frequentis
3	Theory	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C
4	Specificati	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference volume																	
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																	
8	N	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
9	Random s	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sample size																	
11	Burn-in size																	
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v1	v2	v3	v4	v5	v6
13	Vertex weight																	
14	Vertex L/U																	
15	Likelihood	3.49165	5.31967	10.5522	7.26084	21.9834	22.7888	37.5114	37.5114	52.234	59.9438	59.7434	107.19	106.384	95.5669	75.7816	68.0718	60.362
16	p-value	0.127187	0.083367	0.012699	0.034587	7.25E-05	9.37E-05	2.26E-07	2.29E-07	5.64E-10	3.59E-11	1.86E-11	0	0	0	3.66E-15	5.83E-14	8.36E-13
17	Warning																	
18	DIC																	
19	Prior volume																	
20	Posterior volume																	
21	Bayes factor 1																	
22	Bayes factor 2																	
23	Bayes factor exact																	
24	Weighted p-value																	
25	Weighted DIC																	
26	Weighted Bayes factor																	
27	MLE 1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.5	0.5	0.5	0.5	0.5	0.5

This completes the analysis for the Cash I data for $\mathcal{CPT}$-$\mathcal{GE}$ with a 0.50-majority/modal choice specification. We learned how to load the theory, vertices and data file to analyze data in QTEST. And we also saw how to interpret results from a theory with more than one vertex. In Section K we learn how to set, and analyze, vertices with different weights for $\mathcal{CPT}$-$\mathcal{GE}$ with a 0.50-majority/modal choice specification for Cash I data.

I. Guidelines for Replicating Tables 5 & 6

We first provide nomenclature guidelines for working with the folders and files for Tables 5 and 6 of QTBC1. There is a separate folder for each table. Table 5 code and results are contained in the folder "SectionJ_Table5" while Table 6 code and results are contained in the folder "SectionK_Table6". Both folders are organized as follows.

Within each of the main Table folders, there are 5 sub-folders:
"DataSets"
"TheoriesVertices"
"QTEST_Session_Complete"
"QTEST_Session_NoResults"
"QTEST_Results"

The "DataSets" folder contains the raw Cash I and Cash II data sets, in a form *ready for analysis* by QTEST. Cash I is named "Cash1.txt" while Cash II is named "Cash2.txt".

The "TheoriesVertices" folder contains the predictions for all the vertices for the theories $\mathcal{LH}$, $\mathcal{CPT}$-$\mathcal{KT}$ and $\mathcal{CPT}$-$\mathcal{GE}$ for both Cash I and Cash II predictions. To understand the naming structure of these files, consider the example "Vertices_CPT_GE_Cash1.csv". "Vertices" means the file contains the vertices (or predictions). "CPT_GE" means these are the predictions for the theory $\mathcal{CPT}$-$\mathcal{GE}$. And "Cash1" means the predictions are based on the Cash I stimuli. QTEST requires the ".csv" extension format to read these files. (For Table 6, the folder is not called "TheoriesVertices" but instead "TheoriesFDI". And in place of "Vertices" in each file name is "FDI". Otherwise, the nomenclature is identical.)

The folder "QTEST_Session_NoResults" has files that contain the setup of the data set, theory and probabilistic specification—but QTEST has not been run yet. Consider the example file "NR_CPT_GE_Cash1_.5M.mat". The "NR" means this is a QTEST session that has No Results. "CPT_GE_Cash1" specifies the theory $\mathcal{CPT}$-$\mathcal{GE}$ and that the predictions are based on Cash I gambles. ".5M" means 0.50-majority/modal choice specification. Finally, these files end in a ".mat" extension, which QTEST requires. One will also see ".9SM" for some files, instead of ".5M", which denotes the 0.90-supermajority specification.

The "QTEST_Session_Complete" folder contains the complete QTEST interface setup for a given data set, theory, set of predictions and probabilistic specification as well as the output of the complete analysis. These file names begin with "Complete", list the theory name next, the data set used, the supermajority specification and end with a .mat extension. Here is an example of this file type: "Complete_CPT_GE_Cash1_.5M.mat". In this case "Complete" denotes this analysis has the complete setup and a completed analysis. "CPT_GE" means the theory analyzed. "Cash1" is the data set. And ".5M" means 0.50-

majority/modal choice specification. One will also see ".9SM" for some files, instead of ".5M", which denotes the 0.90-supermajority specification.

The folder "QTEST_Results" contains .csv spreadsheet files with the output from the analysis. For instance, "Results_CPT_GE_Cash1_.5M.csv".

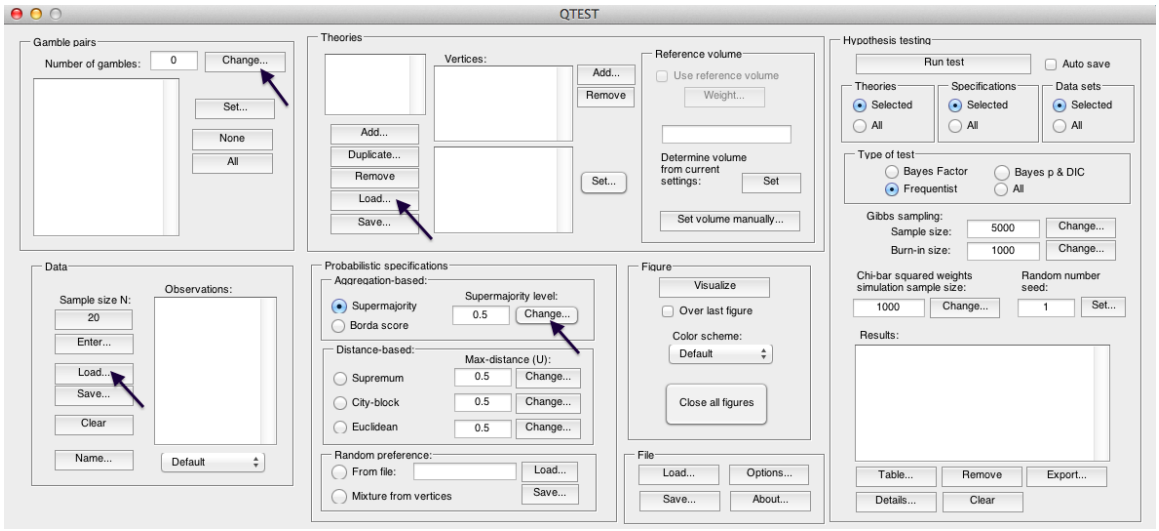
Using the files provided, a user can replicate the results of Tables 5 and 6 of QTBC1 and of Tables 1, 2, and 3 of QTBC2 using one of the following three methods.

1. The first method is like how one might proceed if they have collected experimental data and are ready to do an analysis in QTEST.
   a. First, in the QTEST interface, set the "Number of gambles:" under "Gamble pairs". For all the tables, 5 gambles (or 10 gamble pairs) are needed.
   b. Second, under "Data" in the QTEST interface, select "Load". Navigate to one of the data files (either "Cash1.txt" or "Cash2.txt") from the "DataSets" folder downloaded from the website.
   c. Third, under "Theories" in the QTEST interface, select "Load" and navigate to the "TheoriesVertices" folder and select one of the files. (If one is trying to replicate parts of Table 7 of QTBC1 or parts of Tables 1, 2, or 3 of QTBC2, select "Load" from the "Mixture-based" specification instead of the "Theories" section.)
   d. Fourth, one will need to select the appropriate probabilistic specification in the QTEST interface.
   e. Finally, under "Hypothesis testing" in the QTEST interface select all (or a subset) of the data and then select "Run test".
2. For the second method the gamble pairs are already defined, the data are automatically loaded, the theories and vertices are set, and the probabilistic specification is defined. The only difference from the first method is that the analysis has not actually been run. This is useful, for instance, if one would like to set up their analysis to run, save it and wait until a computer is available to run the analysis. These files are in the folder "QTEST_Session_NoResults". To use this method, simply select "Load…" under "File" and navigate to the appropriate file. And then select "Run test" under "Hypothesis testing".
3. The third method is like how one might proceed if one has already run an analysis in QTEST but would like to look again at that completed analyses. With this method all gamble pairs are defined, the data is automatically loaded, the theories and vertices are set, and the probabilistic specification is automatically loaded. The "Results" are also completed and loaded. One can view those results in table format from the QTEST interface or export them to a .csv file. These files are in the "QTEST_Session_Complete".

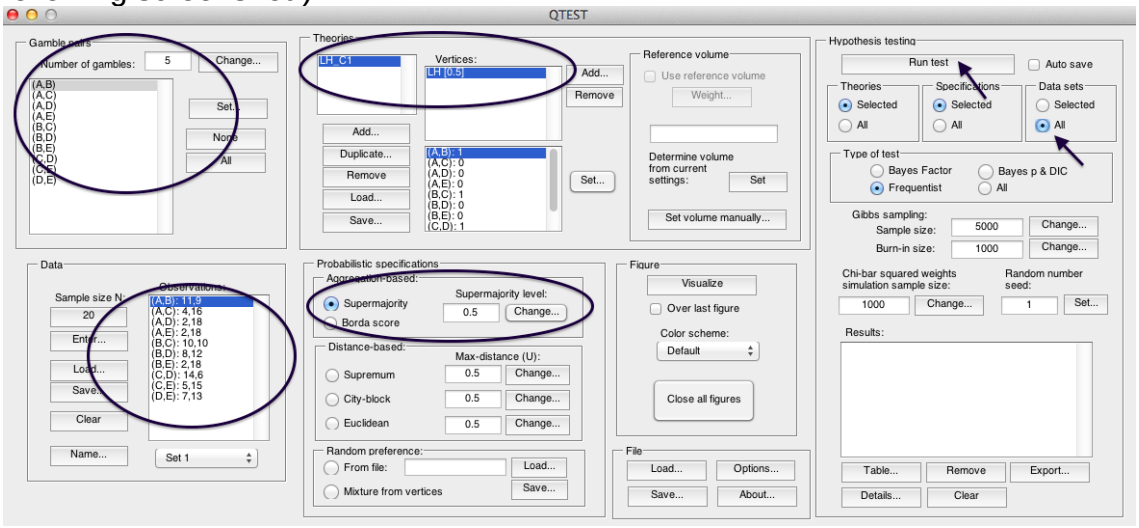
We will illustrate all three of the methods now, analyzing the Cash I data for $L\not{H}$ with a 0.50-majority/modal choice specification. The files for each method are in the folder “SectionL_3Methods”.

Method 1

First, in the QTEST interface, set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed. Second, under “Data” in the QTEST interface, select “Load”. Navigate to “Cash1.txt” in the “SectionI_3Methods” folder, in the folder “Method1”, and then select “Open”. Third, under “Theories”, select “Load” and navigate to the file “Vertices_LH_Cash1.csv” and then select “Open”. In the “Theory” dialogue box that pops up enter “LH_C1” and then select “OK”. Finally, set the “Probabilistic specification” to “Supermajority” at the “0.5” level.

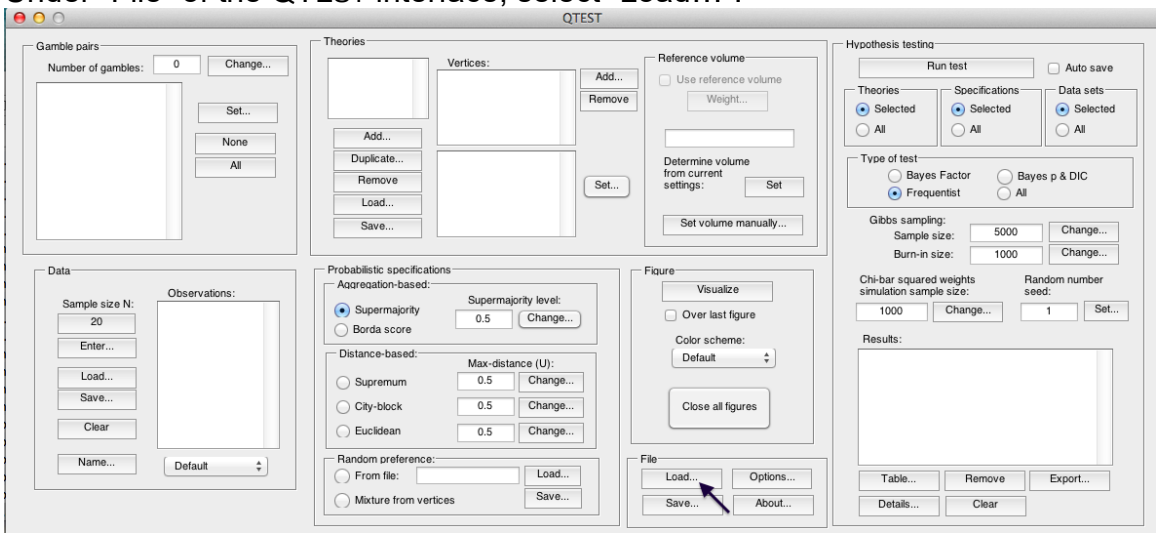


Once these changes have been completed, the QTEST interface should look like the following screenshot. If your session of QTEST matches the screenshot, you can now reproduce the results of Table 5 of QTBC1 for $L\mathcal{H}$ for Cash I data with a 0.50-majority/modal choice specification. To reproduce those results, under "Hypothesis testing" in the QTEST interface, select "All" under "Data sets" and then select "Run test". (Load the file "NR_LH_Cash1_.5M.mat" to replicate the following screenshot.)

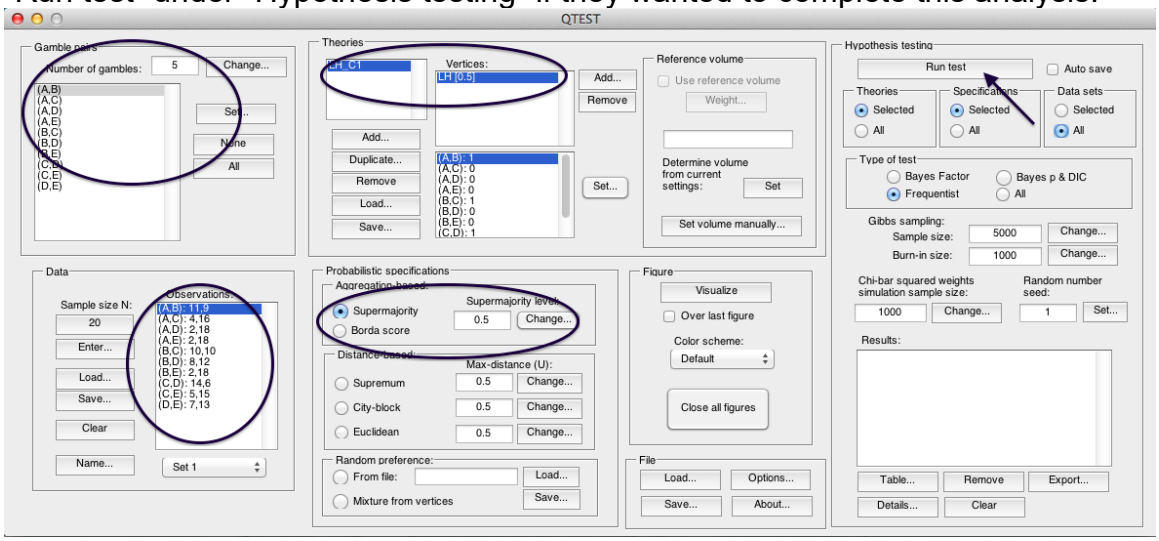


Method 2

Under "File" of the QTEST interface, select "Load…".

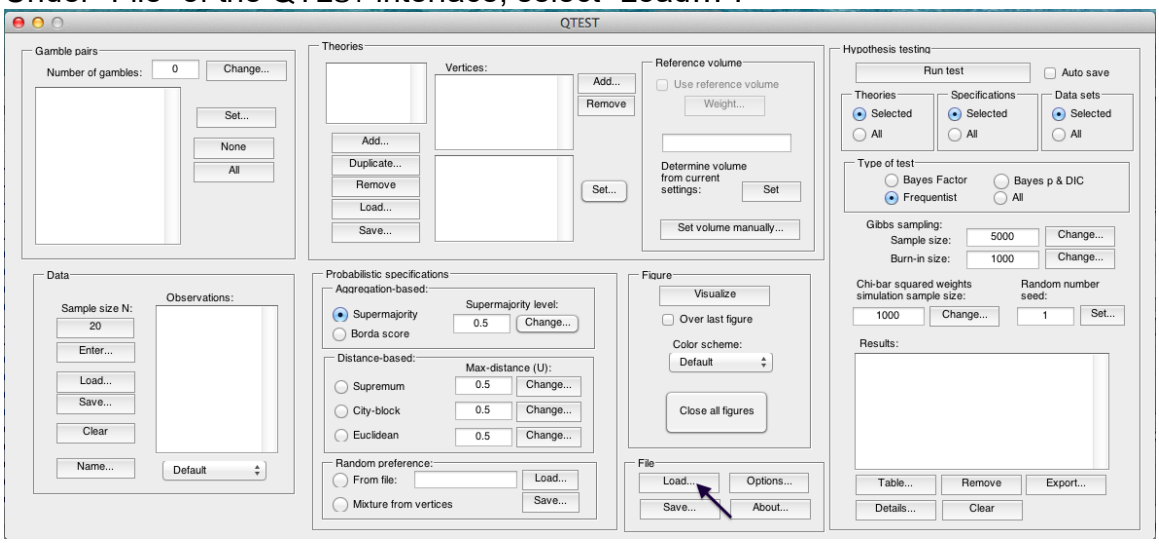


Navigate to the file “NR_LH_Cash1_.5M.mat”. After completing this step, the QTEST interface should look like the following screenshot. Especially note that the “Results:” are NOT completed yet. At this point one would need to select “Run test” under “Hypothesis testing” if they wanted to complete this analysis.

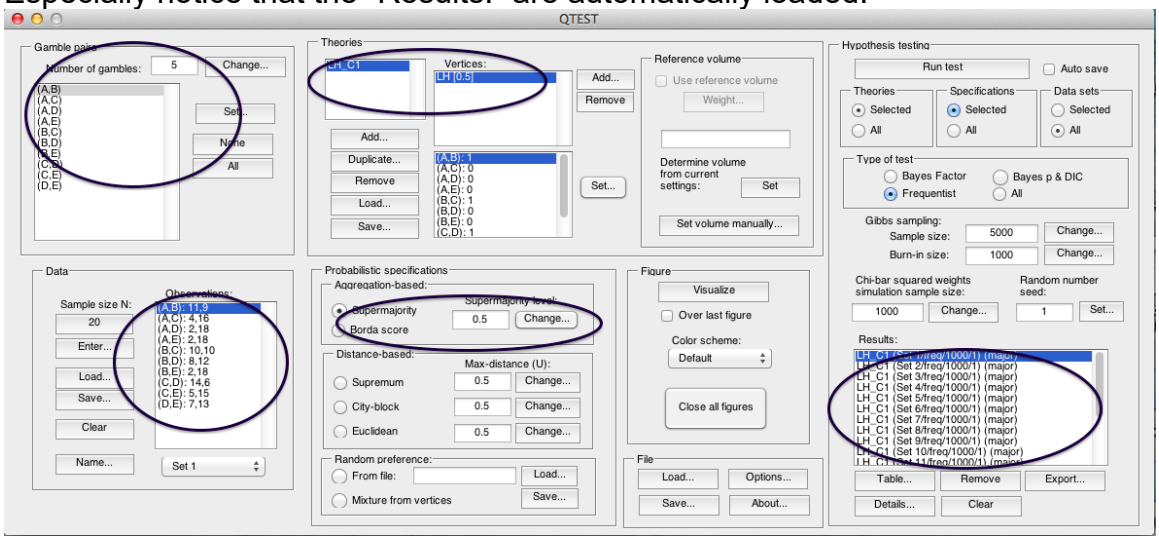


Method 3

Under “File” of the QTEST interface, select “Load…”.

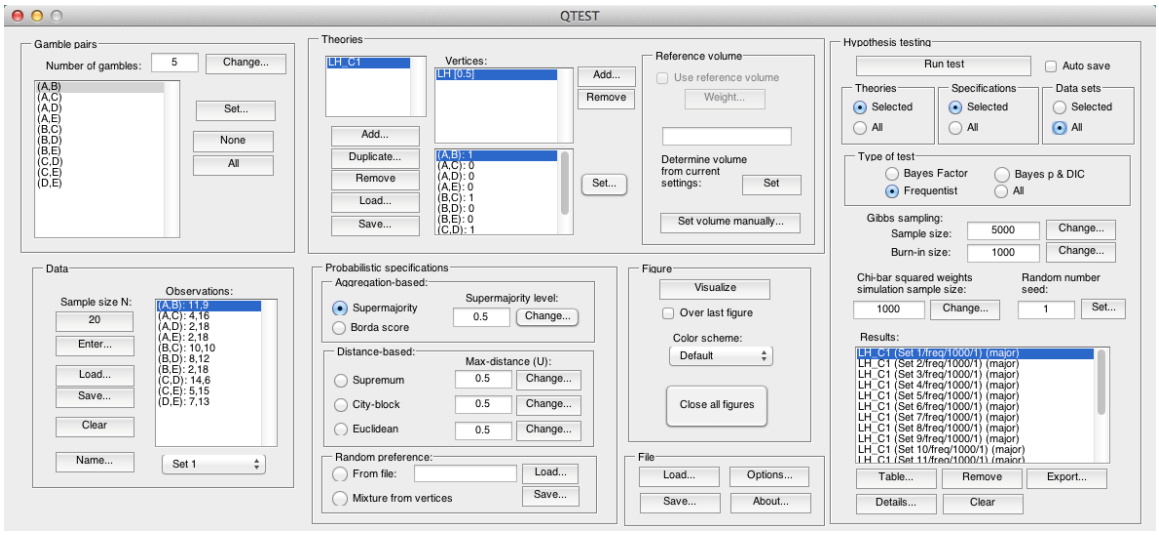


Navigate to the file “Complete_LH_Cash1_.5M.mat” and load it. After finishing this step, the QTEST interface should look like the following screenshot. Especially notice that the “Results:” are automatically loaded.



Results

No matter which of the 3 methods were used, if all the steps were properly completed, the completed QTEST analysis should now look like the following screenshot.



At this point one can verify they have completed the analysis correctly by comparing these results to the appropriate column of Table 5 of QTBC1 or by looking at the file “Results_LH_Cash1_.5M.csv”.

For Sections J and K only, the file names and folders are provided for each of the 3 methods just described.

J. Table 5 of QTBC1

The following section will replicate all results of Table 5 of QTBC1. Each of the 10 subsections (J.1, J.2, …, J.9, J.10) replicate a different column of Table 5.

J.1 Cash I, LH, 0.50-Majority/modal choice

In this section we analyze the Cash I data for $L\mathcal{H}$ with a 0.50-majority/modal choice specification. All files are contained in the folder "SectionJ_Table5".

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash1.txt" in the "DataSets" folder and then select "Open".
- Under "Theories", select "Load" and navigate to the folder "TheoriesVertices". Select the file "Vertices_LH_Cash1.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "LH_C1" and then select "OK".
- Set the "Probabilistic specification" to "Supermajority" at the "0.5" level.
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

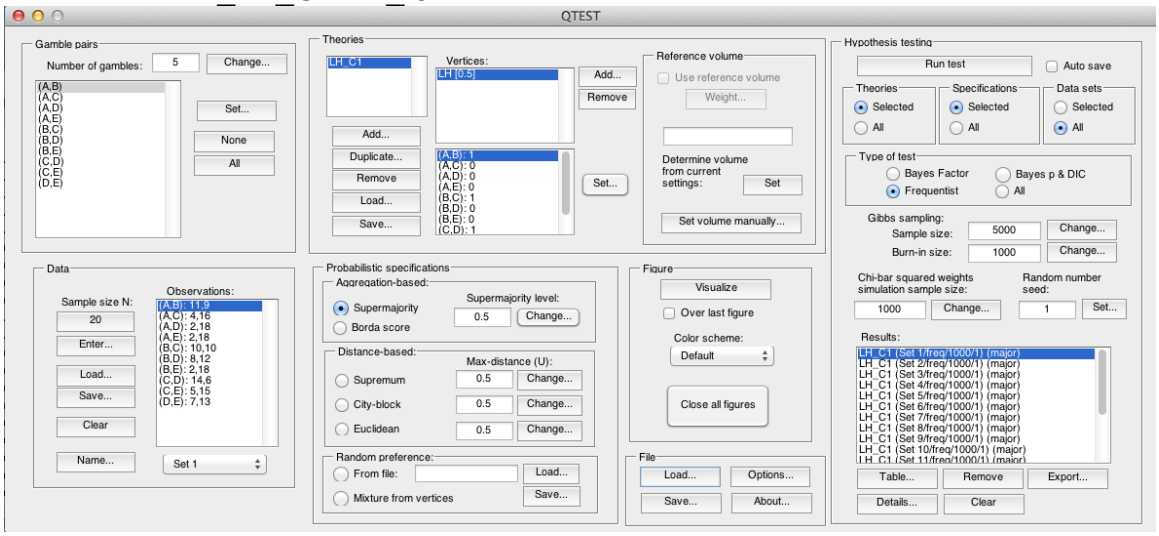
- Under "File" of the QTEST interface, select "Load…". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_LH_Cash1_.5M.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

- Under "File" of the QTEST interface, select "Load…". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_LH_Cash1_.5M.mat".

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_LH_Cash1_.5M.csv”.



J.2 Cash II, LH, 0.50-Majority/modal choice

In this section we analyze the Cash II data for $L\mathcal{H}$ with a 0.50-majority/modal choice specification.

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash2.txt” in the “DataSets” folder and then select “Open”.
- Under “Theories”, select “Load” and navigate to the folder “TheoriesVertices”. Select the file “Vertices_LH_Cash2.csv” and then select “Open”. In the “Theory” dialogue box that pops up enter “LH_C2” and then select “OK”.
- Set the “Probabilistic specification” to “Supermajority” at the “0.5” level.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

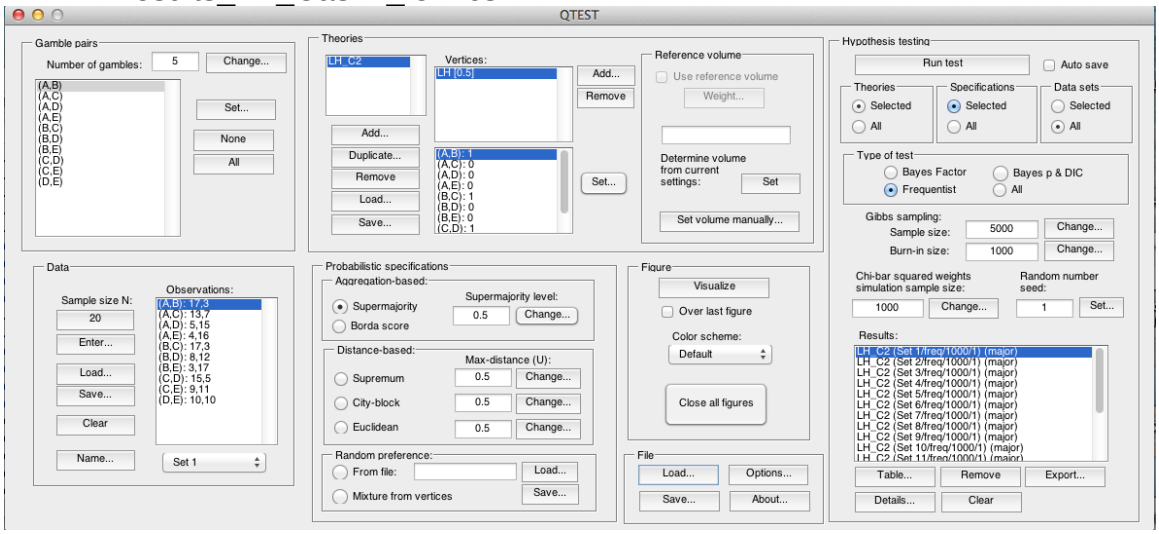
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_LH_Cash2_.5M.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_LH_Cash2_.5M.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_LH_Cash2_.5M.csv”.



J.3 Cash I, *CPT-KT*, 0.50-Majority/modal choice

In this section we analyze the Cash I data for *CPT-KT* with a 0.50-majority/modal choice specification.

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash1.txt” in the “DataSets” folder and then select “Open”.
- Under “Theories”, select “Load” and navigate to the folder “TheoriesVertices”. Select the file “Vertices_CPT_KT_Cash1.csv” and then select “Open”. In the “Theory” dialogue box that pops up enter “CPT_KT_C1” and then select “OK”.
- Set the “Probabilistic specification” to “Supermajority” at the “0.5” level.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

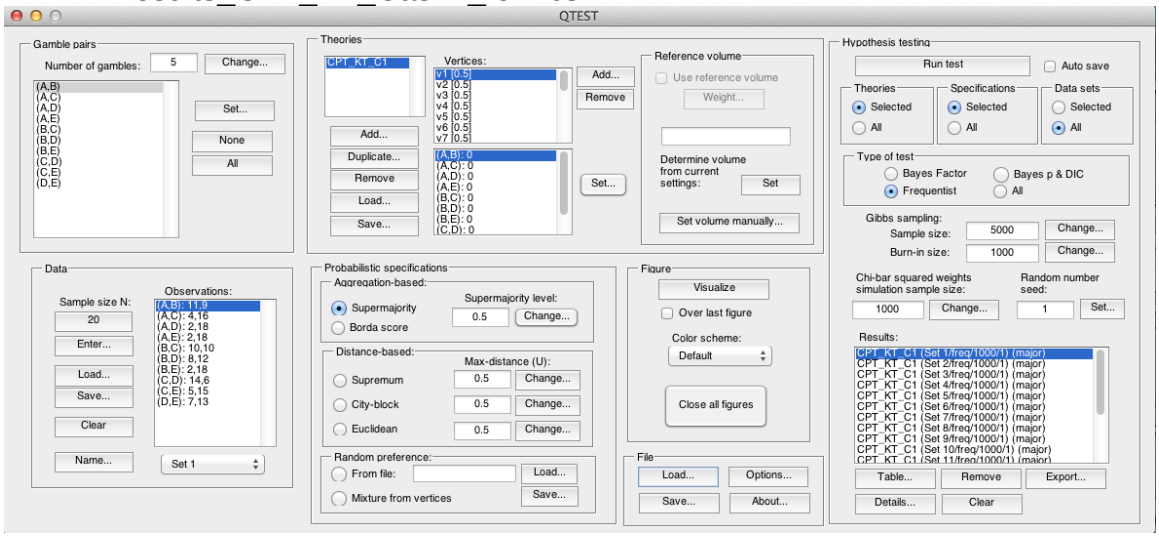
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_CPT_KT_Cash1_.5M.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_CPT_KT_Cash1_.5M.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_CPT_KT_Cash1_.5M.csv”.



J.4 Cash I, *CPT-KT*, 0.90-Supermajority

In this section we analyze the Cash I data for *CPT-KT* with a 0.90-supermajority specification.

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash1.txt” in the “DataSets” folder and then select “Open”.
- Under “Theories”, select “Load” and navigate to the folder “TheoriesVertices”. Select the file “Vertices_CPT_KT_Cash1.csv” and then select “Open”. In the “Theory” dialogue box that pops up enter “CPT_KT_C1” and then select “OK”.
- Set the “Probabilistic specification” to “Supermajority” at the “0.9” level.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

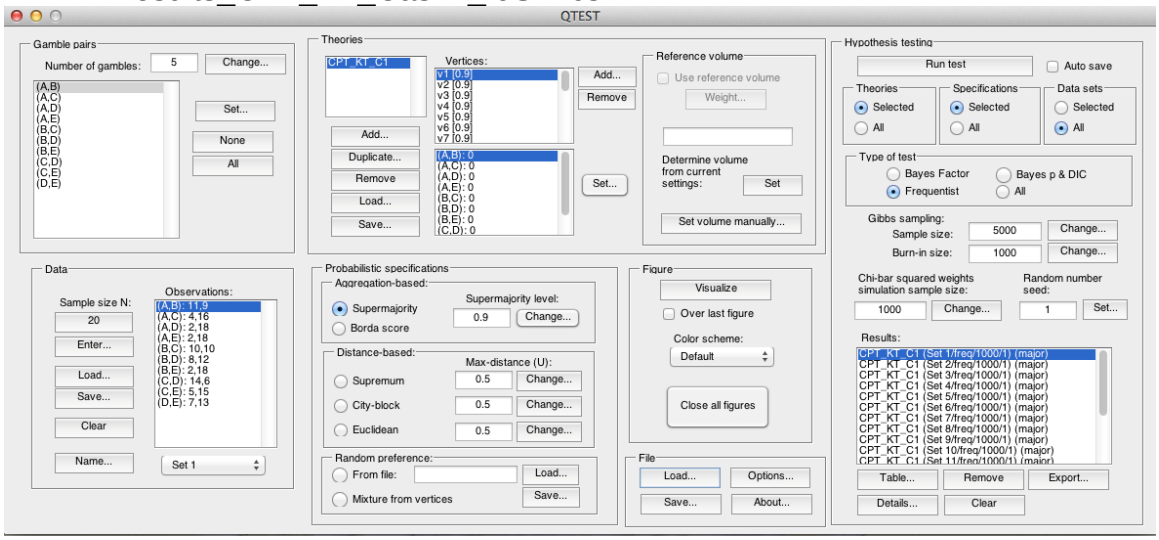
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_CPT_KT_Cash1_.9SM.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_CPT_KT_Cash1_.9SM.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_CPT_KT_Cash1_.9SM.csv”.



J.5 Cash I, *CPT-GE*, 0.50-Majority/modal choice

In this section we analyze the Cash I data for *CPT-GE* with a 0.50-majority/modal choice specification.

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash1.txt” in the “DataSets” folder and then select “Open”.
- Under “Theories”, select “Load” and navigate to the folder “TheoriesVertices”. Select the file “Vertices_CPT_GE_Cash1.csv” and then select “Open”. In the “Theory” dialogue box that pops up enter “CPT_GE_C1” and then select “OK”.
- Set the “Probabilistic specification” to “Supermajority” at the “0.5” level.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

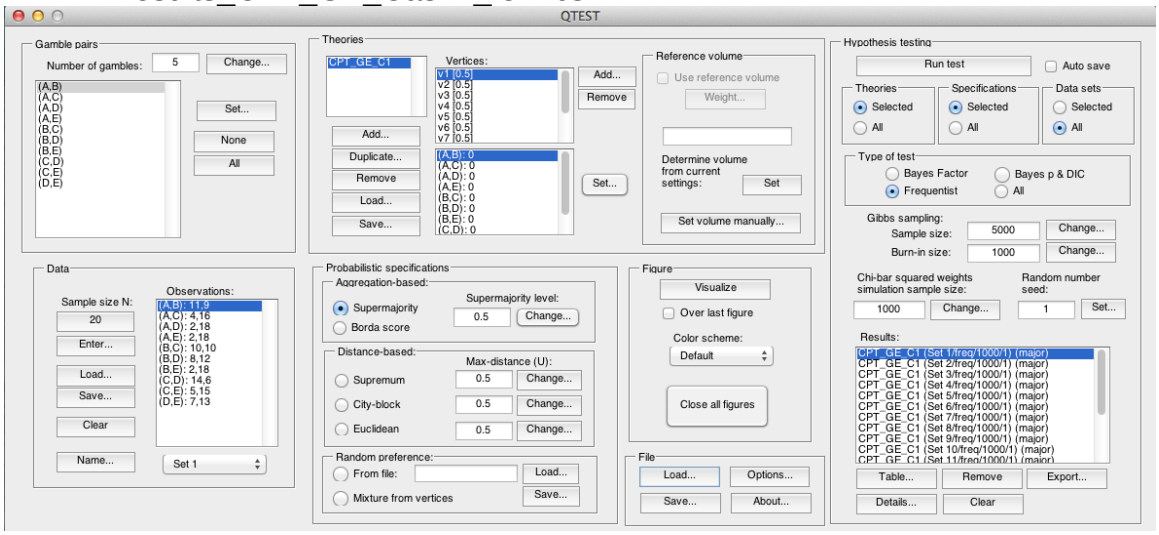
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_CPT_GE_Cash1_.5M.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_CPT_GE_Cash1_.5M.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_CPT_GE_Cash1_.5M.csv”.



J.6 Cash I, *CPT-GE*, 0.90-Supermajority

In this section we analyze the Cash I data for *CPT-GE* with a 0.90-supermajority specification.

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash1.txt” in the “DataSets” folder and then select “Open”.
- Under “Theories”, select “Load” and navigate to the folder “TheoriesVertices”. Select the file “Vertices_CPT_GE_Cash1.csv” and then select “Open”. In the “Theory” dialogue box that pops up enter “CPT_GE_C1” and then select “OK”.
- Set the “Probabilistic specification” to “Supermajority” at the “0.9” level.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

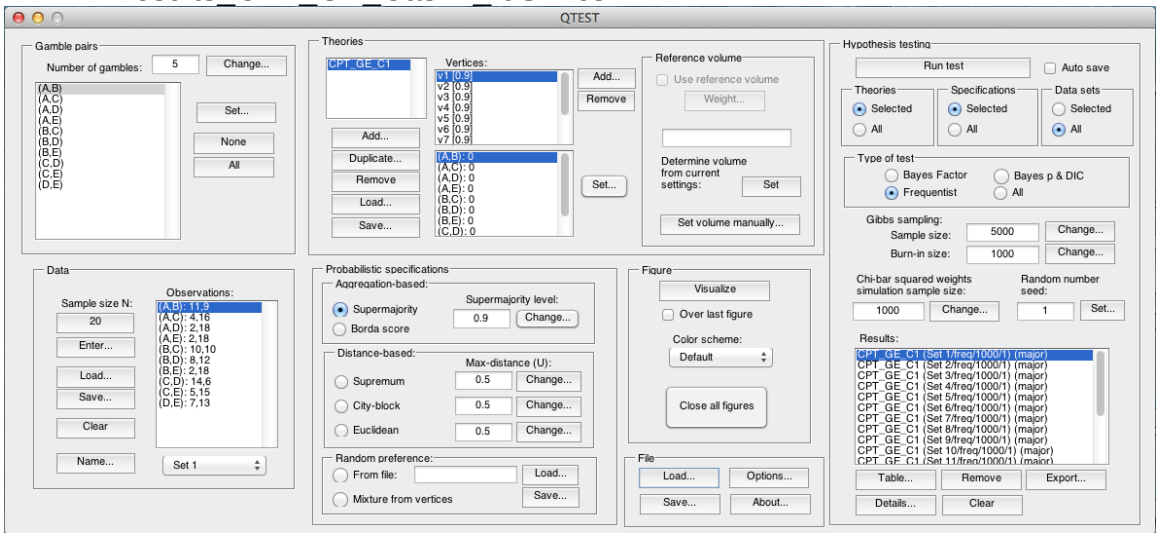
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_CPT_GE_Cash1_.9SM.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_CPT_GE_Cash1_.9SM.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_CPT_GE_Cash1_.9SM.csv”.



J.7 Cash II, $CPT\text{-}KT$, 0.50-Majority/modal choice

In this section we analyze the Cash II data for $CPT\text{-}KT$ with a 0.50-majority/modal choice specification.

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash2.txt” in the “DataSets” folder and then select “Open”.
- Under “Theories”, select “Load” and navigate to the folder “TheoriesVertices”. Select the file “Vertices_CPT_KT_Cash2.csv” and then select “Open”. In the “Theory” dialogue box that pops up enter “CPT_KT_C2” and then select “OK”.
- Set the “Probabilistic specification” to “Supermajority” at the “0.5” level.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

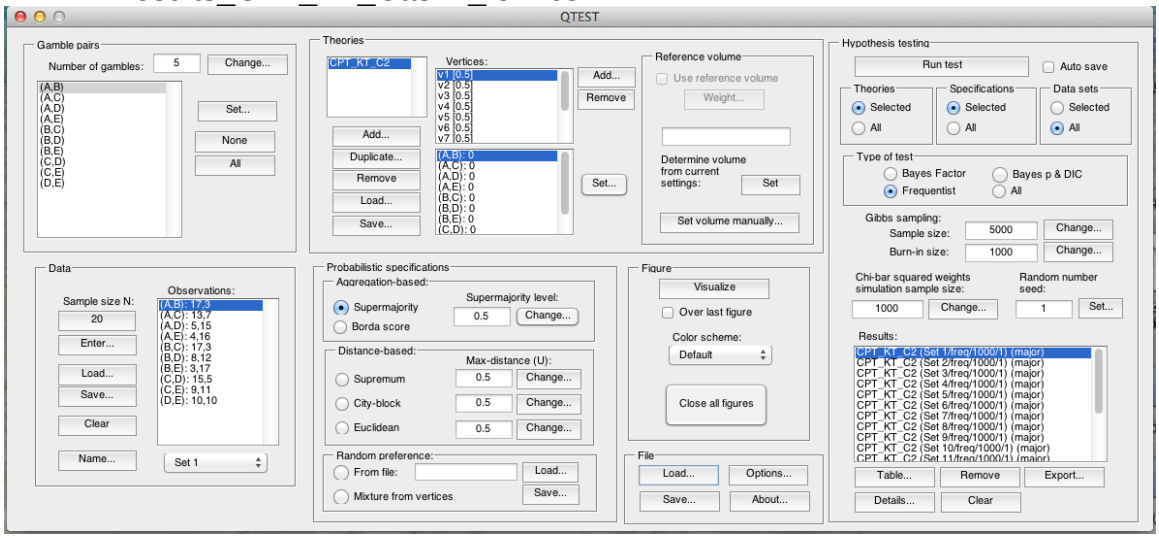
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_CPT_KT_Cash2_.5M.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_CPT_KT_Cash2_.5M.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_CPT_KT_Cash2_.5M.csv”.



J.8 Cash II, *CPT-KT*, 0.90-Supermajority

In this section we analyze the Cash II data for *CPT-KT* with a 0.90-supermajority specification.

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash2.txt” in the “DataSets” folder and then select “Open”.
- Under “Theories”, select “Load” and navigate to the folder “TheoriesVertices”. Select the file “Vertices_CPT_KT_Cash2.csv” and then select “Open”. In the “Theory” dialogue box that pops up enter “CPT_KT_C2” and then select “OK”.
- Set the “Probabilistic specification” to “Supermajority” at the “0.9” level.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

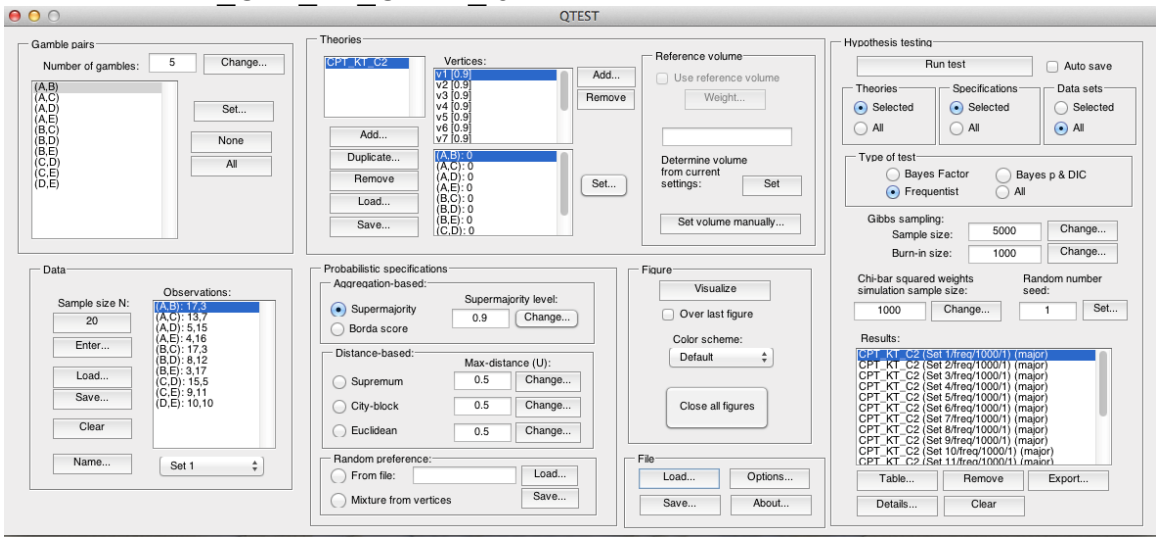
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_CPT_KT_Cash2_.9SM.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_CPT_KT_Cash2_.9SM.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_CPT_KT_Cash2_.9SM.csv”.



J.9 Cash II, *CPT-GE*, 0.50-Majority/modal choice

In this section we analyze the Cash I data for *CPT-GE* with a 0.50-majority/modal choice specification.

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash2.txt” in the “DataSets” folder and then select “Open”.
- Under “Theories”, select “Load” and navigate to the folder “TheoriesVertices”. Select the file “Vertices_CPT_GE_Cash2.csv” and then select “Open”. In the “Theory” dialogue box that pops up enter “CPT_GE_C2” and then select “OK”.
- Set the “Probabilistic specification” to “Supermajority” at the “0.5” level.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

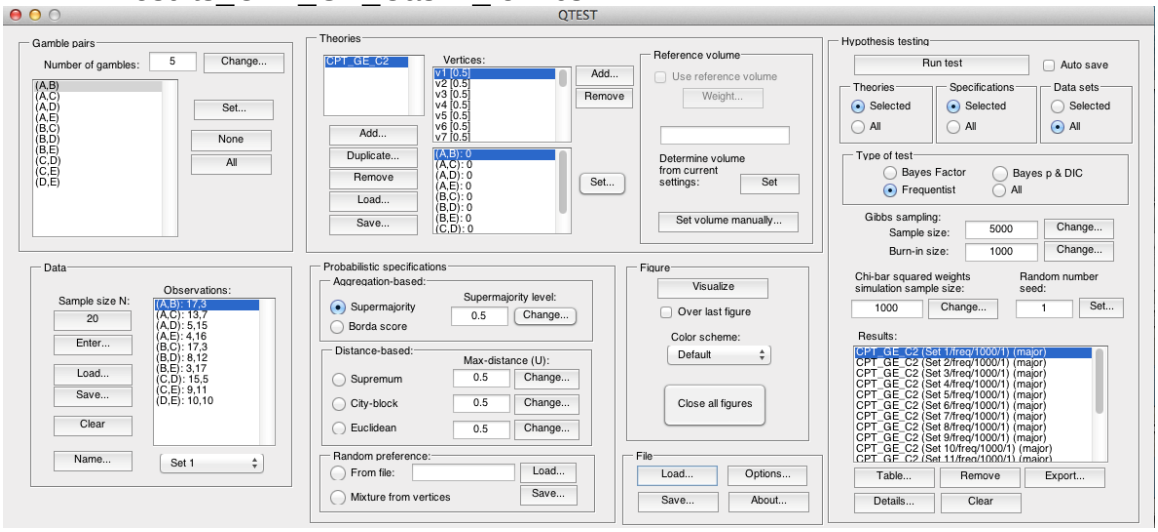
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_CPT_GE_Cash2_.5M.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_CPT_GE_Cash2_.5M.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_CPT_GE_Cash2_.5M.csv”.



J.10 Cash II, *CPT-GE*, 0.90-Supermajority

In this section we analyze the Cash I data for *CPT-GE* with a 0.90-supermajority specification.

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash2.txt” in the “DataSets” folder and then select “Open”.
- Under “Theories”, select “Load” and navigate to the folder “TheoriesVertices”. Select the file “Vertices_CPT_GE_Cash2.csv” and then select “Open”. In the “Theory” dialogue box that pops up enter “CPT_GE_C2” and then select “OK”.
- Set the “Probabilistic specification” to “Supermajority” at the “0.9” level.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

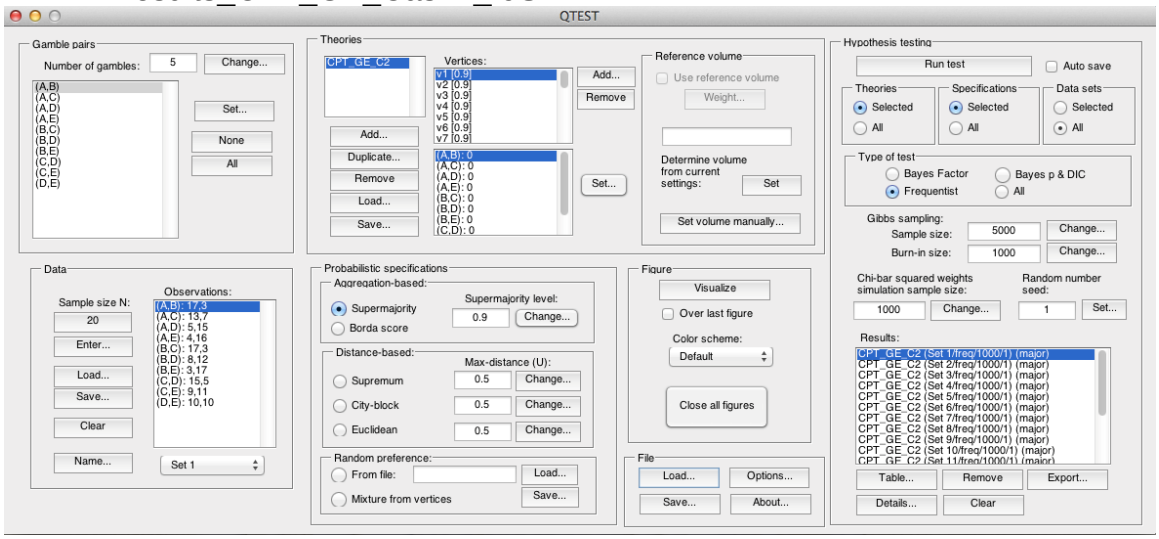
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_CPT_GE_Cash2_.9SM.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_CPT_GE_Cash2_.9SM.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_CPT_GE_Cash2_.9SM.csv”.



K. Table 6 of QTBC1

This section of the tutorial allows a user of QTEST to replicate Table 6 of QTBC1. Once again, the 3 different methods for running an analysis are presented.

K.1 Cash I, Random *CPT-KT*

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash1.txt" in the "DataSets" folder and then select "Open".
- Under "Probabilistic specifications", under "Mixture-based:" select "Load" and navigate to the folder "TheoriesFDI". Select the file "FDI_CPT_KT_Cash1.txt" and then select "Open".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

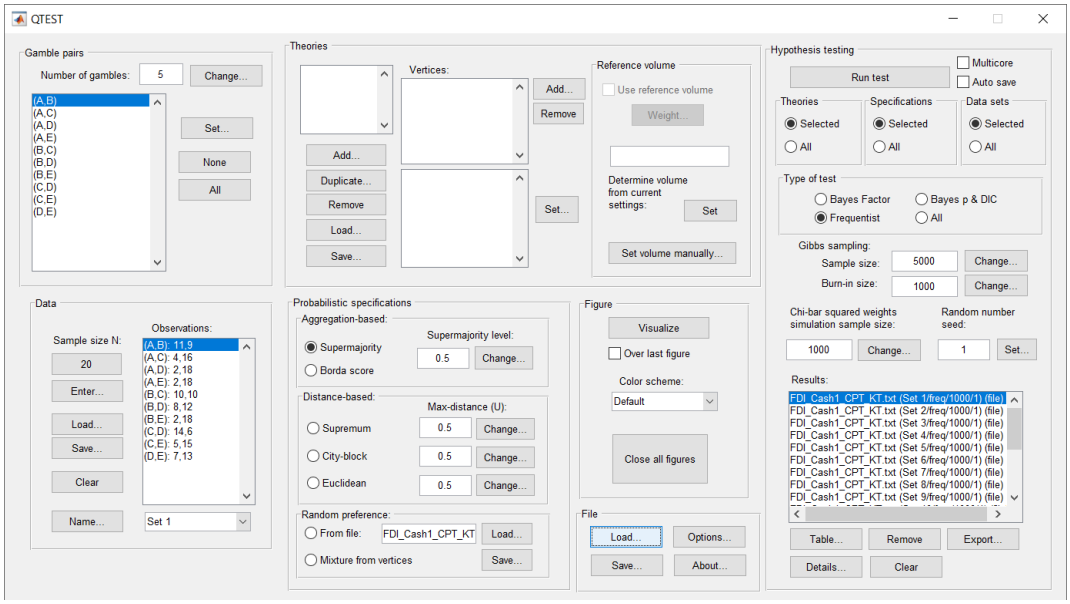
- Under "File" of the QTEST interface, select "Load…". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_KT_Cash1_Mixture.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

- Under "File" of the QTEST interface, select "Load…". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_KT_Cash1_Mixture.mat".

Results

- The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_KT_Cash1_Mixture.csv".



K.2 Cash II, Random *CPT-KT*

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash2.txt” in the “DataSets” folder and then select “Open”.
- Under “Probabilistic specifications”, under “Mixture-based:” select “Load” and navigate to the folder “TheoriesFDI”. Select the file “FDI_CPT_KT_Cash2.txt” and then select “Open”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

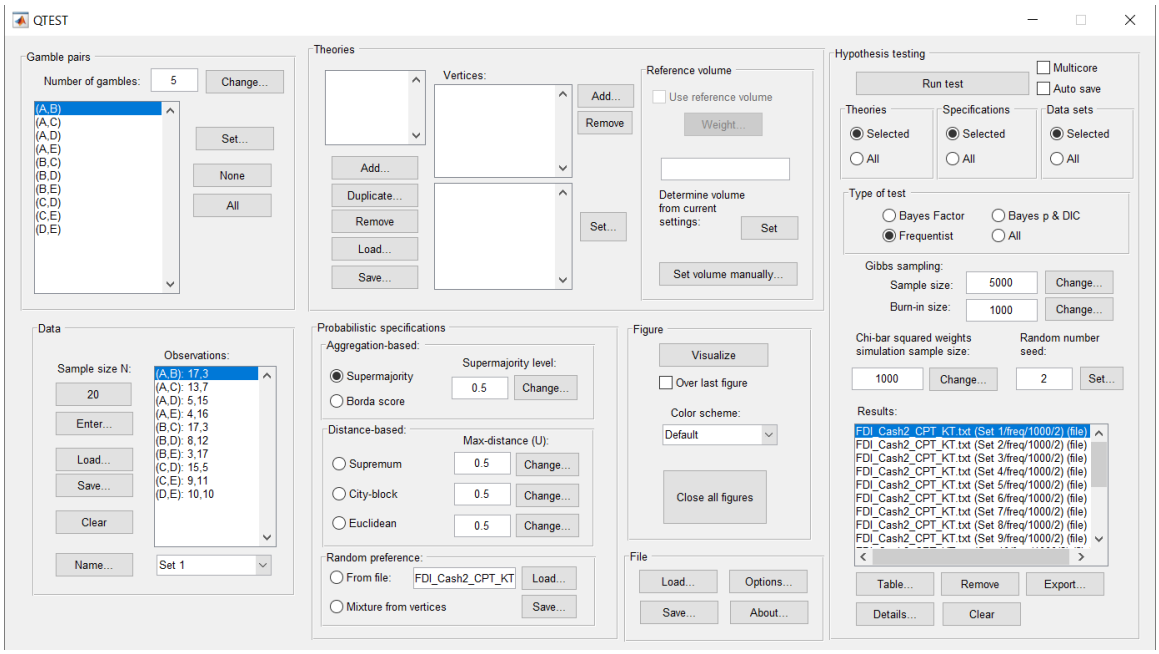
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_CPT_KT_Cash2_Mixture.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_CPT_KT_Cash2_Mixture.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_CPT_KT_Cash2_Mixture.csv”.



K.3 Cash I, Random *CPT-GE*

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash1.txt” in the “DataSets” folder and then select “Open”.
- Under “Probabilistic specifications”, under “Mixture-based:” select “Load” and navigate to the folder “TheoriesFDI”. Select the file “FDI_CPT_GE_Cash1.txt” and then select “Open”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

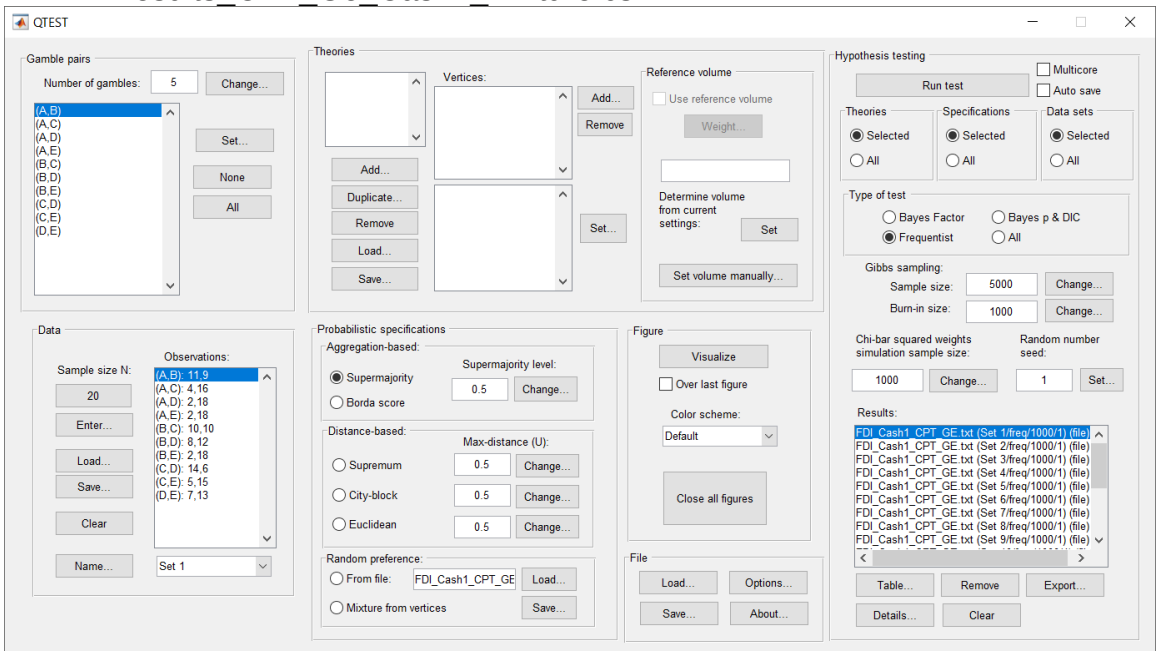
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_CPT_GE_Cash1_Mixture.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_CPT_GE_Cash1_Mixture.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_CPT_Ge_Cash1_Mixture.csv”.



K.4 Cash II, Random *CPT-GE*

Method 1

- Set the “Number of gambles:” under “Gamble pairs” to 5. Then select “All” (also under “Gamble pairs”) so all 10 gamble pairs are now listed.
- Under “Data”, select “Load”. Navigate to “Cash2.txt” in the “DataSets” folder and then select “Open”.
- Under “Probabilistic specifications”, under “Mixture-based:” select “Load” and navigate to the folder “TheoriesFDI”. Select the file “FDI_CPT_GE_Cash2.txt” and then select “Open”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 2

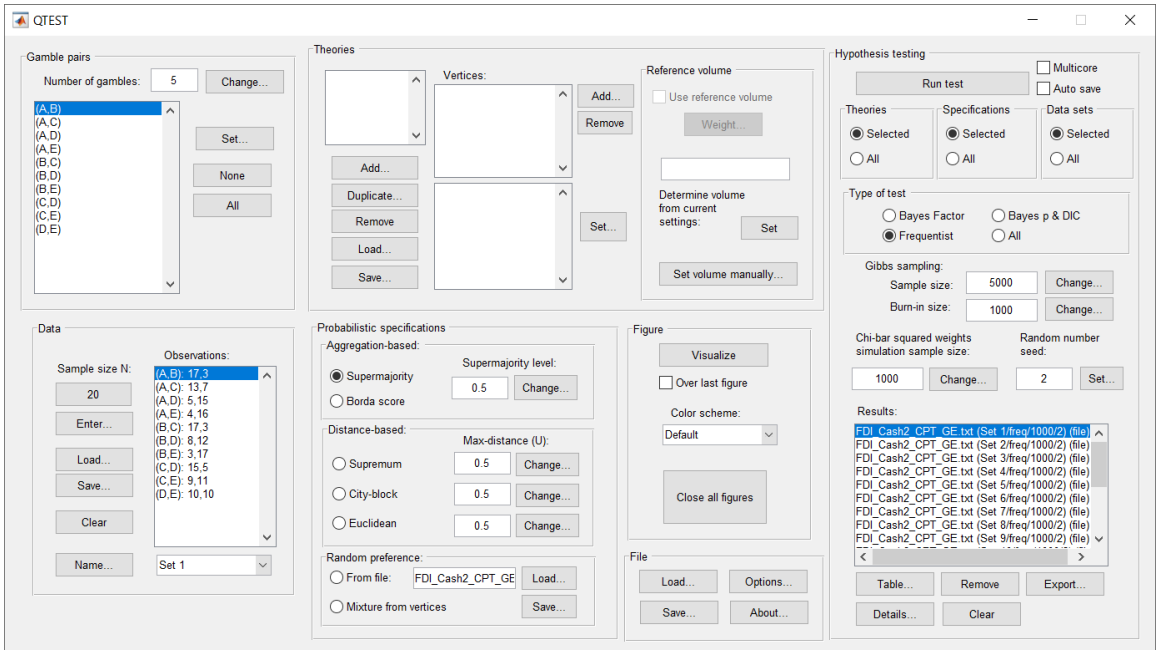
- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_NoResults” folder and open the file “NR_CPT_GE_Cash2_Mixture.mat”.
- Under “Hypothesis testing”, select “All” under “Data sets” and then select “Run test”.

Method 3

- Under “File” of the QTEST interface, select “Load…”. Navigate to the “QTEST_Session_Complete” folder and open the file “Complete_CPT_GE_Cash2_Mixture.mat”.

Results

- The results for this section are in the folder “QTEST_Results” in the file “Results_CPT_GE_Cash2_Mixture.csv”.



L. Tables 1 and 2 of QTBC2

This section of the tutorial allows a user of QTEST to replicate the Cash 1 Bayes p and DIC values of Tables 1 and 2 in QTBC2.

Section L.2 demonstrates to a user the steps in running the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{KT}$ for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications.

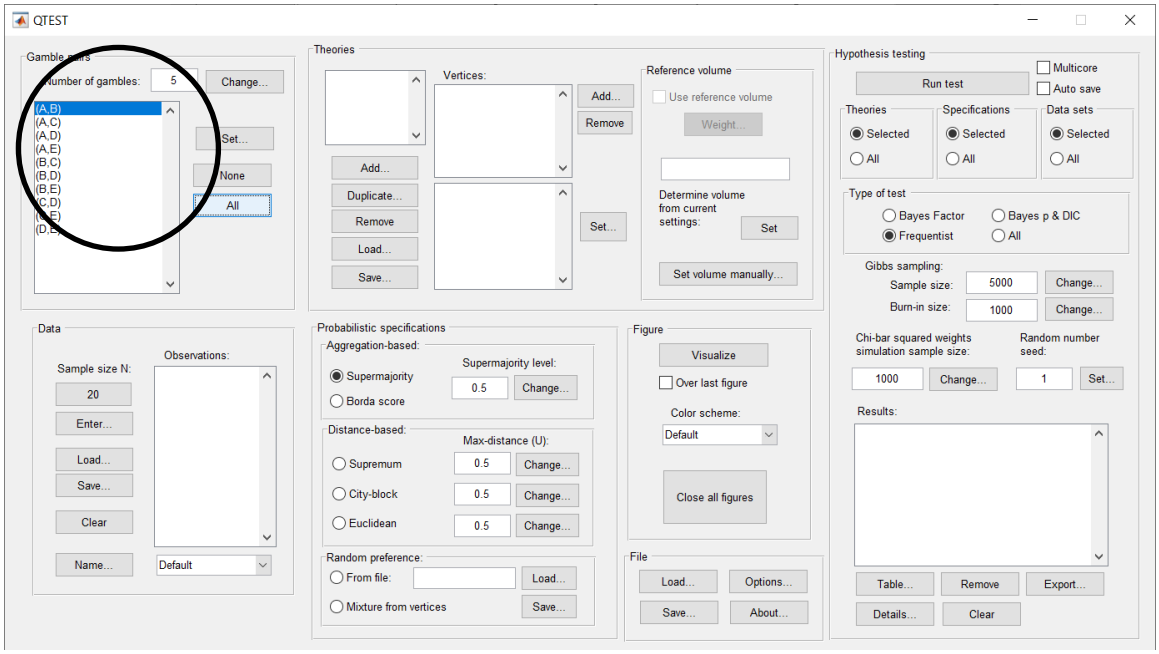
Section L.3 demonstrates to a user the steps in running the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{GE}$ for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications.

Then, section L.4 demonstrates to a user the steps in running the Bayes p & DIC test of $\mathcal{LH}$ for the .50-majority/modal choice and the .90-supermajority probabilistic specifications.

Finally, section L.5 demonstrates to a user the steps in running the Bayes p & DIC test for the unconstrained model.

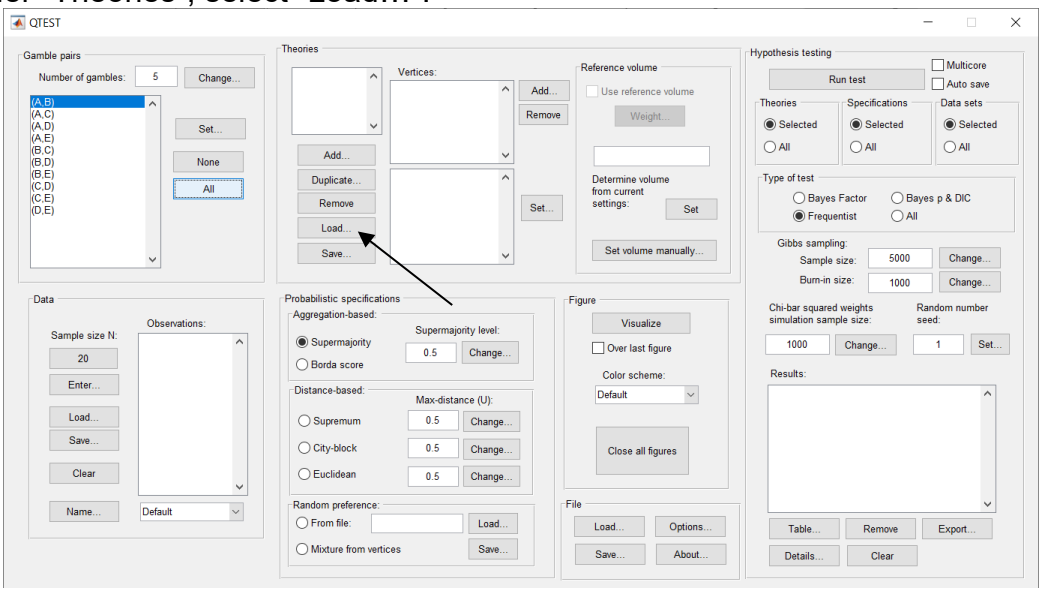
L.1 Gamble pairs

Starting with a clear (or new) QTEST interface, under “Gamble pairs”, “Change” the “Number of gambles:” to “5” and then select “All”. QTEST should look like the following screenshot.

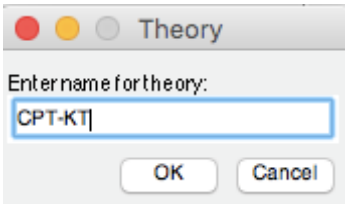


L.2.1 Theory and Vertex: Cash I, *CPT-KT*

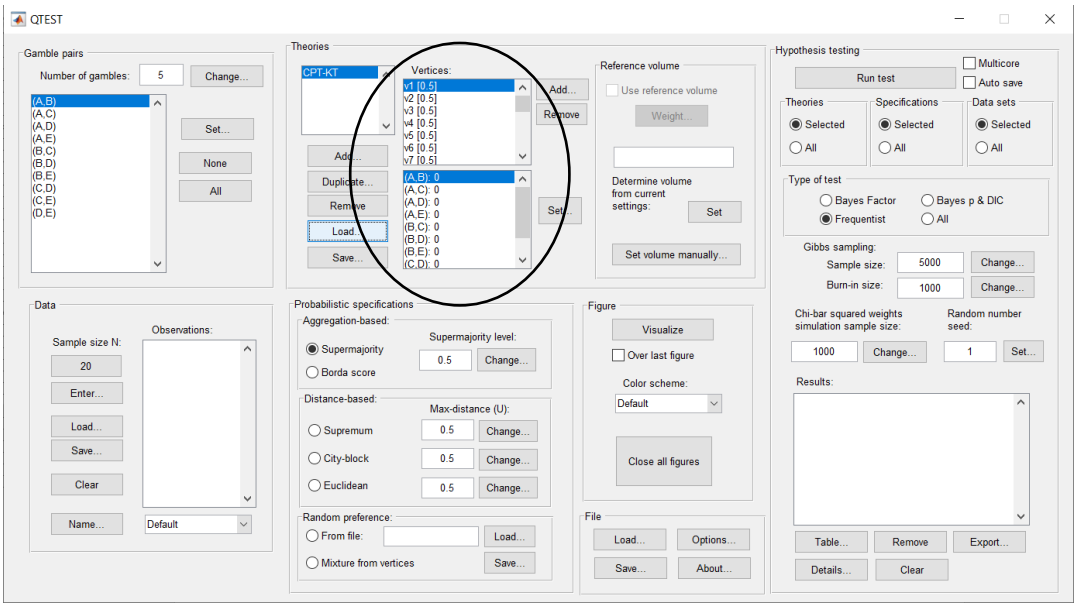
Under “Theories”, select “Load…”.



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “TheoriesVertices” folder and open “Vertices_CPT_KT_Cash1.csv”. In the dialog box, type “CPT-KT” and select “OK”.

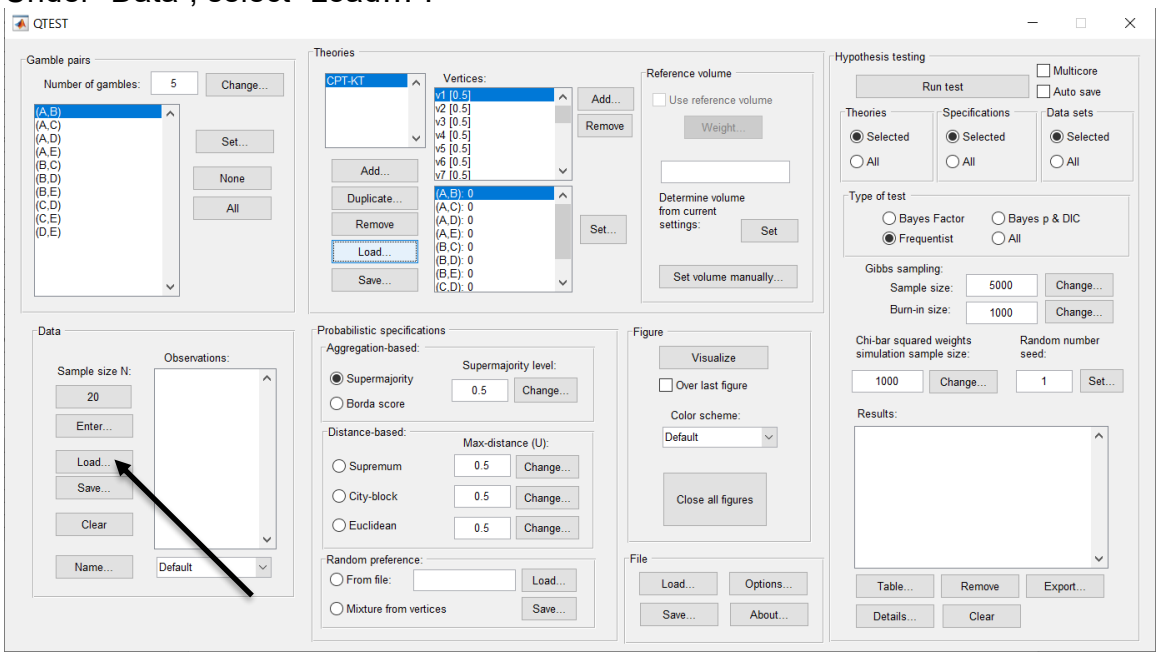


On the QTEST interface there should now be a list of 22 vertices for *CPT-KT* under “Theories”. Verify your screen matches the screenshot below.



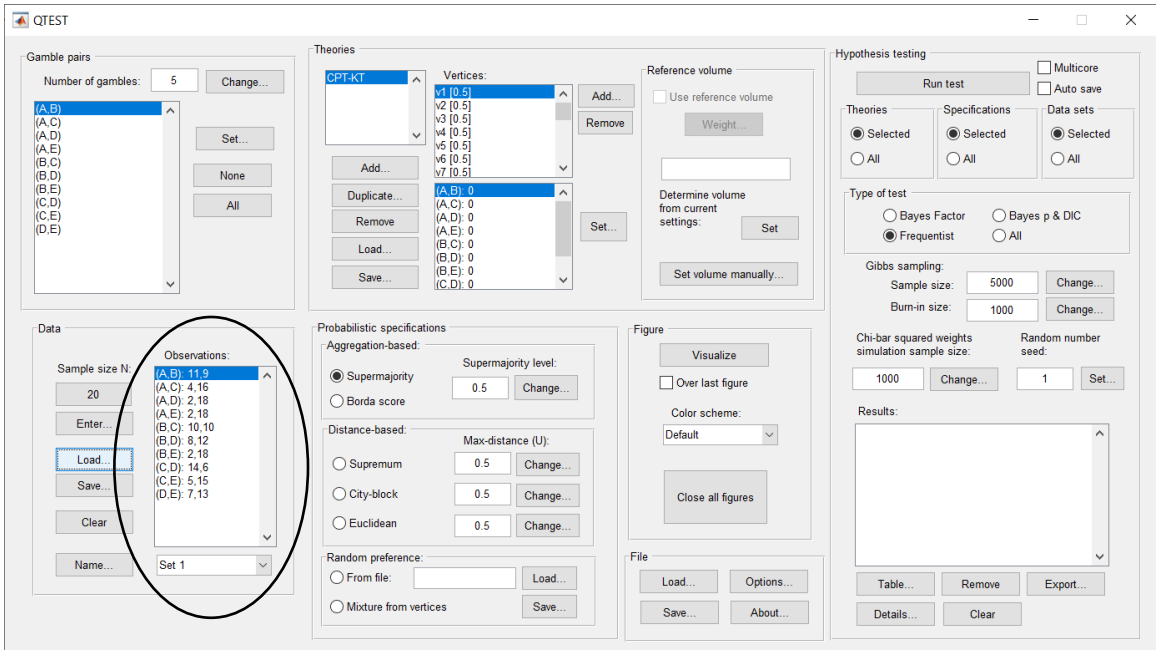
L.2.2 Data: Cash I, *CPT-KT*

Under “Data”, select “Load…”.



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “DataSets” folder and open “Cash1.txt”.

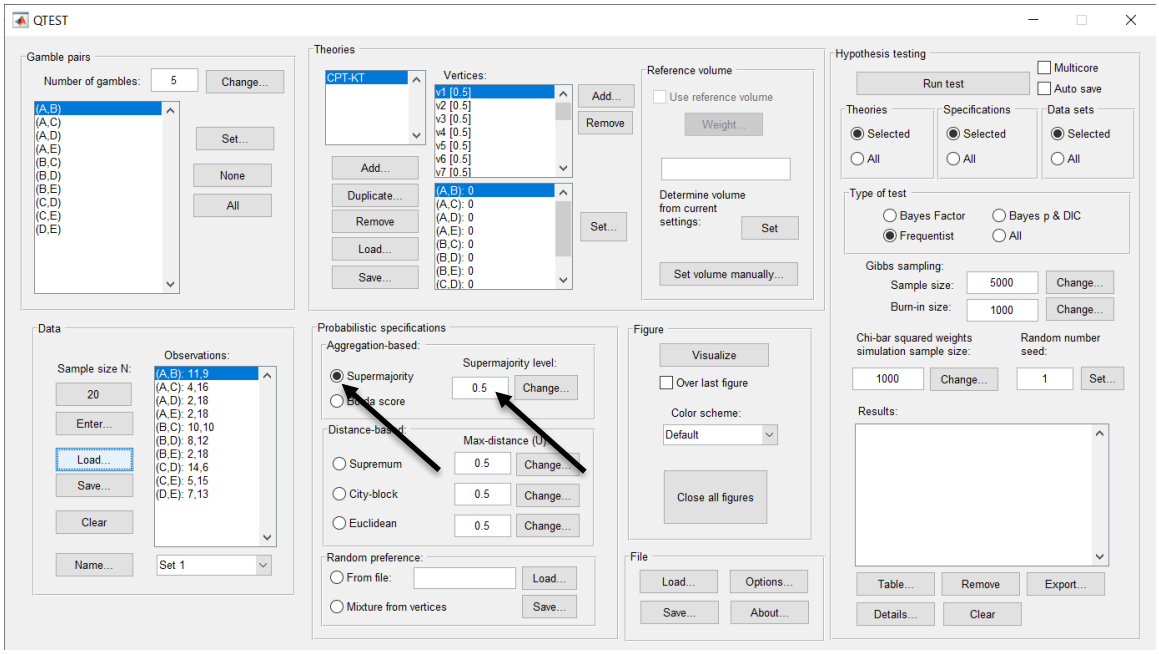
Under “Data” notice the “Observations:” list has now been populated:



Under “Data”, select the dropdown menu next to “Name…” to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

L.2.3 Probabilistic specification: Cash I, *CPT-KT*, 0.50-Majority/modal choice

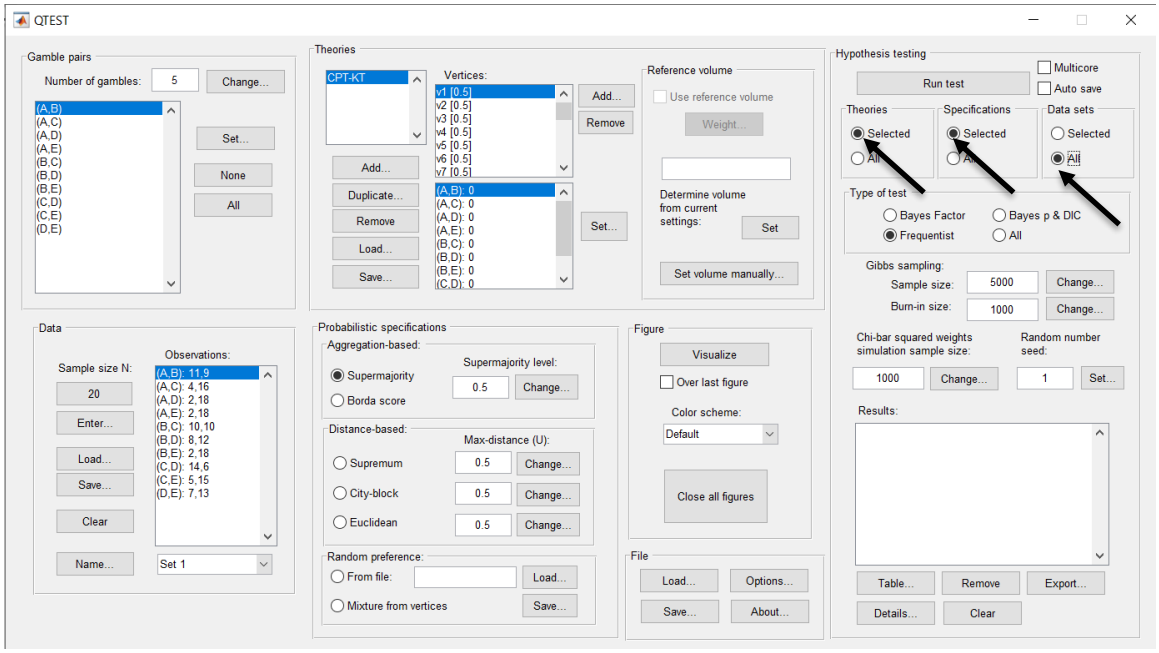
To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected and that the “Supermajority level:” is set to “0.5”.



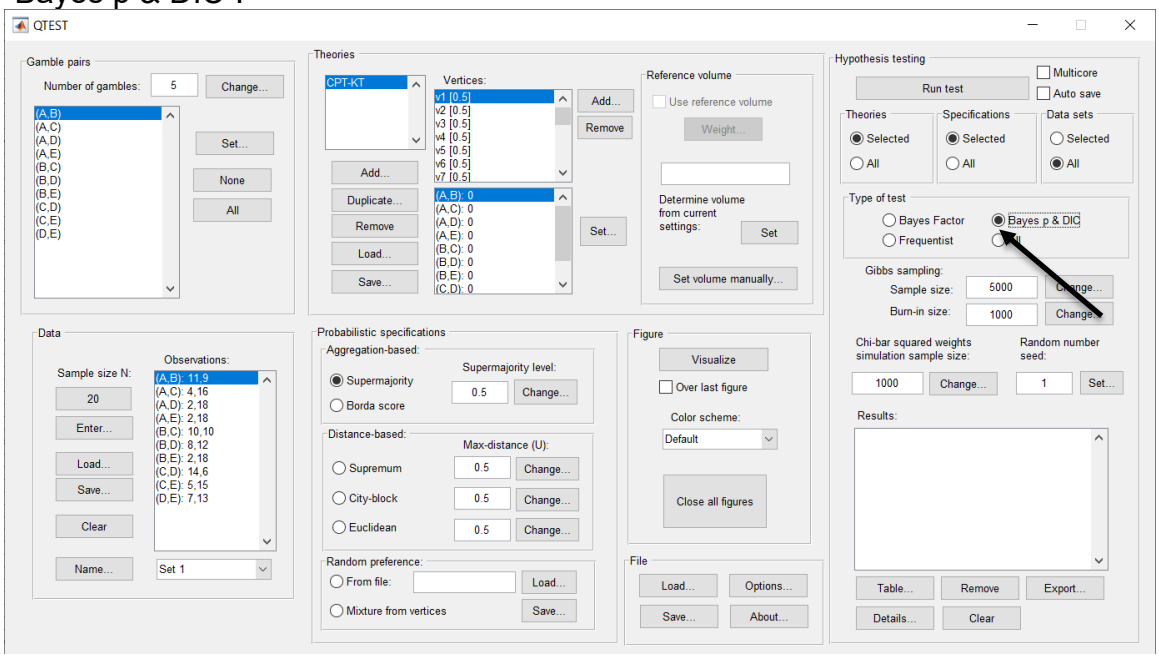
L.2.4 Hypothesis Testing: Cash I, $\mathcal{CPT}$-$\mathcal{KT}$, 0.50-Majority/modal choice

We are now ready for the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{KT}$ .50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under “Hypothesis testing”, under the “Run test” button, there are 3 columns: “Theories”, “Specifications” and “Data sets”. For each of these, the user must choose the radio button next to either “Selected” or “All”. For more information on these settings, as well as the inputs for “Chi-bar squared weights simulation sample size:” and “Random number seed:”, see section G.5.

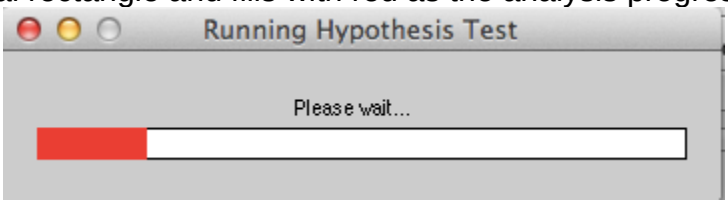
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



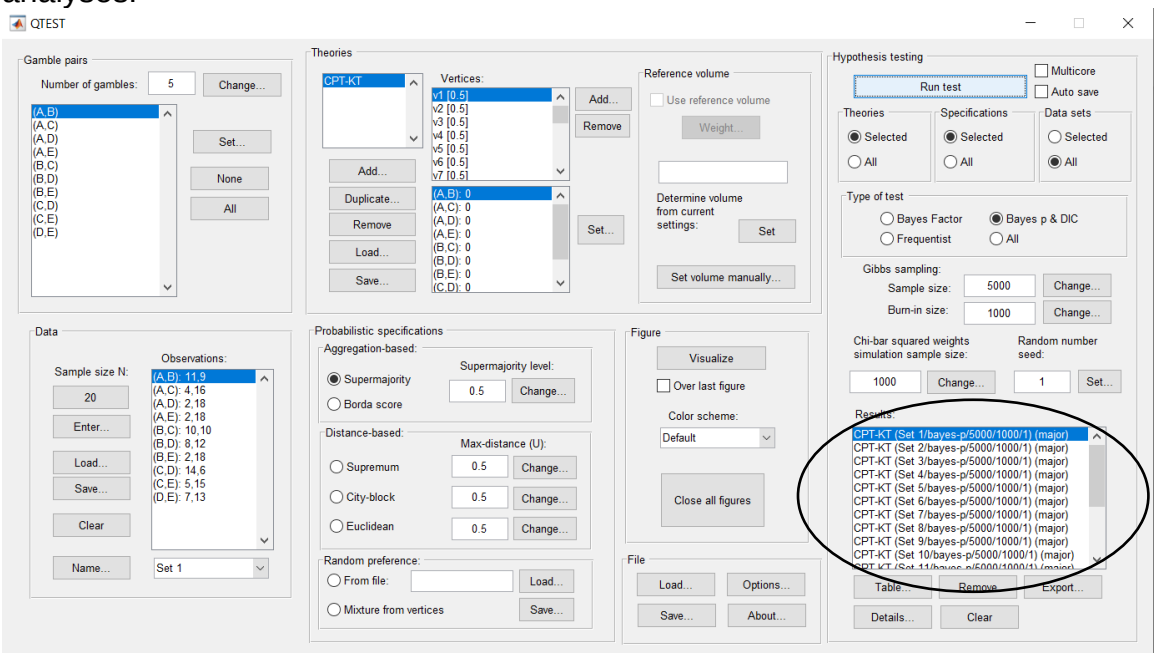
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes p & DIC”.



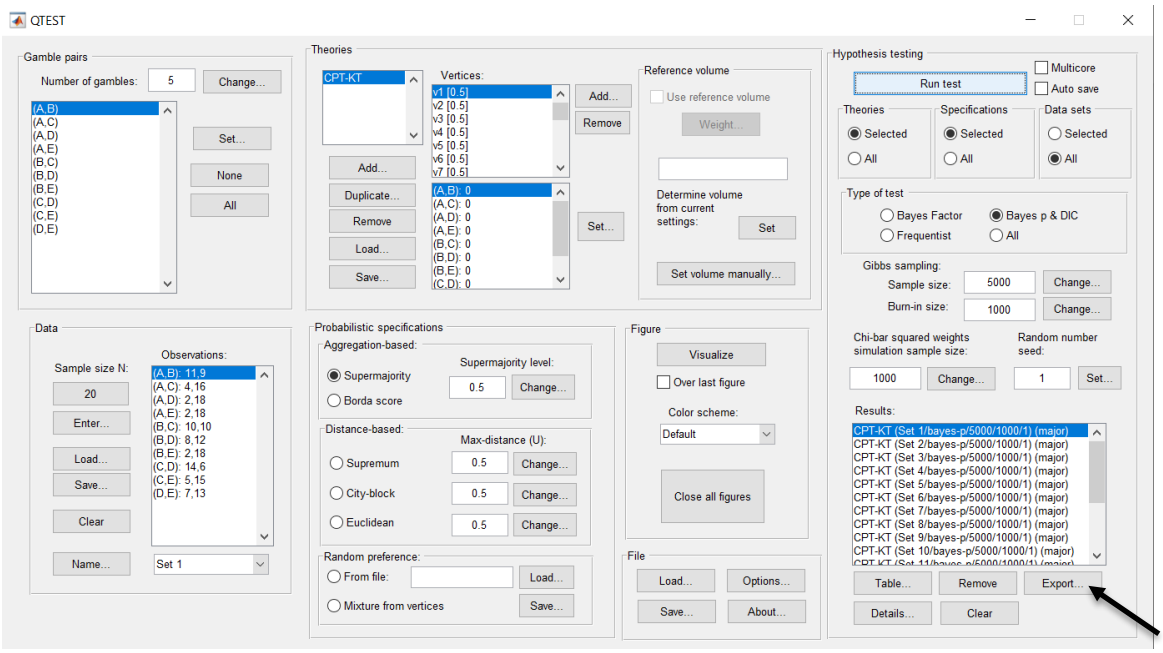
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



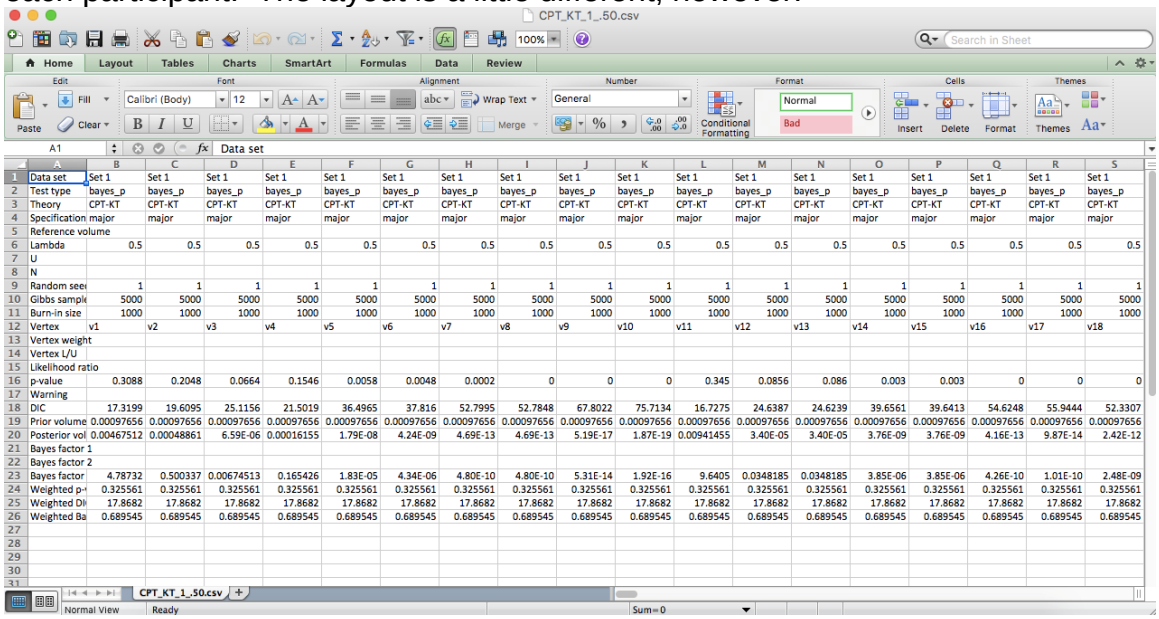
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory. Therefore, under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file. For more information on other ways a user can view the results, see section G.5.


QTEST
Gamble pairs
Number of gambles:
5
Change...
(A,B)
(A,C)
(A,D)
(A,E)
(B,C)
(B,D)
(B,E)
(C,D)
(C,E)
(D,E)
Set...
None
All
Theories
CPT-KT
Vertices:
v1 [0.5]
v2 [0.5]
v3 [0.5]
v4 [0.5]
v5 [0.5]
v6 [0.5]
v7 [0.5]
Add...
Remove
Add...
Duplicate...
Remove
Load...
Save...
(A,B): 0
(A,C): 0
(A,D): 0
(A,E): 0
(B,C): 0
(B,D): 0
(B,E): 0
(C,D): 0
Set...
Reference volume
Use reference volume
Weight...
Determine volume from current settings:
Set
Set volume manually...
Hypothesis testing
Run test
Multicore
Auto save
Theories
Selected
All
Specifications
Selected
All
Data sets
Selected
All
Type of test
Bayes Factor
Frequentist
Bayes p & DIC
All
Gibbs sampling:
Sample size:
5000
Change...
Burn-in size:
1000
Change...
Chi-bar squared weights simulation sample size:
1000
Change...
Random number seed:
1
Set...
Results:
CPT-KT (Set 1/bayes-p/5000/1000/1) (major)
CPT-KT (Set 2/bayes-p/5000/1000/1) (major)
CPT-KT (Set 3/bayes-p/5000/1000/1) (major)
CPT-KT (Set 4/bayes-p/5000/1000/1) (major)
CPT-KT (Set 5/bayes-p/5000/1000/1) (major)
CPT-KT (Set 6/bayes-p/5000/1000/1) (major)
CPT-KT (Set 7/bayes-p/5000/1000/1) (major)
CPT-KT (Set 8/bayes-p/5000/1000/1) (major)
CPT-KT (Set 9/bayes-p/5000/1000/1) (major)
CPT-KT (Set 10/bayes-p/5000/1000/1) (major)
Table...
Remove
Export...
Details...
Clear
Data
Sample size N:
20
Enter...
Load...
Save...
Clear
Name...
Observations:
(A,B): 11,9
(A,C): 4,16
(A,D): 2,18
(A,E): 2,18
(B,C): 10,10
(B,D): 8,12
(B,E): 2,18
(C,D): 14,6
(C,E): 5,15
(D,E): 7,13
Set 1
Probabilistic specifications
Aggregation-based:
Supermajority
Borda score
Supermajority level:
0.5
Change...
Distance-based:
Max-distance (U):
Supremum
City-block
Euclidean
0.5
Change...
Random preference:
From file:
Load...
Mixture from vertices
Save...
Figure
Visualize
Over last figure
Color scheme:
Default
Close all figures
File
Load...
Options...
Save...
About...

The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “OG” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on. All the information in this spreadsheet is identical to what one would see if they selected “Details…” for each participant. The layout is a little different, however.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT
4	Specification	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference volume																		
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																		
8	N																		
9	Random see	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sampl	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14	v15	v16	v17	v18
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value	0.3088	0.2048	0.0664	0.1546	0.0058	0.0048	0.0002	0	0	0	0.345	0.0856	0.086	0.003	0.003	0	0	0
17	Warning																		
18	DIC	17.3199	19.6095	25.1156	21.5019	36.4965	37.816	52.7995	52.7848	67.8022	75.7134	16.7275	24.6387	24.6239	39.6561	39.6413	54.6248	55.9444	52.3307
19	Prior volume	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656
20	Posterior vol	0.00467512	0.00048861	6.59E-06	0.00016155	1.79E-08	4.24E-09	4.69E-13	4.69E-13	5.19E-17	1.87E-19	0.00941455	3.40E-05	3.40E-05	3.76E-09	3.76E-09	4.16E-13	9.87E-14	2.42E-12
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor	4.78732	0.500337	0.00674513	0.165426	1.83E-05	4.34E-06	4.80E-10	4.80E-10	5.31E-14	1.92E-16	9.6405	0.0348185	0.0348185	3.85E-06	3.85E-06	4.26E-10	1.01E-10	2.48E-09
24	Weighted p-	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561
25	Weighted DI	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682
26	Weighted Ba	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545
27																			
28																			
29																			
30																			
31																			

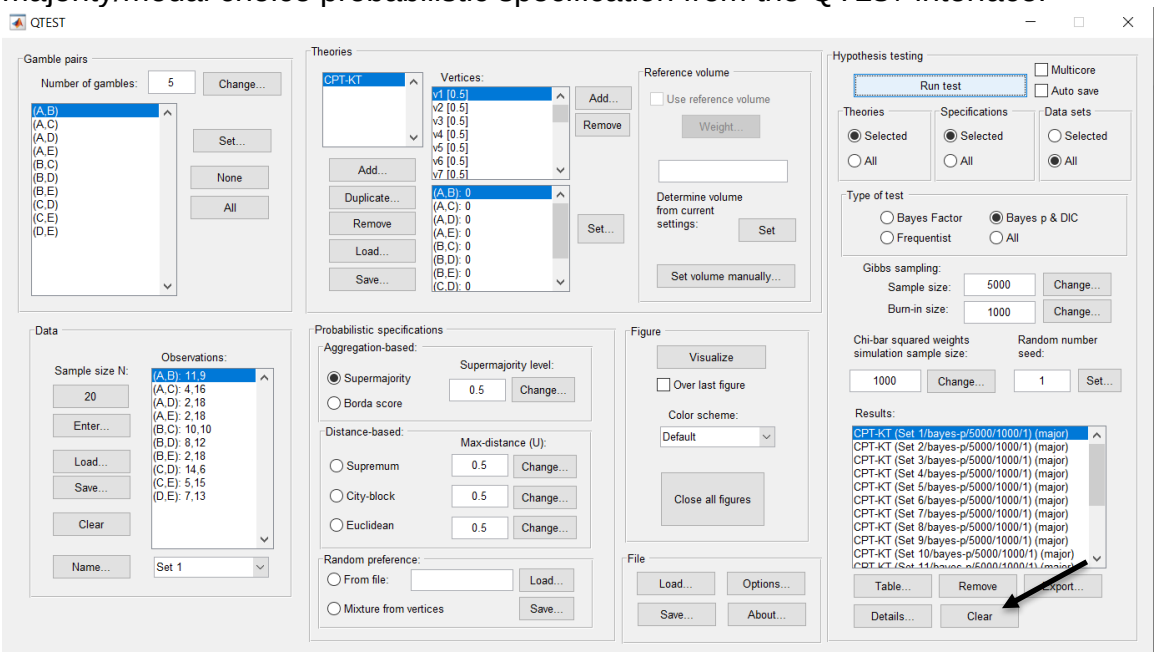
The weighted p-values are in row 24 of the spreadsheet. Notice the same p-value repeats for all the columns “B” through “W” listed as “Set 1”—this is the Bayes p value for participant 1, listed under “0.50 Majority Choice” and “KT” in Table 1 of QTBC2. Notice the same holds true for all the columns “X” through “AS” listed as “Set 2”, for participant 2, and so on. From this file, column “KT” under “0.50 Majority Choice” of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

The weighted DIC values are in row 25 of the spreadsheet. Again, notice the same DIC value repeats for all the columns “B” through “W” listed as “Set 1”—this is the DIC value for participant 1, listed under “0.50 Majority Choice” and “KT” in Table 2 of QTBC2. Notice the same holds true for all the columns “X” through “AS” listed as “Set 2”, for participant 2, and so on. From this file, column “KT” under “0.50 Majority Choice” of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

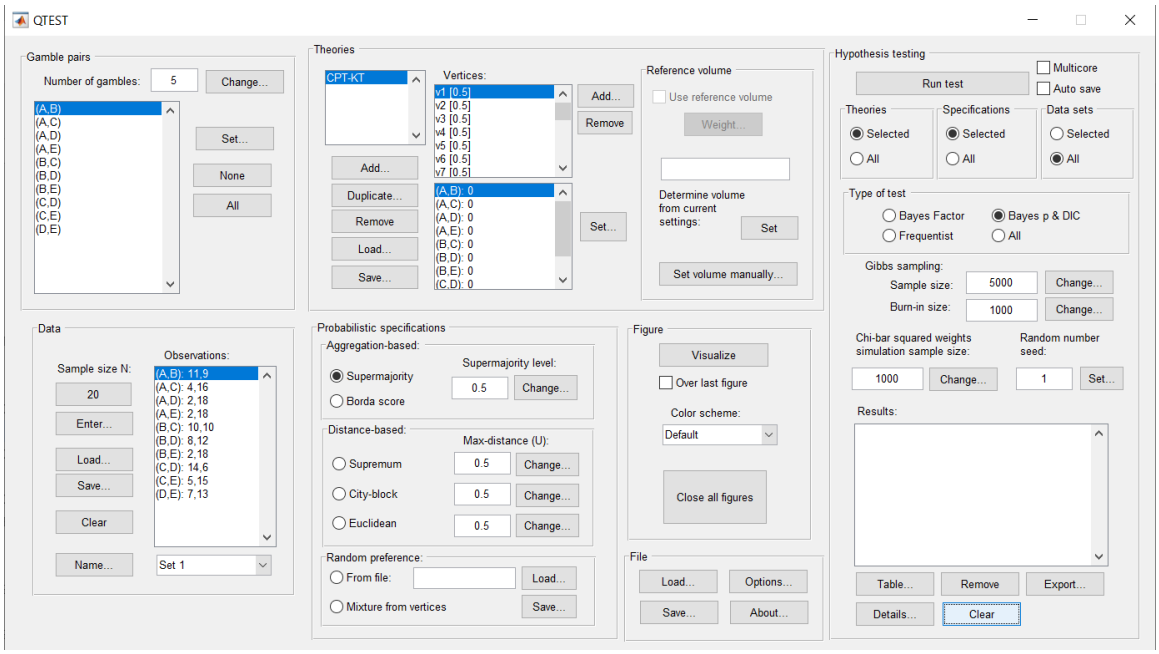
This completes the analysis for Cash I data for the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{KT}$ .50-majority/modal choice probabilistic specification. We will, again, demonstrate the analysis for the Cash I data for the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{KT}$, but now with a .90-supermajority probabilistic specification in the following two sections, L.2.5 and L.2.6.

L.2.5 Probabilistic specification: Cash I, $\mathcal{CPT}$-$\mathcal{KT}$, 0.90-Supermajority

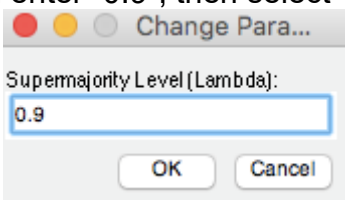
If continuing from section L.2.4, select “Clear” under “Hypothesis testing” and “Results:”. This step clears the results of the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{KT}$ .50-majority/modal choice probabilistic specification from the QTEST interface.



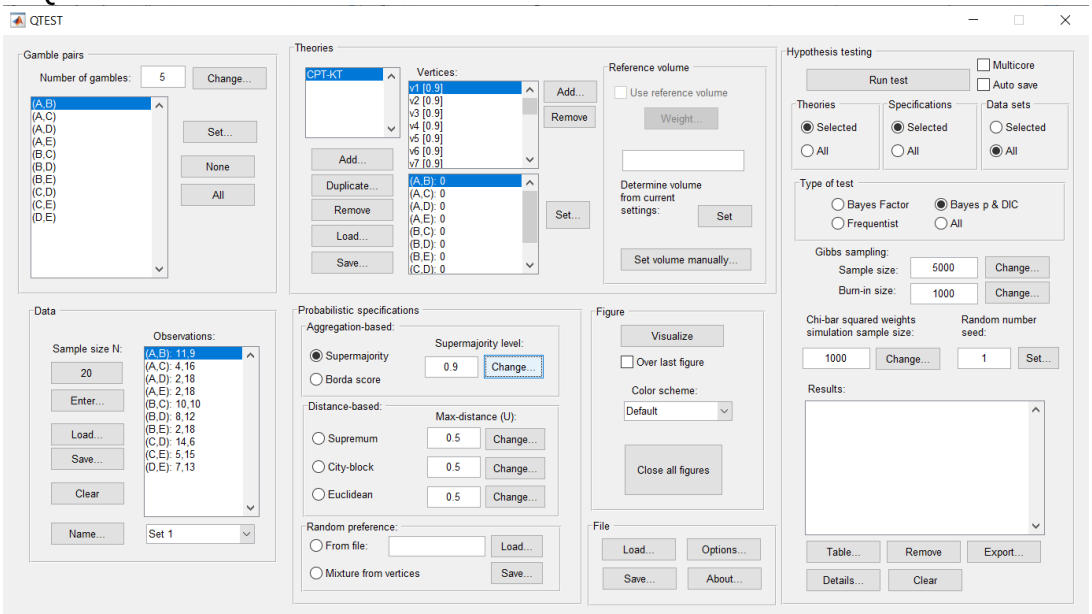
Whether the user is continuing from section L.2.2 or L.2.4, the QTEST interface should match the screenshot below.



To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected. To set the “Supermajority level:” to “0.9”, select “Change…” and enter “0.9”, then select “OK.”



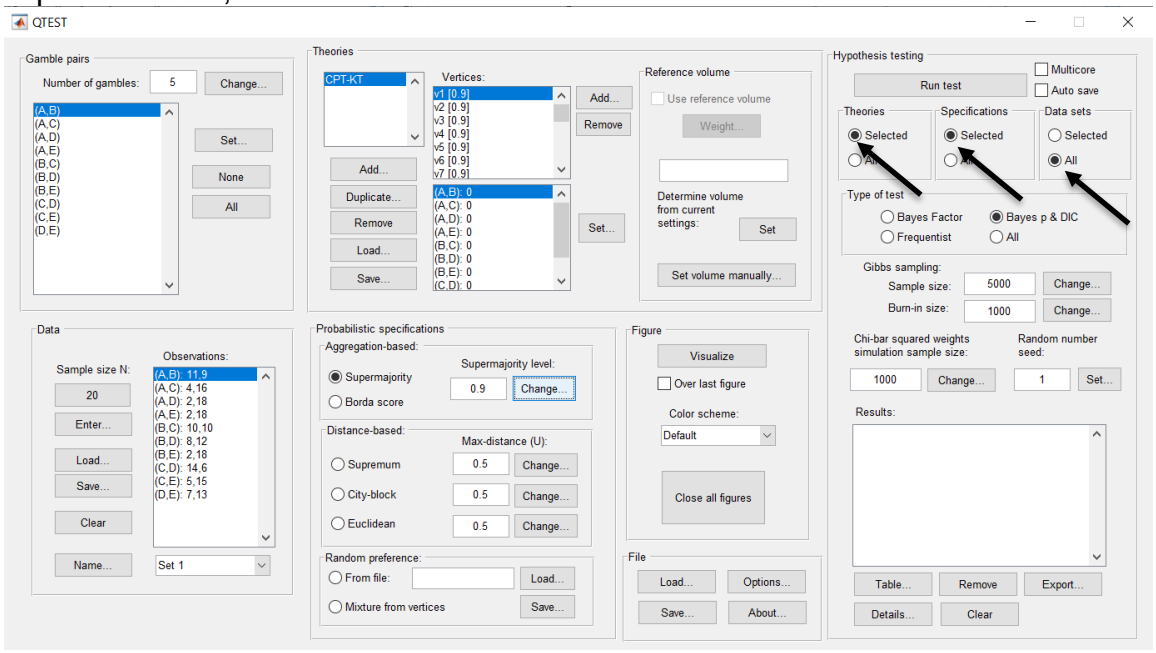
The QTEST interface should now match the screenshot below.



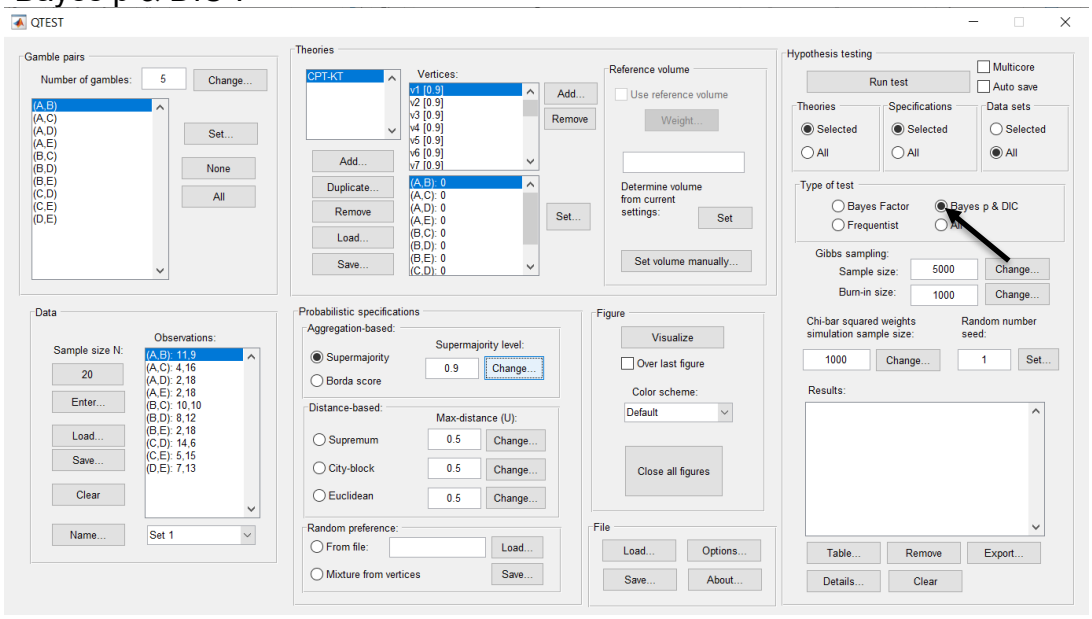
L.2.6 Hypothesis Testing: Cash I, *CPT-KT*, 0.90-Supermajority

We are now ready for the Bayes p & DIC test of *CPT-KT* .90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

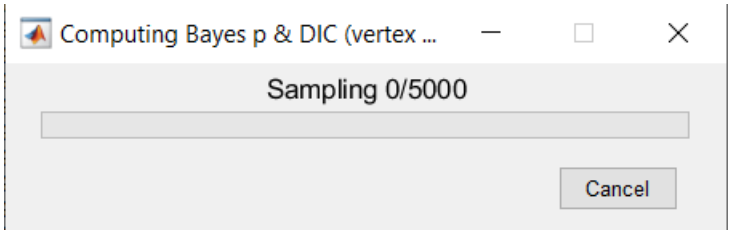
Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".



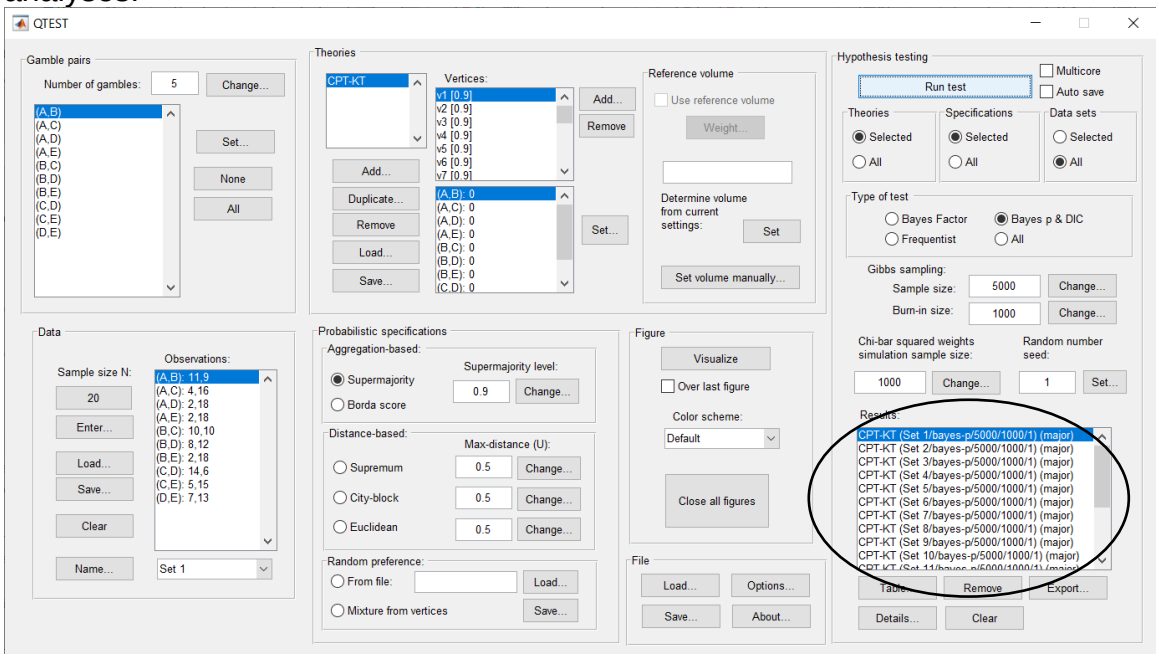
Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes p & DIC".



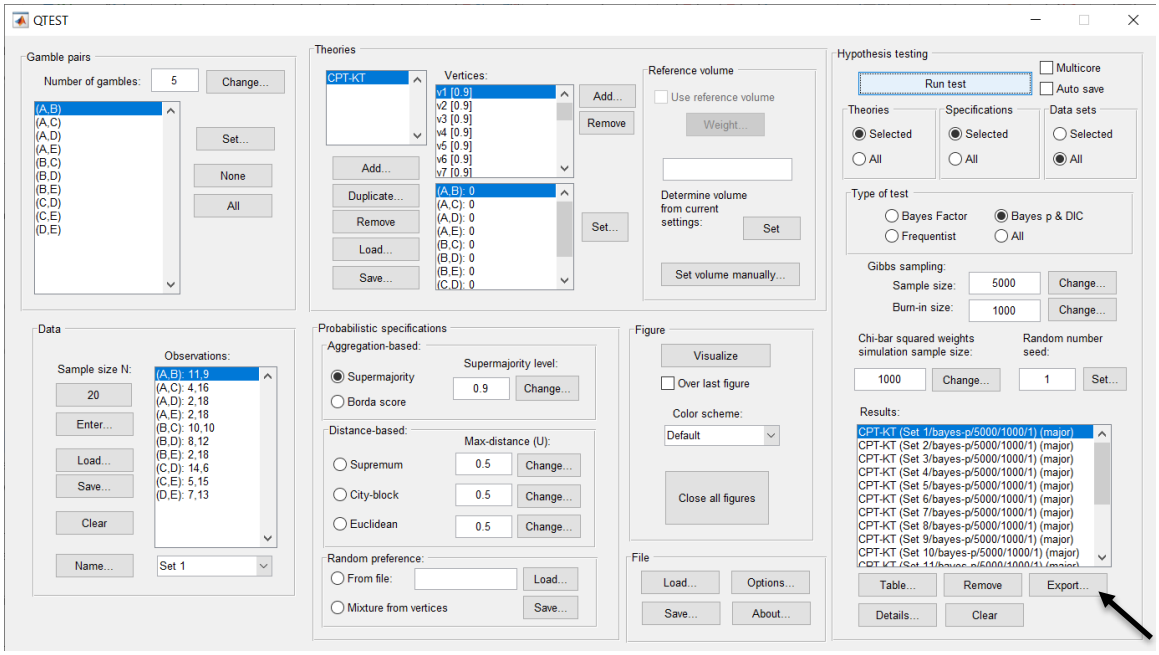
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with green as each analysis progresses.



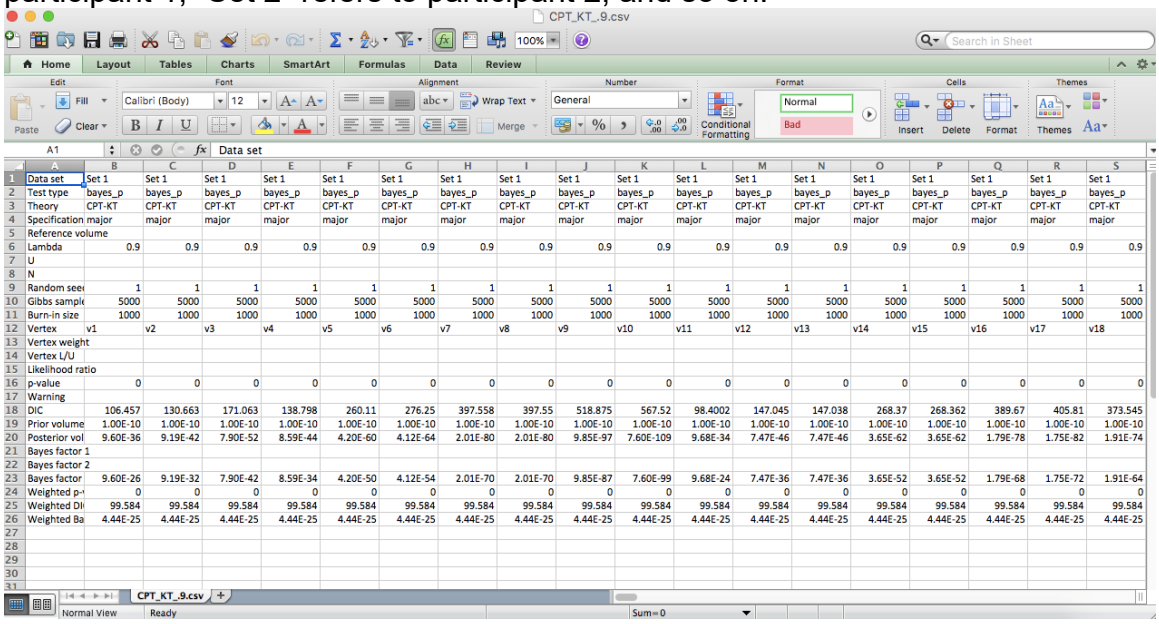
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “OG” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



The weighted p-values are in row 24 of the spreadsheet. Notice the same p-value repeats for all the columns “B” through “W” listed as “Set 1”—this is the Bayes p value for participant 1, listed under “0.90 Supermajority” and “KT” in Table 1 of QTBC2. Notice the same holds true for all the columns “X” through “AS” listed as “Set 2”, for participant 2, and so on. From this file, column “KT” under “0.90 Supermajority” of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

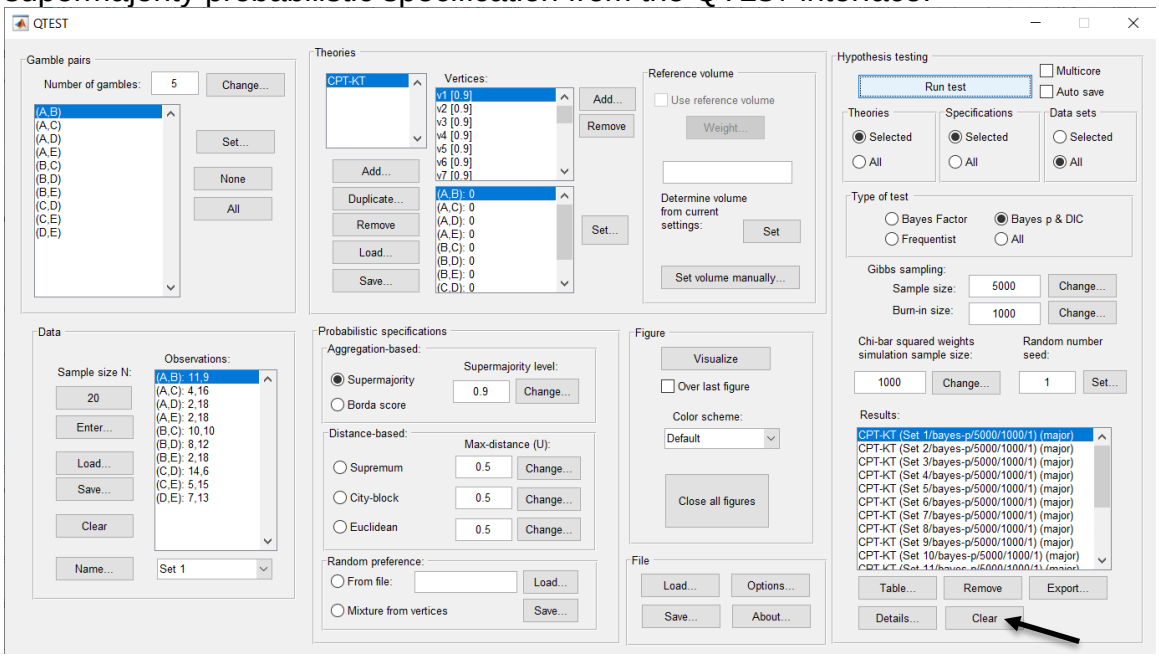
The weighted DIC values are in row 25 of the spreadsheet. Again, notice the same DIC value repeats for all the columns “B” through “W” listed as “Set 1”—this is the DIC value for participant 1, listed under “0.90 Supermajority” and “KT” in Table 2 of QTBC2. Notice the same holds true for all the columns “X” through “AS” listed as “Set 2”, for participant 2, and so on. From this file, column “KT” under “0.90 Supermajority” of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

This completes the analysis for Cash I data for the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{KT}$ .90-supermajority probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{KT}$, but now with

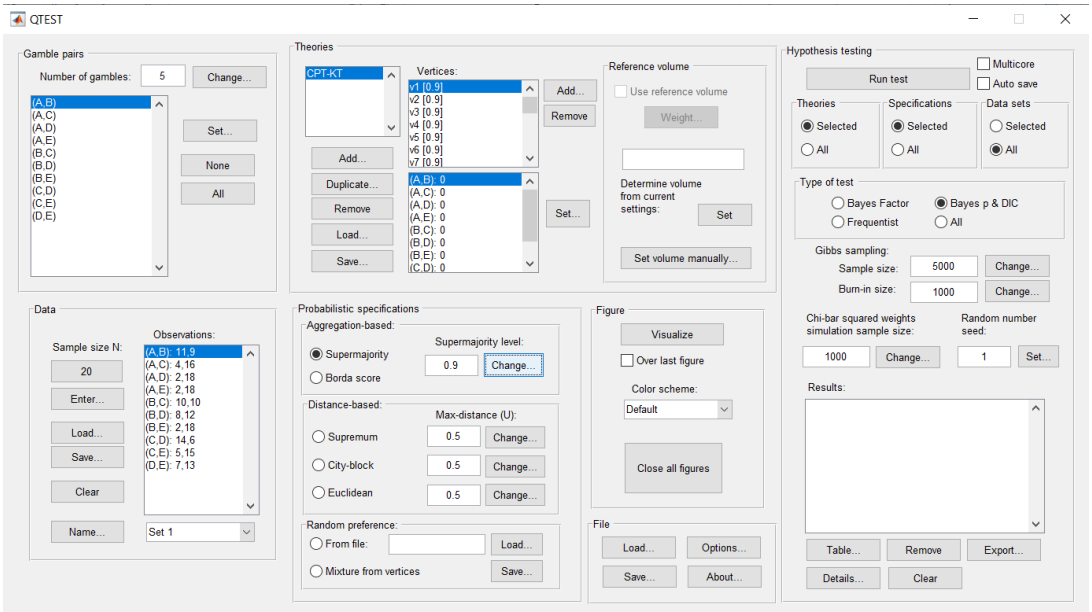
a random preference probabilistic specification in the following two sections, L.2.7 and L.2.8.

L.2.7 Probabilistic specification: Cash I, *CPT-KT*, Random Preference

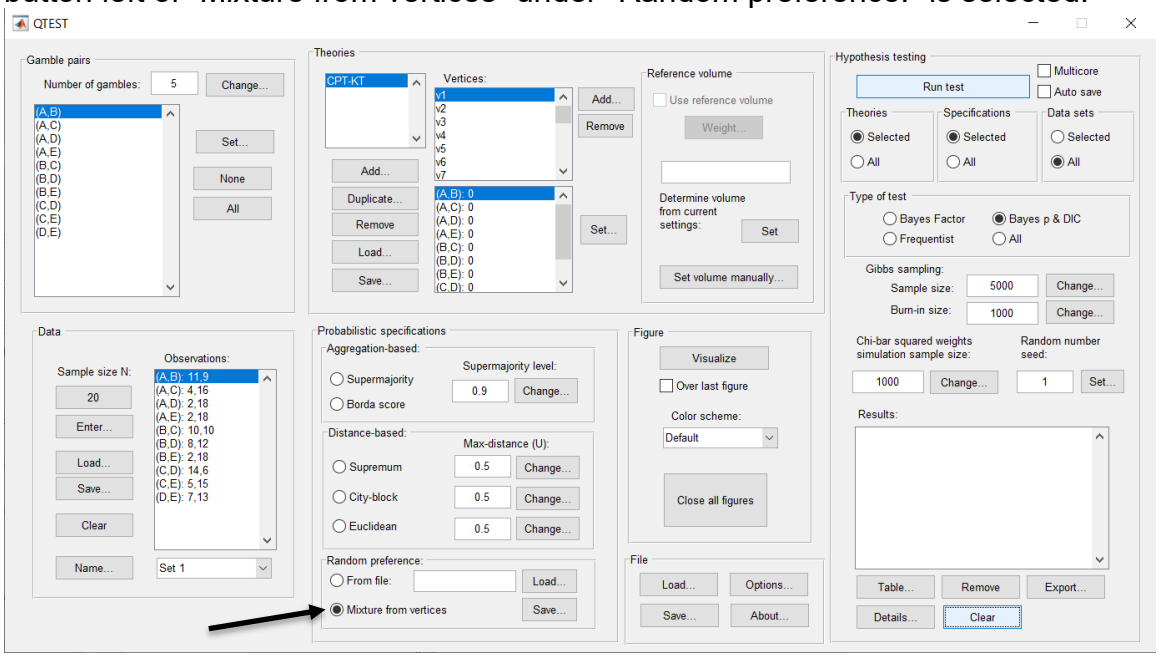
If continuing from section L.2.6, click “Clear” under “Hypothesis testing” and “Results:”. This step clears the results of the Bayes p & DIC test of *CPT-KT* .90-supermajority probabilistic specification from the QTEST interface.



Whether the user is continuing from section L.2.2 or L.2.6, the QTEST interface should match the screenshot below.



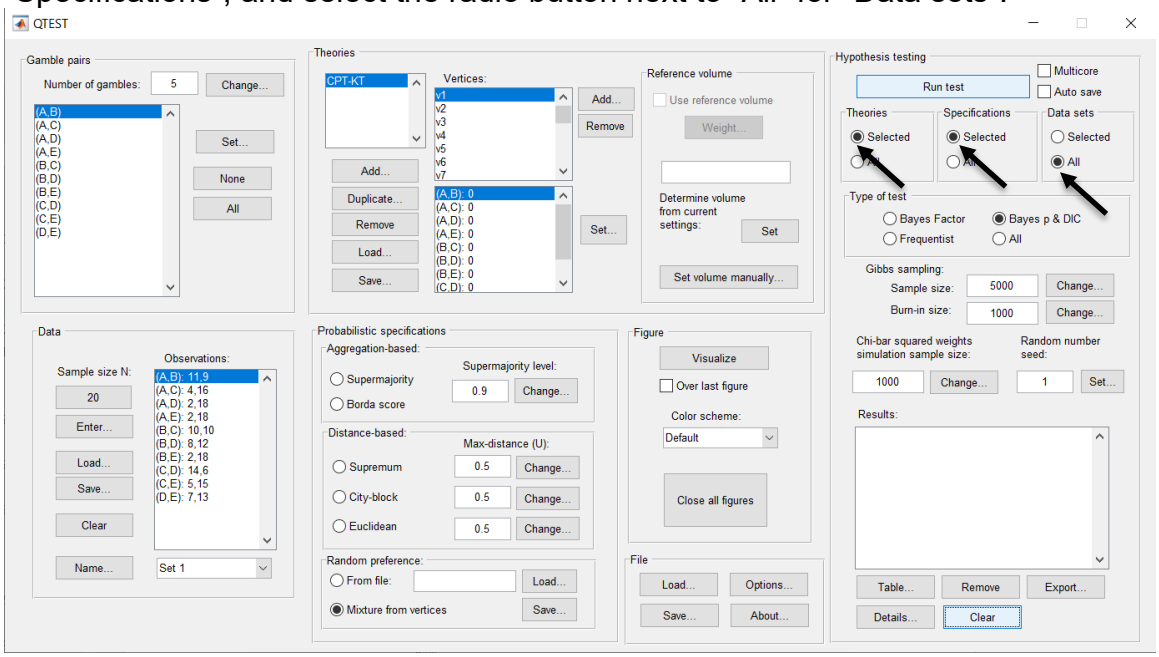
To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Mixture from vertices” under “Random preference:” is selected.



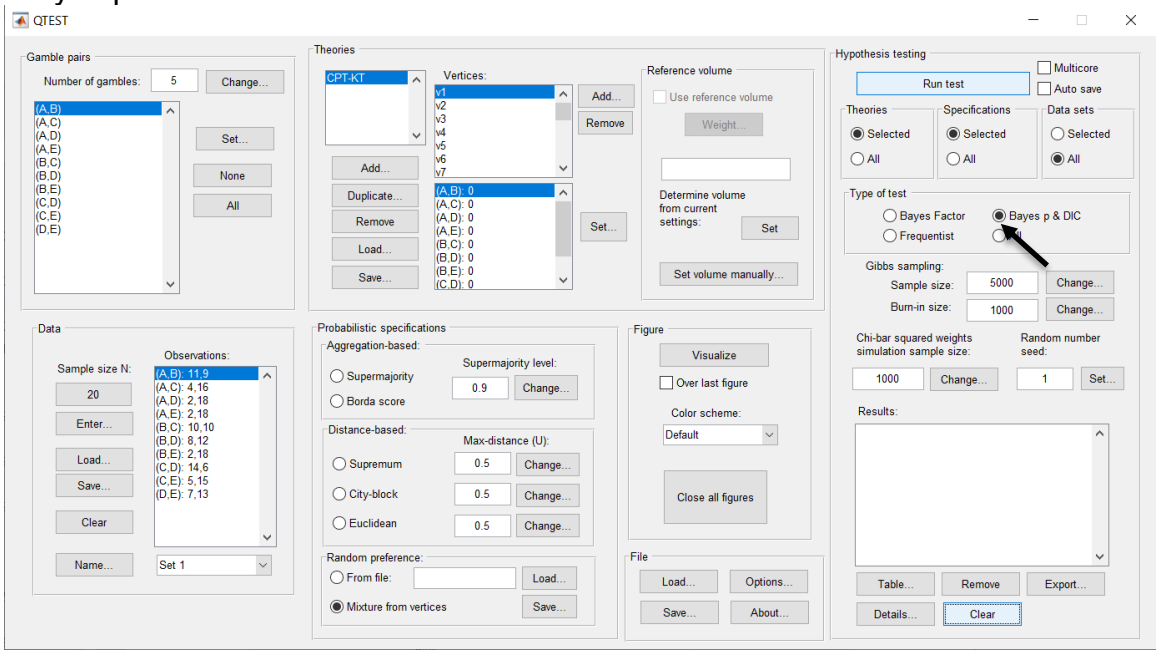
L.2.8 Hypothesis Testing: Cash I, *CPT-KT*, Random Preference

We are now ready for the Bayes p & DIC test of *CPT-KT* random preference probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

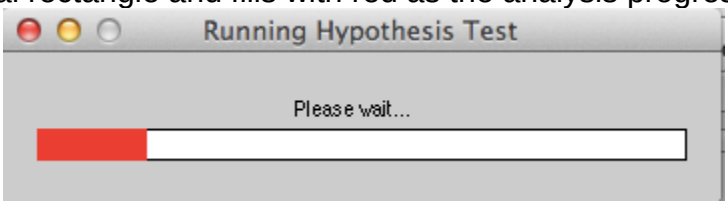
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



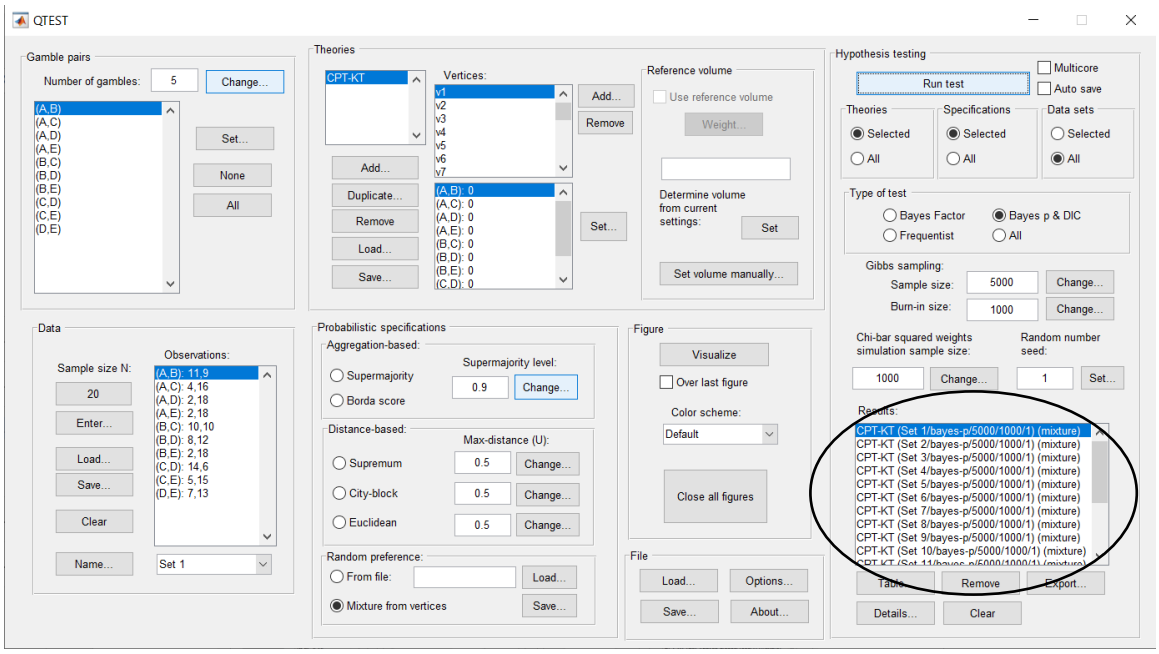
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes p & DIC”.



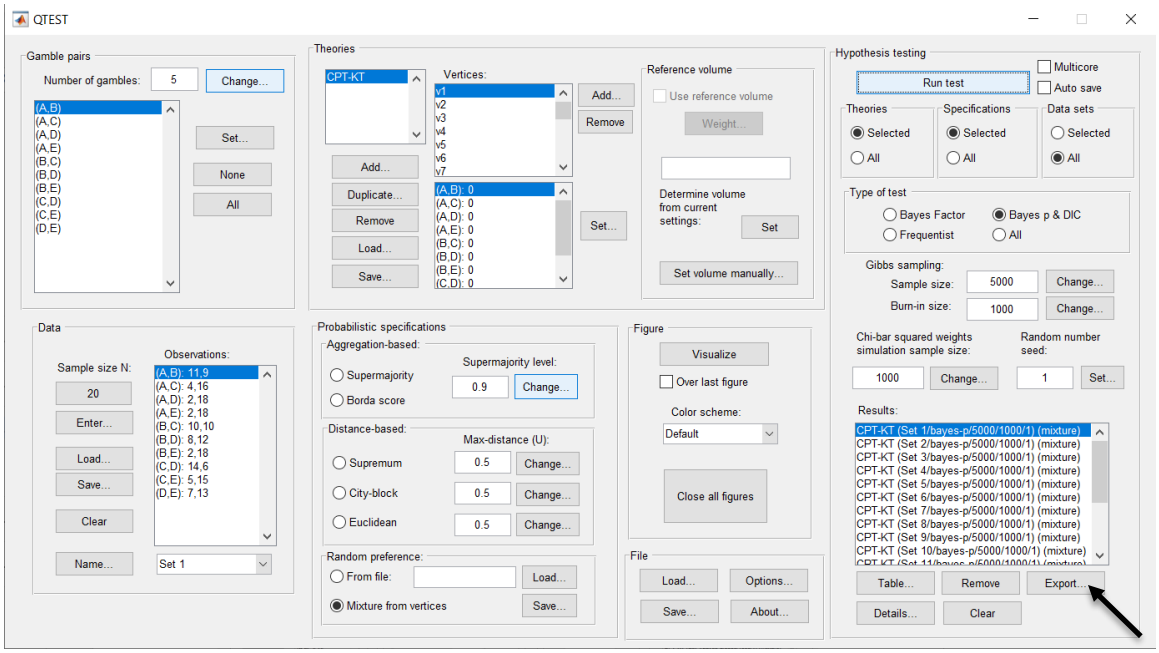
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



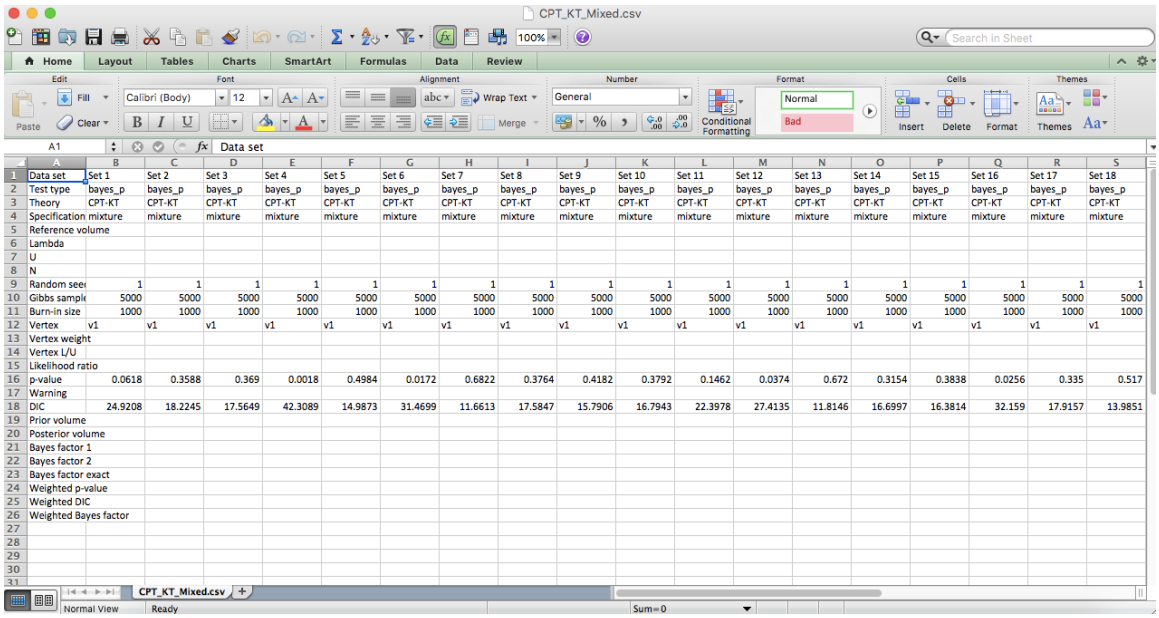
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “S” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT
4	Specification	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture
5	Reference volume																		
6	Lambda																		
7	U																		
8	N																		
9	Random see	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sampl	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value	0.0618	0.3588	0.369	0.0018	0.4984	0.0172	0.6822	0.3764	0.4182	0.3792	0.1462	0.0374	0.672	0.3154	0.3838	0.0256	0.335	0.517
17	Warning																		
18	DIC	24.9208	18.2245	17.5649	42.3089	14.9873	31.4699	11.6613	17.5847	15.7906	16.7943	22.3978	27.4135	11.8146	16.6997	16.3814	32.159	17.9157	13.9851
19	Prior volume																		
20	Posterior volume																		
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor exact																		
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Bayes factor																		
27																			
28																			
29																			
30																			
31																			

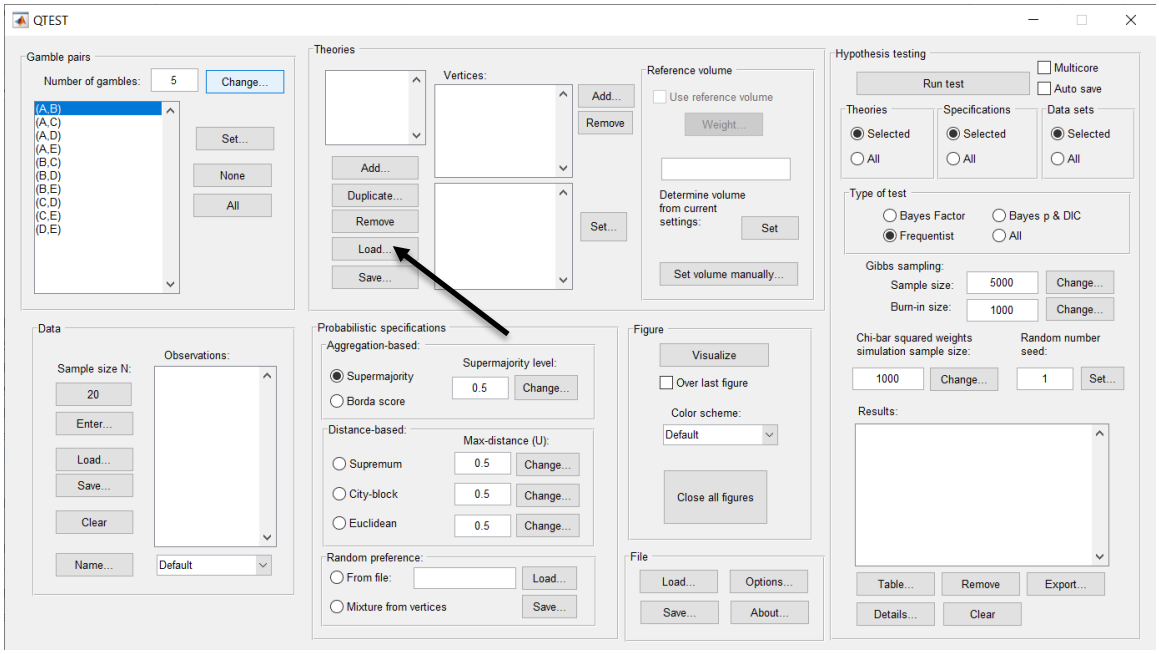
The p-values are in row 16 of the spreadsheet. The p-value in column “B” listed as “Set 1” is the Bayes p value for participant 1, listed under “Mixture” and “KT” in Table 1 of QTBC2. Notice the same holds true for the column “C” listed as “Set 2”, for participant 2, and so on. From this file, column “KT” under “Mixture” of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

The DIC values are in row 18 of the spreadsheet. Again, the DIC value in column “B” listed as “Set 1” is the DIC value for participant 1, listed under “Mixture” and “KT” in Table 2 of QTBC2. Notice the same holds true for the column “C” listed as “Set 2”, for participant 2, and so on. From this file, column “KT” under “Mixture” of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

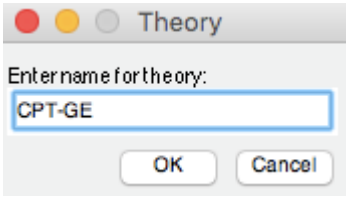
This completes the analysis for Cash I data for the Bayes p & DIC test of *CPT-KT* random preference probabilistic specification.

L.3.1 Theory and Vertex: Cash I, *CPT-GE*

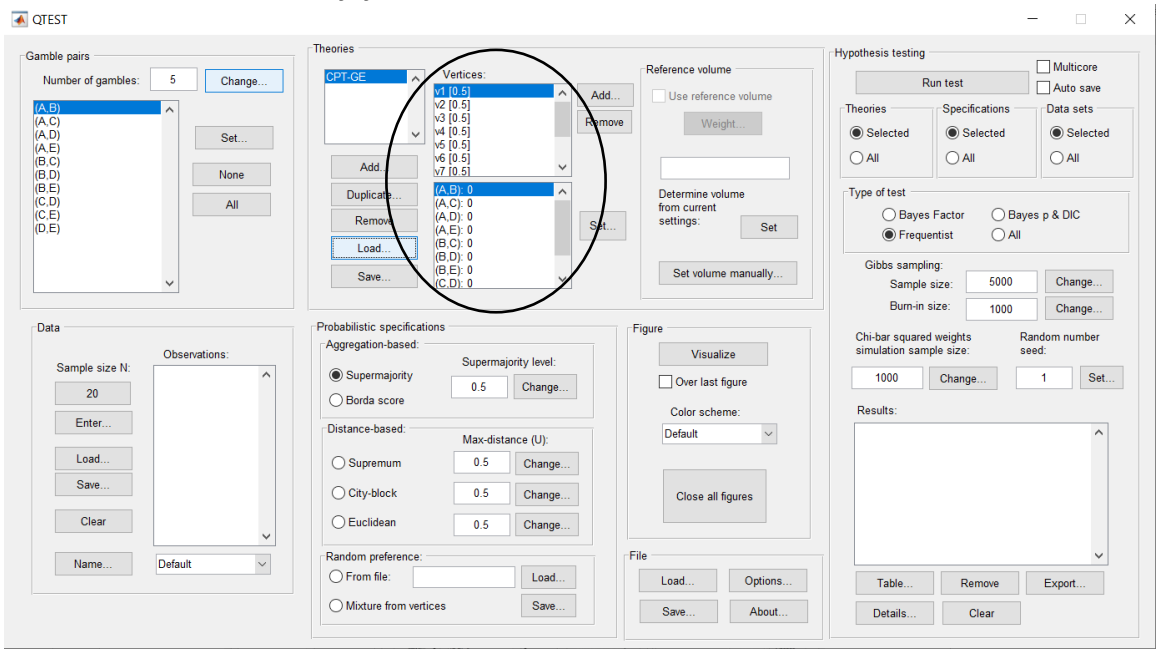
Under “Theories”, select “Load…”.



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “TheoriesVertices” folder and open “Vertices_CPT_GE_Cash1.csv”. In the dialog box, type “CPT-GE” and select “OK”.

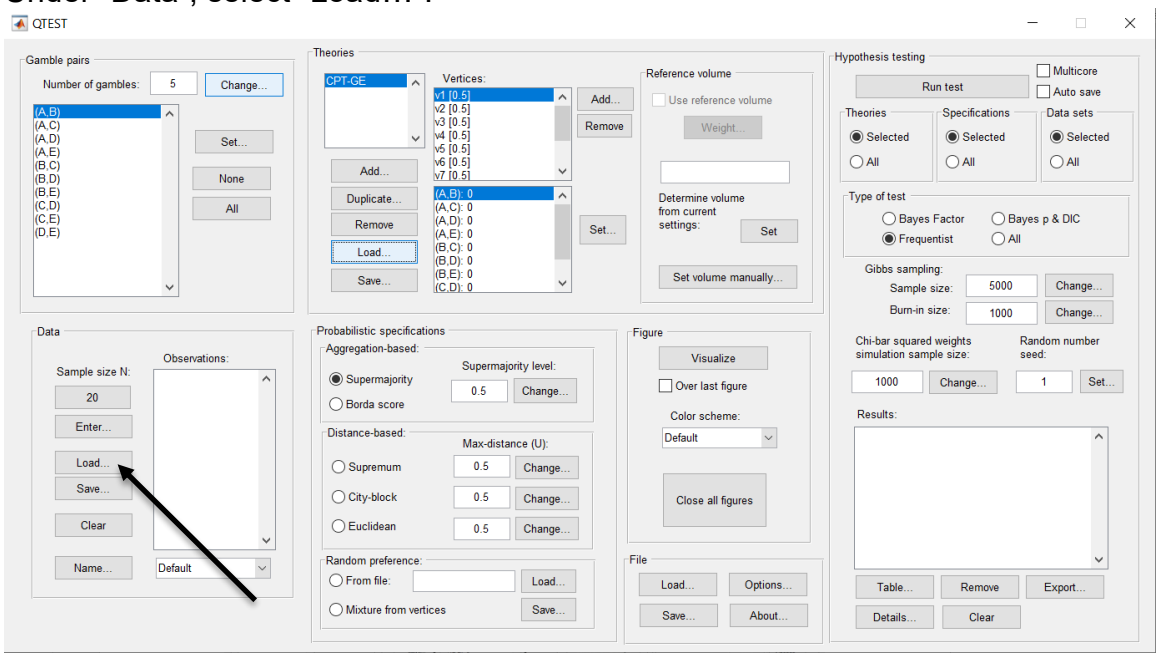


On the QTEST interface there should now be a list of 11 vertices for $\mathcal{CPT\text{-}GE}$ under “Theories”. Verify your screen matches the screenshot below.



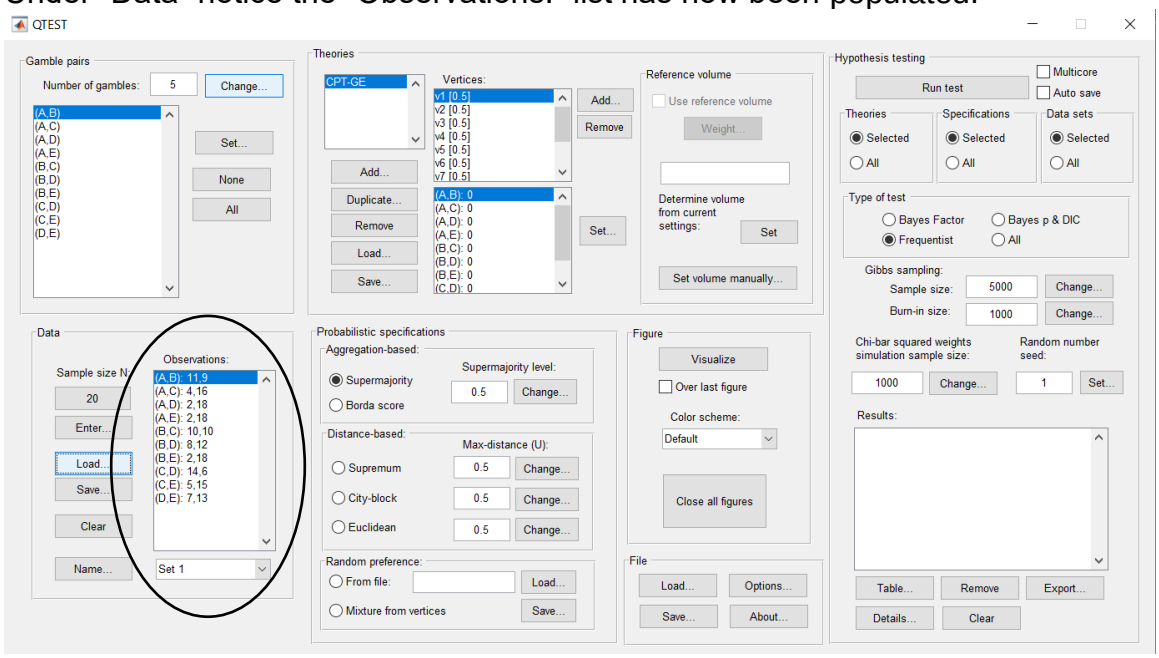
L.3.2 Data: Cash I, *CPT-GE*

Under “Data”, select “Load…”.



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “DataSets” folder and open “Cash1.txt”.

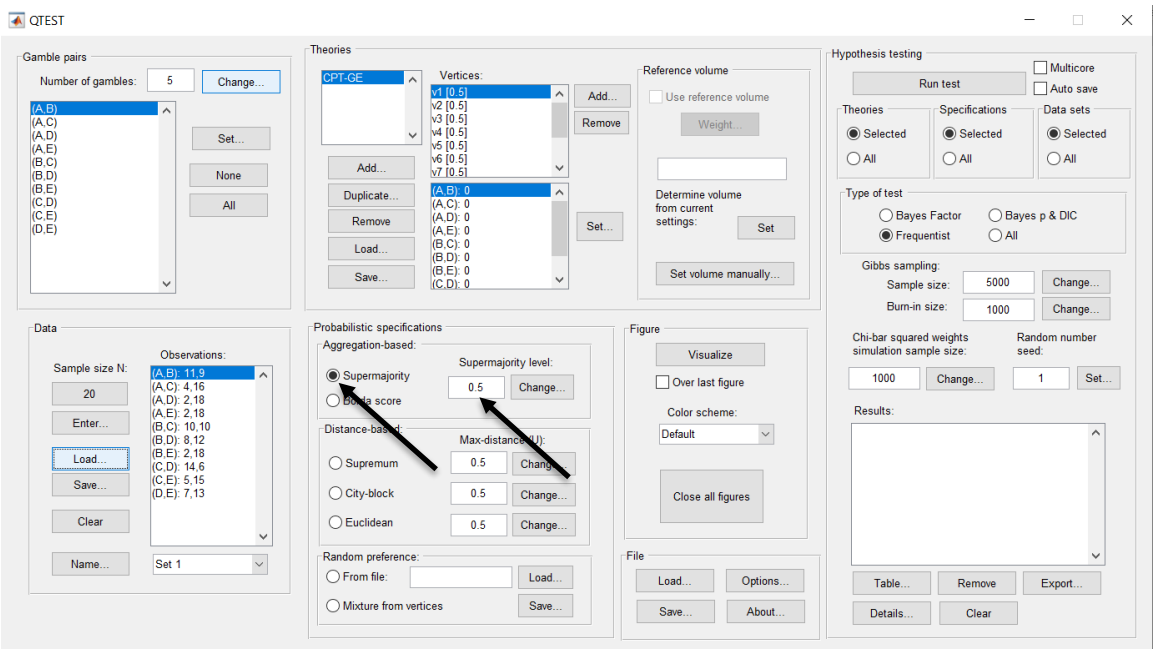
Under “Data” notice the “Observations:” list has now been populated:



Under “Data”, select the dropdown menu next to “Name…” to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

L.3.3 Probabilistic specification: Cash I, *CPT-GE*, 0.50-Majority/modal choice

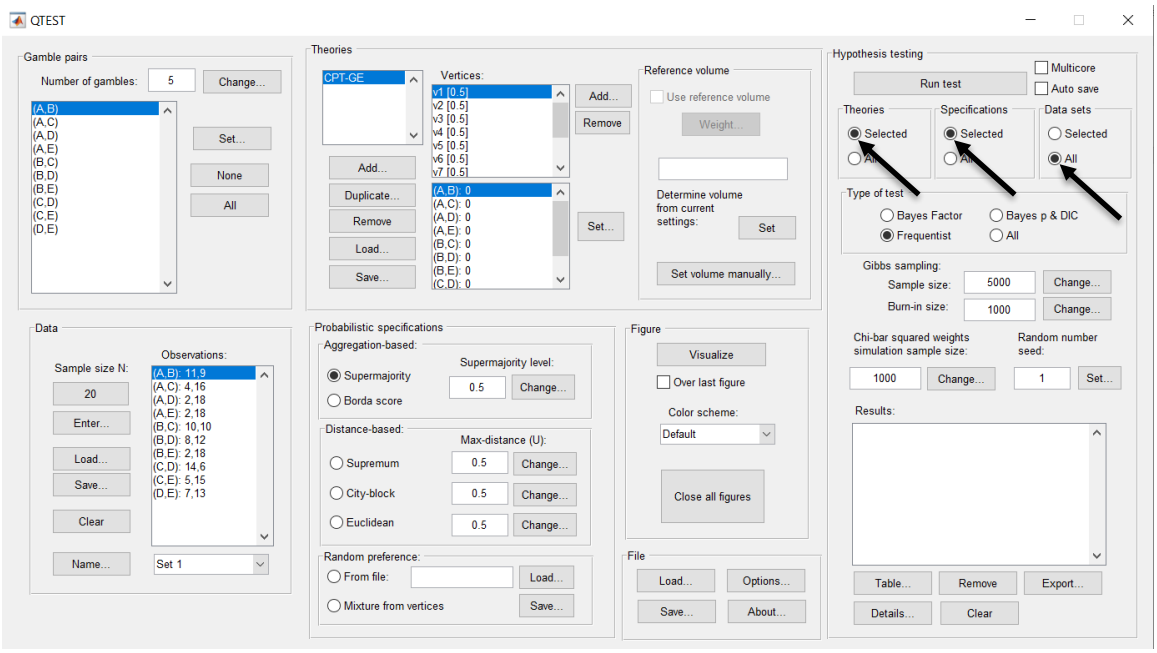
To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected and that the “Supermajority level:” is set to “0.5”.



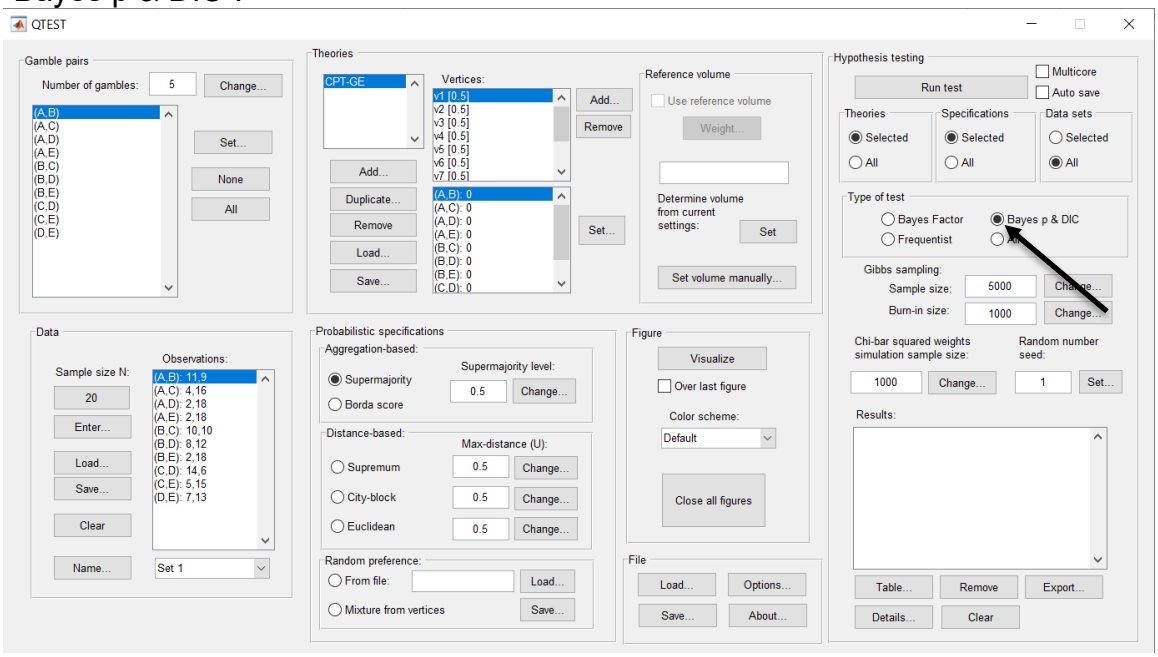
L.3.4 Hypothesis Testing: Cash I, *CPT-GE*, 0.50-Majority/modal choice

We are now ready for the Bayes p & DIC test of *CPT-GE* .50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under "Hypothesis testing", under the "Run test" button, there are 3 columns: "Theories", "Specifications" and "Data sets". For each of these, the user must choose the radio button next to either "Selected" or "All". For more information on these settings, as well as the inputs for "Chi-bar squared weights simulation sample size:" and "Random number seed:", see section G.5.

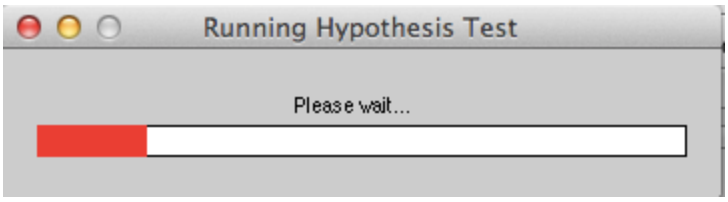
Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".



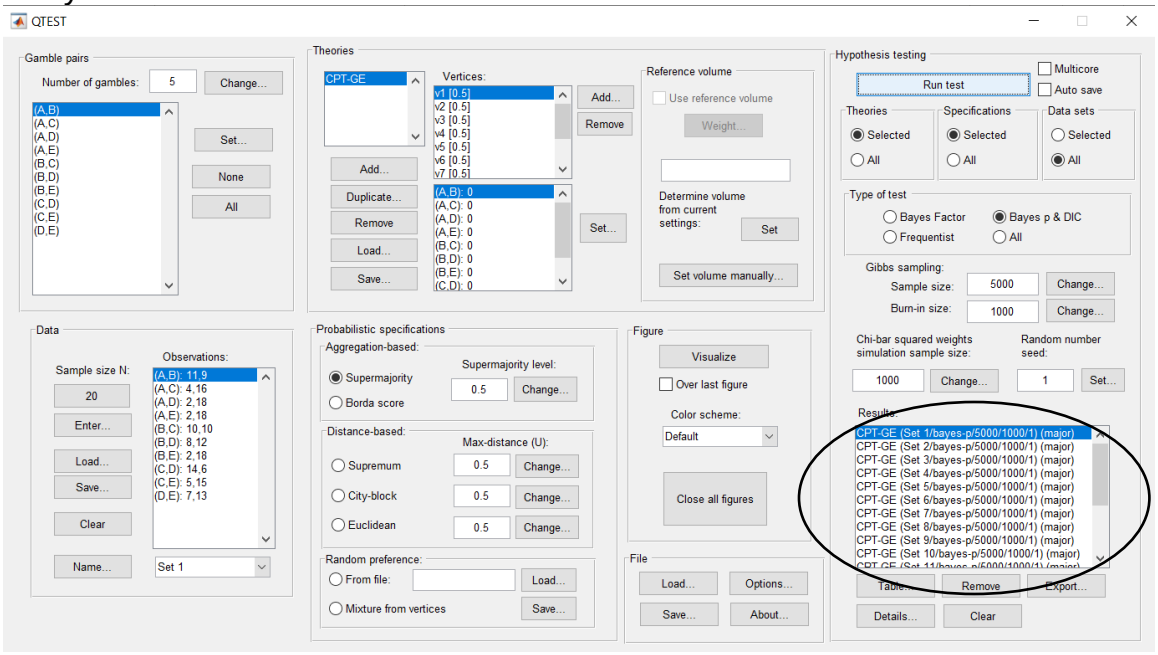
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes p & DIC”.



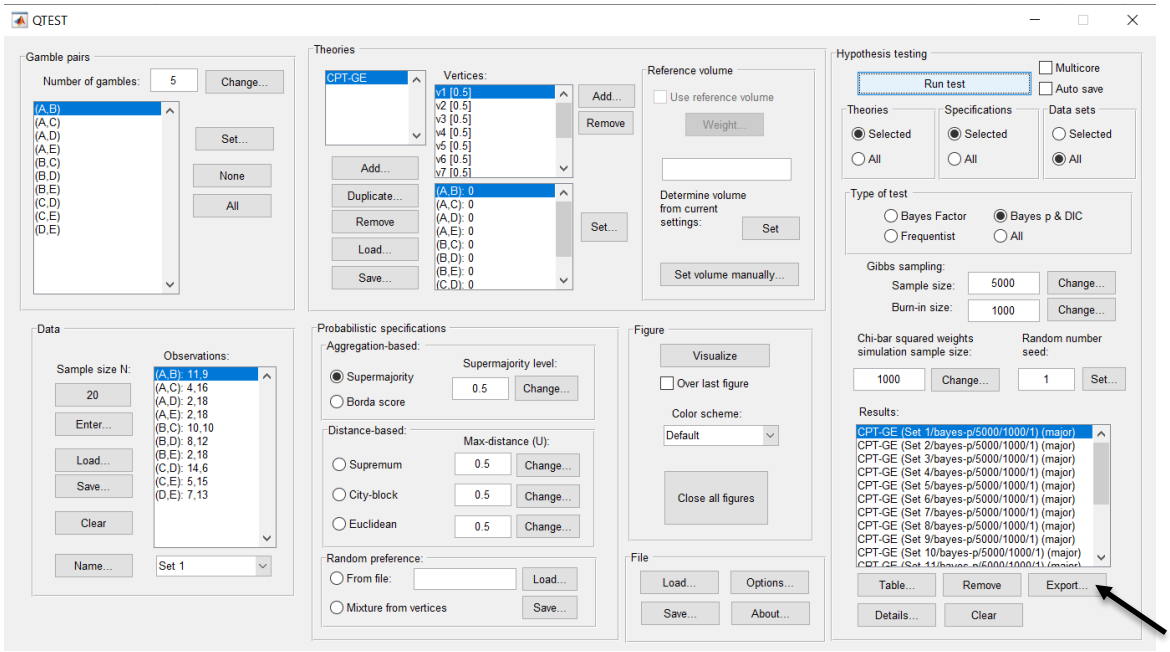
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



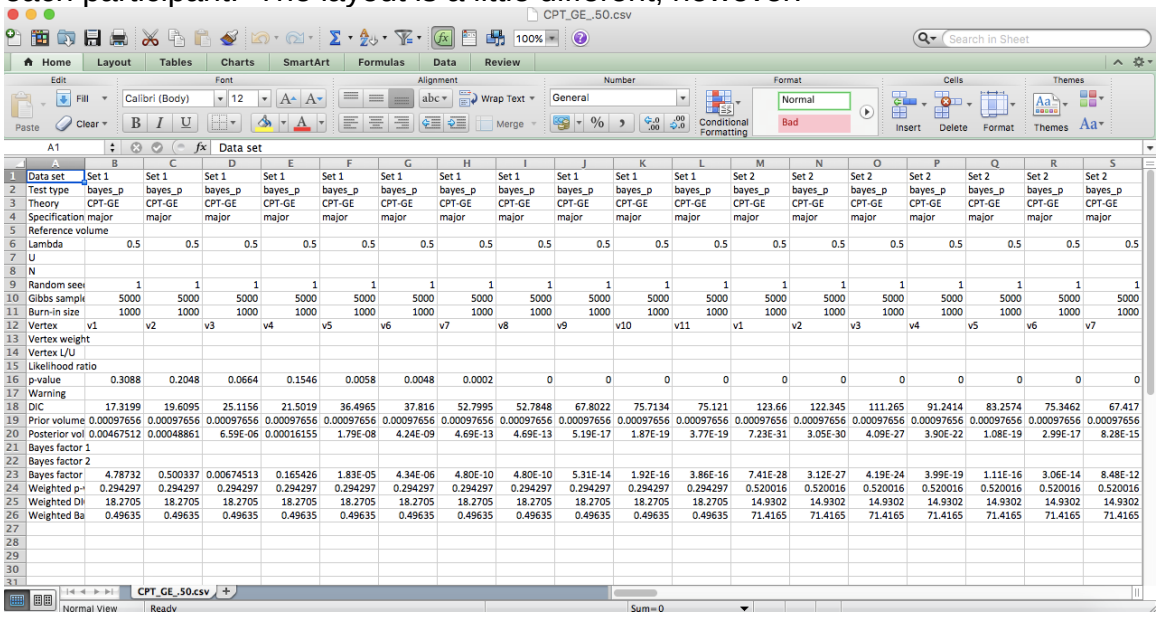
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory. Therefore, under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file. For more information on other ways a user can view the results, see section G.5.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “GQ” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on. All the information in this spreadsheet is identical to what one would see if they selected “Details…” for each participant. The layout is a little different, however.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
4	Specification	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference volume																		
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																		
8	N																		
9	Random see	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sampl	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v1	v2	v3	v4	v5	v6	v7
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value	0.3088	0.2048	0.0664	0.1546	0.0058	0.0048	0.0002	0	0	0	0	0	0	0	0	0	0	0
17	Warning																		
18	DIC	17.3199	19.6095	25.1156	21.5019	36.4965	37.816	52.7995	52.7848	67.8022	75.7134	75.121	123.66	122.345	111.265	91.2414	83.2574	75.3462	67.417
19	Prior volume	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656
20	Posterior vol	0.00467512	0.00048861	6.59E-06	0.00016155	1.79E-08	4.24E-09	4.69E-13	4.69E-13	5.19E-17	1.87E-19	3.77E-19	7.23E-31	3.05E-30	4.09E-27	3.90E-22	1.08E-19	2.99E-17	8.28E-15
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor	4.78732	0.500337	0.00674513	0.165426	1.83E-05	4.34E-06	4.80E-10	4.80E-10	5.31E-14	1.92E-16	3.86E-16	7.41E-28	3.12E-27	4.19E-24	3.99E-19	1.11E-16	3.06E-14	8.48E-12
24	Weighted p-	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.520016	0.520016	0.520016	0.520016	0.520016	0.520016	0.520016
25	Weighted DI	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	14.9302	14.9302	14.9302	14.9302	14.9302	14.9302	14.9302
26	Weighted Ba	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	71.4165	71.4165	71.4165	71.4165	71.4165	71.4165	71.4165
27																			
28																			
29																			
30																			
31																			

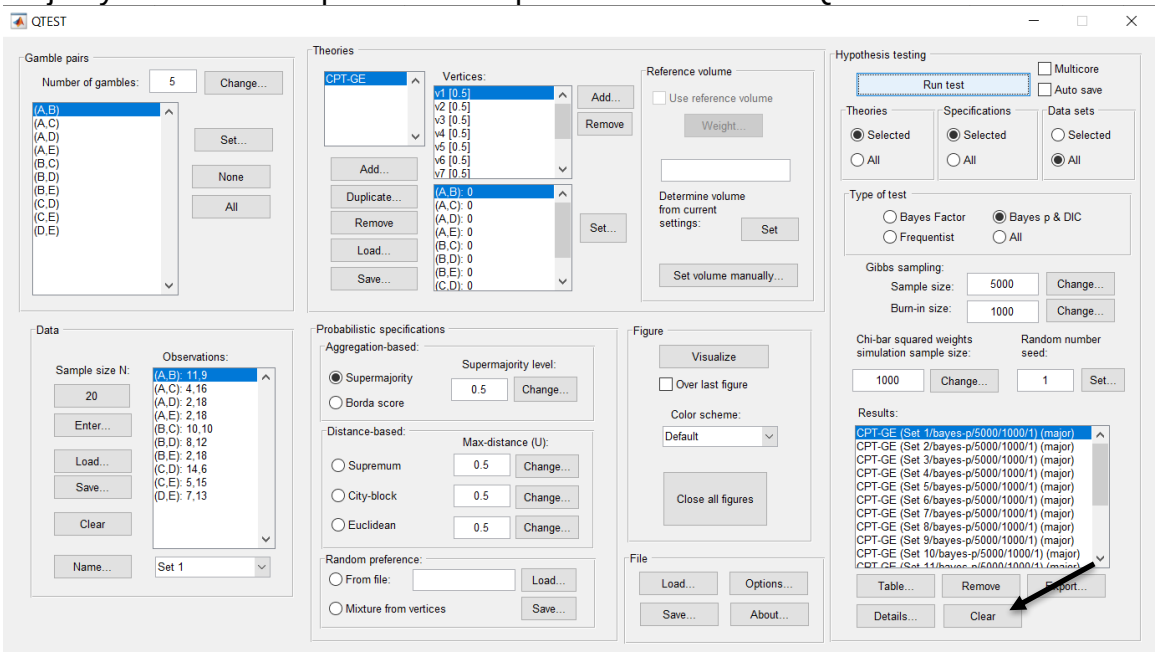
The weighted p-values are in row 24 of the spreadsheet. Notice the same p-value repeats for all the columns “B” through “L” listed as “Set 1”—this is the Bayes p value for participant 1, listed under “0.50 Majority Choice” and “GE” in Table 1 of QTBC2. Notice the same holds true for all the columns “M” through “W” listed as “Set 2”, for participant 2, and so on. From this file, column “GE” under “0.50 Majority Choice” of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

The weighted DIC values are in row 25 of the spreadsheet. Again, notice the same DIC value repeats for all the columns “B” through “L” listed as “Set 1”—this is the DIC value for participant 1, listed under “0.50 Majority Choice” and “GE” in Table 2 of QTBC2. Notice the same holds true for all the columns “M” through “W” listed as “Set 2”, for participant 2, and so on. From this file, column “GE” under “0.50 Majority Choice” of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

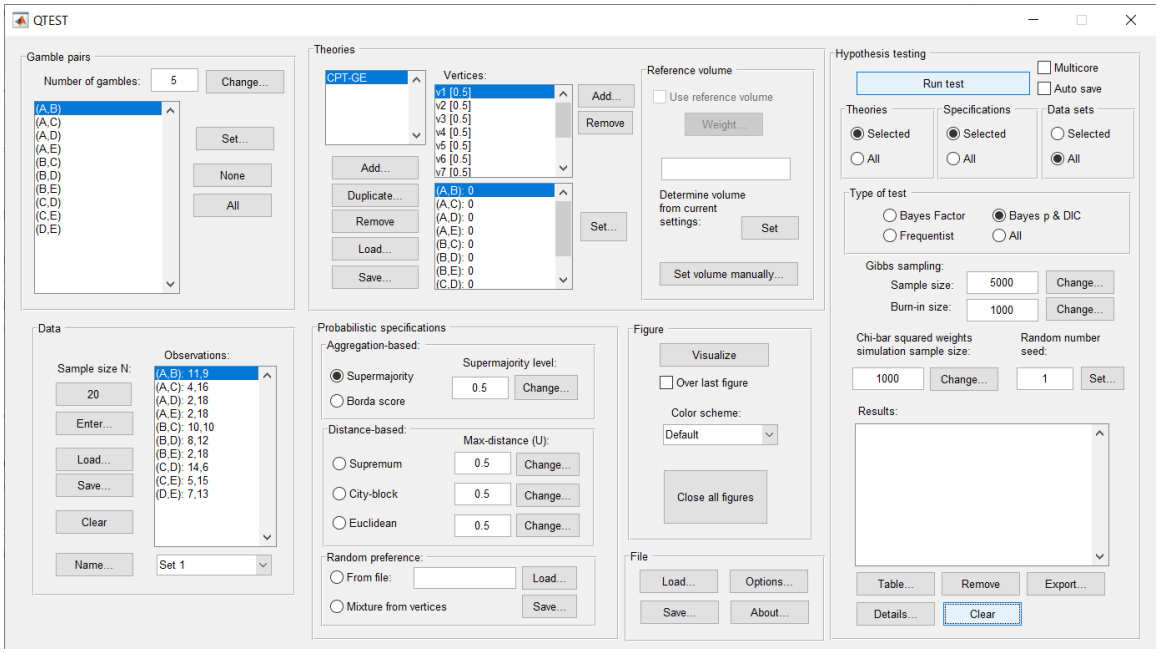
This completes the analysis for Cash I data for the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{GE}$ .50-majority/modal choice probabilistic specification. We will, again, demonstrate the analysis for the Cash I data for the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{GE}$, but now with a .90-supermajority probabilistic specification in the following two sections, L.3.5 and L.3.6.

L.3.5 Probabilistic specification: Cash I, $\mathcal{CPT}$-$\mathcal{GE}$, 0.90-Supermajority

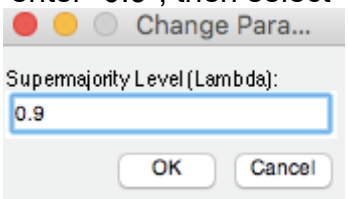
If continuing from section L.3.4, select “Clear” under “Hypothesis testing” and “Results:”. This step clears the results of the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{GE}$ .50-majority/modal choice probabilistic specification from the QTEST interface.



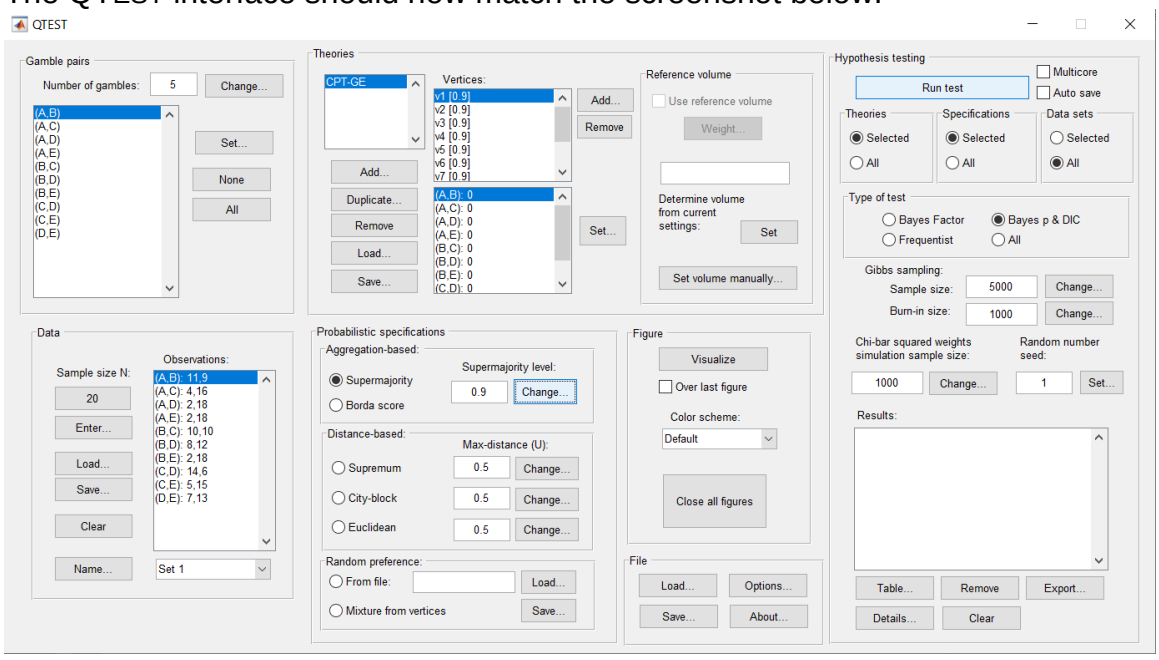
Whether the user is continuing from section L.3.2 or L.3.4, the QTEST interface should match the screenshot below.



To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected. To set the “Supermajority level:” to “0.9”, select “Change…” and enter “0.9”, then select “OK.”



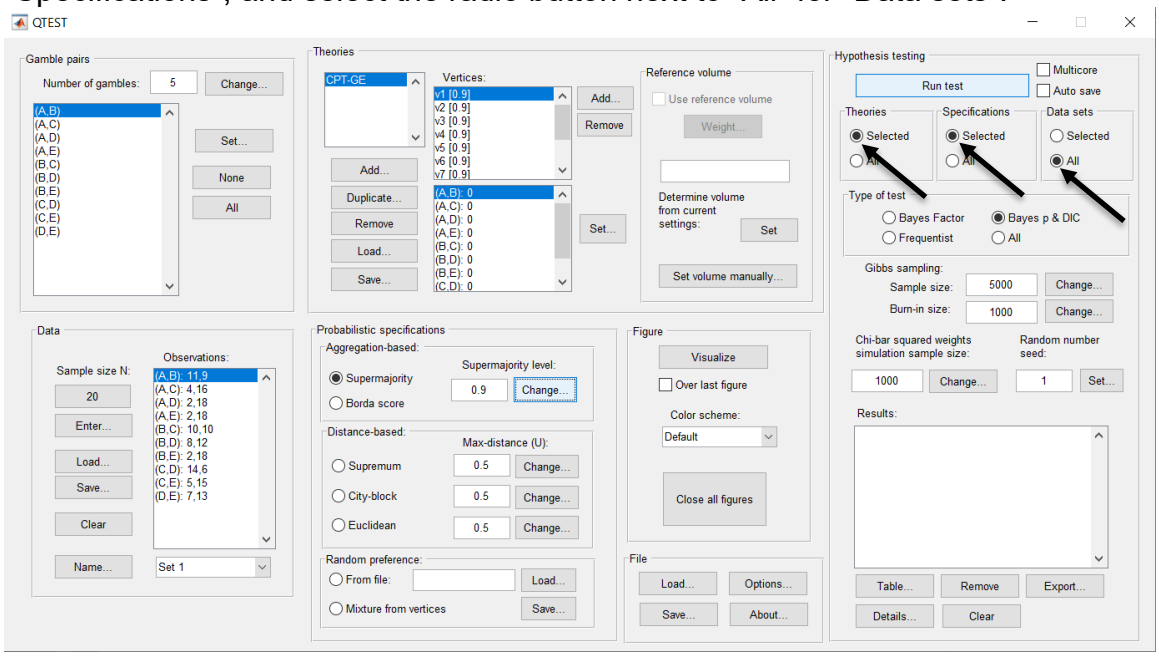
The QTEST interface should now match the screenshot below.



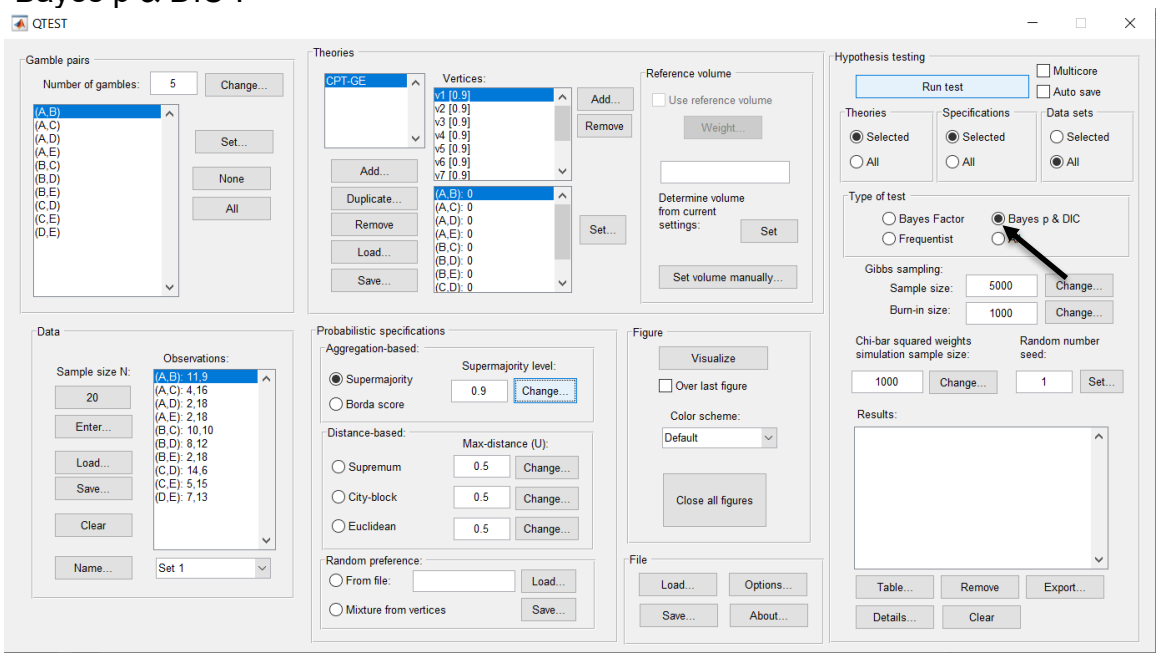
L.3.6 Hypothesis Testing: Cash I, $\mathcal{CPT}$-$\mathcal{GE}$, 0.90-Supermajority

We are now ready for the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{GE}$ .90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

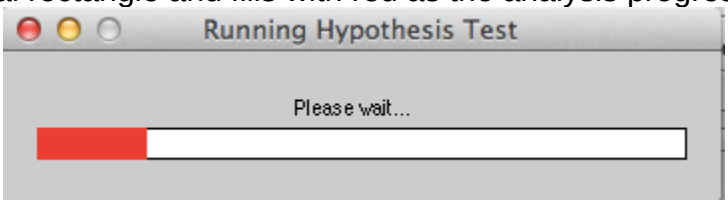
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



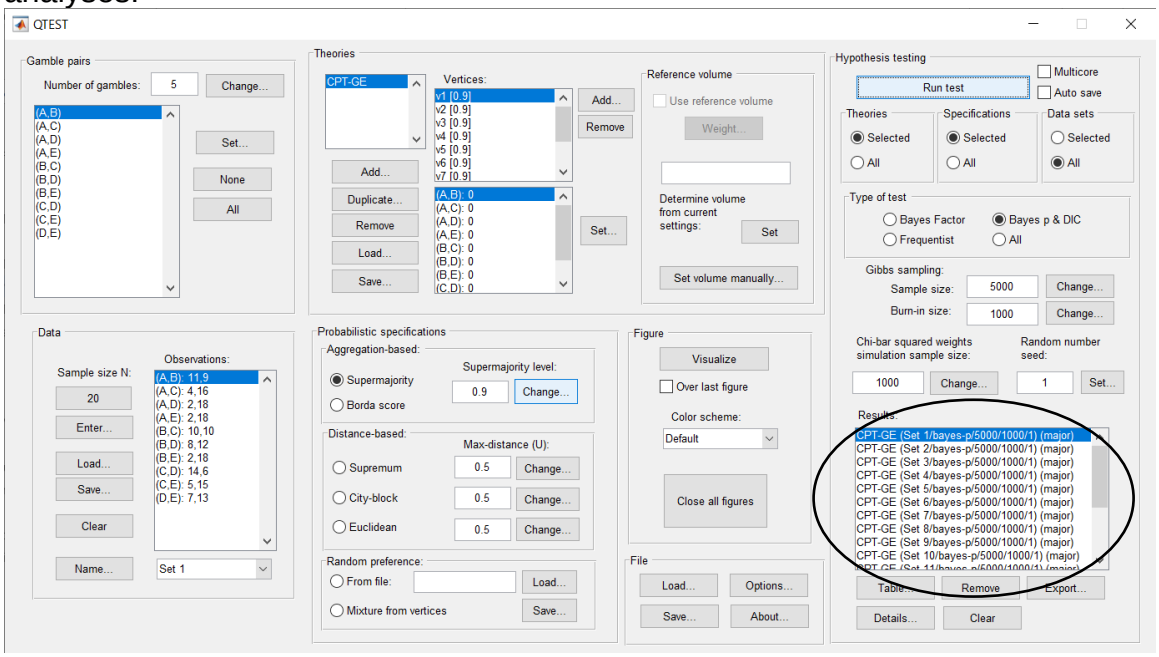
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes p & DIC”.



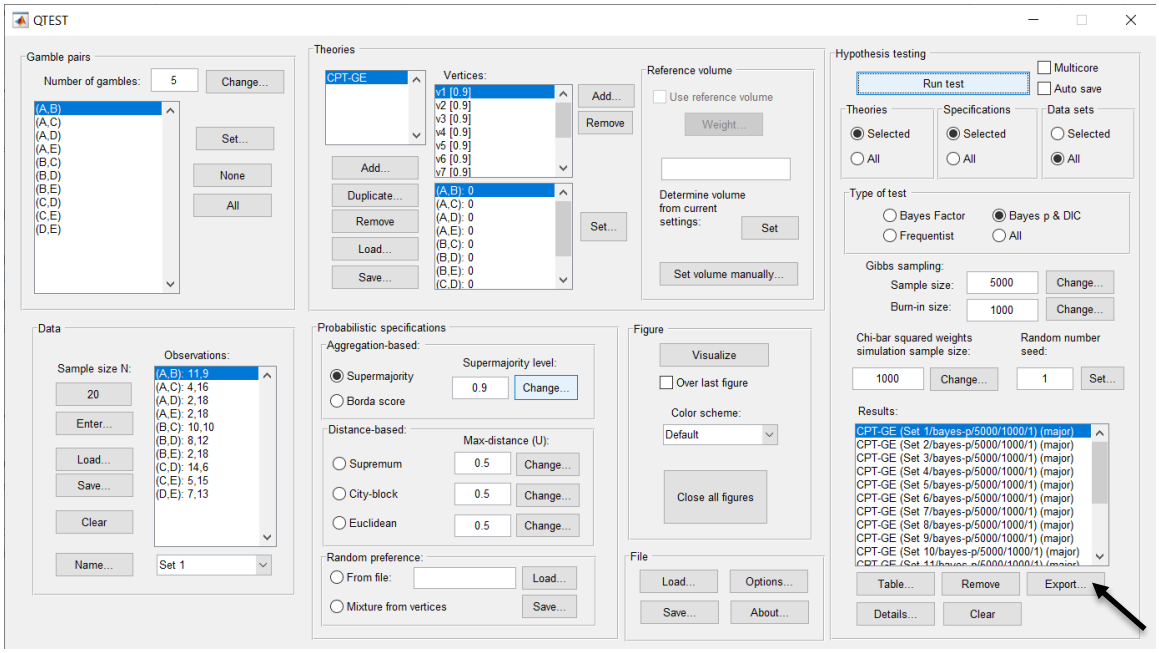
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



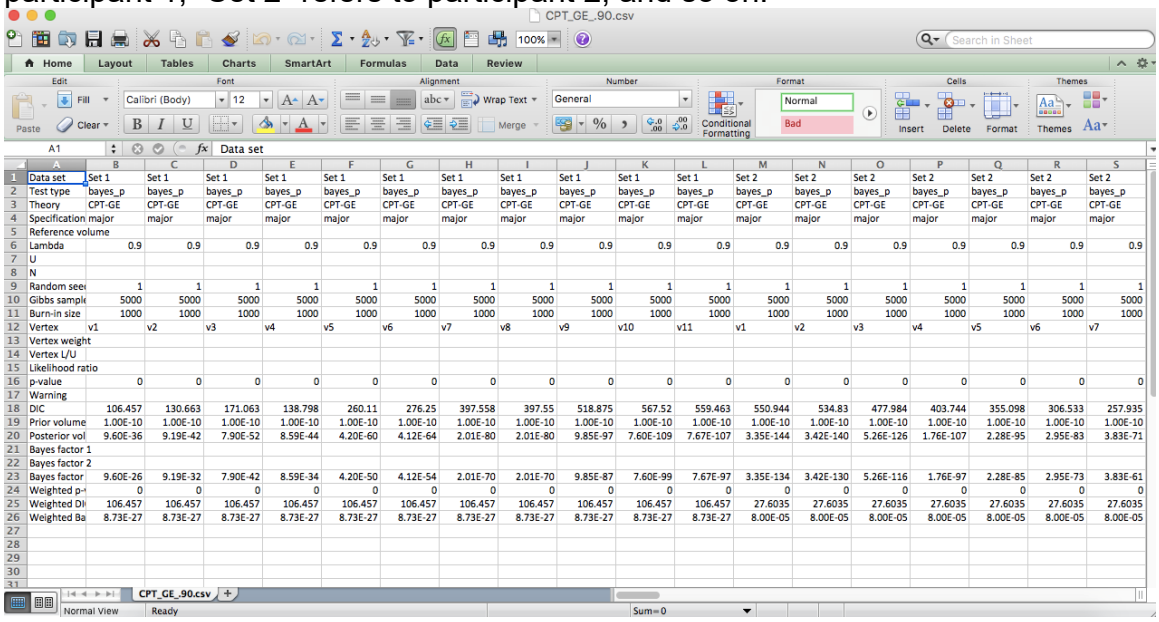
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “GQ” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
4	Specification	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference volume																		
6	Lambda	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7	U																		
8	N																		
9	Random see	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sampl	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v1	v2	v3	v4	v5	v6	v7
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Warning																		
18	DIC	106.457	130.663	171.063	138.798	260.11	276.25	397.558	397.55	518.875	567.52	559.463	550.944	534.83	477.984	403.744	355.098	306.533	257.935
19	Prior volume	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10
20	Posterior vol	9.60E-36	9.19E-42	7.90E-52	8.59E-44	4.20E-60	4.12E-64	2.01E-80	2.01E-80	9.85E-97	7.60E-109	7.67E-107	3.35E-144	3.42E-140	5.26E-126	1.76E-107	2.28E-95	2.95E-83	3.83E-71
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor	9.60E-26	9.19E-32	7.90E-42	8.59E-34	4.20E-50	4.12E-54	2.01E-70	2.01E-70	9.85E-87	7.60E-99	7.67E-97	3.35E-134	3.42E-130	5.26E-116	1.76E-97	2.28E-85	2.95E-73	3.83E-61
24	Weighted p-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Weighted DI	106.457	106.457	106.457	106.457	106.457	106.457	106.457	106.457	106.457	106.457	106.457	27.6035	27.6035	27.6035	27.6035	27.6035	27.6035	27.6035
26	Weighted Ba	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05
27																			
28																			
29																			
30																			
31																			

The weighted p-values are in row 24 of the spreadsheet. Notice the same p-value repeats for all the columns “B” through “L” listed as “Set 1”—this is the Bayes p value for participant 1, listed under “0.90 Supermajority” and “GE” in Table 1 of QTBC2. Notice the same holds true for all the columns “M” through “W” listed as “Set 2”, for participant 2, and so on. From this file, column “GE” under “0.90 Majority Choice” of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

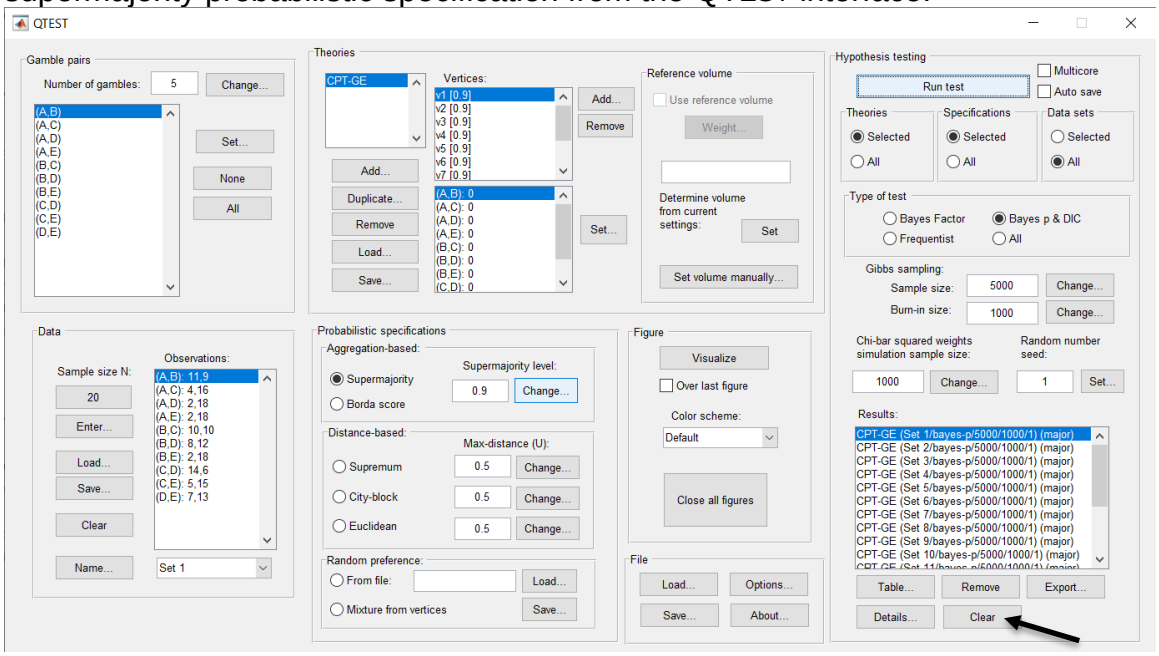
The weighted DIC values are in row 25 of the spreadsheet. Again, notice the same DIC value repeats for all the columns “B” through “L” listed as “Set 1”—this is the DIC value for participant 1, listed under “0.90 Supermajority” and “GE” in Table 2 of QTBC2. Notice the same holds true for all the columns “M” through “W” listed as “Set 2”, for participant 2, and so on. From this file, column “GE” under “0.90 Supermajority” of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

This completes the analysis for Cash I data for the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{GE}$ .90-supermajority probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{GE}$, but now with

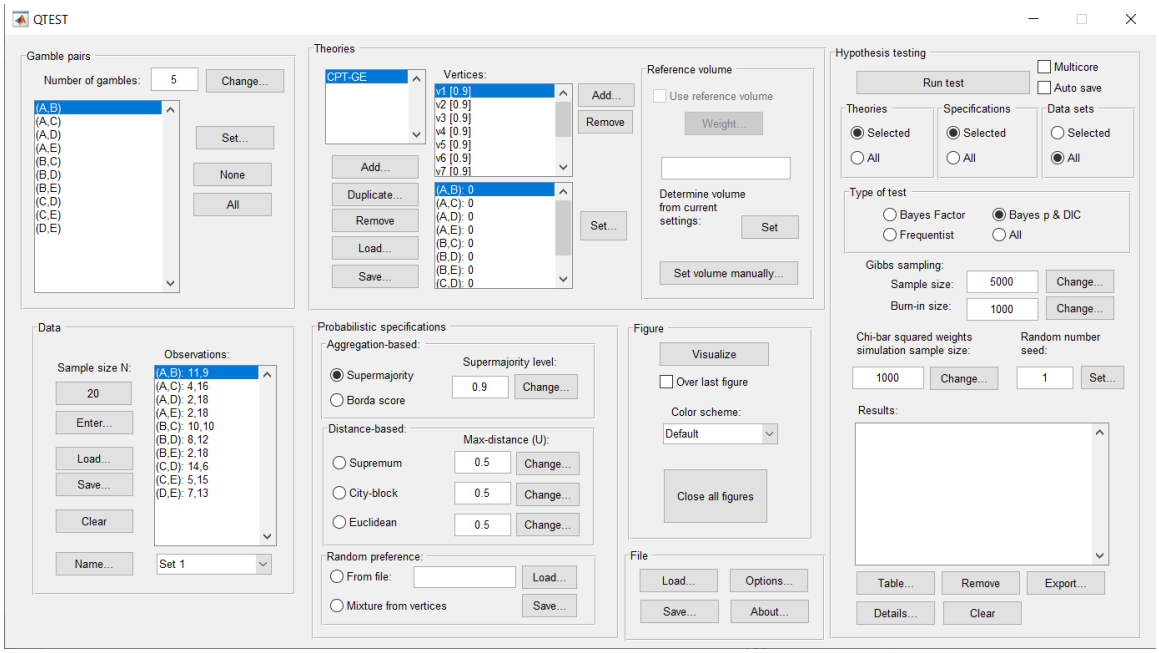
a random preference probabilistic specification in the following two sections, L.3.7 and L.3.8.

L.3.7 Probabilistic specification: Cash I, *CPT-GE*, Random Preference

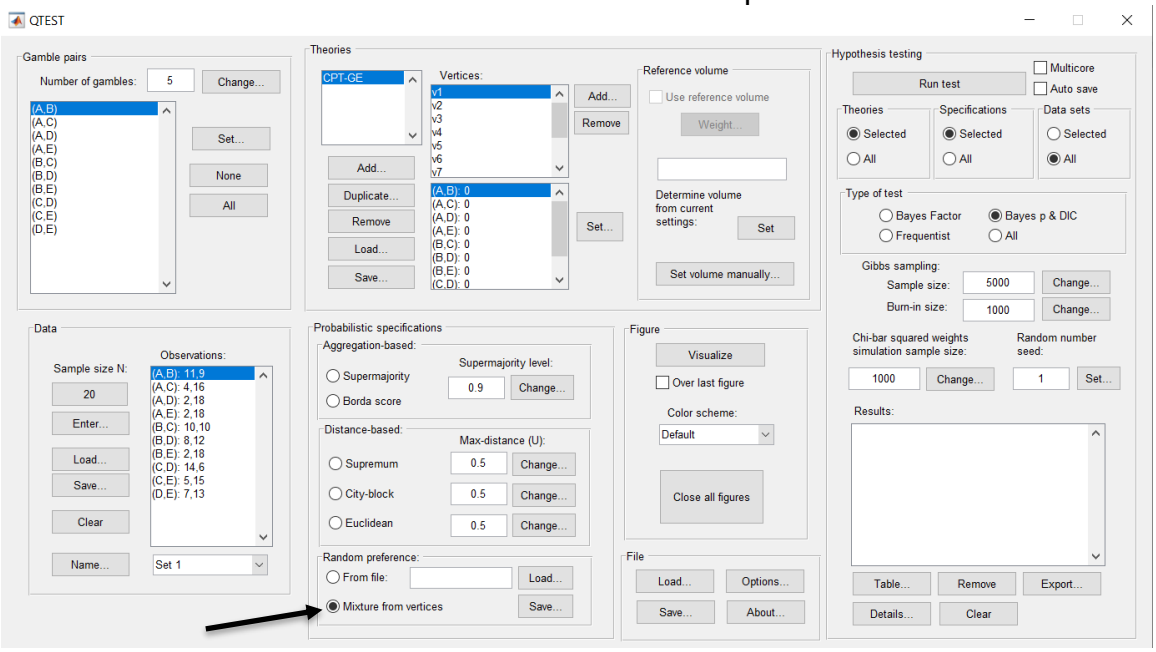
If continuing from section L.3.6, click “Clear” under “Hypothesis testing” and “Results:”. This step clears the results of the Bayes p & DIC test of *CPT-GE* .90-supermajority probabilistic specification from the QTEST interface.



Whether the user is continuing from section L.3.2 or L.3.6, the QTEST interface should match the screenshot below.



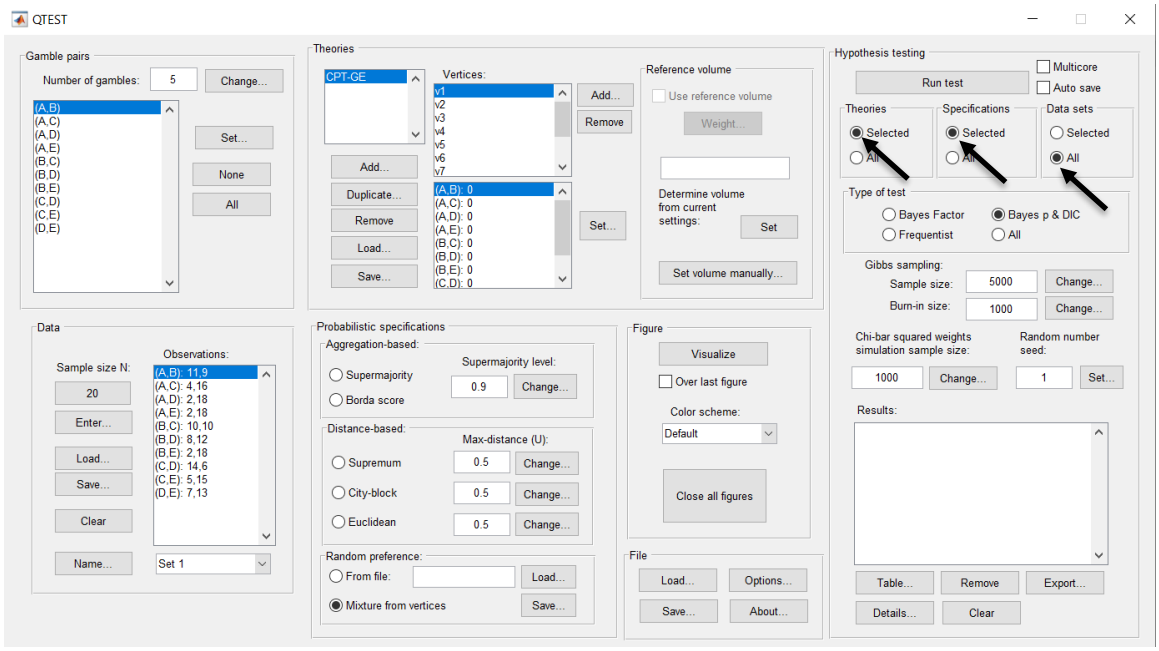
To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Mixture from vertices” under “Random preference:” is selected.



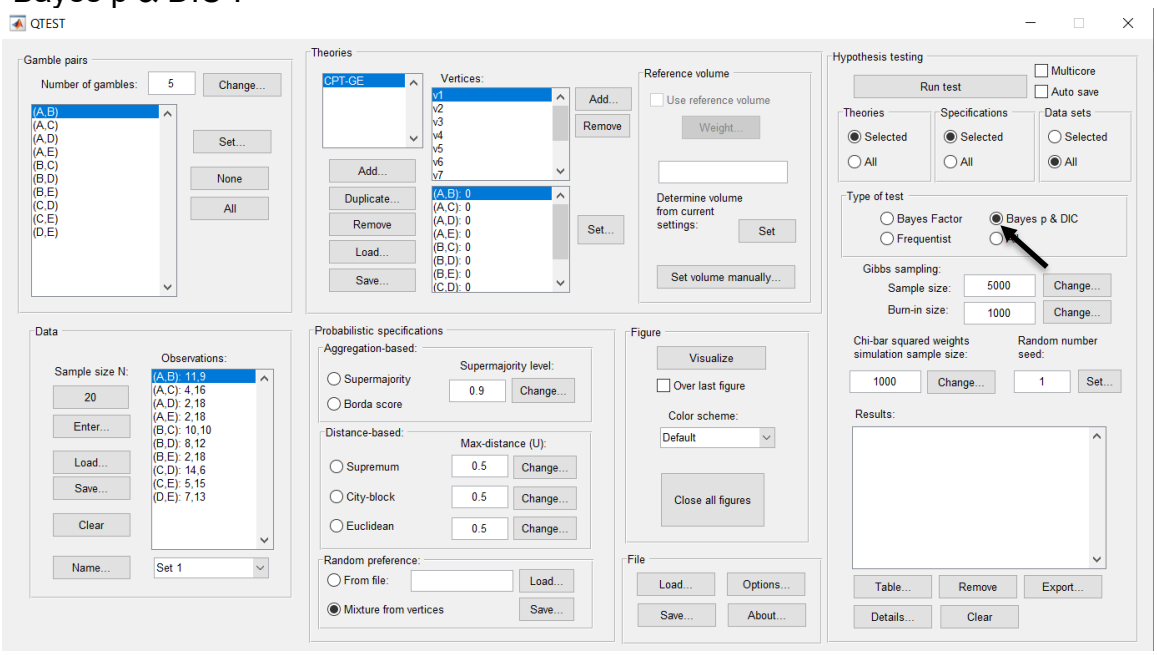
L.3.8 Hypothesis Testing: Cash I, *CPT-GE*, Random Preference

We are now ready for the Bayes p & DIC test of *CPT-GE* random preference probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

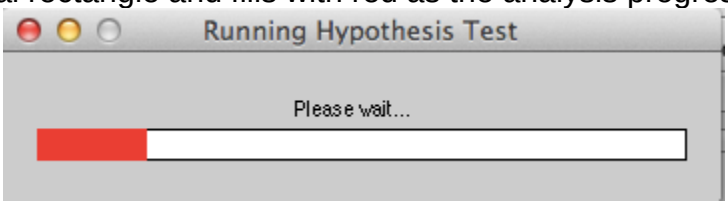
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



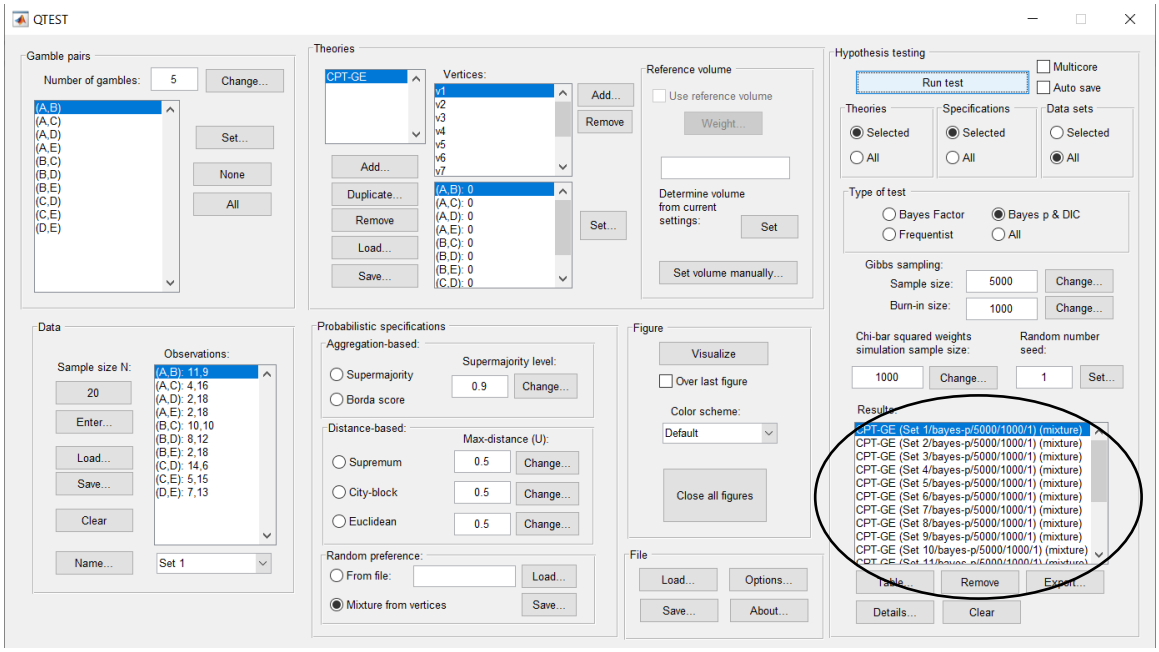
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes p & DIC”.



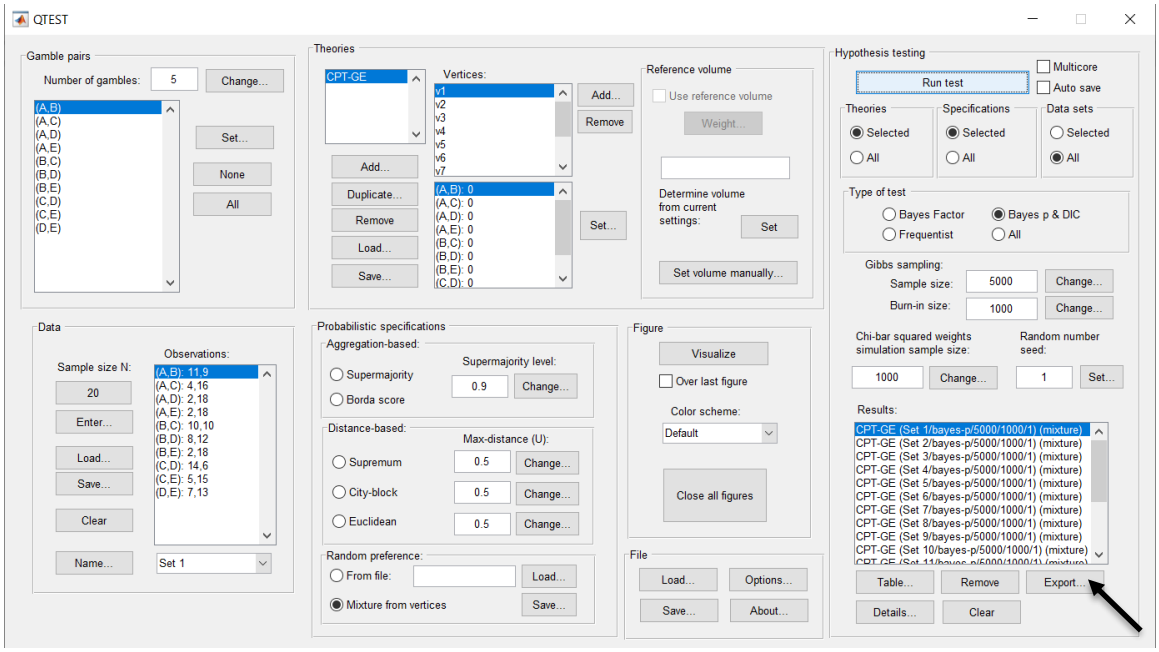
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



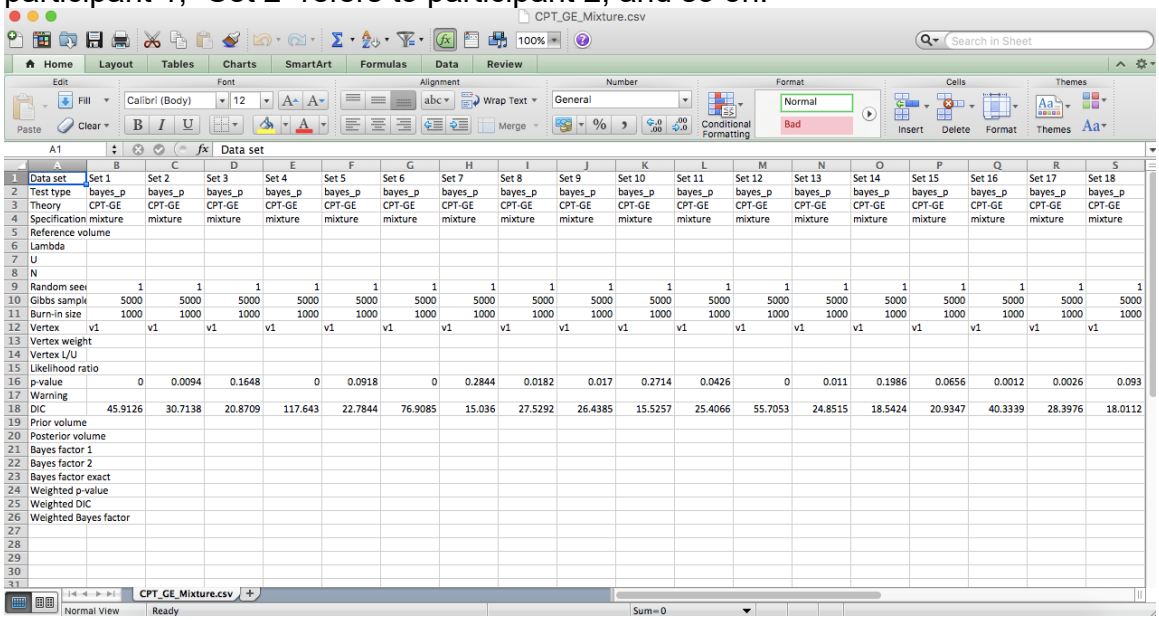
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “S” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



CPT_GE_Mixture.csv

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
4	Specification	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture
5	Reference volume																		
6	Lambda																		
7	U																		
8	N																		
9	Random see	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sampl	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value	0	0.0094	0.1648	0	0.0918	0	0.2844	0.0182	0.017	0.2714	0.0426	0	0.011	0.1986	0.0656	0.0012	0.0026	0.093
17	Warning																		
18	DIC	45.9126	30.7138	20.8709	117.643	22.7844	76.9085	15.036	27.5292	26.4385	15.5257	25.4066	55.7053	24.8515	18.5424	20.9347	40.3339	28.3976	18.0112
19	Prior volume																		
20	Posterior volume																		
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor exact																		
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Bayes factor																		

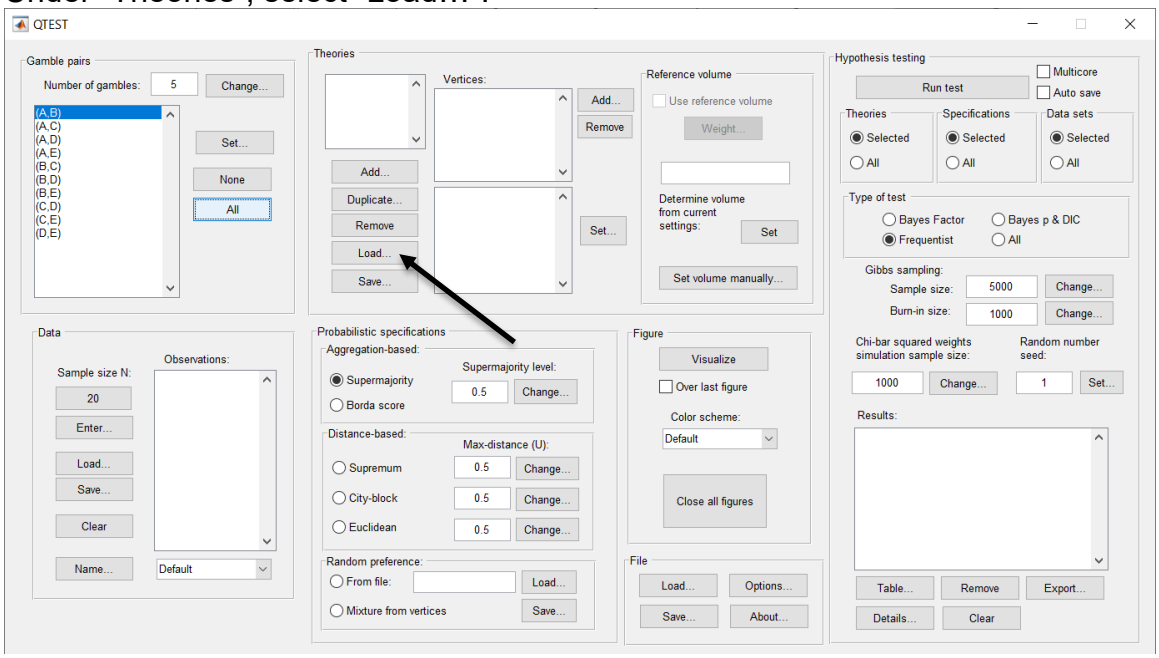
The p-values are in row 16 of the spreadsheet. The p-value in column “B” listed as “Set 1” is the Bayes p value for participant 1, listed under “Mixture” and “GE” in Table 1 of QTBC2. Notice the same holds true for the column “C” listed as “Set 2”, for participant 2, and so on. From this file, column “GE” under “Mixture” of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

The DIC values are in row 18 of the spreadsheet. Again, the DIC value in column “B” listed as “Set 1” is the DIC value for participant 1, listed under “Mixture” and “GE” in Table 2 of QTBC2. Notice the same holds true for the column “C” listed as “Set 2”, for participant 2, and so on. From this file, column “GE” under “Mixture” of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

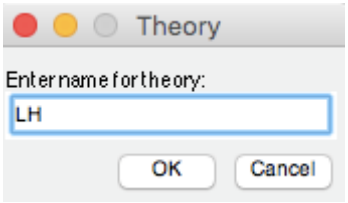
This completes the analysis for Cash I data for the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{GE}$ random preference probabilistic specification.

L.4.1 Theory and Vertex: Cash I, $\mathcal{LH}$

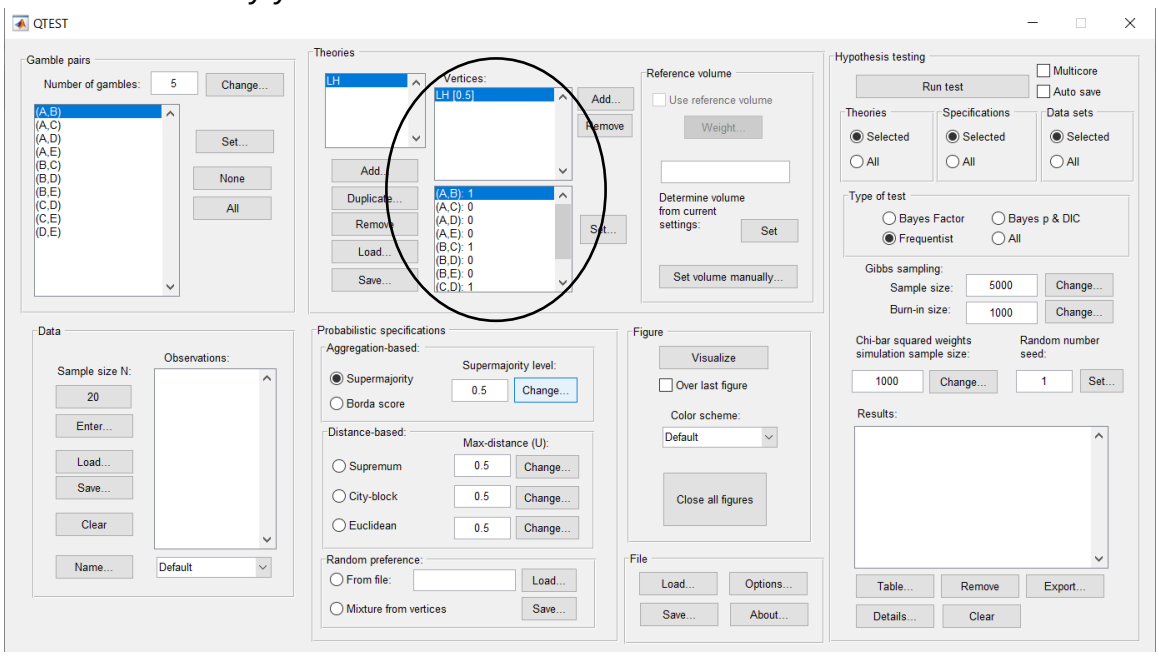
Under “Theories”, select “Load…”.



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “TheoriesVertices” folder and open “Vertices_LH_Cash1.csv”. In the dialog box, type “LH” and select “OK”.

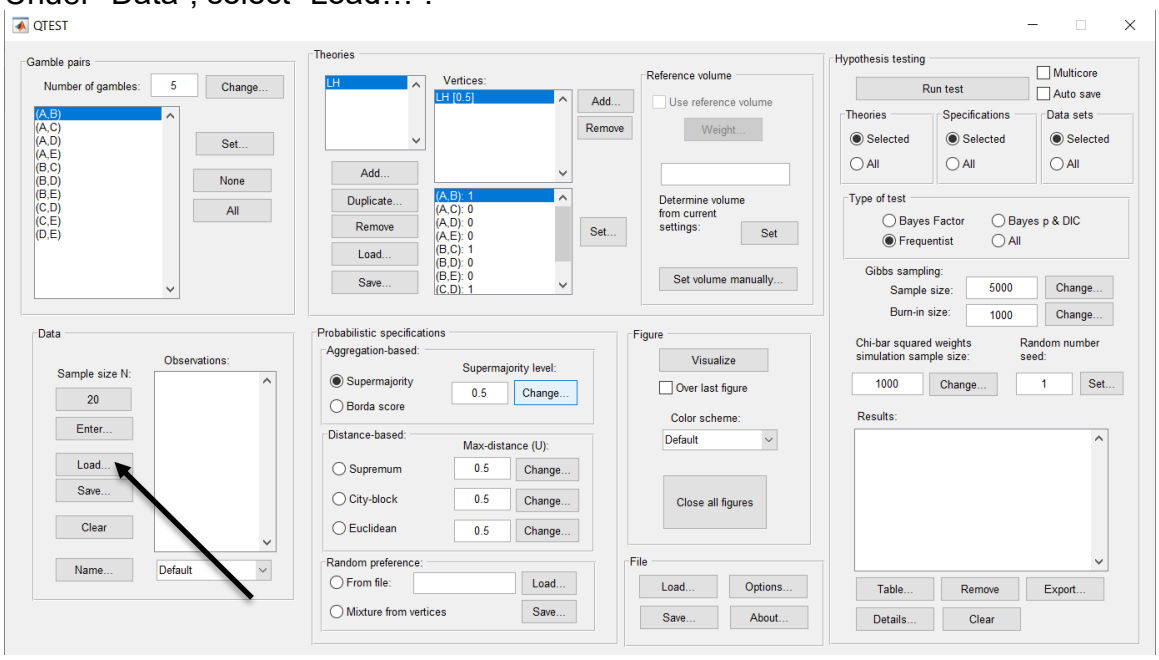


On the QTEST interface there should now be a list of 1 vertex for $\mathcal{LH}$ under "Theories". Verify your screen matches the screenshot below.



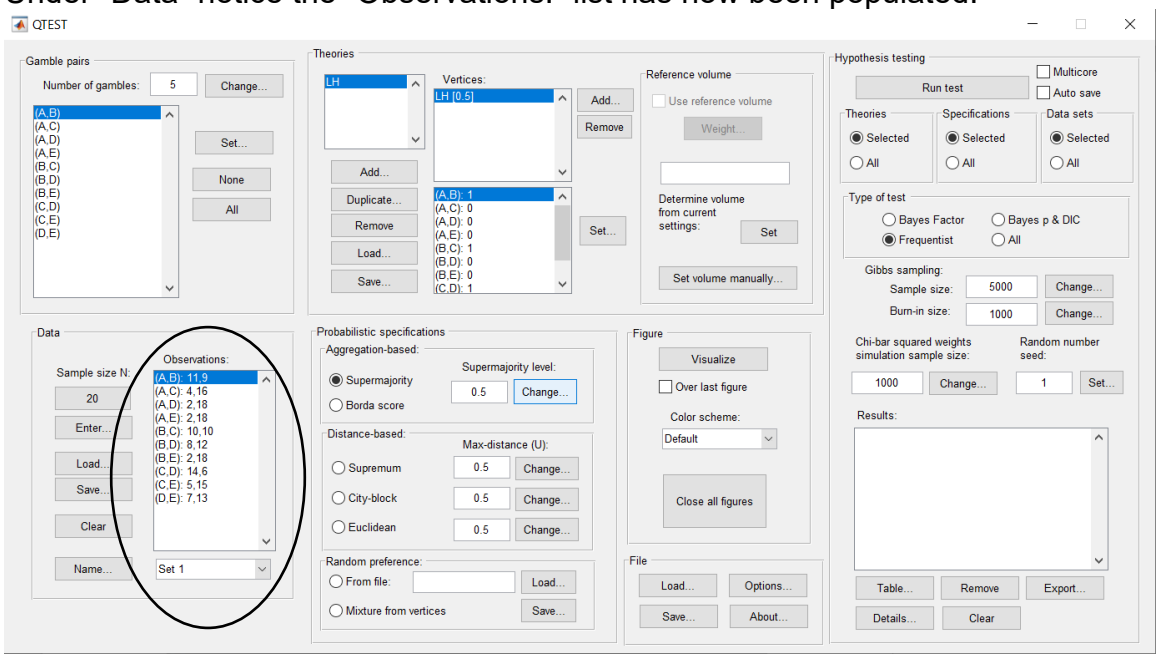
L.4.2 Data: Cash I, $\mathcal{LH}$

Under "Data", select "Load…".



Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "DataSets" folder and open "Cash1.txt".

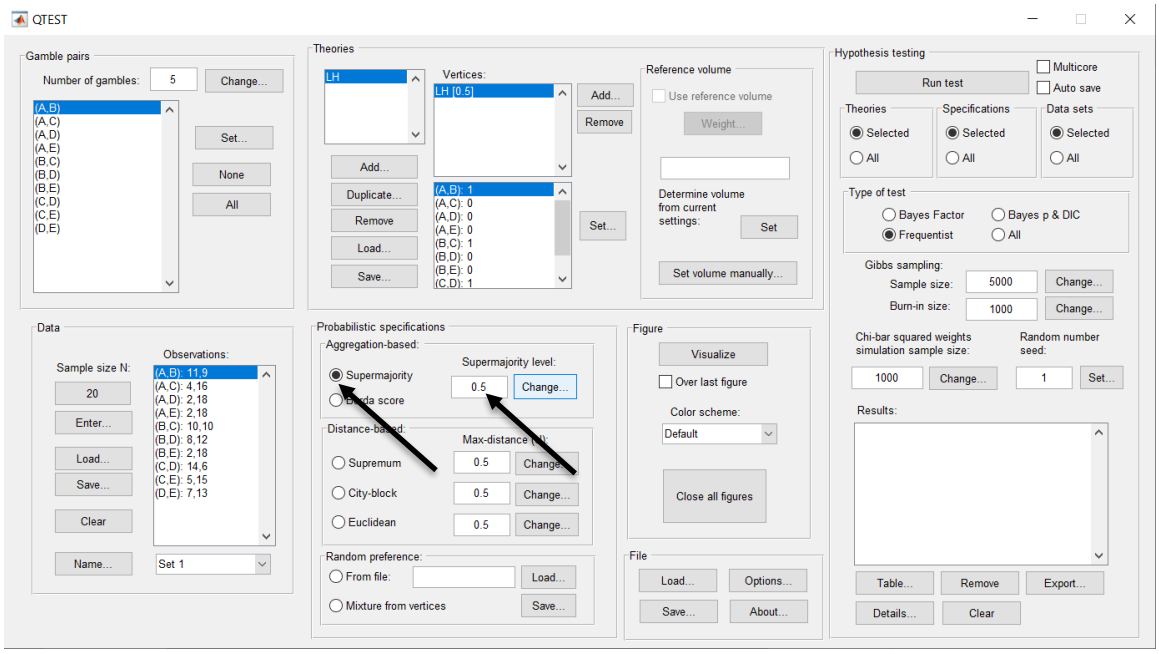
Under “Data” notice the “Observations:” list has now been populated:



Under “Data”, select the dropdown menu next to “Name…” to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

L.4.3 Probabilistic specification: Cash I, $\mathcal{LH}$, 0.50-Majority/modal choice

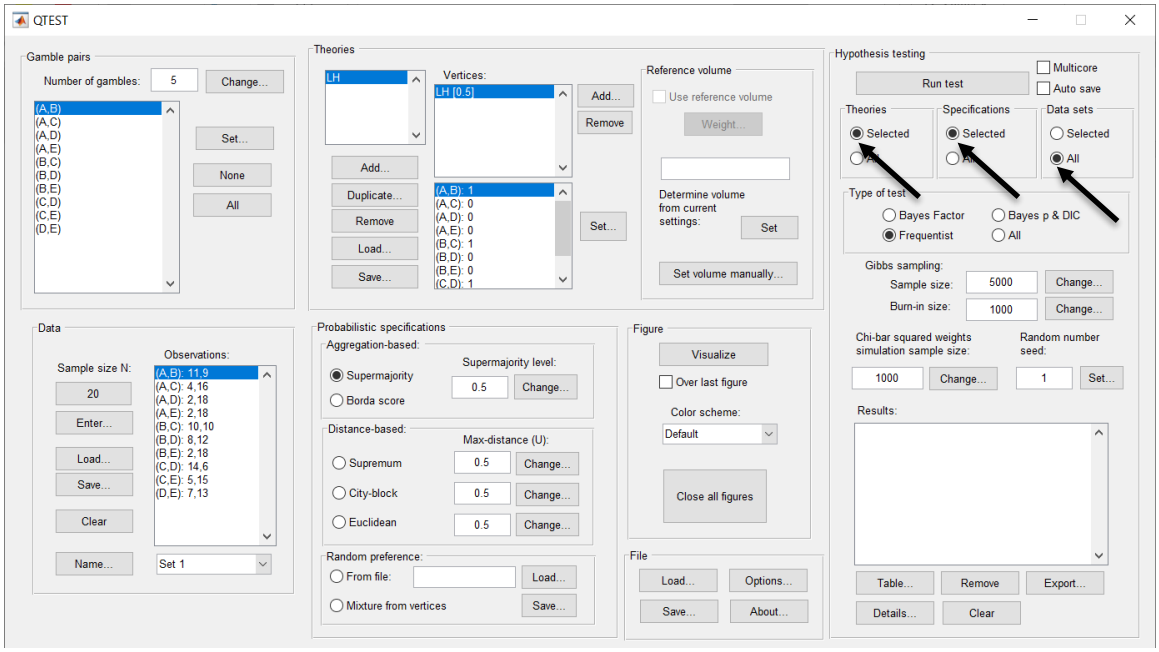
To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected and that the “Supermajority level:” is set to “0.5”.



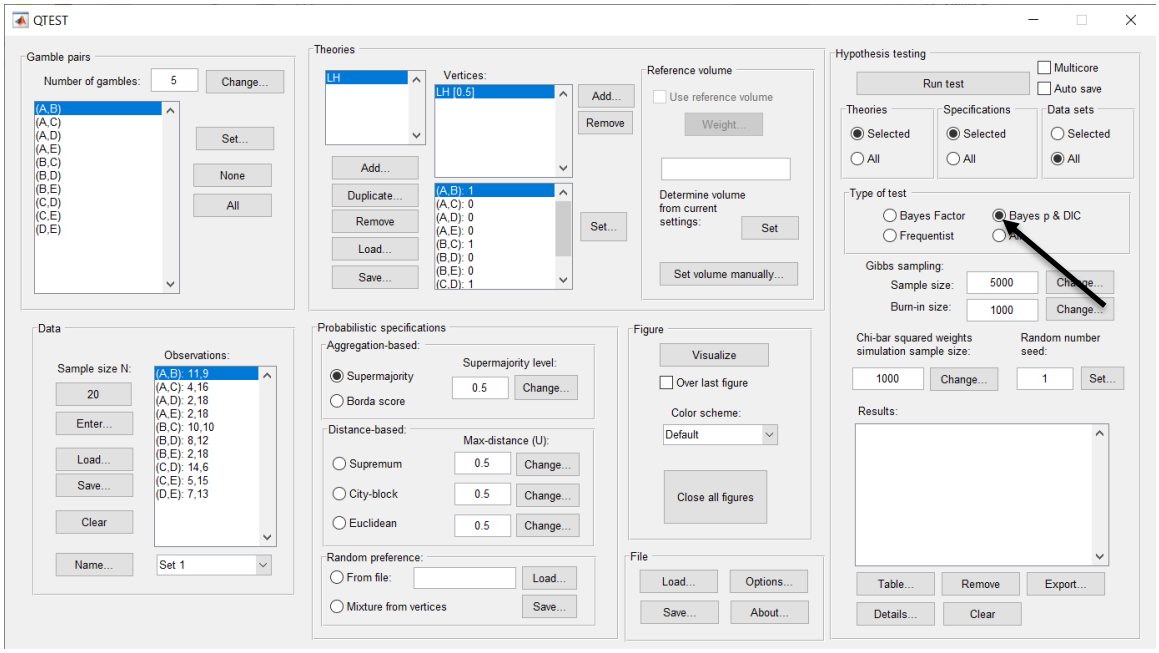
L.4.4 Hypothesis Testing: Cash I, $\mathcal{LH}$, 0.50-Majority/modal choice

We are now ready for the Bayes p & DIC test of $\mathcal{LH}$ .50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under “Hypothesis testing”, under the “Run test” button, there are 3 columns: “Theories”, “Specifications” and “Data sets”. For each of these, the user must choose the radio button next to either “Selected” or “All”. For more information on these settings, as well as the inputs for “Chi-bar squared weights simulation sample size:” and “Random number seed:”, see section G.5.

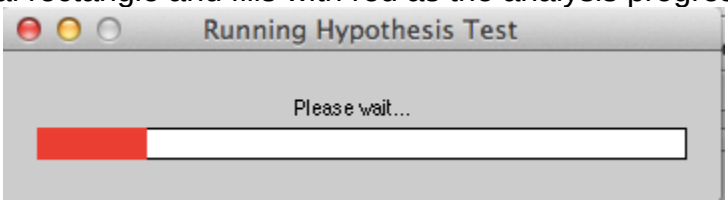
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



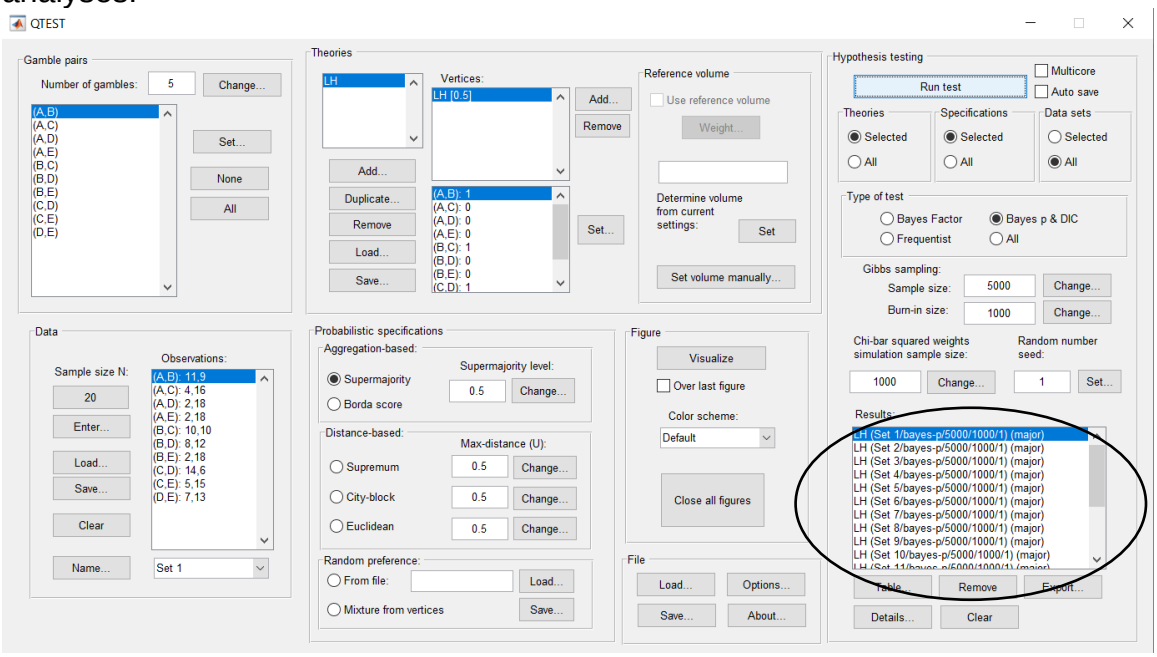
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes p & DIC”.



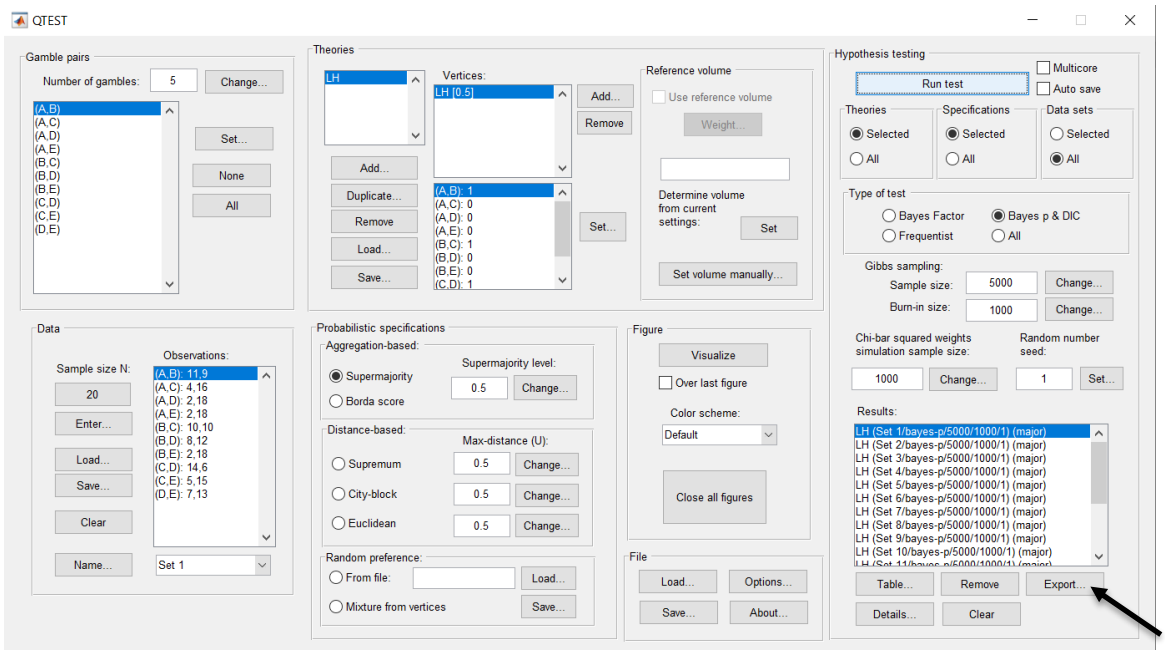
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



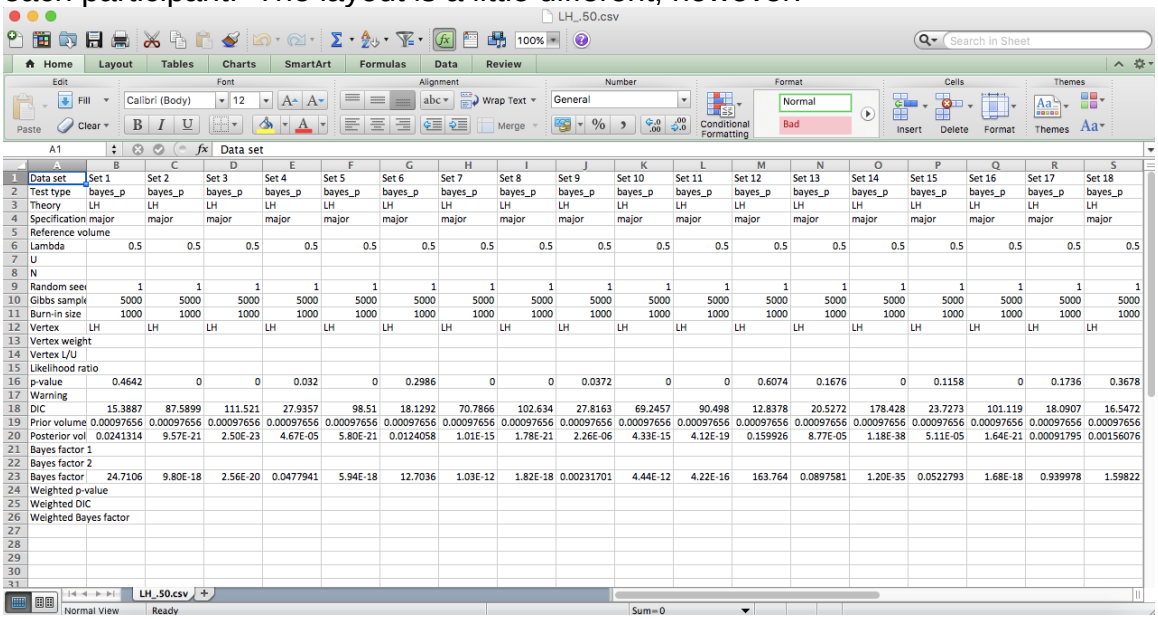
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory. Therefore, under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file. For more information on other ways a user can view the results, see section G.5.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “S” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on. All the information in this spreadsheet is identical to what one would see if they selected “Details…” for each participant. The layout is a little different, however.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
4	Specification	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference volume																		
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																		
8	N																		
9	Random see	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sampl	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value	0.4642	0	0	0.032	0	0.2986	0	0	0.0372	0	0	0.6074	0.1676	0	0.1158	0	0.1736	0.3678
17	Warning																		
18	DIC	15.3887	87.5899	111.521	27.9357	98.51	18.1292	70.7866	102.634	27.8163	69.2457	90.498	12.8378	20.5272	178.428	23.7273	101.119	18.0907	16.5472
19	Prior volume	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656
20	Posterior vol	0.0241314	9.57E-21	2.50E-23	4.67E-05	5.80E-21	0.0124058	1.01E-15	1.78E-21	2.26E-06	4.33E-15	4.12E-19	0.159926	8.77E-05	1.18E-38	5.11E-05	1.64E-21	0.00091795	0.00156076
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor	24.7106	9.80E-18	2.56E-20	0.0477941	5.94E-18	12.7036	1.03E-12	1.82E-18	0.00231701	4.44E-12	4.22E-16	163.764	0.0897581	1.20E-35	0.0522793	1.68E-18	0.939978	1.59822
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Bayes factor																		
27																			
28																			
29																			
30																			
31																			

The p-values are in row 16 of the spreadsheet. The p-value in column “B” listed as “Set 1” is the Bayes p value for participant 1, listed under “0.50 Majority Choice” and “LH” in Table 1 of QTBC2. Notice the same holds true for the column “C” listed as “Set 2”, for participant 2, and so on. From this file, column “0.50 Majority Choice” under “LH” of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

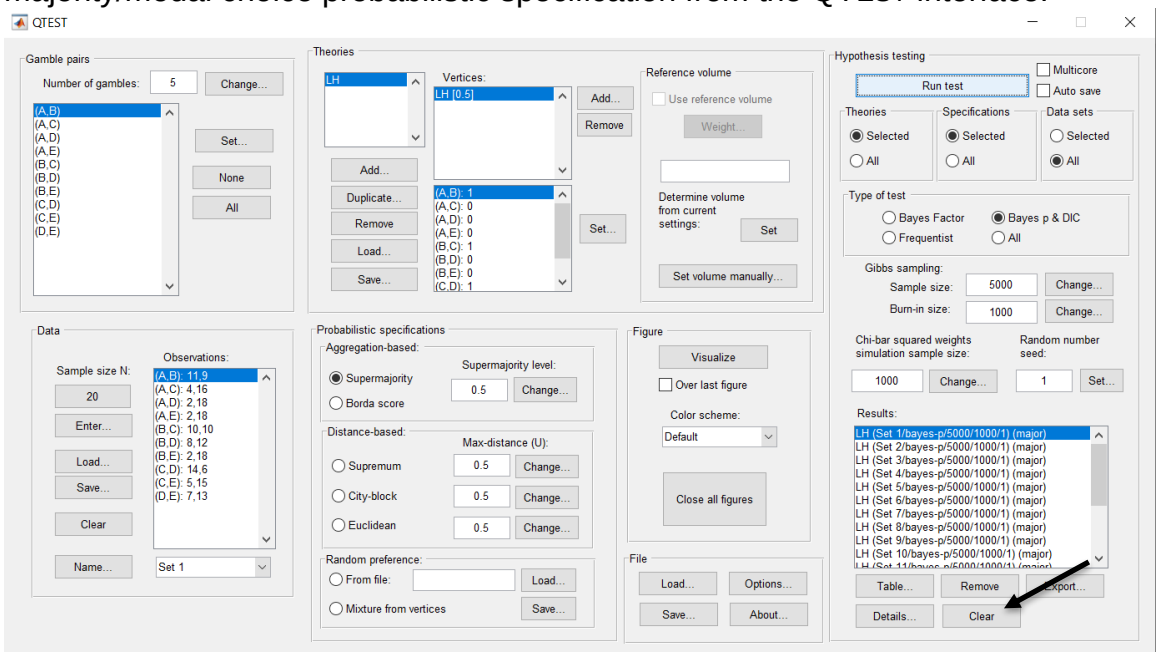
The DIC values are in row 18 of the spreadsheet. Again, the DIC value in column “B” listed as “Set 1” is the DIC value for participant 1, listed under “0.50 Majority Choice” and “LH” in Table 2 of QTBC2. Notice the same holds true for the column “C” listed as “Set 2”, for participant 2, and so on. From this file, column “LH” under “0.50 Majority Choice” of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

This completes the analysis for Cash I data for the Bayes p & DIC test of $L\!\not\!H$ .50-majority/modal choice probabilistic specification. We will, again, demonstrate the analysis for the Cash I data for the Bayes p & DIC test of $L\!\not\!H$, but now with a .90-

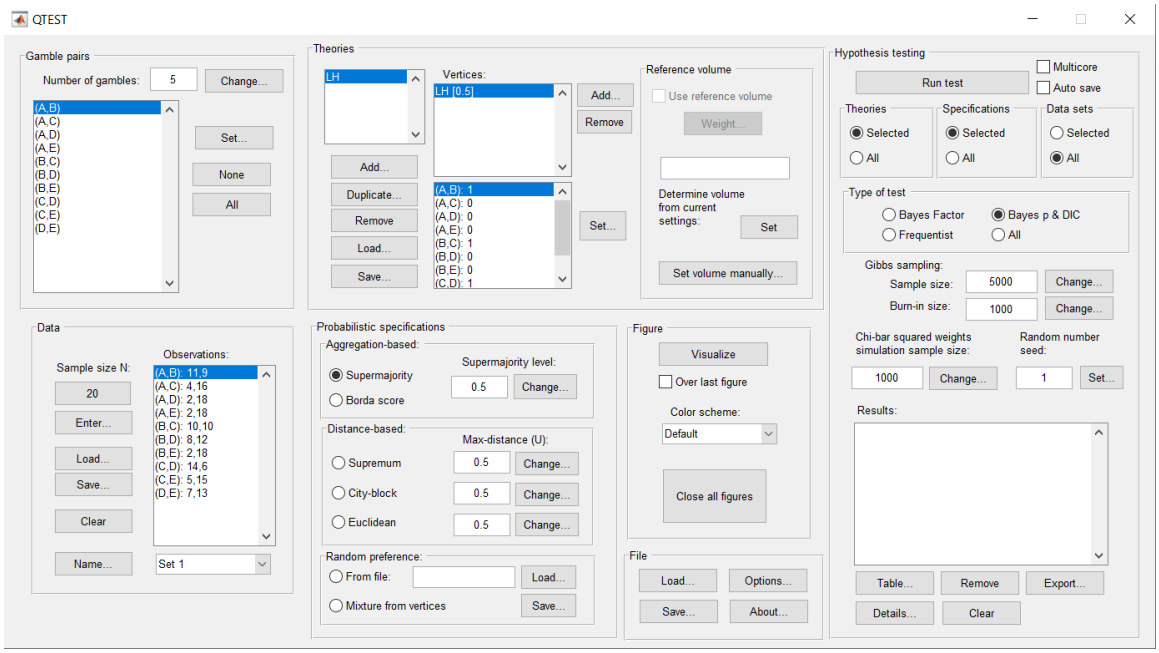
supermajority probabilistic specification in the following two sections, L.4.5 and L.4.6.

L.4.5 Probabilistic specification: Cash I, $\mathcal{LH}$, 0.90-Supermajority

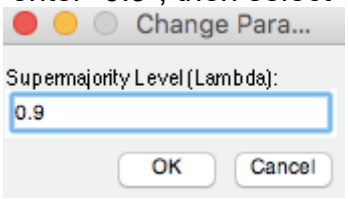
If continuing from section L.4.4, select “Clear” under “Hypothesis testing” and “Results:”. This step clears the results of the Bayes p & DIC test of $\mathcal{LH}$ .50-majority/modal choice probabilistic specification from the QTEST interface.



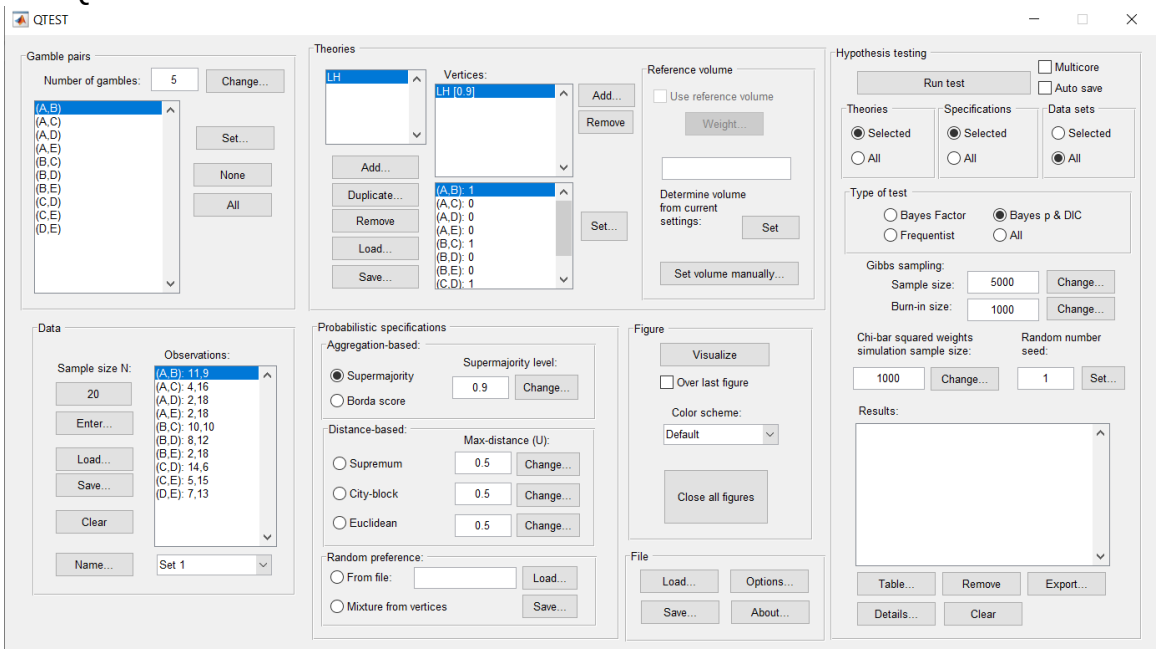
Whether the user is continuing from section L.4.2 or L.4.4, the QTEST interface should match the screenshot below.



To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected. To set the “Supermajority level:” to “0.9”, select “Change…” and enter “0.9”, then select “OK.”



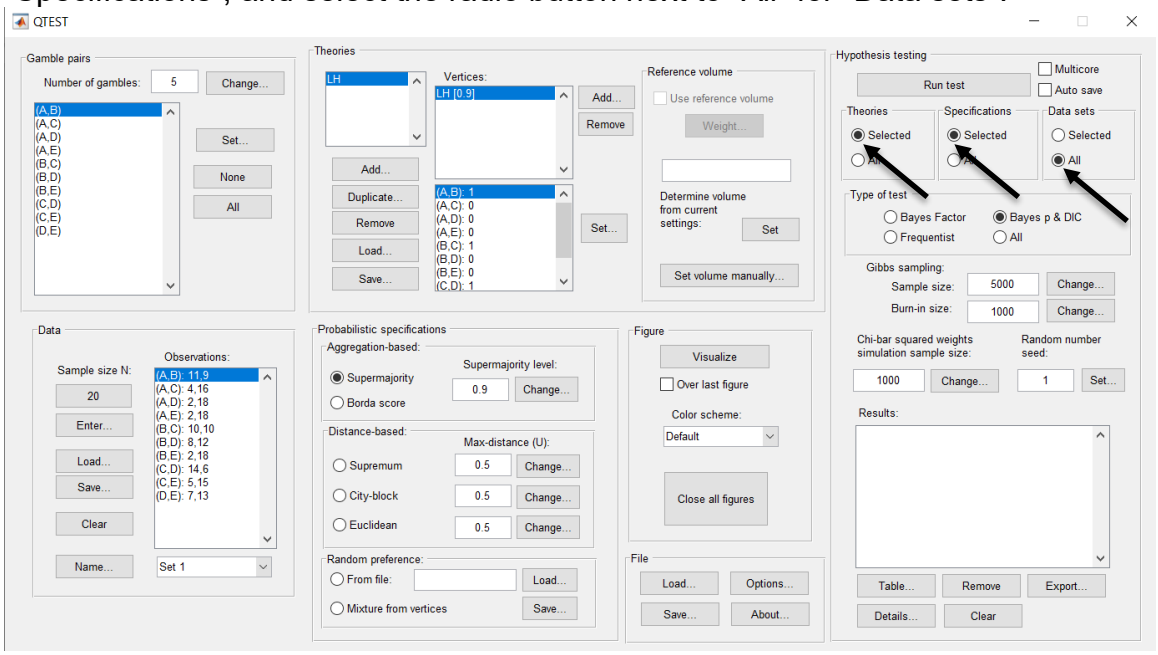
The QTEST interface should now match the screenshot below.



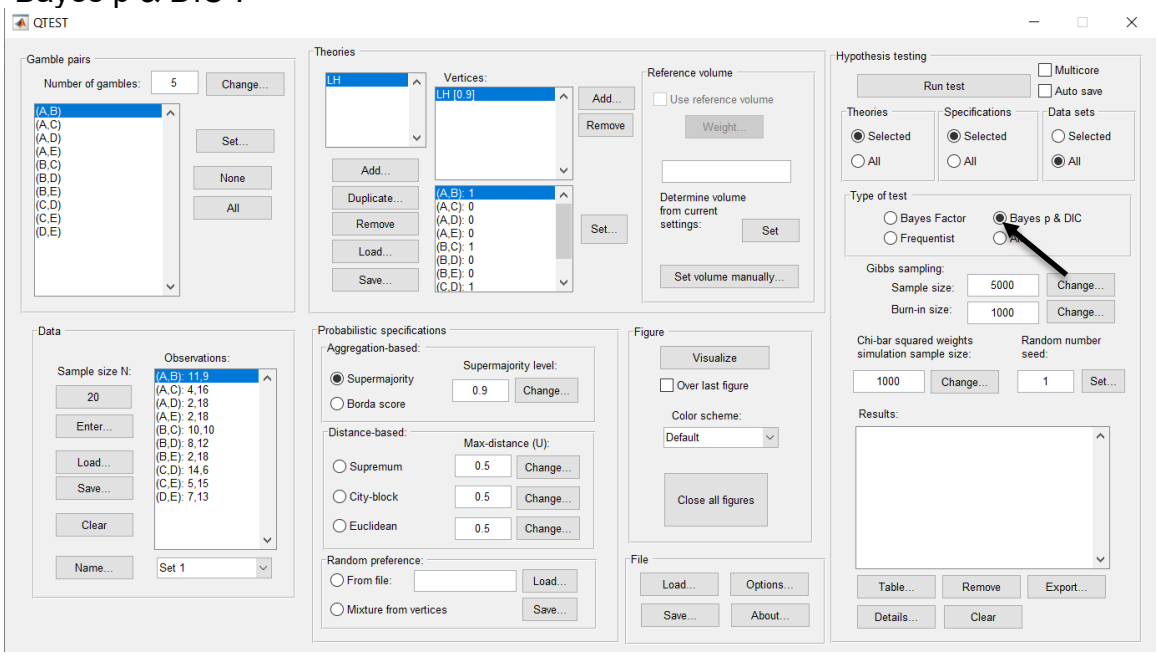
L.4.6 Hypothesis Testing: Cash I, $\mathcal{LH}$, 0.90-Supermajority

We are now ready for the Bayes p & DIC test of $\mathcal{LH}$ .90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

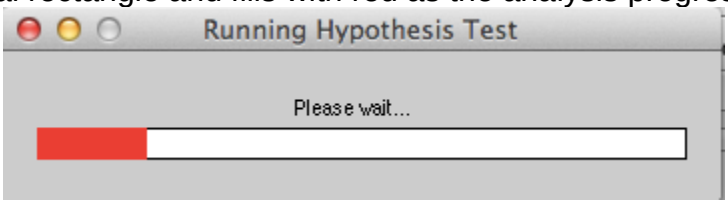
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



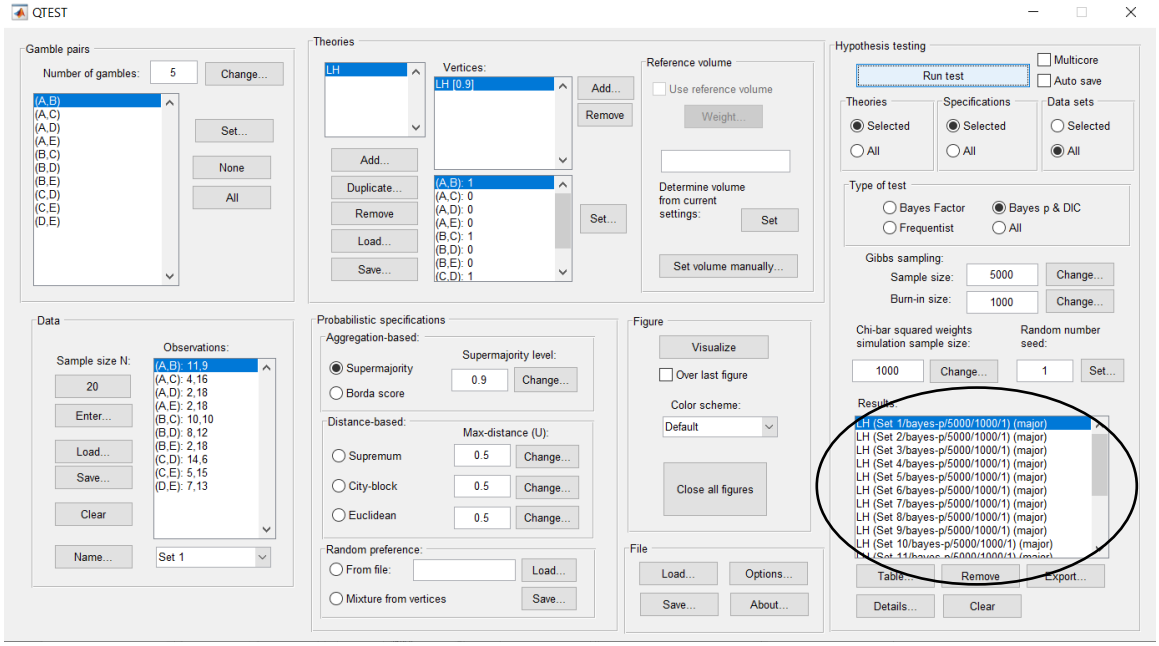
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes p & DIC”.



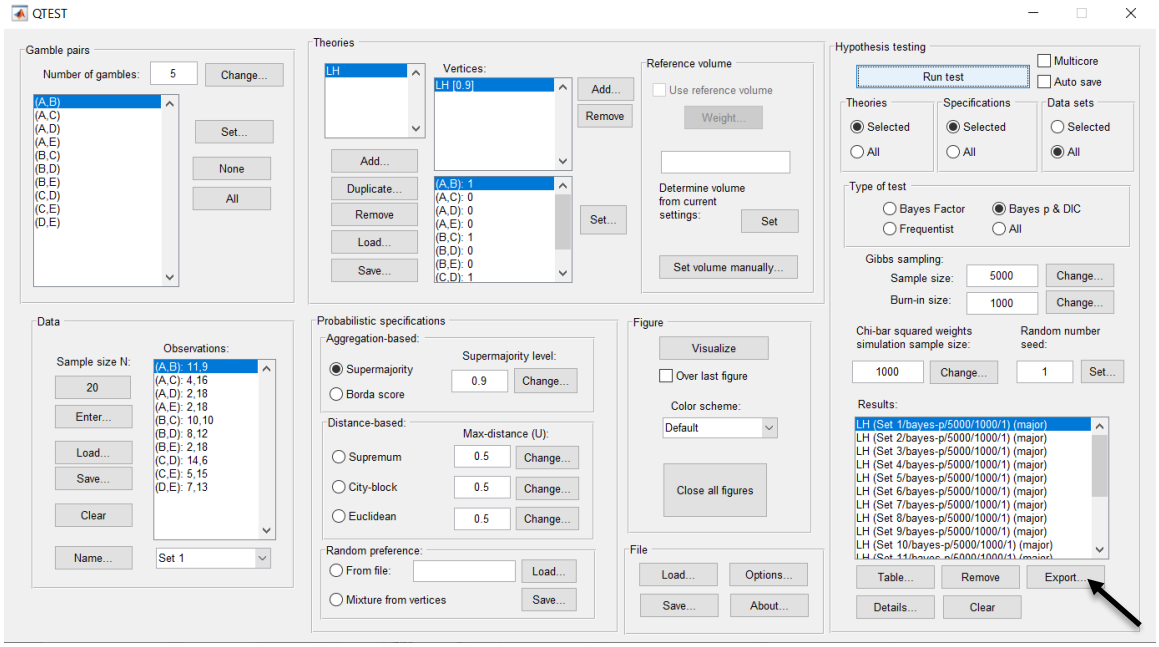
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



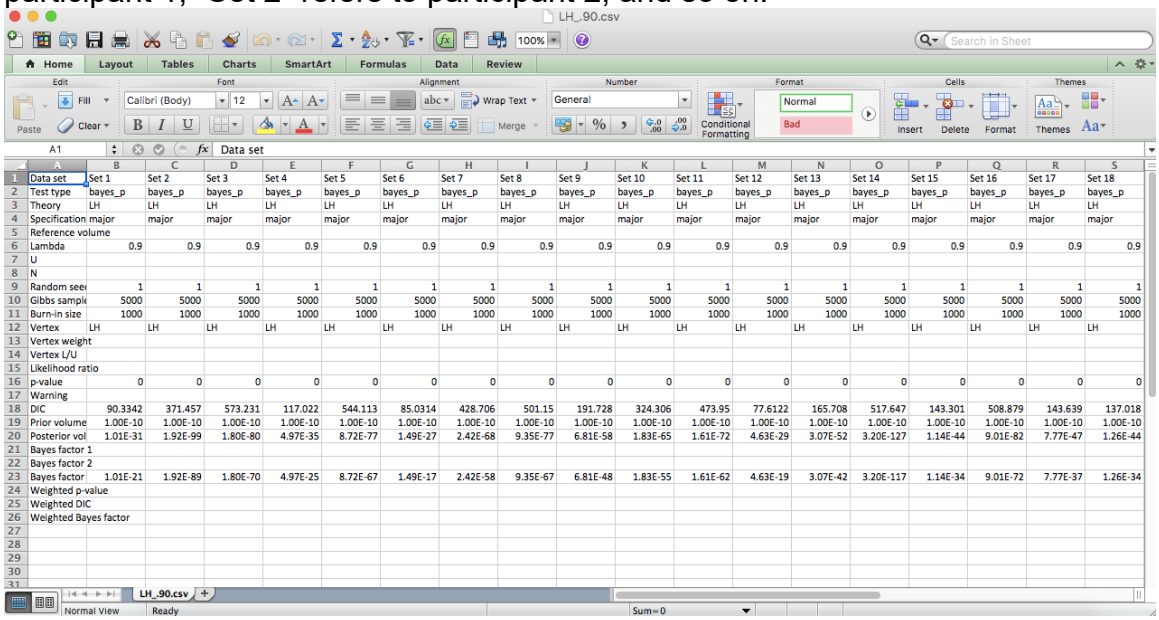
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “S” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
4	Specification	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference volume																		
6	Lambda	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7	U																		
8	N																		
9	Random see	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sampl	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Warning																		
18	DIC	90.3342	371.457	573.231	117.022	544.113	85.0314	428.706	501.15	191.728	324.306	473.95	77.6122	165.708	517.647	143.301	508.879	143.639	137.018
19	Prior volume	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10
20	Posterior vol	1.01E-31	1.92E-99	1.80E-80	4.97E-35	8.72E-77	1.49E-27	2.42E-68	9.35E-77	6.81E-58	1.83E-65	1.61E-72	4.63E-29	3.07E-52	3.20E-127	1.14E-44	9.01E-82	7.77E-47	1.26E-44
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor	1.01E-21	1.92E-89	1.80E-70	4.97E-25	8.72E-67	1.49E-17	2.42E-58	9.35E-67	6.81E-48	1.83E-55	1.61E-62	4.63E-19	3.07E-42	3.20E-117	1.14E-34	9.01E-72	7.77E-37	1.26E-34
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Bayes factor																		

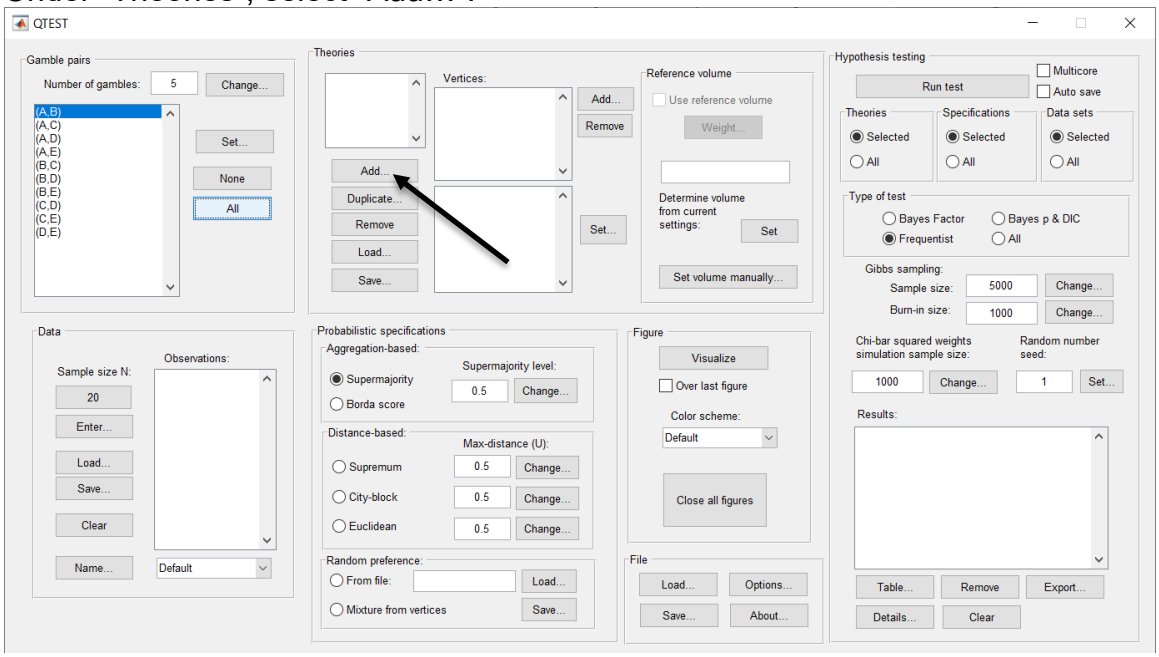
The p-values are in row 16 of the spreadsheet. The p-value in column “B” listed as “Set 1” is the Bayes p value for participant 1, listed under “0.90 Supermajority” and “LH” in Table 1 of QTBC2. Notice the same holds true for the column “C” listed as “Set 2”, for participant 2, and so on. From this file, column “0.90 Supermajority” under “LH” of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

The DIC values are in row 18 of the spreadsheet. Again, the DIC value in column “B” listed as “Set 1” is the DIC value for participant 1, listed under “0.90 Supermajority” and “LH” in Table 2 of QTBC2. Notice the same holds true for the column “C” listed as “Set 2”, for participant 2, and so on. From this file, column “LH” under “0.90 Supermajority” of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

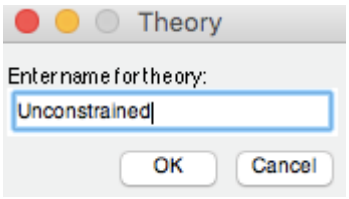
This completes the analysis for Cash I data for the Bayes p & DIC test of $L\not{H}$ .90-supermajority probabilistic specification.

L.5.1 Theory and Vertex: Cash I, Unconstrained Model

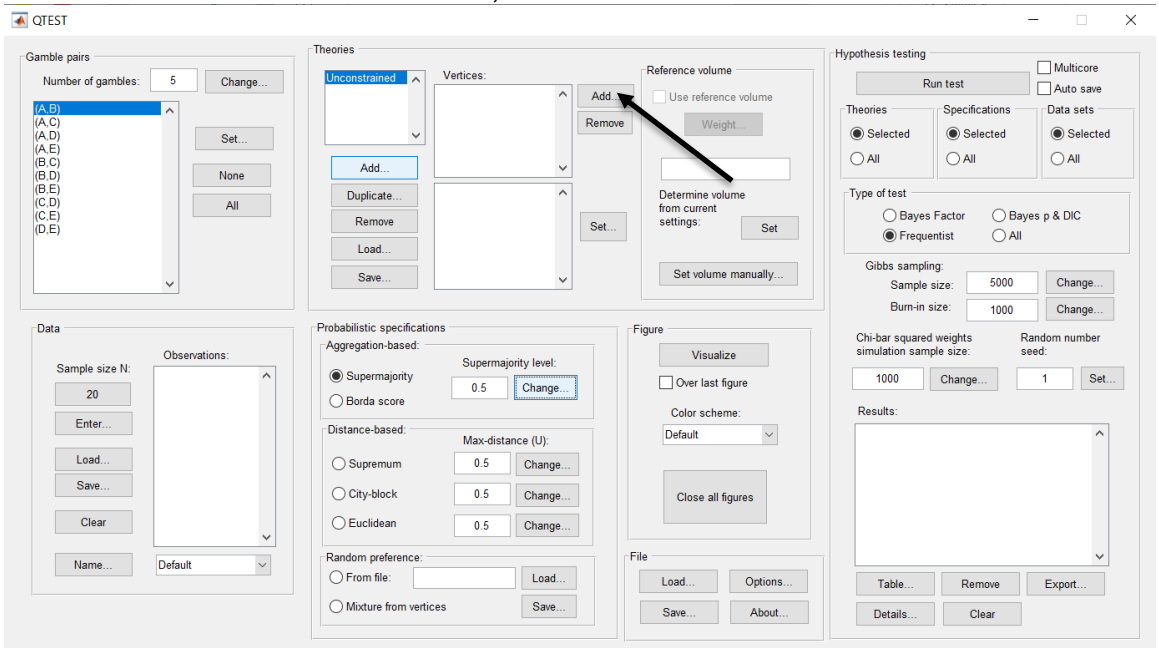
Under “Theories”, select “Add…”.



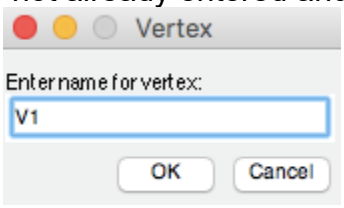
In the dialog box, type “Unconstrained” and select “OK”.



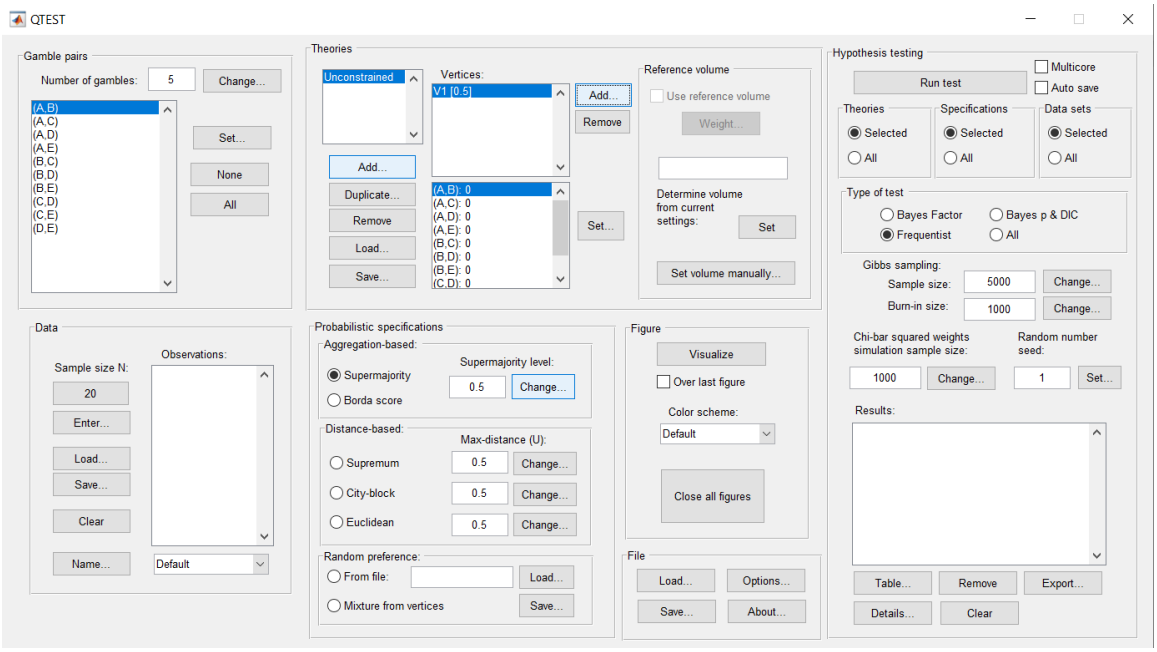
Under “Vertices:” under “Theories”, select “Add…”.



In the dialog box, type “V1” if not already entered and select “OK”.

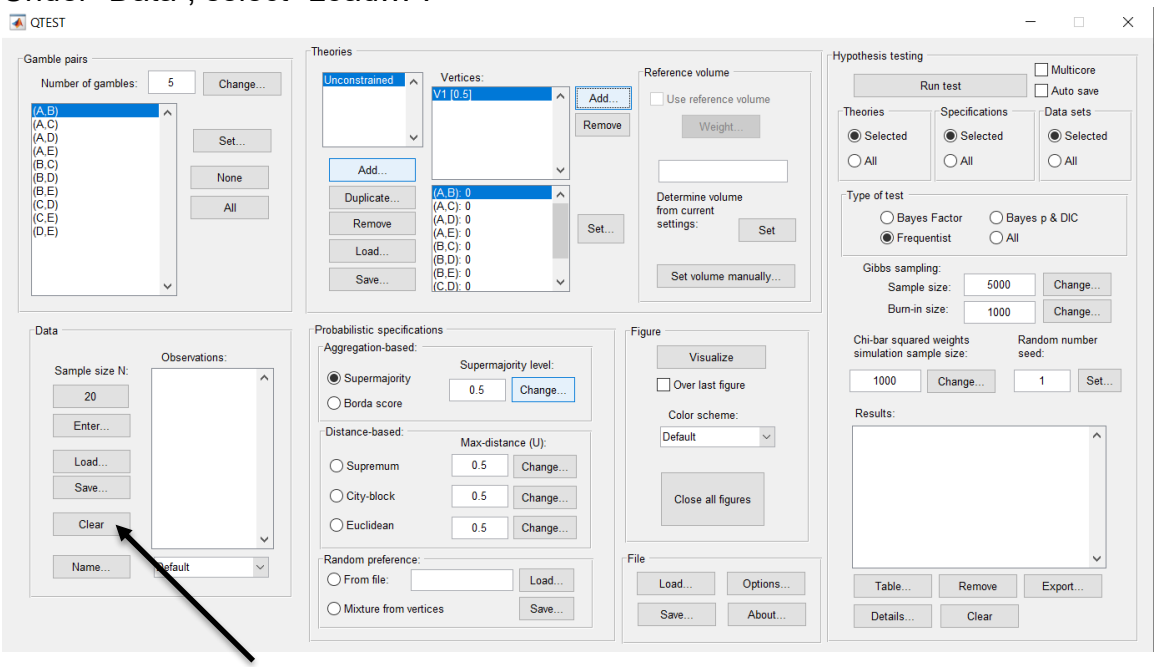


On the QTEST interface there should now be a list of 1 vertex for the unconstrained model under “Theories”. Verify your screen matches the screenshot below.



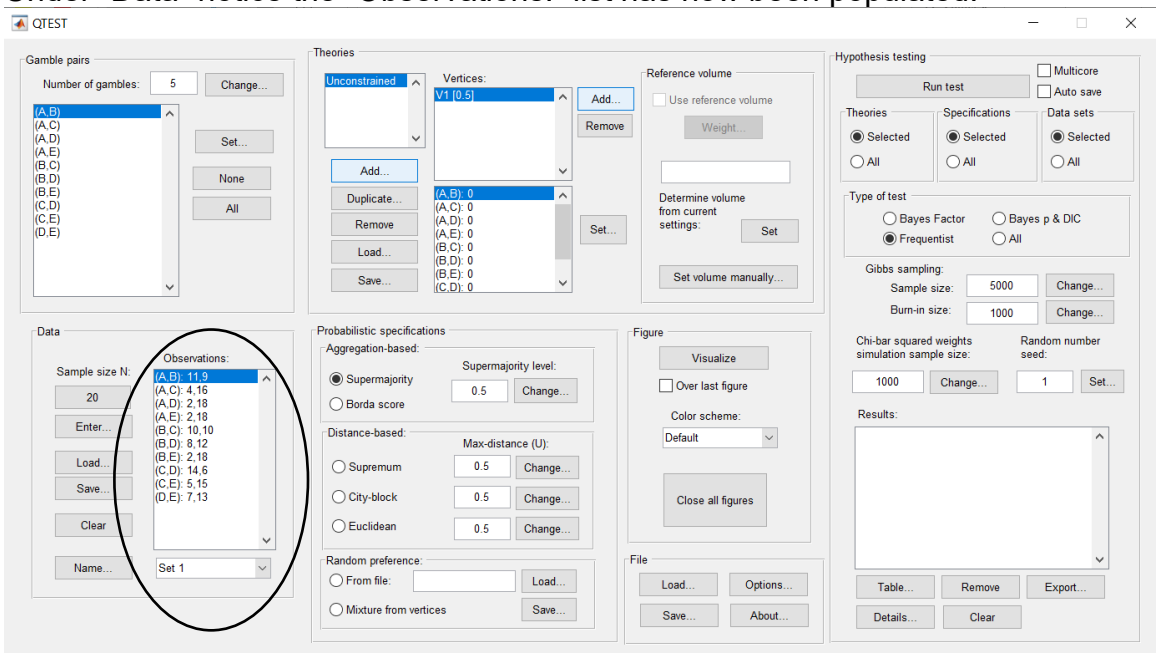
L.5.2 Data: Cash I, Unconstrained Model

Under “Data”, select “Load…”.



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “DataSets” folder and open “Cash1.txt”.

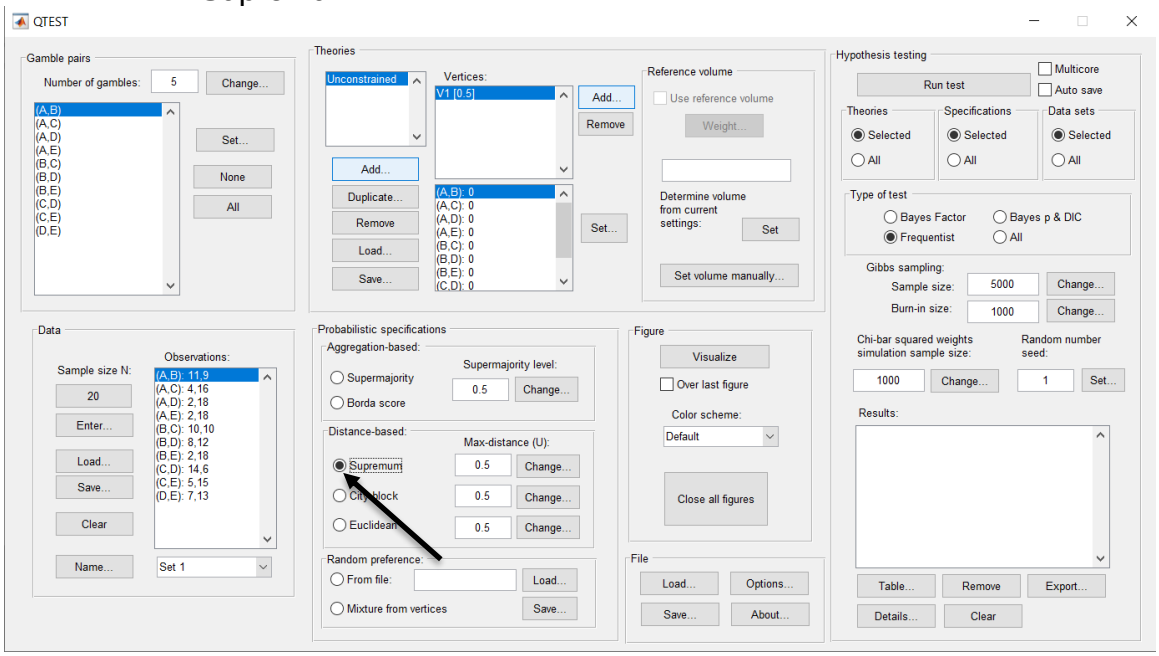
Under “Data” notice the “Observations:” list has now been populated:



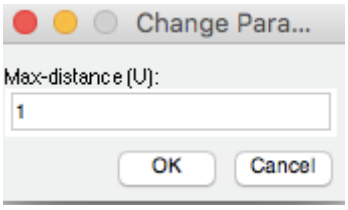
Under “Data”, select the dropdown menu next to “Name…” to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

L.5.3 Probabilistic specification: Cash I, Unconstrained Model, Max-Distance (U) Supremum of 1

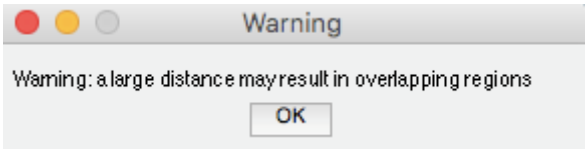
To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supremum” is selected.



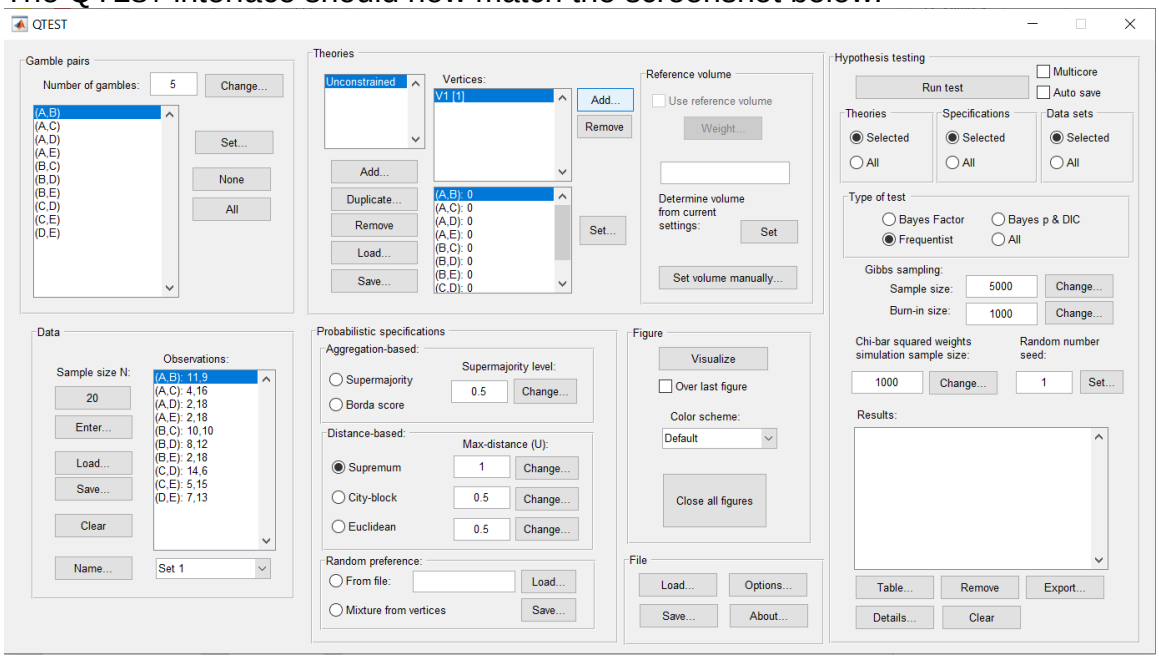
To set the “Max-distance (U):” to “1”, select “Change…” and enter “1”, then select “OK.”



Next, a warning dialog box will pop up, matching the one in the screenshot below. Select “OK”.



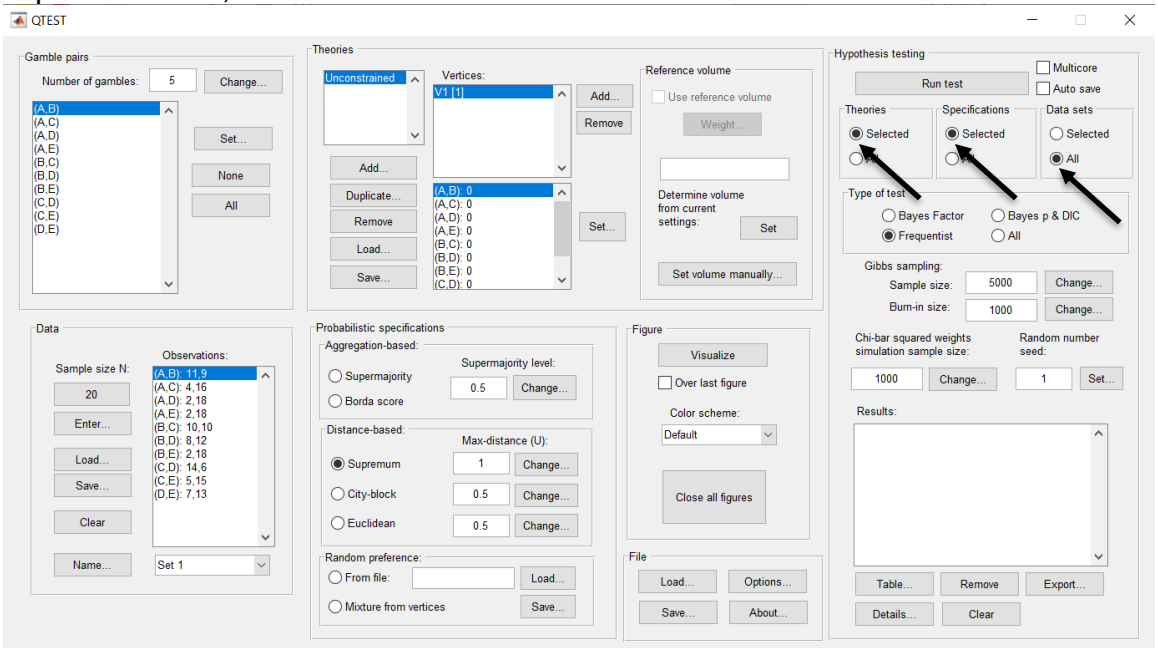
The QTEST interface should now match the screenshot below.



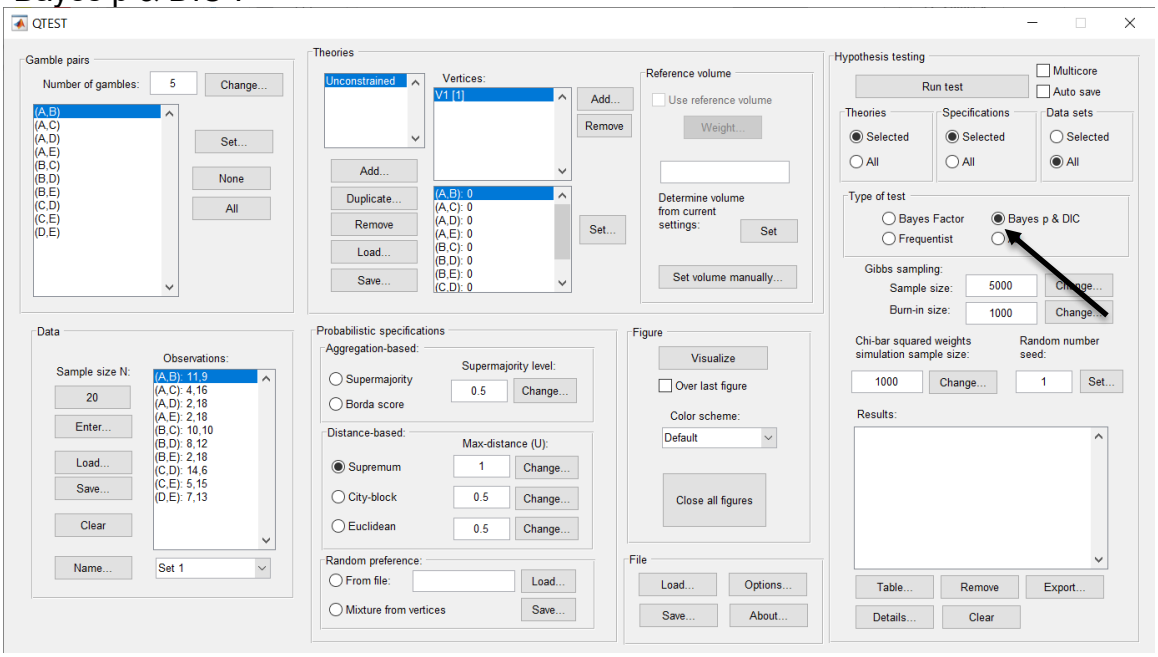
L.5.4 Hypothesis Testing: Cash I, Unconstrained Model, Max-Distance (U) Supremum of 1

We are now ready for the Bayes p & DIC test of the unconstrained model max-distance (U) supremum of 1 probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under “Hypothesis testing”, under the “Run test” button, there are 3 columns: “Theories”, “Specifications” and “Data sets”. For each of these, the user must choose the radio button next to either “Selected” or “All”. For more information on these settings, as well as the inputs for “Chi-bar squared weights simulation sample size:” and “Random number seed:”, see section G.5.

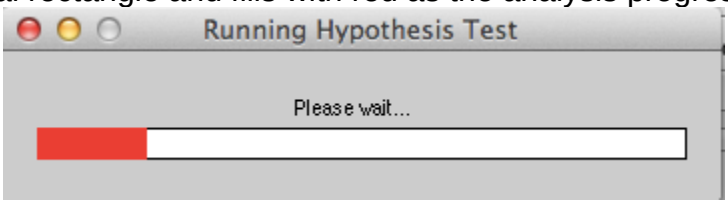
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



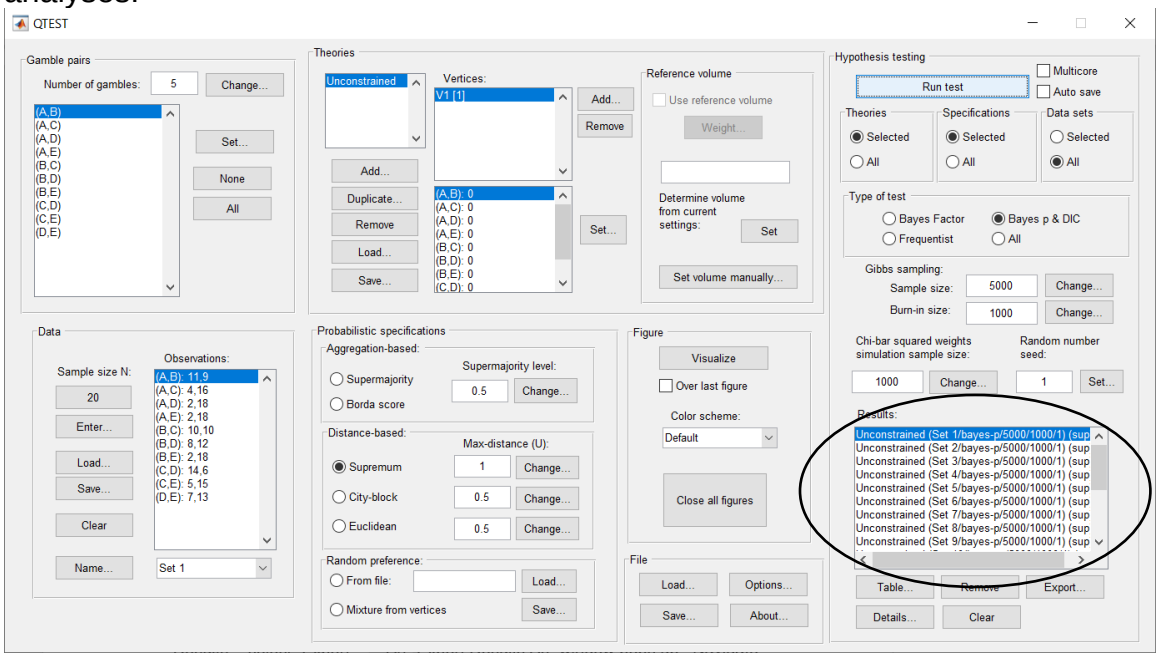
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes p & DIC”.



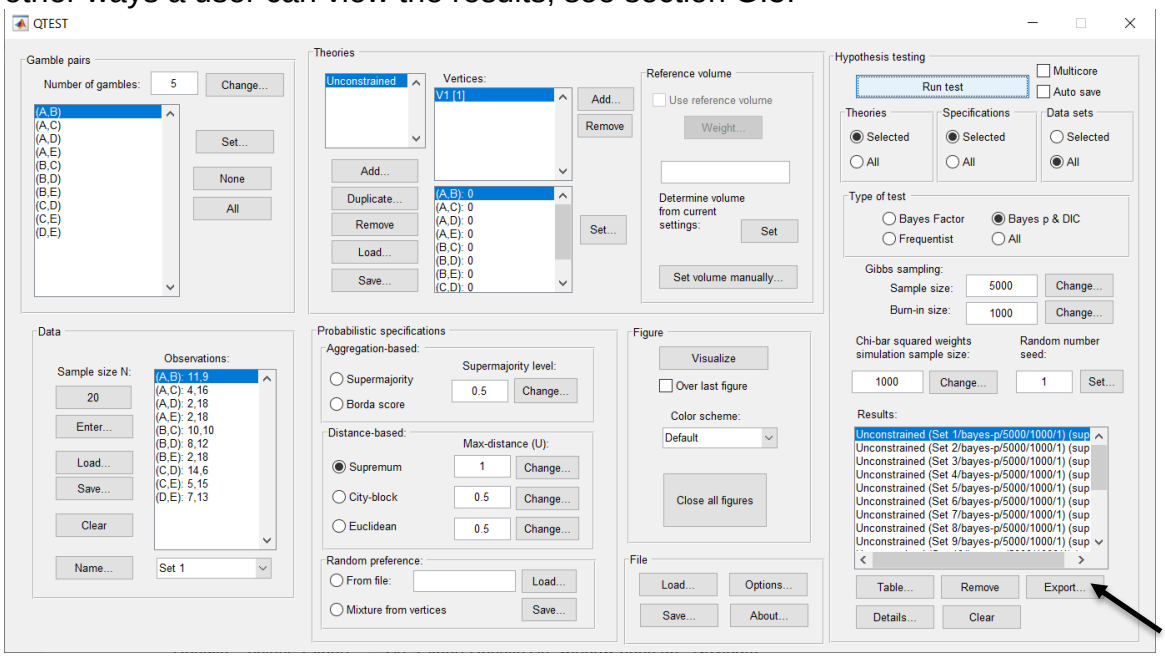
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



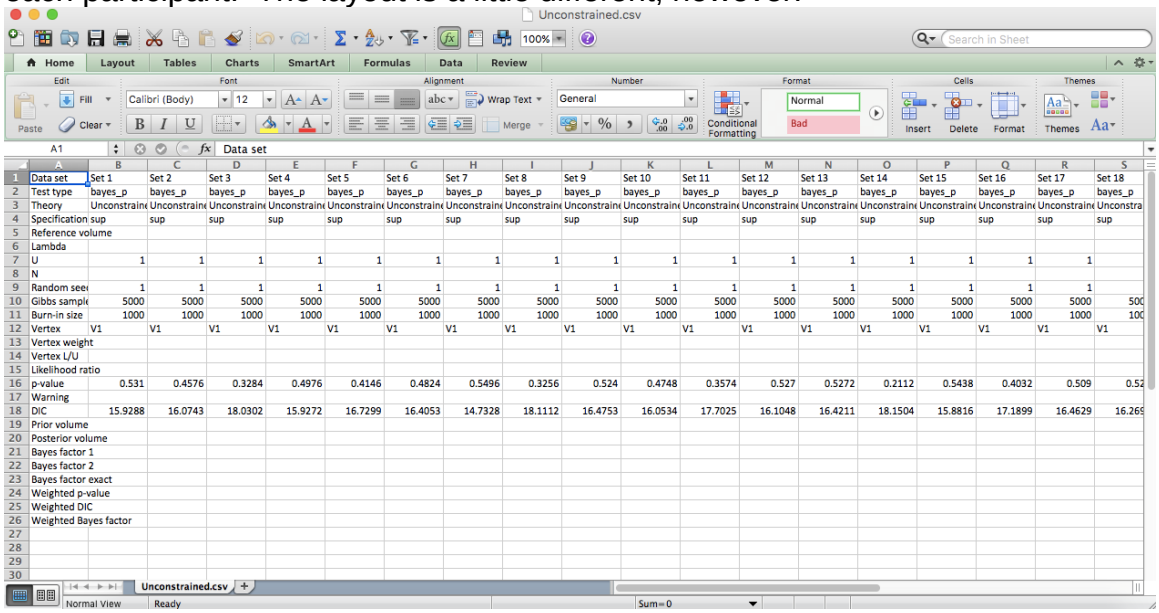
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory. Therefore, under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file. For more information on other ways a user can view the results, see section G.5.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “S” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on. All the information in this spreadsheet is identical to what one would see if they selected “Details…” for each participant. The layout is a little different, however.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstrain	Unconstra
4	Specification	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup
5	Reference volume																		
6	Lambda																		
7	U	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
8	N																		
9	Random see	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
10	Gibbs sample	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	500
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	100
12	Vertex	V1	V1	V1	V1	V1	V1	V1	V1	V1	V1	V1	V1	V1	V1	V1	V1	V1	V1
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value	0.531	0.4576	0.3284	0.4976	0.4146	0.4824	0.5496	0.3256	0.524	0.4748	0.3574	0.527	0.5272	0.2112	0.5438	0.4032	0.509	0.52
17	Warning																		
18	DIC	15.9288	16.0743	18.0302	15.9272	16.7299	16.4053	14.7328	18.1112	16.4753	16.0534	17.7025	16.1048	16.4211	18.1504	15.8816	17.1899	16.4629	16.269
19	Prior volume																		
20	Posterior volume																		
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor exact																		
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Bayes factor																		
27																			
28																			
29																			
30																			

The DIC values are in row 18 of the spreadsheet. The DIC value in column “B” listed as “Set 1” is the DIC value for participant 1, listed under “Unconstr.”—an abbreviation for the unconstrained model—in Table 2 of QTBC2. Notice the same holds true for the column “C” listed as “Set 2”, for participant 2, and so on. From this file, column “Unconstr.” of Table 2 can be replicated.

This completes the analysis for Cash I data for the Bayes p & DIC test of the unconstrained model max-distance (U) supremum of 1 probabilistic specification.

Now the user should have replicated all the Cash 1 Bayes p and DIC values of Tables 1 and 2 in QTBC2. To summarize, section L.2 demonstrated the steps in running the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{KT}$ for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications. Section L.3 demonstrated the steps in running the Bayes p & DIC test of $\mathcal{CPT}$-$\mathcal{GE}$ for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications. Then, section L.4 demonstrated the steps in running the Bayes p & DIC test of $\mathcal{LH}$ for the .50-majority/modal choice and the .90-supermajority probabilistic specifications. Lastly, section L.5 demonstrated the steps in running the Bayes p & DIC test for the unconstrained model.

M. Table 3 of QTBC2

This section of the tutorial allows a user of QTEST to replicate the Cash 1 Bayes factor values of Table 3 in QTBC2.

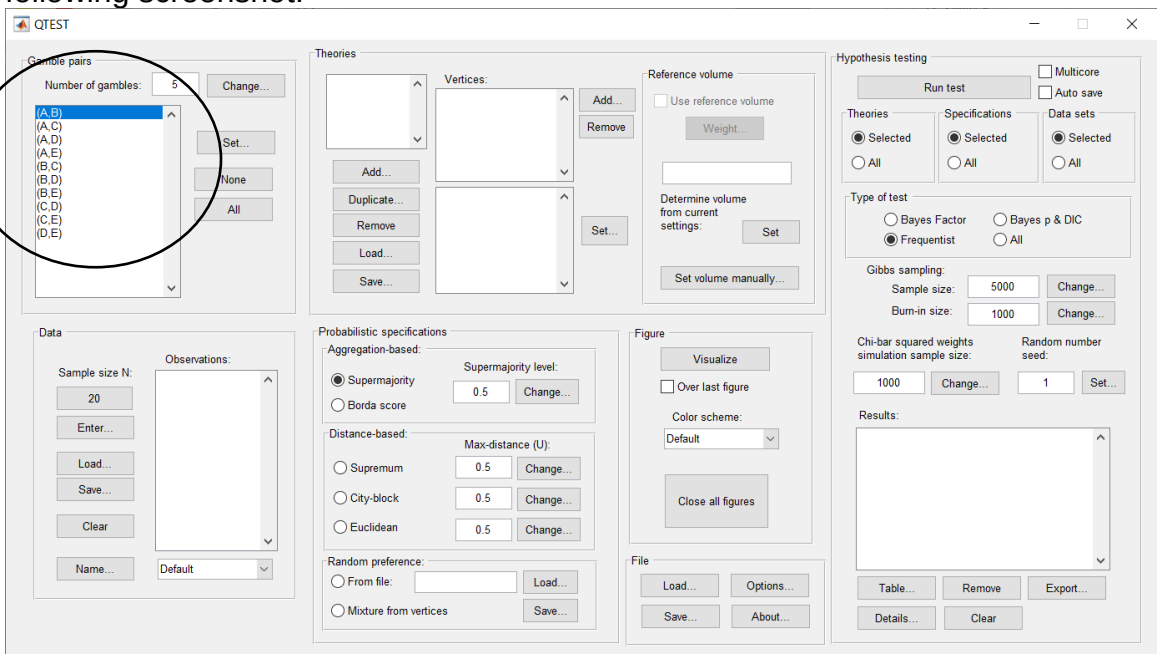
Section M.2 demonstrates to a user the steps in running the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{KT}$ for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications.

Section M.3 demonstrates to a user the steps in running the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{GE}$ for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications.

Then, section M.4 demonstrates to a user the steps in running the Bayes Factor test of $\mathcal{LH}$ for the .50-majority/modal choice and the .90-supermajority probabilistic specifications.

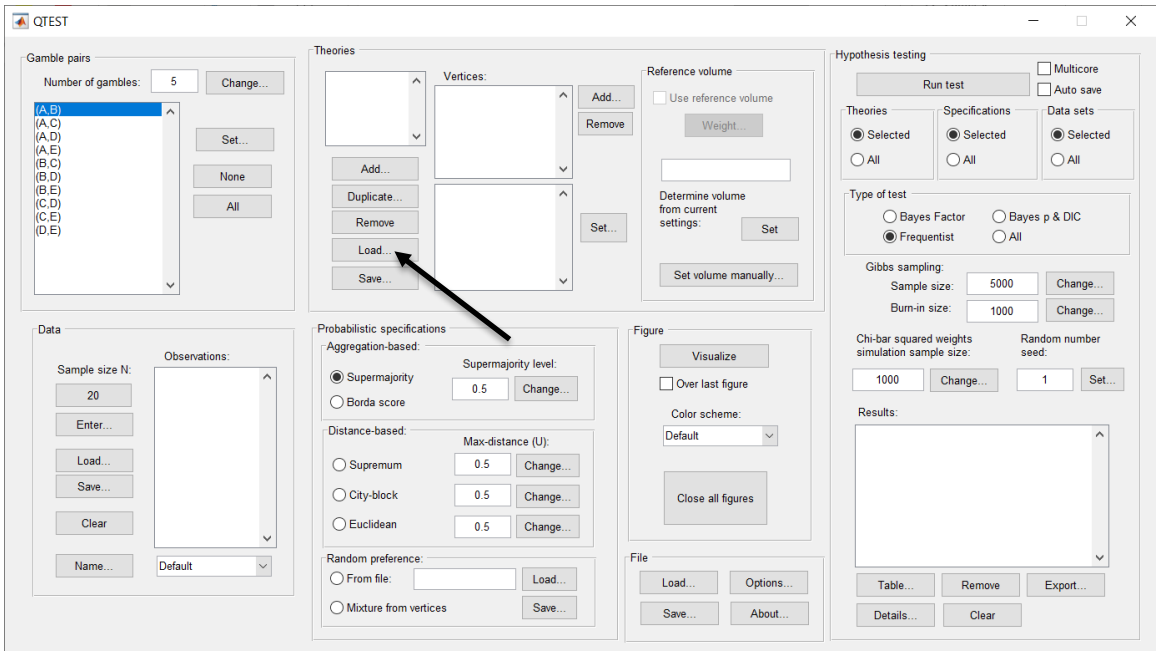
M.1 Gamble pairs

Starting with a clear (or new) QTEST interface, under “Gamble pairs”, “Change” the “Number of gambles:” to “5” and then select “All”. QTEST should look like the following screenshot.

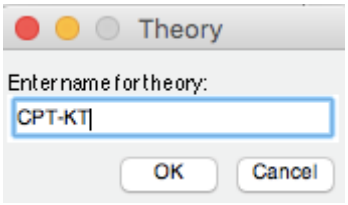


M.2.1 Theory and Vertex: Cash I, *CPT-KT*

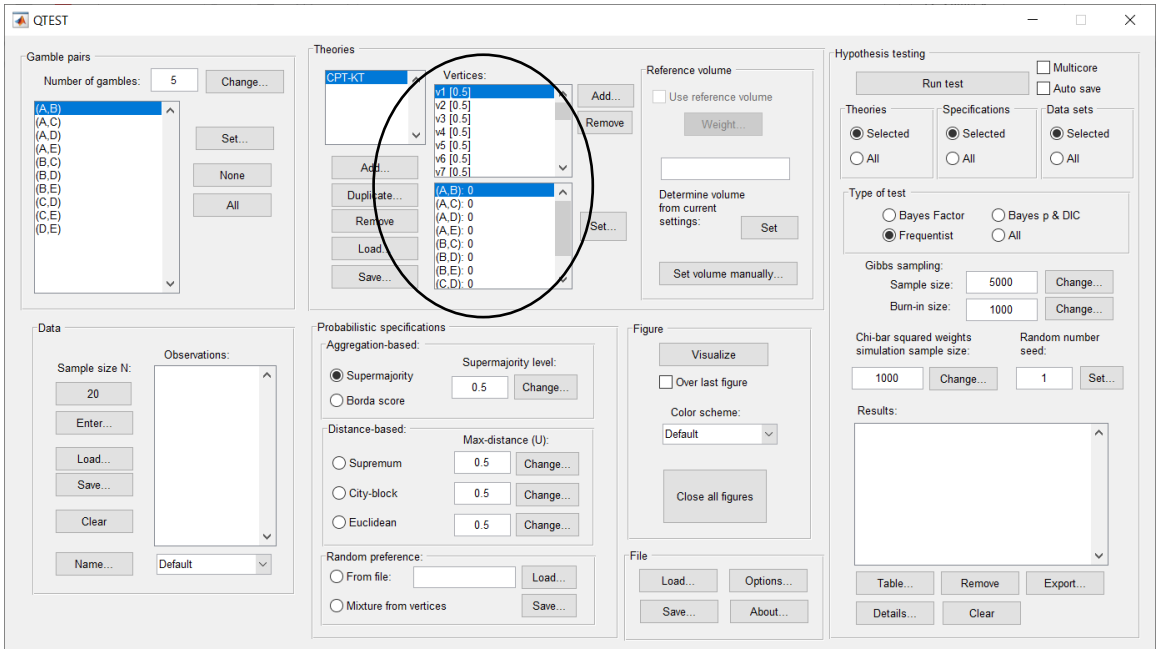
Under “Theories”, select “Load…”.



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “TheoriesVertices” folder and open “Vertices_CPT_KT_Cash1.csv”. In the dialog box, type “CPT-KT” and select “OK”.

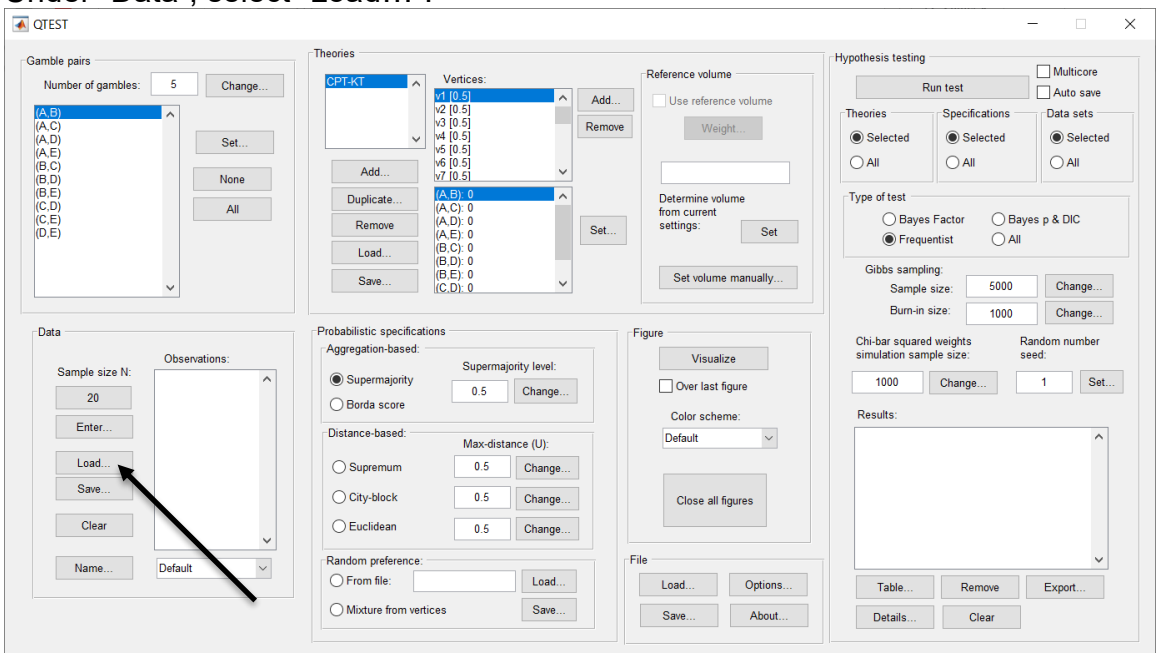


On the QTEST interface there should now be a list of 22 vertices for *CPT-KT* under “Theories”. Verify your screen matches the screenshot below.



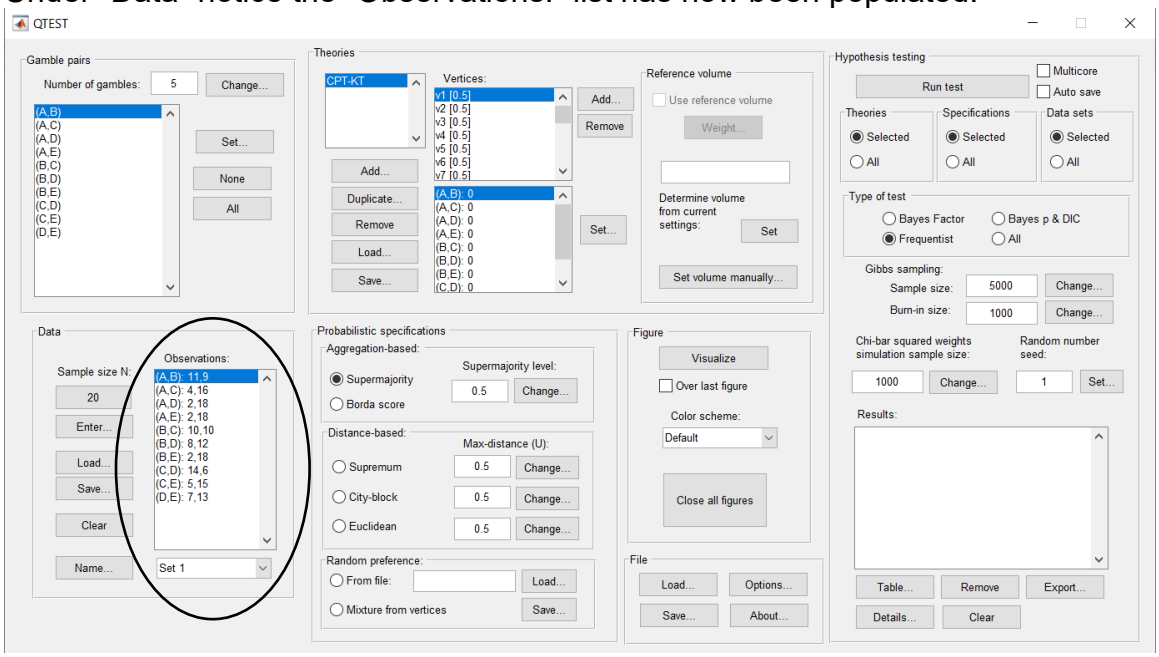
M.2.2 Data: Cash I, *CPT-KT*

Under “Data”, select “Load…”.



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “DataSets” folder and open “Cash1.txt”.

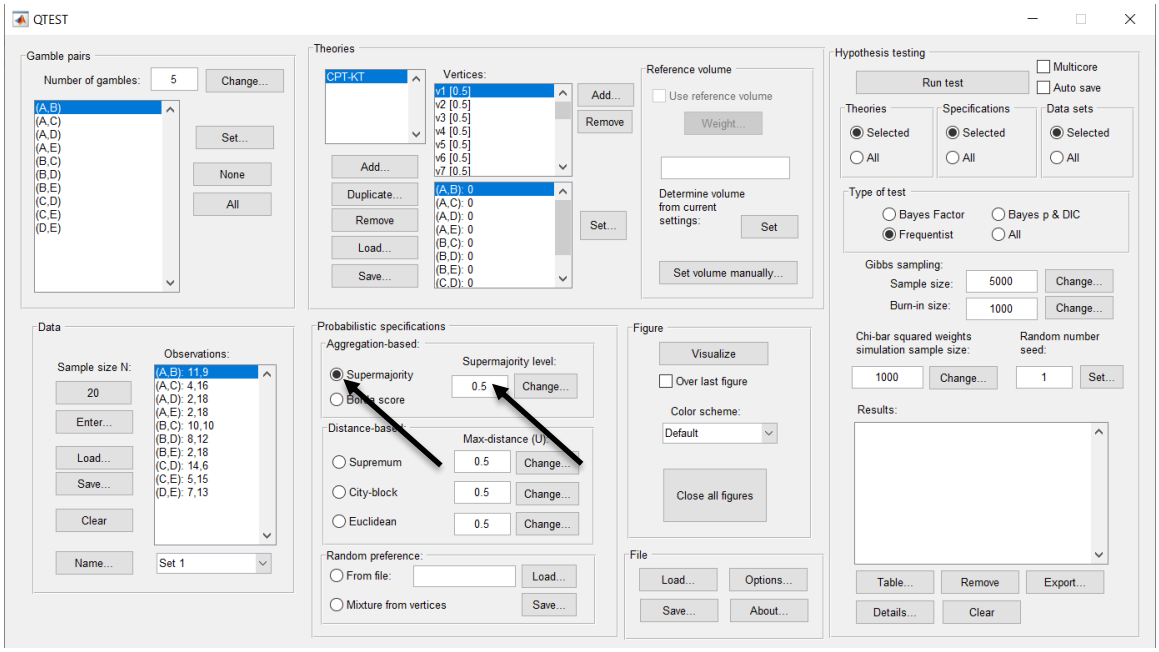
Under “Data” notice the “Observations:” list has now been populated:



Under “Data”, select the dropdown menu next to “Name…” to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

M.2.3 Probabilistic Specification: Cash I, *CPT-KT*, .50-Majority/modal choice

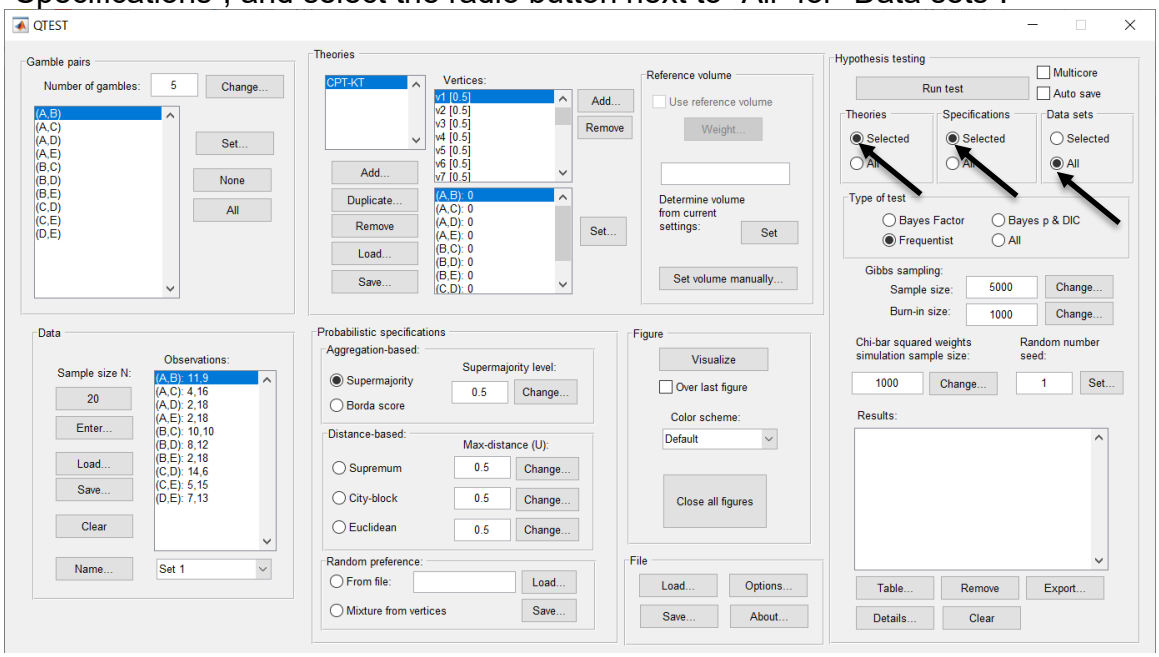
To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected and that the “Supermajority level:” is set to “0.5”.



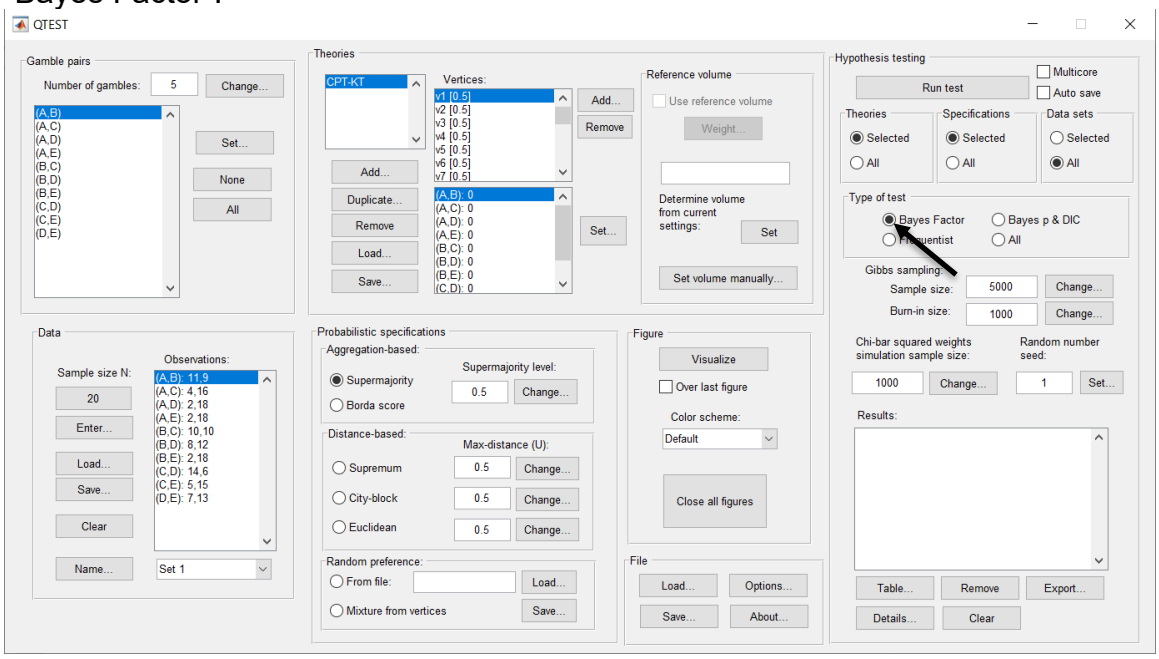
M.2.4 Hypothesis Testing: Cash I, *CPT-KT*, .50-Majority/modal choice

We are now ready for the Bayes Factor test of *CPT-KT* .50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under “Hypothesis testing”, under the “Run test” button, there are 3 columns: “Theories”, “Specifications” and “Data sets”. For each of these, the user must choose the radio button next to either “Selected” or “All”. For more information on these settings, as well as the inputs for “Chi-bar squared weights simulation sample size:” and “Random number seed:”, see section G.5.

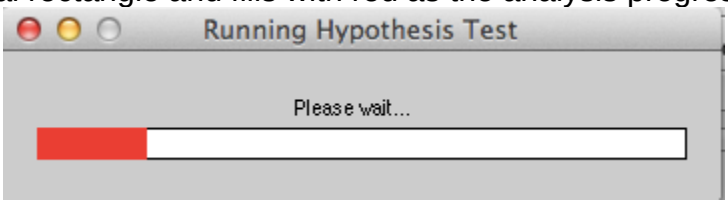
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



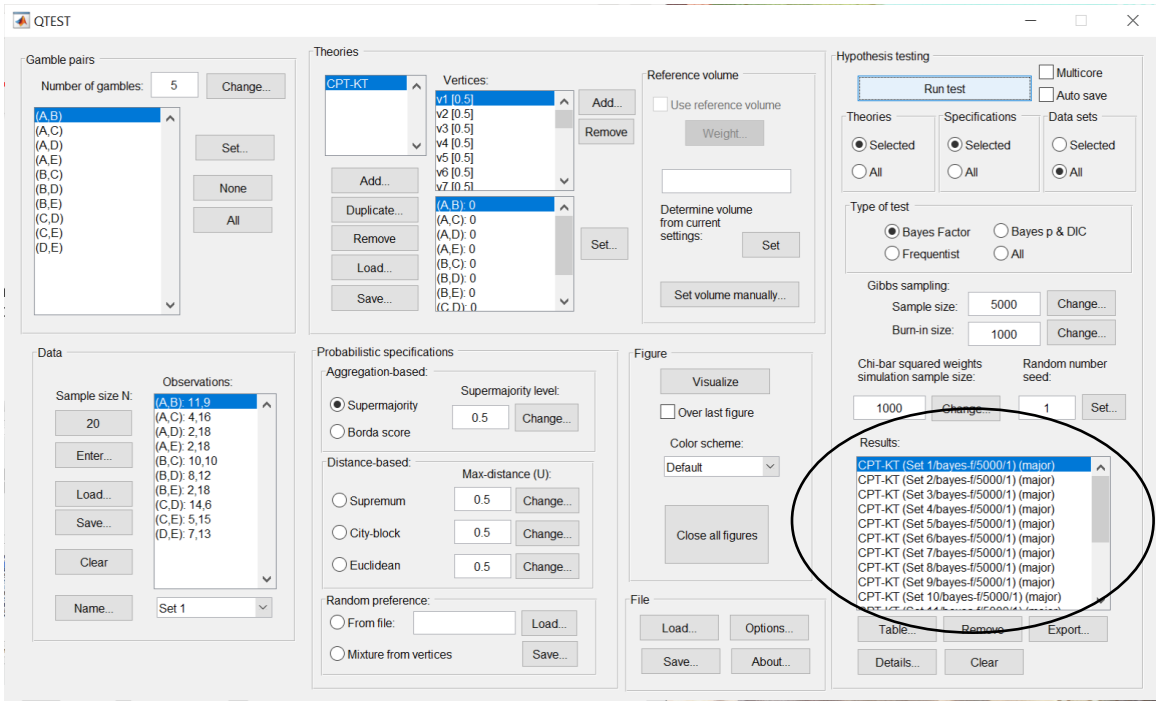
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes Factor”.



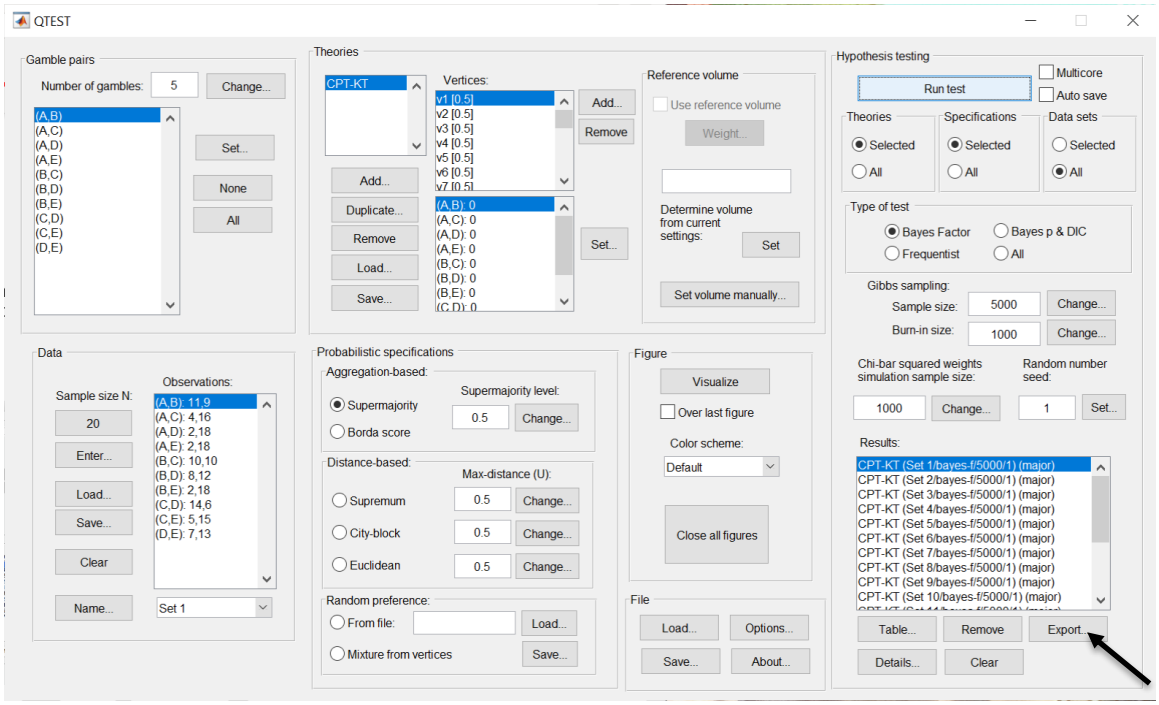
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



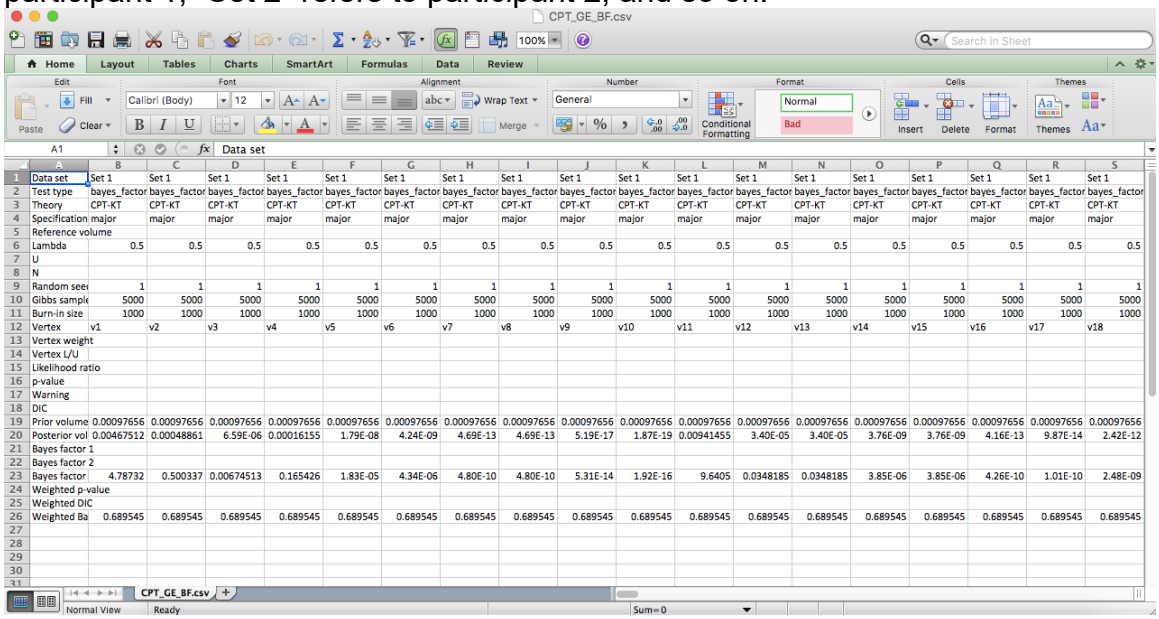
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “OG” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1
2	Test type	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor
3	Theory	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT
4	Specification	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference volume																		
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																		
8	N																		
9	Random seed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sample	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14	v15	v16	v17	v18
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value																		
17	Warning																		
18	DIC																		
19	Prior volume	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656
20	Posterior vol	0.00467512	0.00048861	6.59E-06	0.00016155	1.79E-08	4.24E-09	4.69E-13	4.69E-13	5.19E-17	1.87E-19	0.00941455	3.40E-05	3.40E-05	3.76E-09	3.76E-09	4.16E-13	9.87E-14	2.42E-12
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor	4.78732	0.500337	0.00674513	0.165426	1.83E-05	4.34E-06	4.80E-10	4.80E-10	5.31E-14	1.92E-16	9.6405	0.0348185	0.0348185	3.85E-06	3.85E-06	4.26E-10	1.01E-10	2.48E-09
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Ba	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545
27																			
28																			
29																			
30																			
31																			

The weighted Bayes factor values are in row 26 of the spreadsheet. Notice the same Bayes factor repeats for all the columns “B” through “W” listed as “Set 1”—this is where the Bayes factor for participant 1 can be found, listed under “0.50 Majority Choice” and “KT” in Table 3 of QTBC2. Notice the same holds true for all the columns “X” through “AS” listed as “Set 2”, for participant 2, and so on.

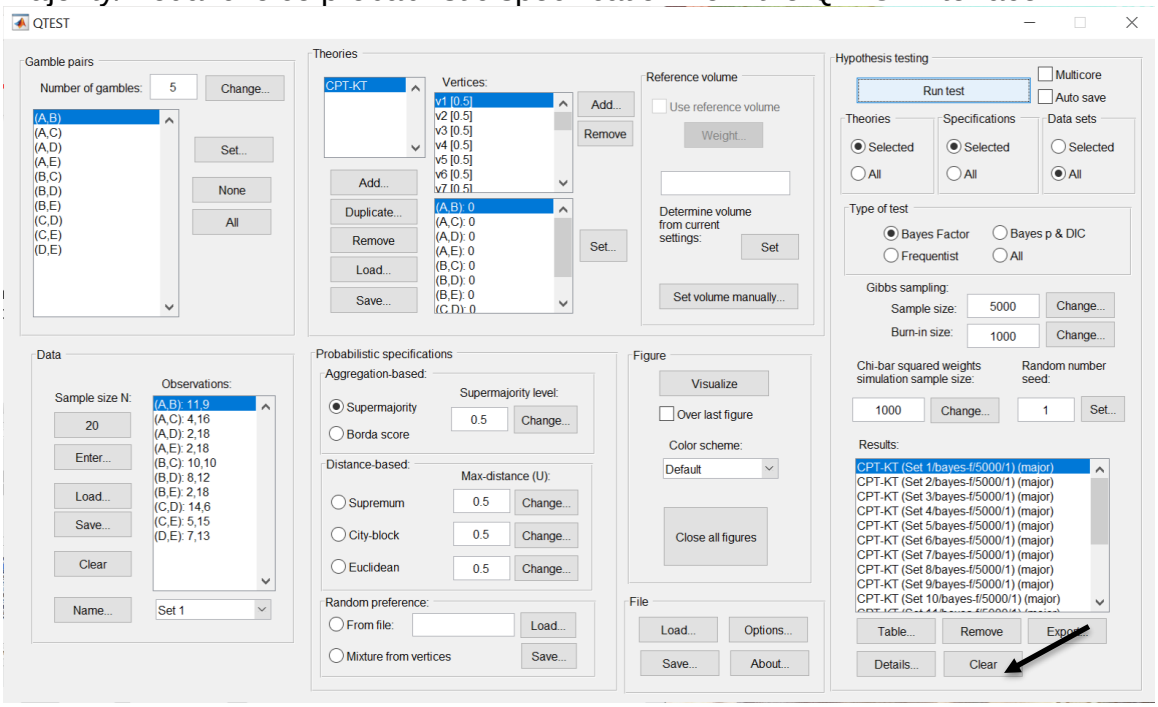
Note, however, that the weighted Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select “Change…” next to “Sample size:” under “Hypothesis testing” and “Gibbs sampling:”. Then, in the “Gibbs sampling” dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column “KT” under “0.50 Majority Choice” of Table 3 can be replicated.

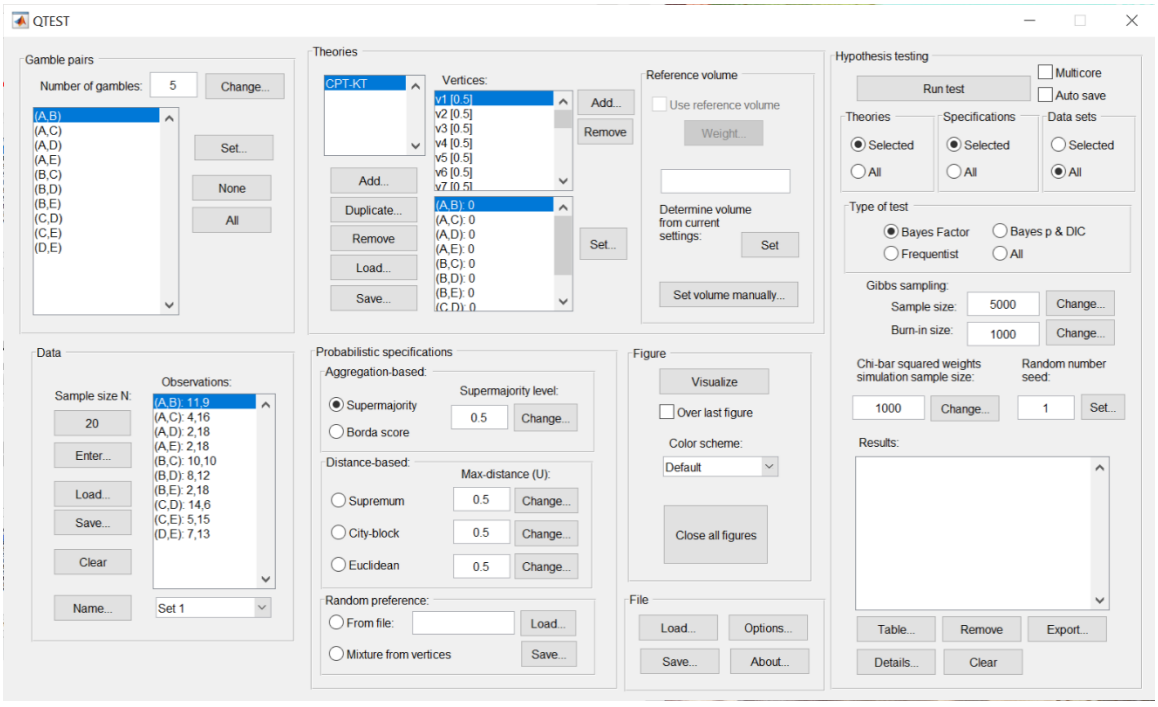
This completes the analysis for Cash I data for the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{KT}$ .50-majority/modal choice probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{KT}$, but now with a .90-supermajority probabilistic specification in the following two sections, M.2.5 and M.2.6.

M.2.5 Probabilistic Specification: Cash I, *CPT-KT*, .90-Supermajority

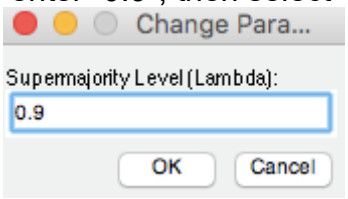
If continuing from section M.2.4, select “Clear” under “Hypothesis testing” and “Results:”. This step clears the results of the Bayes Factor test of *CPT-KT* .50-majority/modal choice probabilistic specification from the QTEST interface.



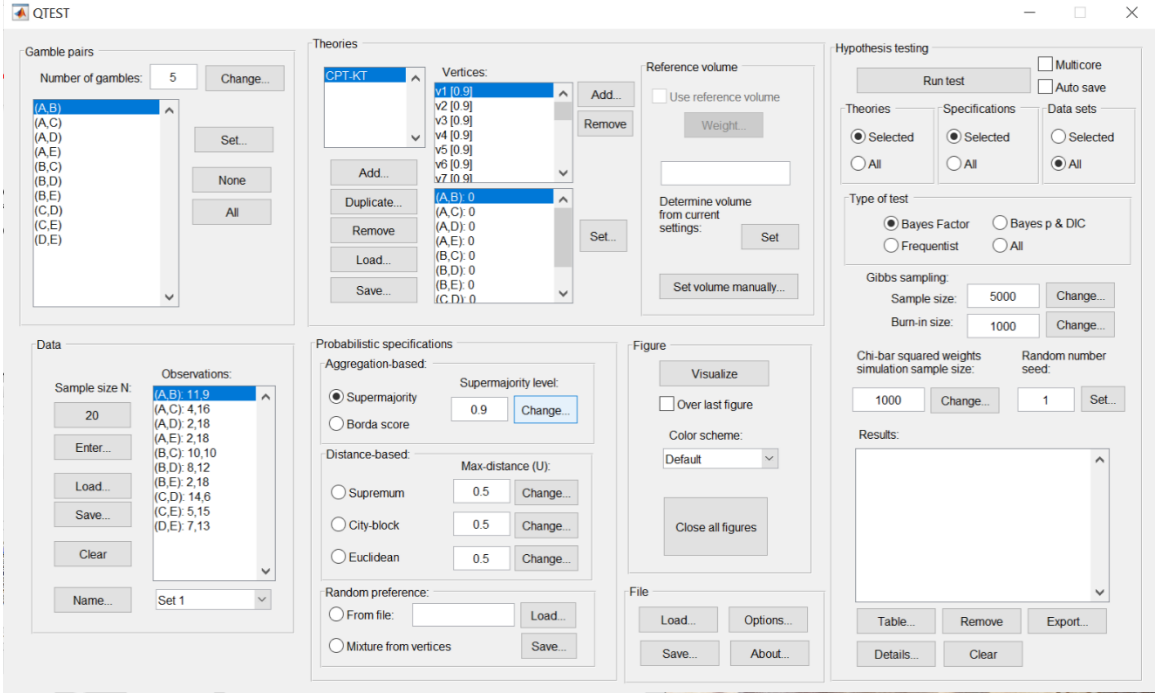
Whether the user is continuing from section M.2.2 or M.2.4, the QTEST interface should match the screenshot below.



To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected. To set the “Supermajority level:” to “0.9”, select “Change…” and enter “0.9”, then select “OK.”



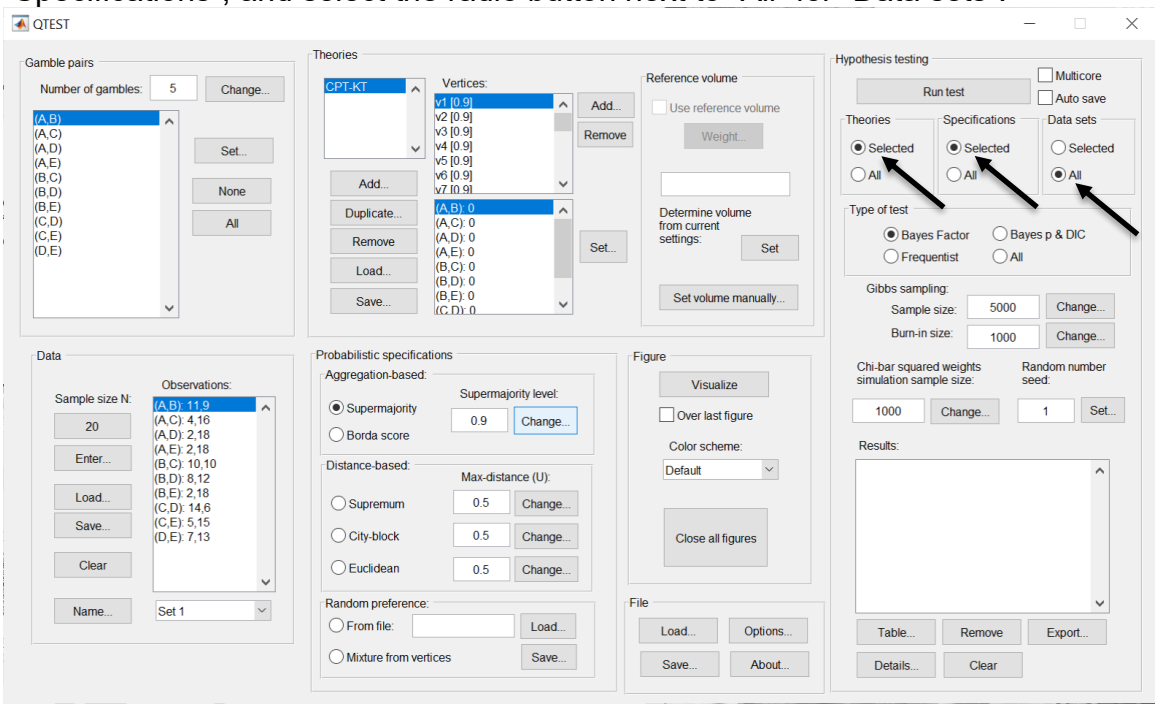
The QTEST interface should now match the screenshot below.



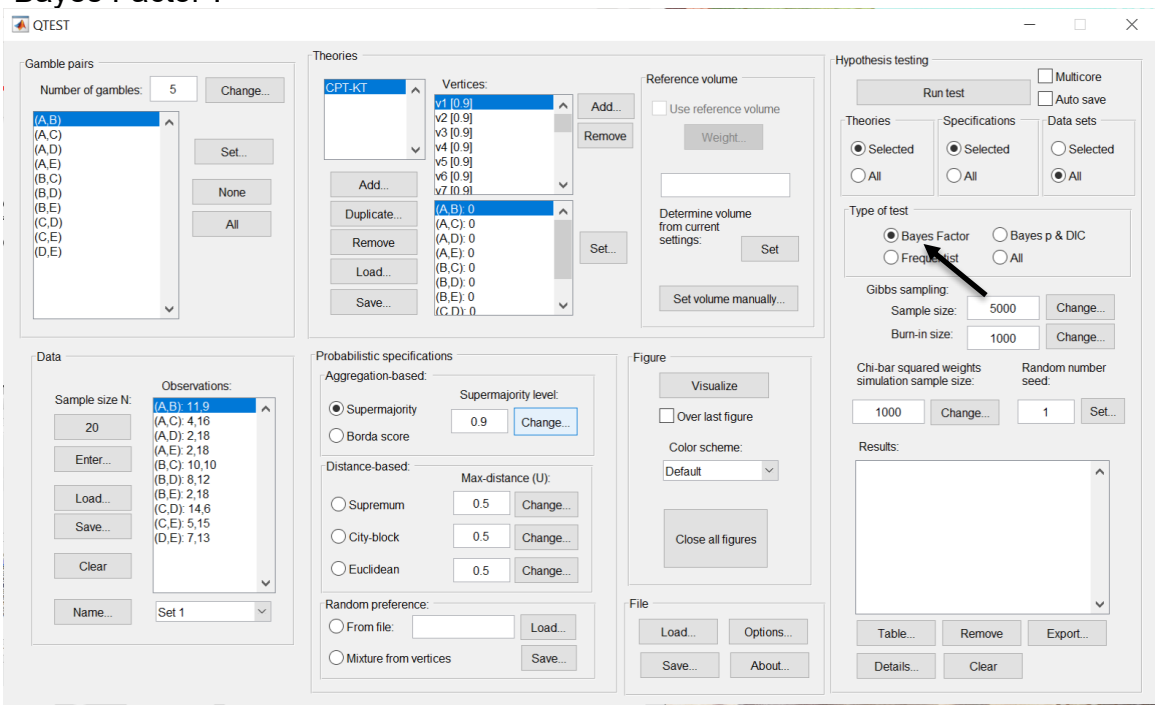
M.2.6 Hypothesis Testing: Cash I, *CPT-KT*, .90-Supermajority

We are now ready for the Bayes Factor test of *CPT-KT* .90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

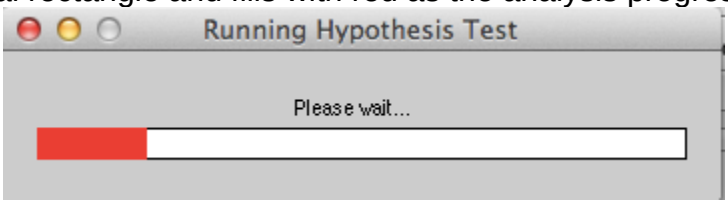
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



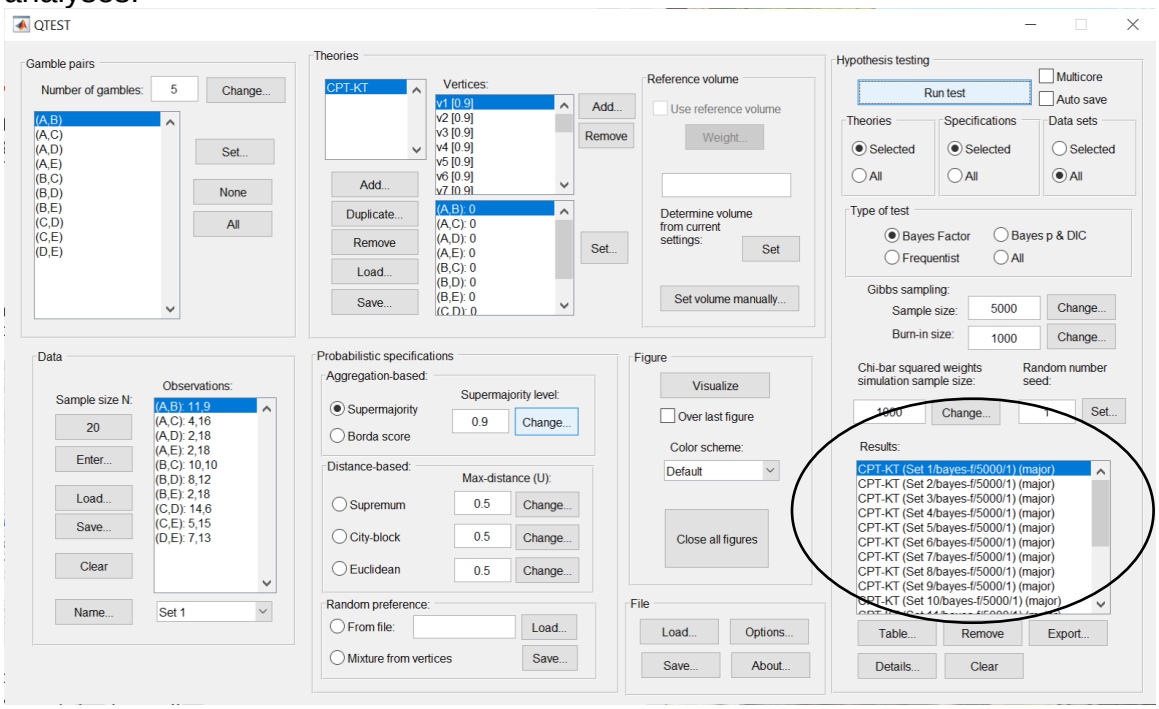
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes Factor”.



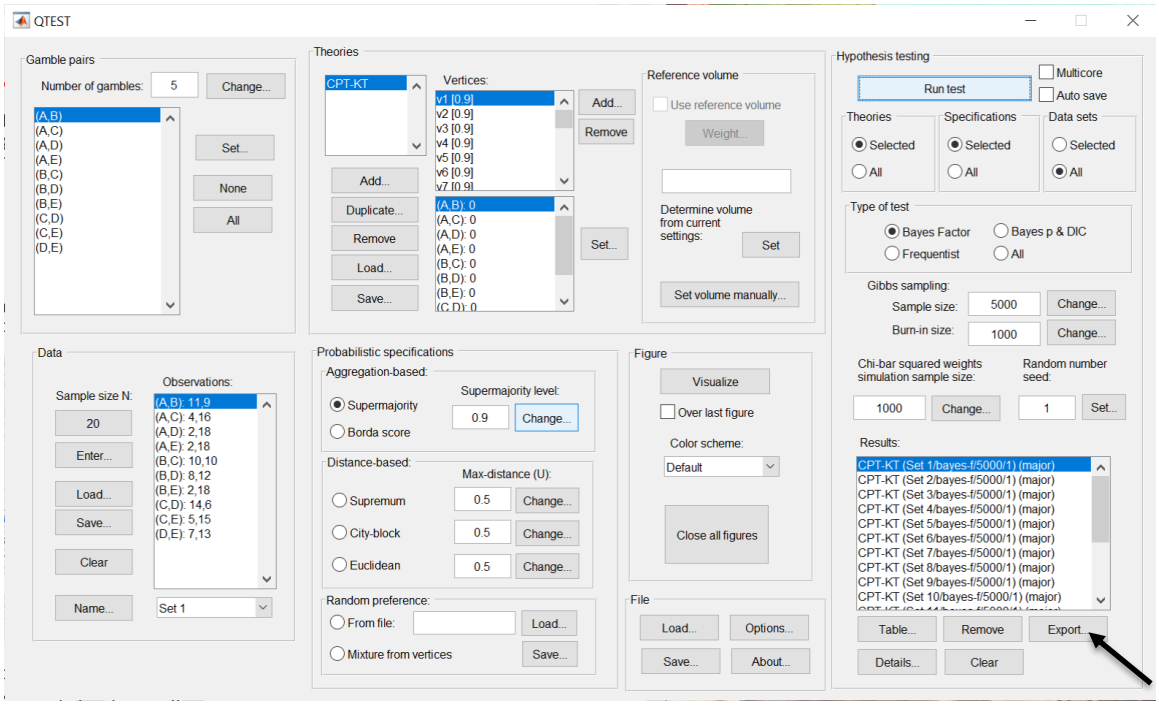
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



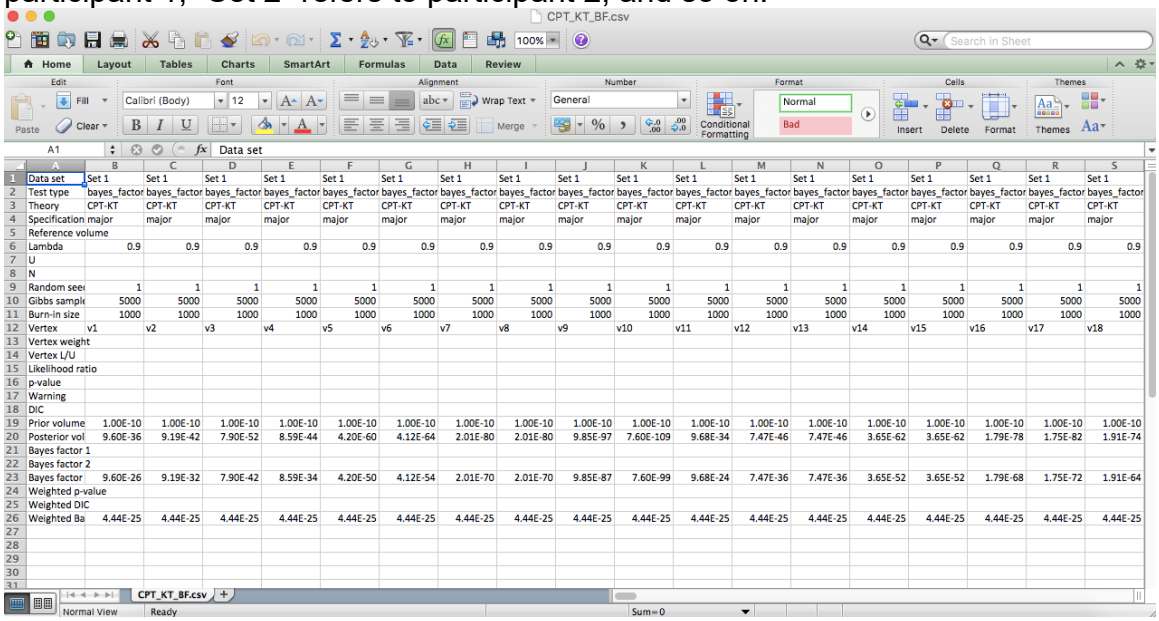
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “OG” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



The weighted Bayes factor values are in row 26 of the spreadsheet. Notice the same Bayes factor repeats for all the columns “B” through “W” listed as “Set 1”—this is where the Bayes factor for participant 1 can be found, listed under “0.90 Supermajority” and “KT” in Table 3 of QTBC2. Notice the same holds true for all the columns “X” through “AS” listed as “Set 2”, for participant 2, and so on.

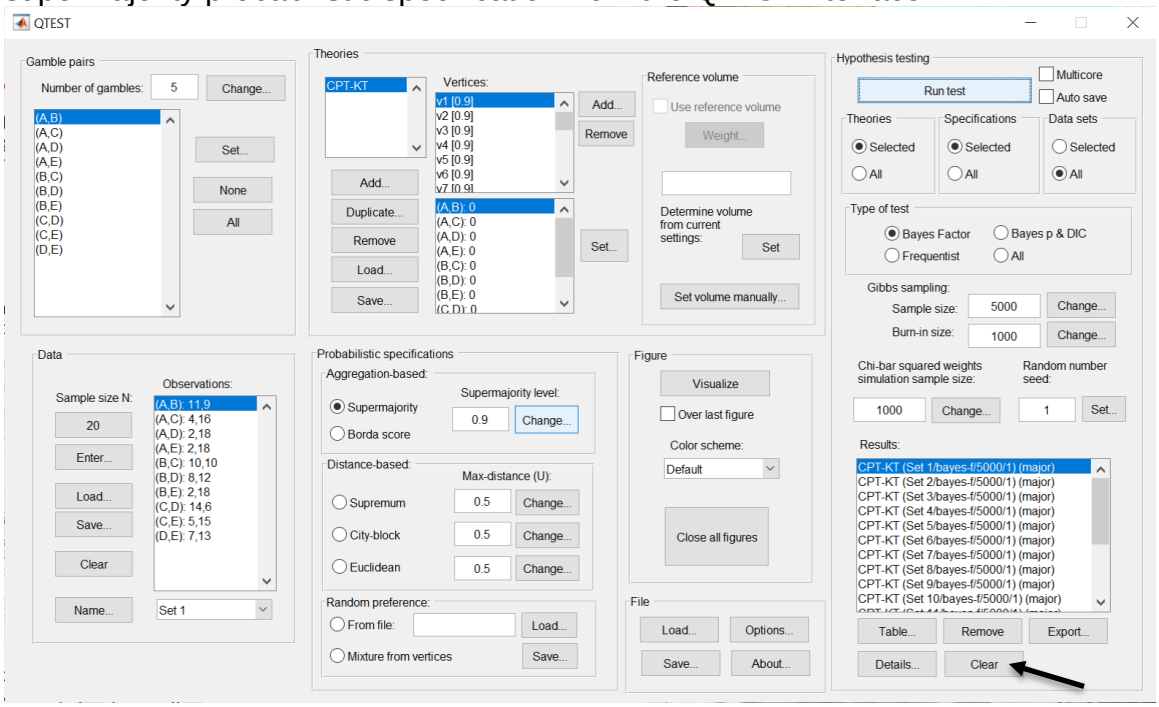
Note, however, that the weighted Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select “Change…” next to “Sample size:” under “Hypothesis testing” and “Gibbs sampling:”. Then, in the “Gibbs sampling” dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column “KT” under “0.90 Supermajority” of Table 3 can be replicated.

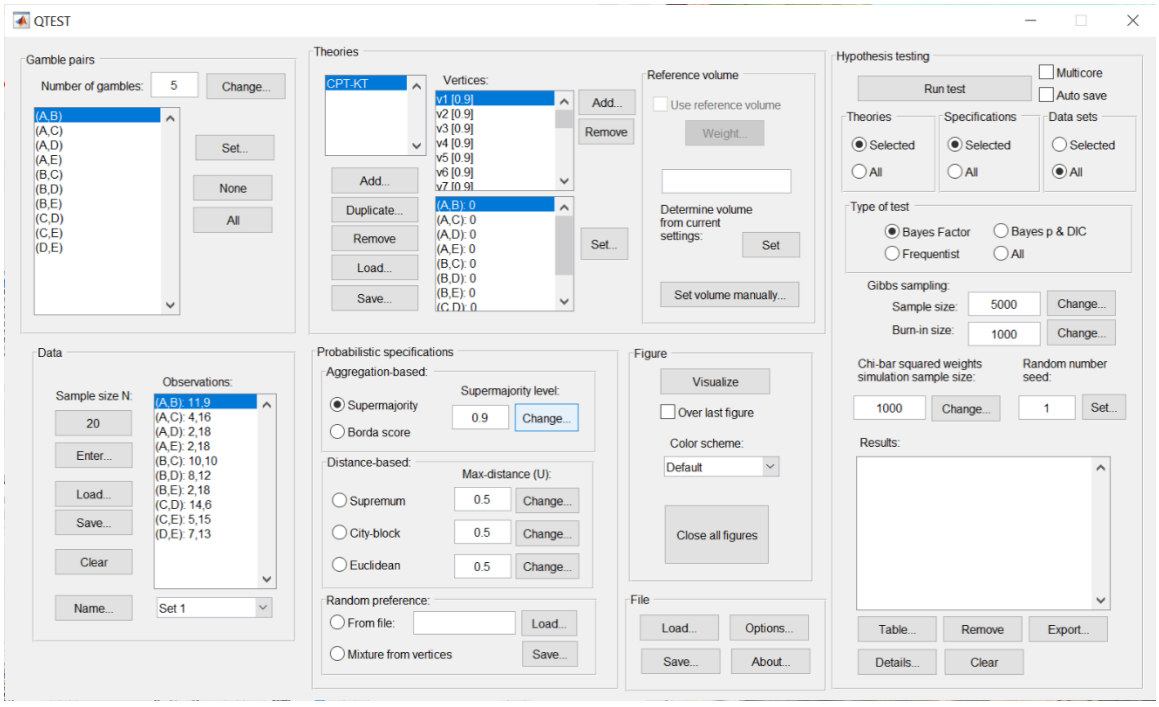
This completes the analysis for Cash I data for the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{KT}$ .90-supermajority probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{KT}$, but now with a random preference probabilistic specification in the following two sections, M.2.7 and M.2.8.

M.2.7 Probabilistic Specification: Cash I, *CPT-KT*, Random Preference

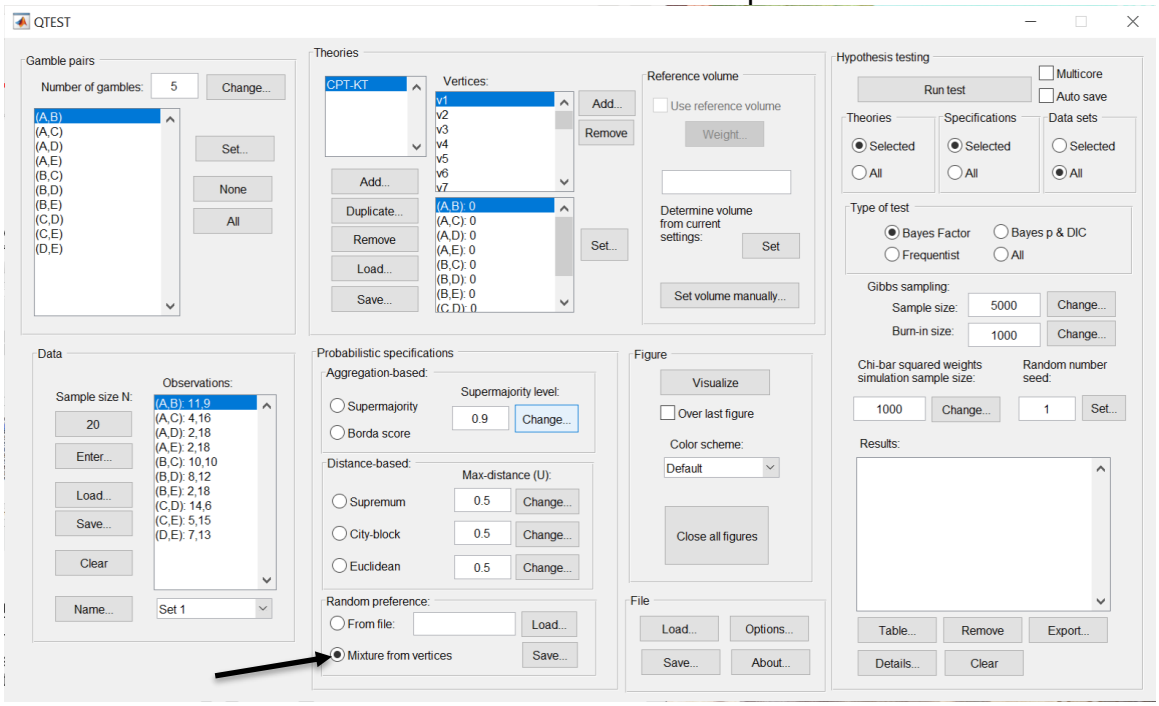
If continuing from section M.2.6, click “Clear” under “Hypothesis testing” and “Results:”. This step clears the results of the Bayes Factor test of *CPT-KT* .90-supermajority probabilistic specification from the QTEST interface.



Whether the user is continuing from section M.2.2 or M.2.6, the QTEST interface should match the screenshot below.



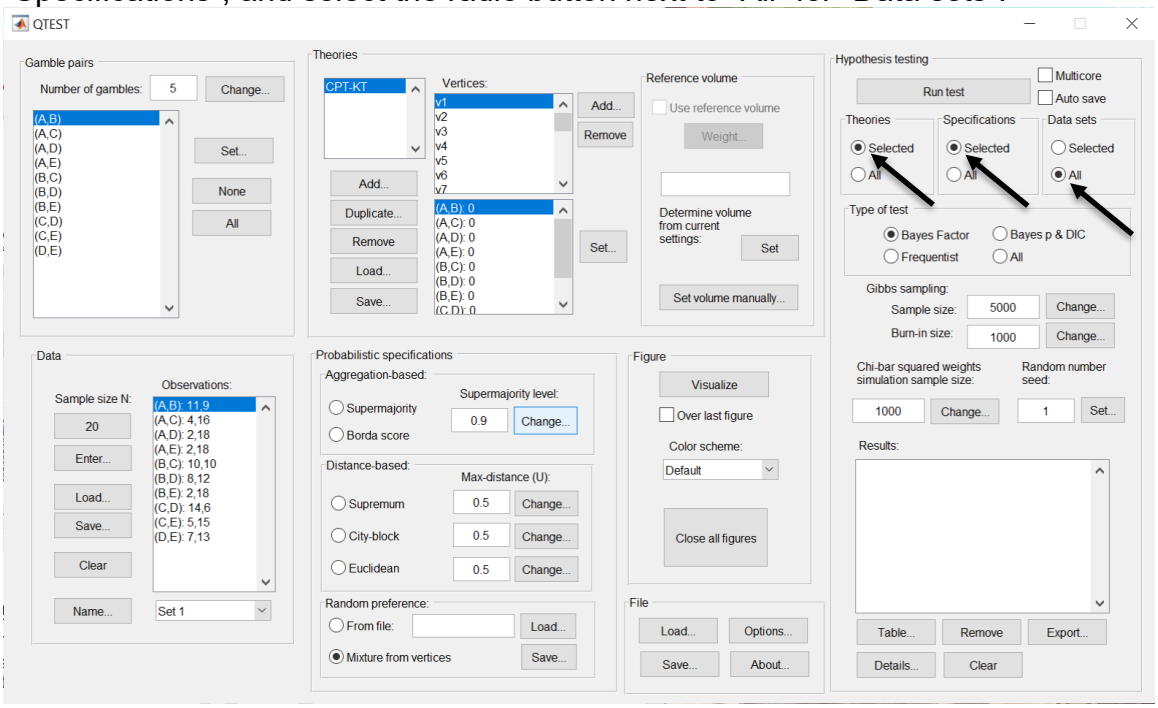
To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Mixture from vertices” under “Random preference:” is selected.



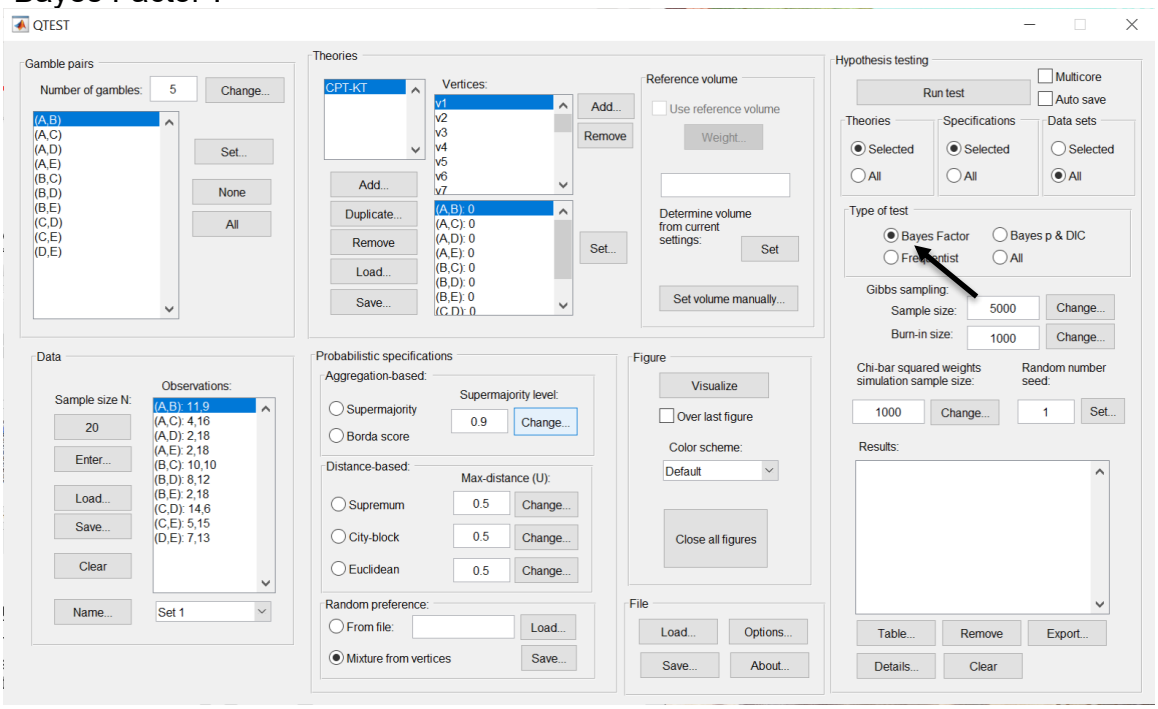
M.2.8 Hypothesis Testing: Cash I, *CPT-KT*, Random Preference

We are now ready for the Bayes Factor test of *CPT-KT* random preference probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

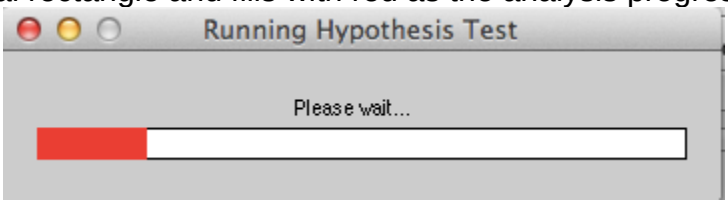
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



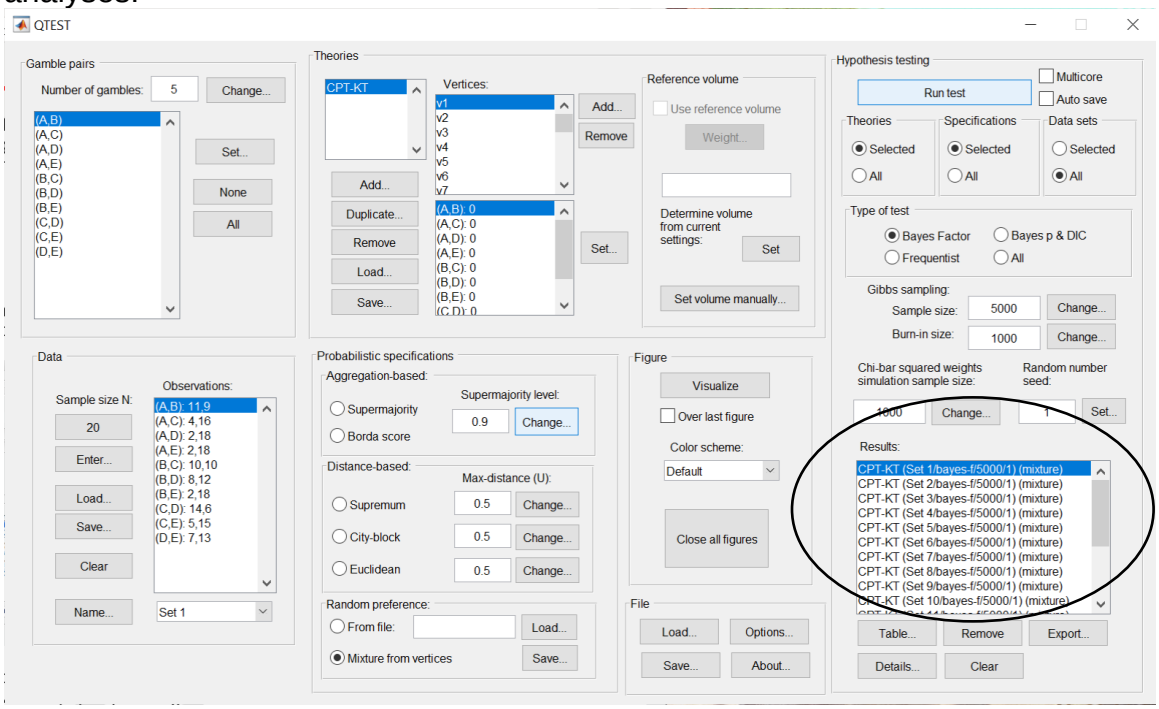
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes Factor”.



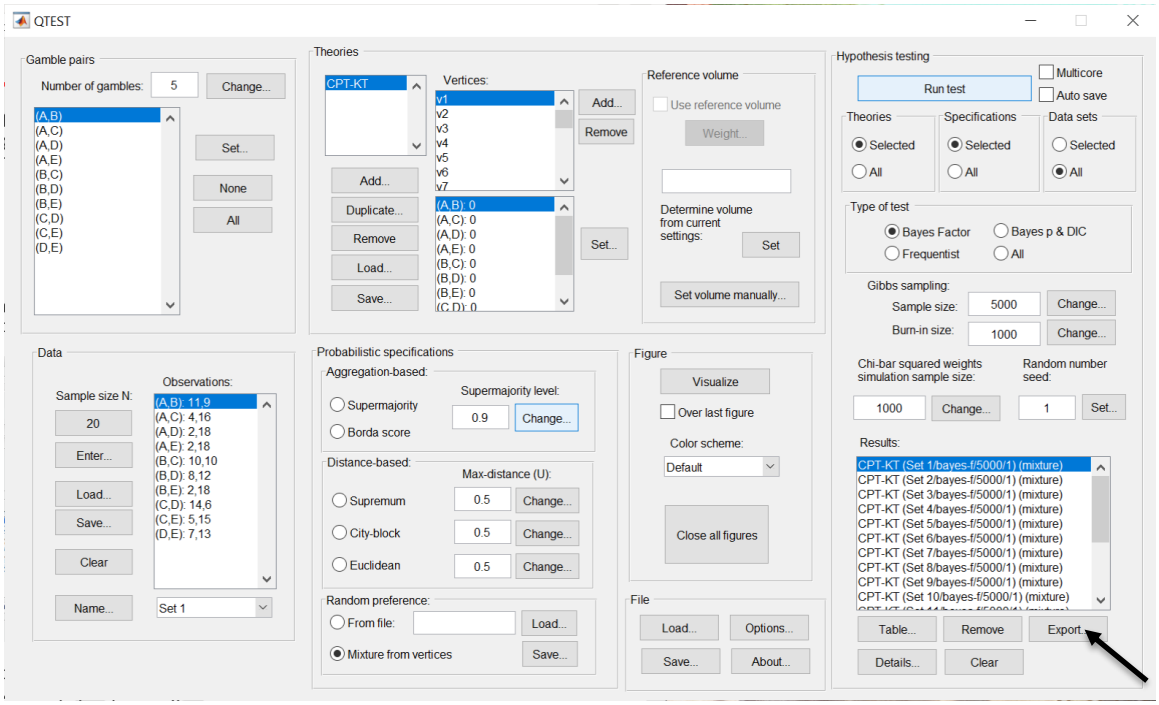
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



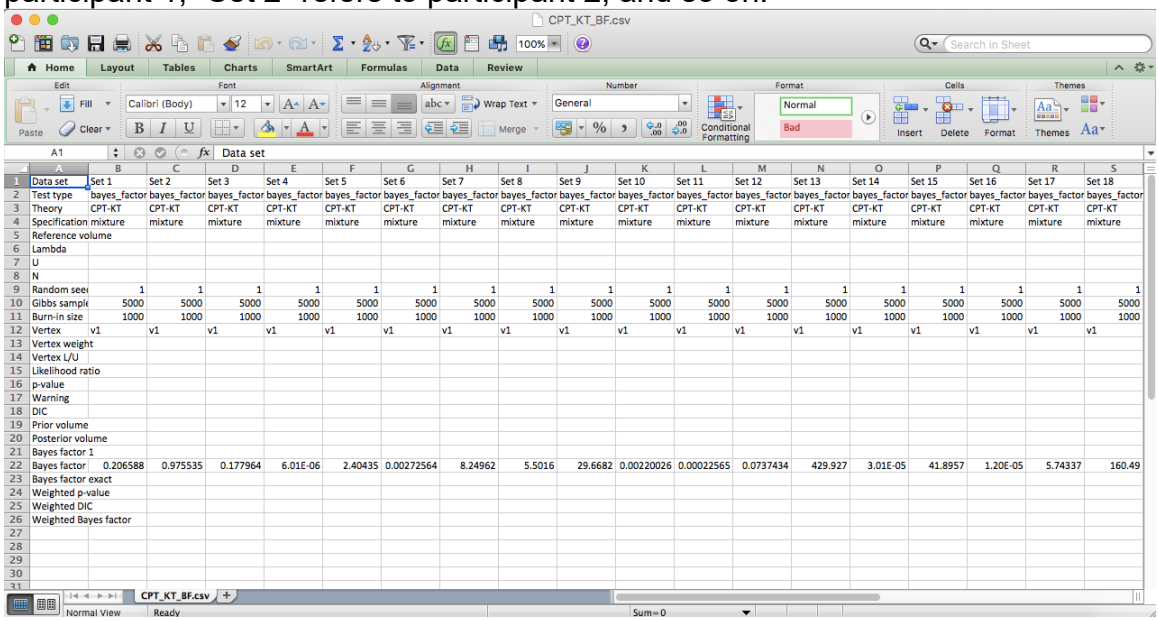
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “S” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor
3	Theory	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT
4	Specification	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture
5	Reference volume																		
6	Lambda																		
7	U																		
8	N																		
9	Random seed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sample	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value																		
17	Warning																		
18	DIC																		
19	Prior volume																		
20	Posterior volume																		
21	Bayes factor 1																		
22	Bayes factor	0.206588	0.975535	0.177964	6.01E-06	2.40435	0.00272564	8.24962	5.5016	29.6682	0.00220026	0.00022565	0.0737434	429.927	3.01E-05	41.8957	1.20E-05	5.74337	160.49
23	Bayes factor exact																		
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Bayes factor																		

The Bayes factor values are in row 22 of the spreadsheet. The Bayes factor in column “B” listed as “Set 1” is where the Bayes factor for participant 1 can be

found, listed under “Mixture” and “KT” in Table 3 of QTBC2. Notice the same holds true for column “C” listed as “Set 2”, for participant 2, and so on.

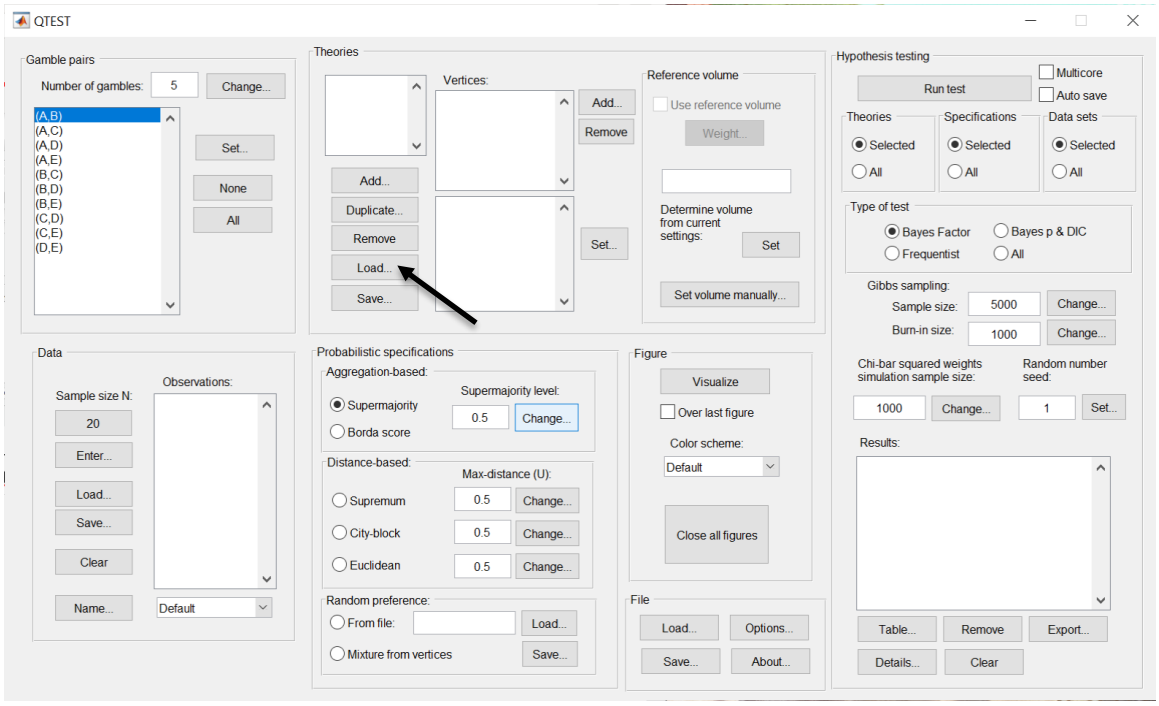
Note, however, that the Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select “Change…” next to “Sample size:” under “Hypothesis testing” and “Gibbs sampling:”. Then, in the “Gibbs sampling” dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column “KT” under “Mixture” of Table 3 can be replicated.

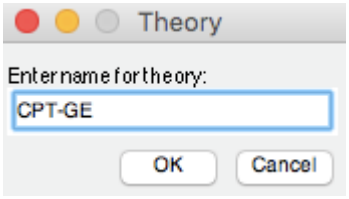
This completes the analysis for Cash I data for the Bayes Factor test of *CPT-KT* random preference probabilistic specification.

M.3.1 Theory and Vertex: Cash I, *CPT-GE*

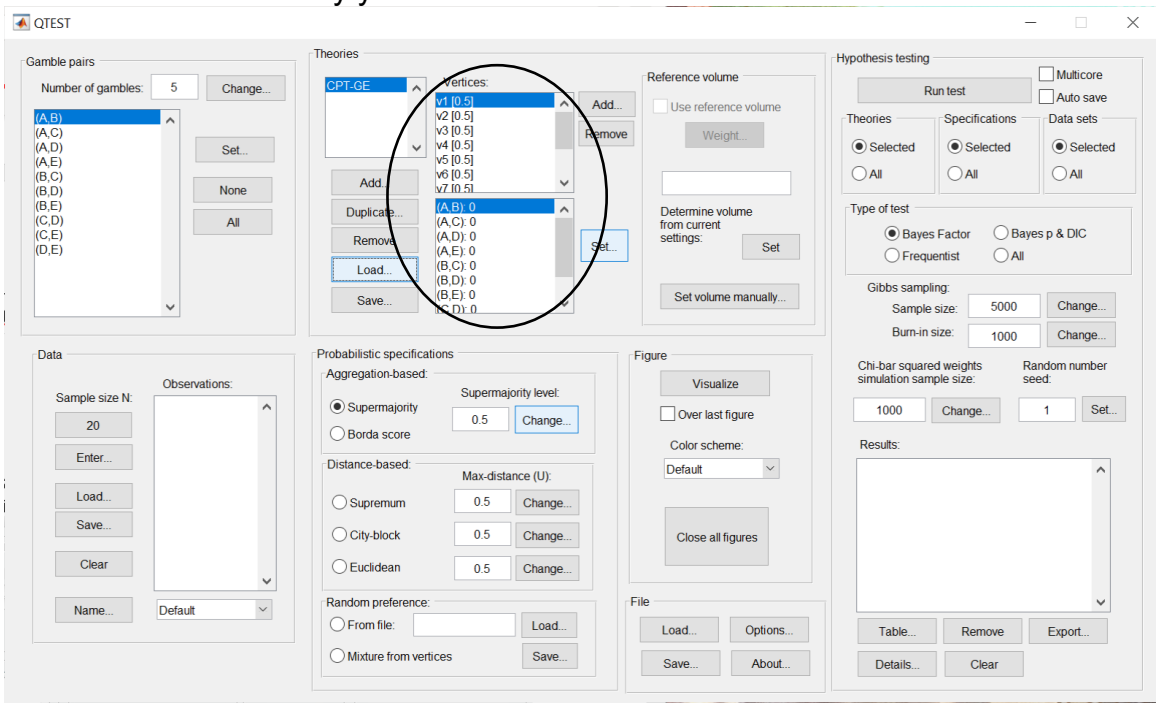
Under “Theories”, select “Load…”.



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “TheoriesVertices” folder and open “Vertices_CPT_GE_Cash1.csv”. In the dialog box, type “CPT-GE” and select “OK”.

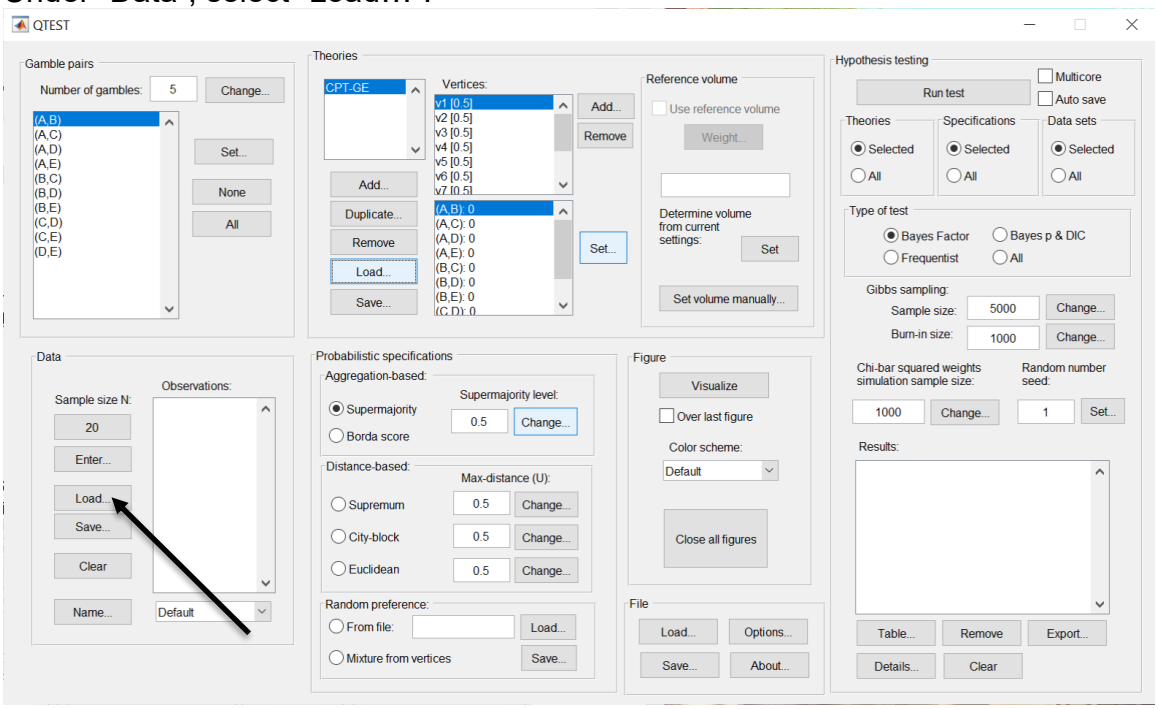


On the QTEST interface there should now be a list of 11 vertices for *CPT-GE* under “Theories”. Verify your screen matches the screenshot below.



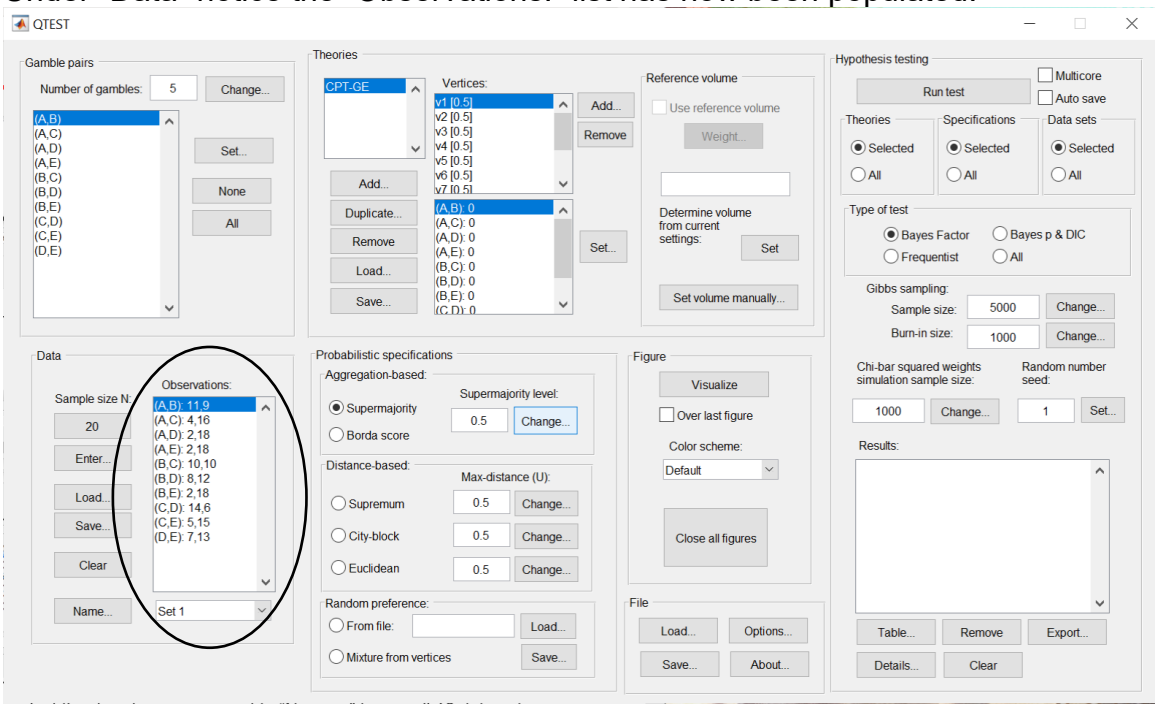
M.3.2 Data: Cash I, *CPT-GE*

Under “Data”, select “Load…”.



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “DataSets” folder and open “Cash1.txt”.

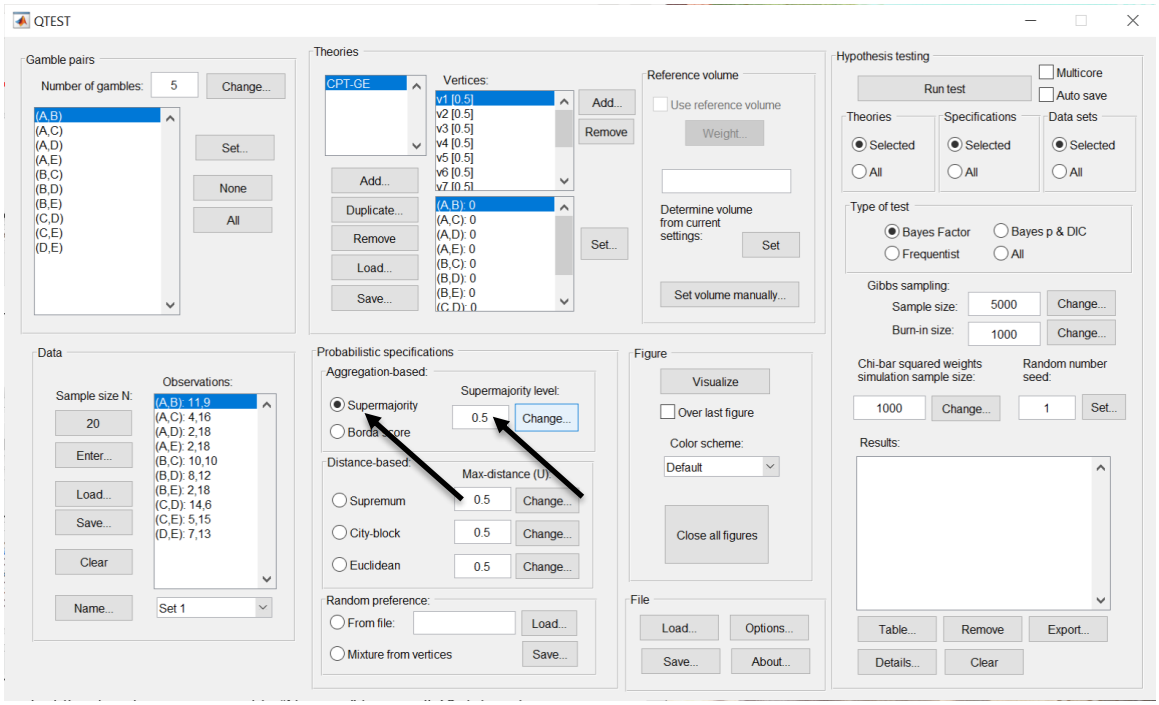
Under “Data” notice the “Observations:” list has now been populated:



Under “Data”, select the dropdown menu next to “Name…” to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

M.3.3 Probabilistic Specification: Cash I, *CPT-GE*, .50-Majority/modal choice

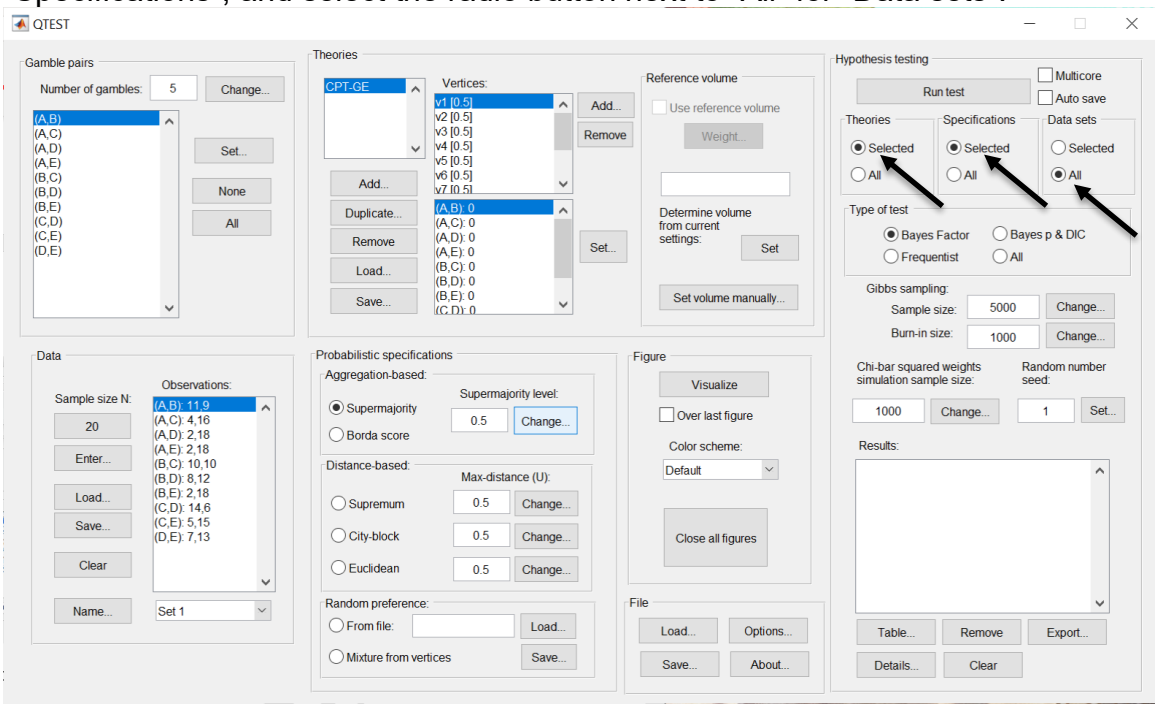
To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected and that the “Supermajority level:” is set to “0.5”.



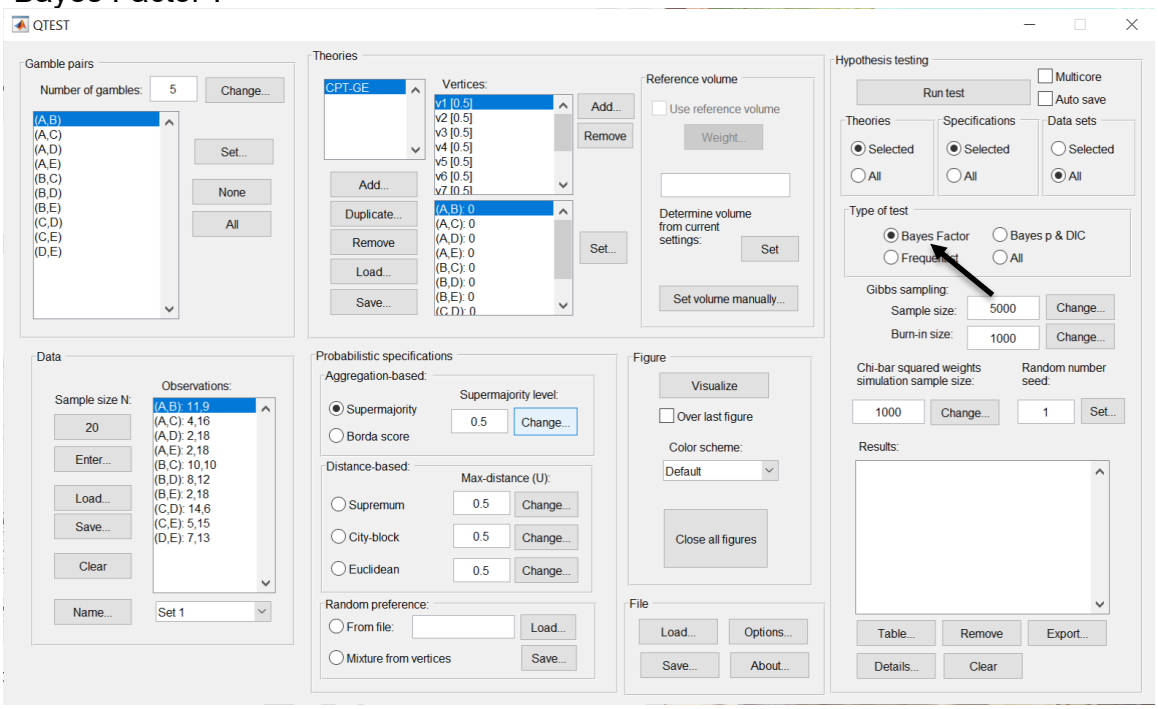
M.3.4 Hypothesis Testing: Cash I, *CPT-GE*, .50-Majority/modal choice

We are now ready for the Bayes Factor test of *CPT-GE* .50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under “Hypothesis testing”, under the “Run test” button, there are 3 columns: “Theories”, “Specifications” and “Data sets”. For each of these, the user must choose the radio button next to either “Selected” or “All”. For more information on these settings, as well as the inputs for “Chi-bar squared weights simulation sample size:” and “Random number seed:”, see section G.5.

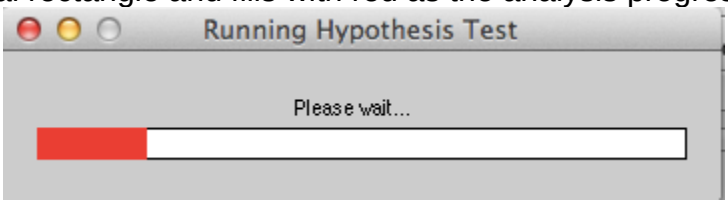
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



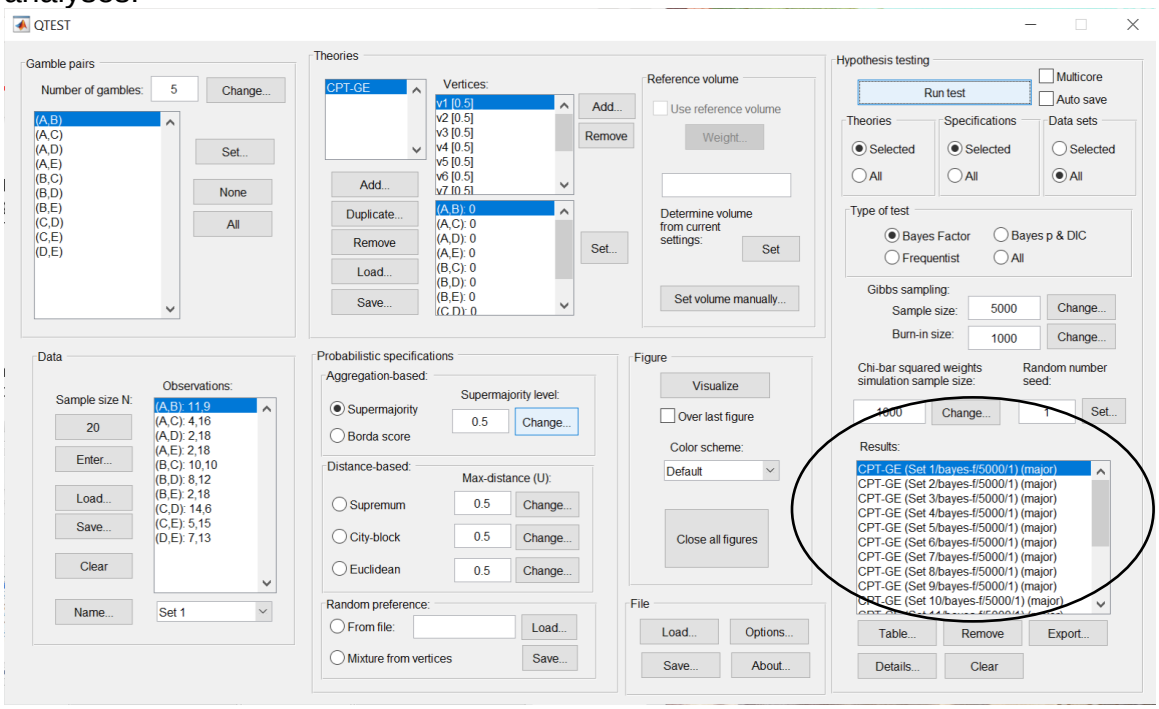
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes Factor”.



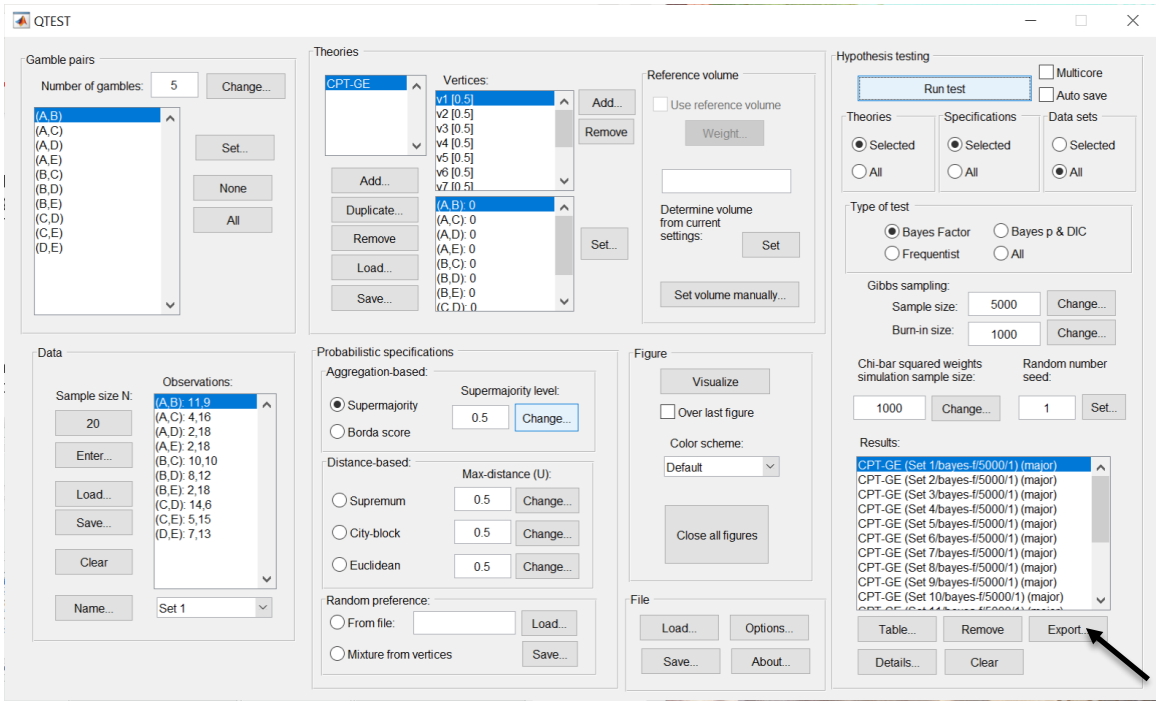
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



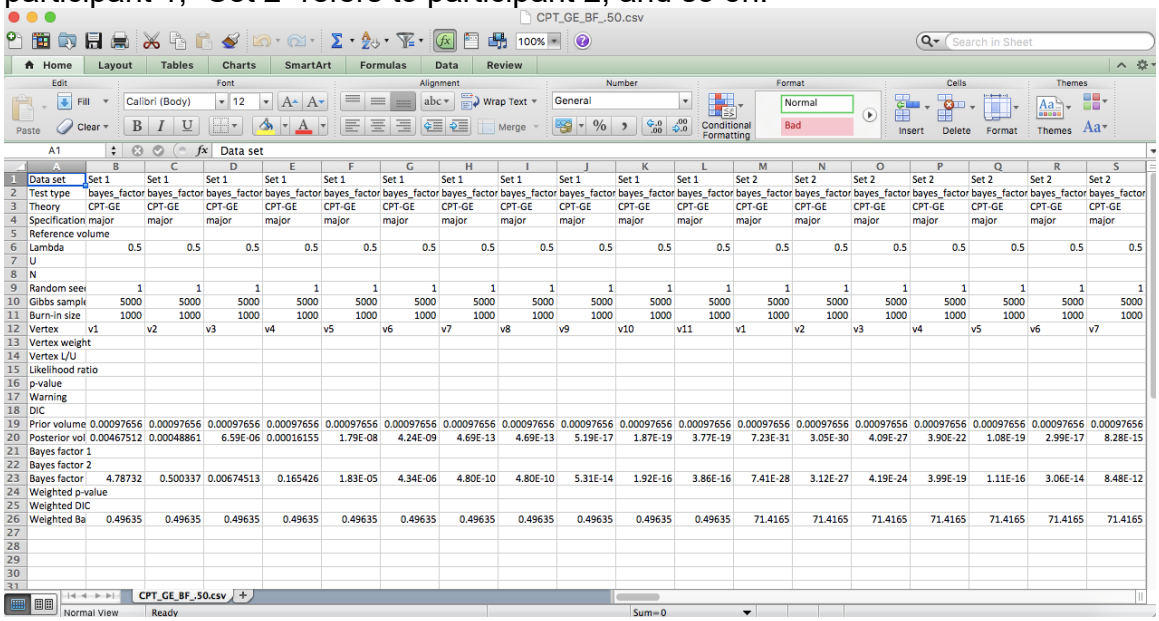
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “GQ” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2
2	Test type	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor
3	Theory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
4	Specification	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference volume																		
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																		
8	N																		
9	Random see	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sampl	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v1	v2	v3	v4	v5	v6	v7
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value																		
17	Warning																		
18	DIC																		
19	Prior volume	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656
20	Posterior vol	0.00467512	0.00048861	6.59E-06	0.00016155	1.79E-08	4.24E-09	4.69E-13	4.69E-13	5.19E-17	1.87E-19	3.77E-19	7.23E-31	3.05E-30	4.09E-27	3.90E-22	1.08E-19	2.99E-17	8.28E-15
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor	4.78732	0.500337	0.00674513	0.165426	1.83E-05	4.34E-06	4.80E-10	4.80E-10	5.31E-14	1.92E-16	3.86E-16	7.41E-28	3.12E-27	4.19E-24	3.99E-19	1.11E-16	3.06E-14	8.48E-12
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Ba	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	71.4165	71.4165	71.4165	71.4165	71.4165	71.4165	71.4165
27																			
28																			
29																			
30																			
31																			

The weighted Bayes factor values are in row 26 of the spreadsheet. Notice the same Bayes factor repeats for all the columns “B” through “L” listed as “Set 1”—this is where the Bayes factor for participant 1 can be found, listed under “0.50 Majority Choice” and “GE” in Table 3 of QTBC2. Notice the same holds true for all the columns “M” through “W” listed as “Set 2”, for participant 2, and so on.

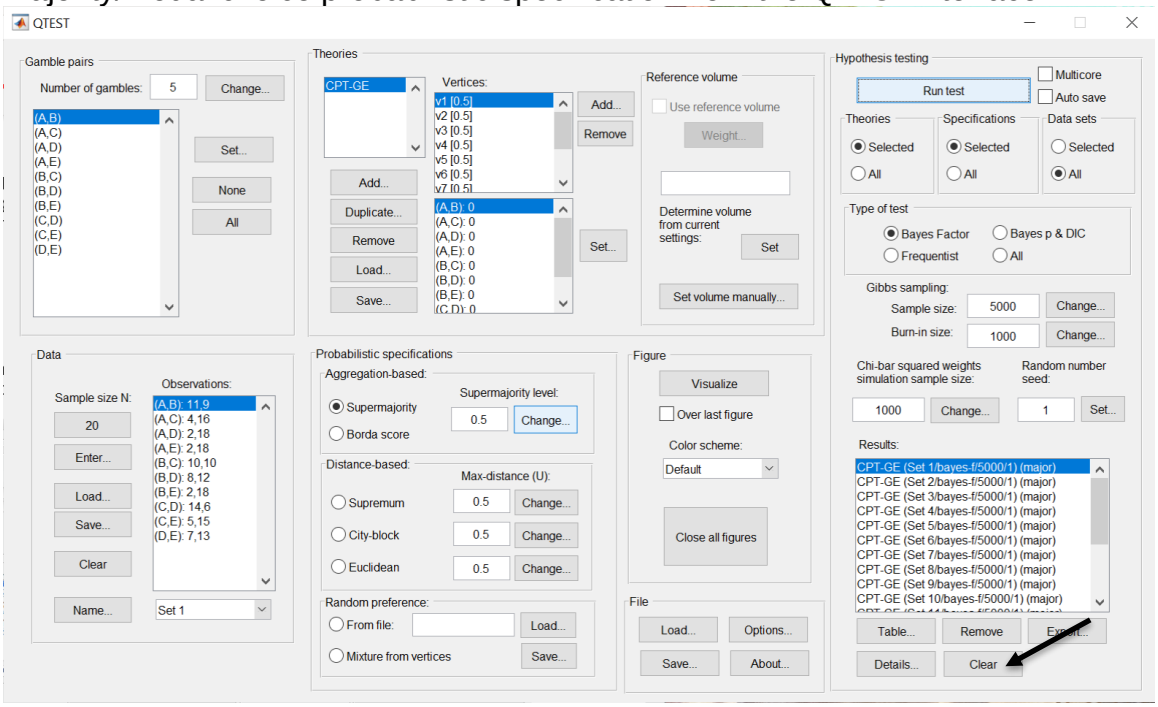
Note, however, that the weighted Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select “Change…” next to “Sample size:” under “Hypothesis testing” and “Gibbs sampling:”. Then, in the “Gibbs sampling” dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column “GE” under “0.50 Majority Choice” of Table 3 can be replicated.

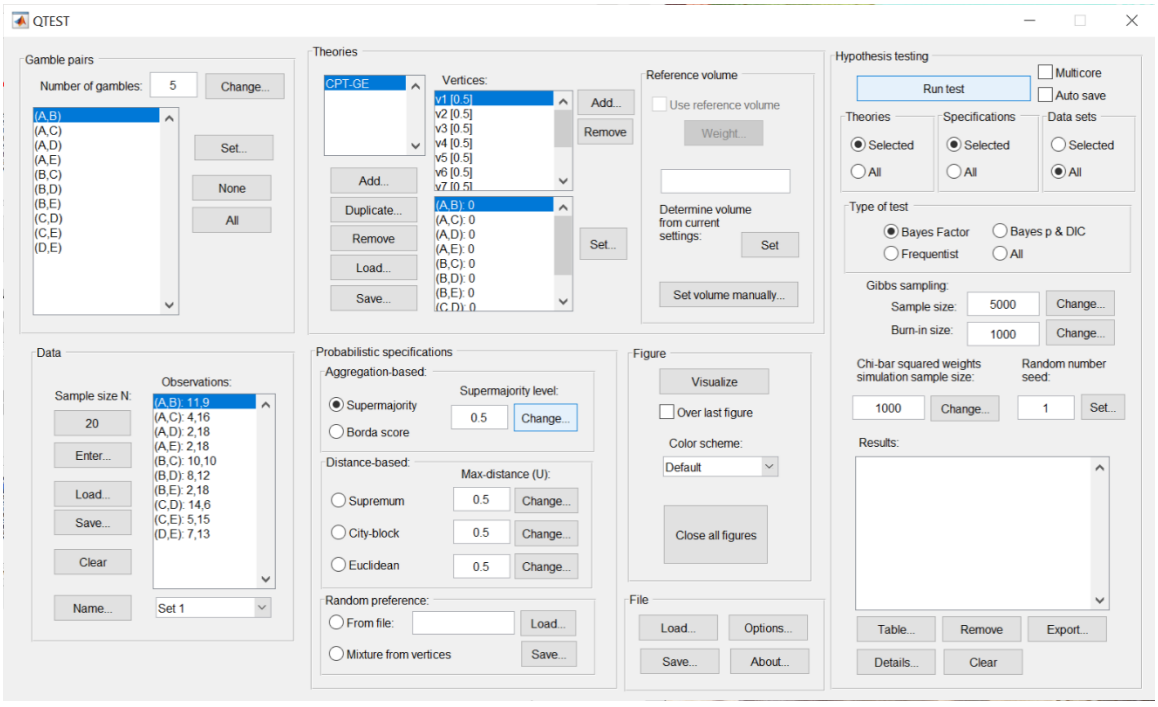
This completes the analysis for Cash I data for the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{GE}$ .50-majority/modal choice probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{GE}$, but now with a .90-supermajority probabilistic specification in the following two sections, M.3.5 and M.3.6.

M.3.5 Probabilistic Specification: Cash I, *CPT-GE*, .90-Supermajority

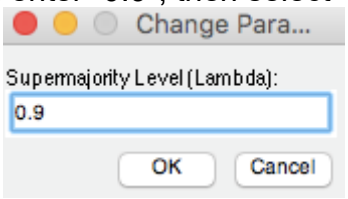
If continuing from section M.3.4, select “Clear” under “Hypothesis testing” and “Results:”. This step clears the results of the Bayes Factor test of *CPT-GE* .50-majority/modal choice probabilistic specification from the QTEST interface.



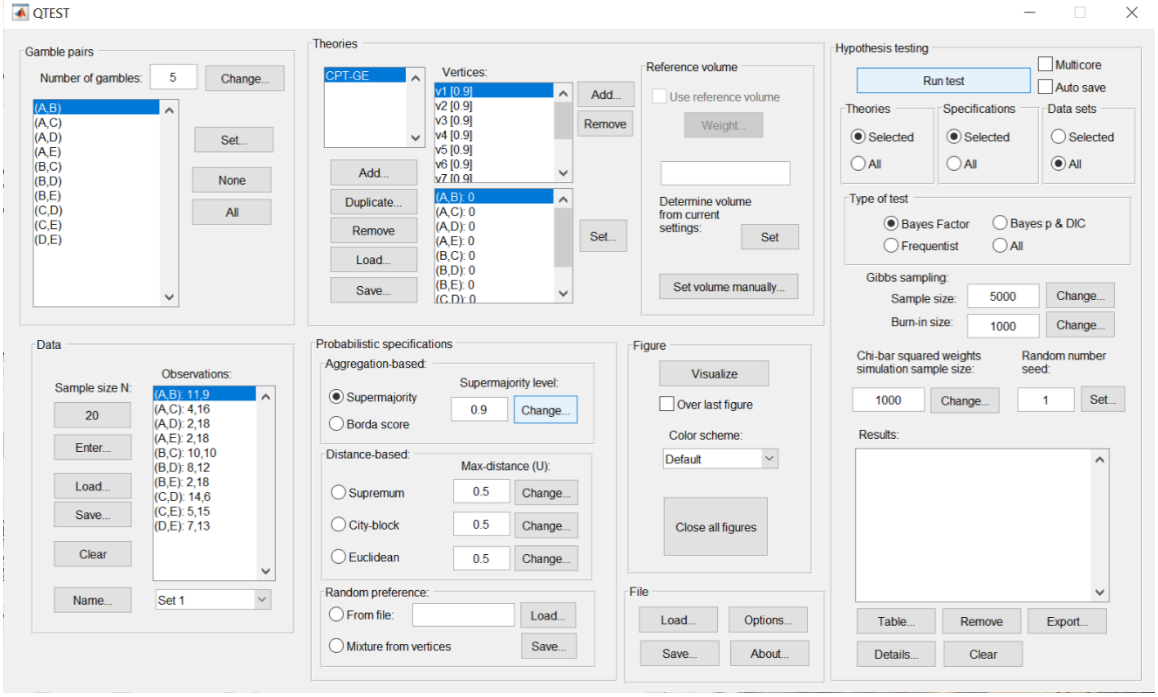
Whether the user is continuing from section M.3.2 or M.3.4, the QTEST interface should match the screenshot below.



To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected. To set the “Supermajority level:” to “0.9”, select “Change…” and enter “0.9”, then select “OK.”



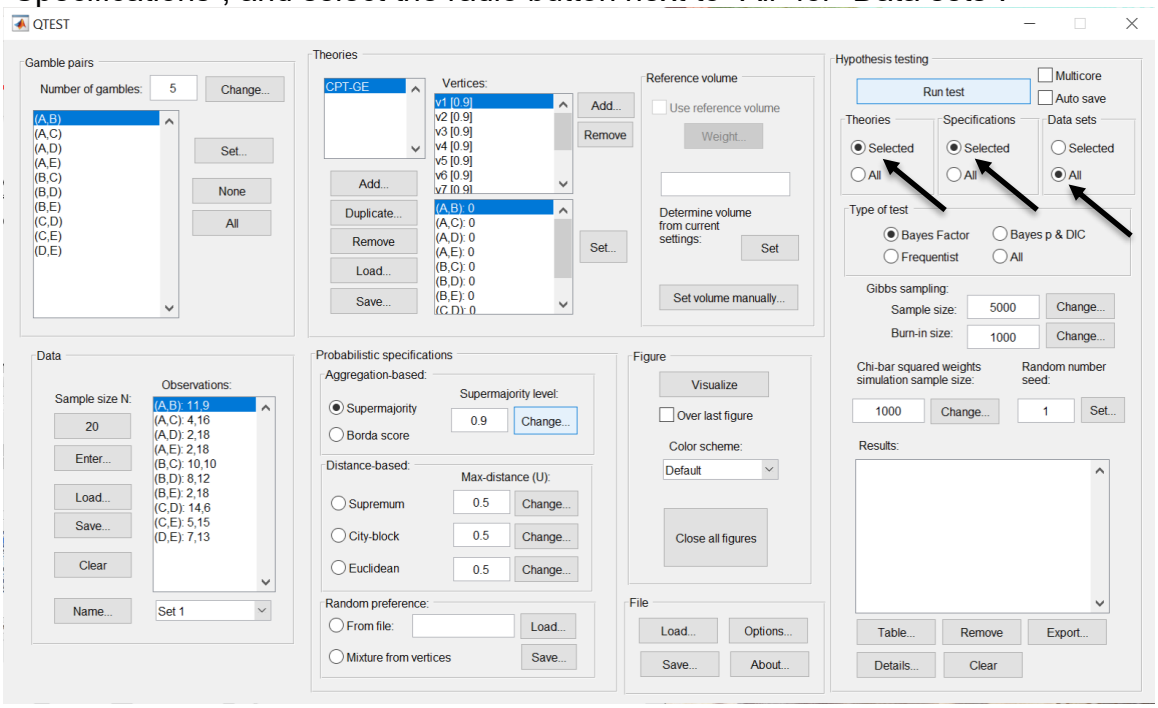
The QTEST interface should now match the screenshot below.



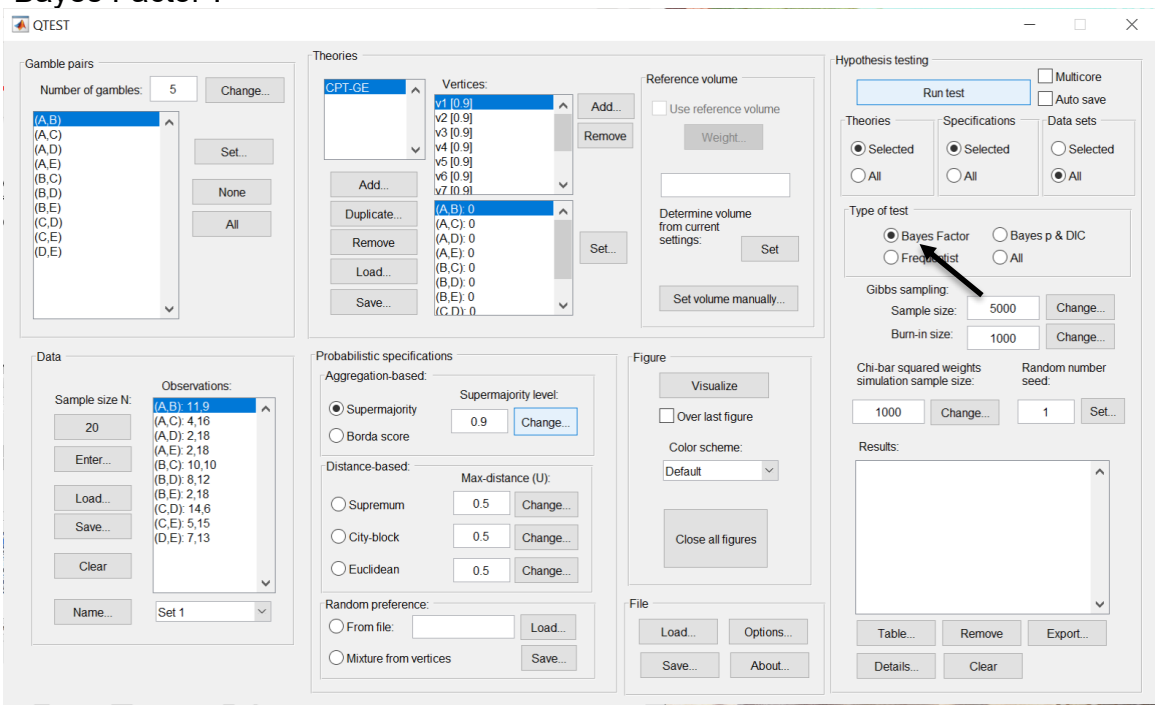
M.3.6 Hypothesis Testing: Cash I, *CPT-GE*, .90-Supermajority

We are now ready for the Bayes Factor test of *CPT-GE* .90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

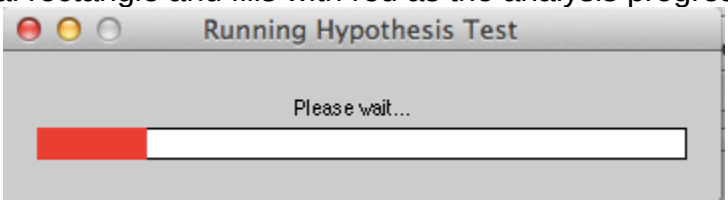
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



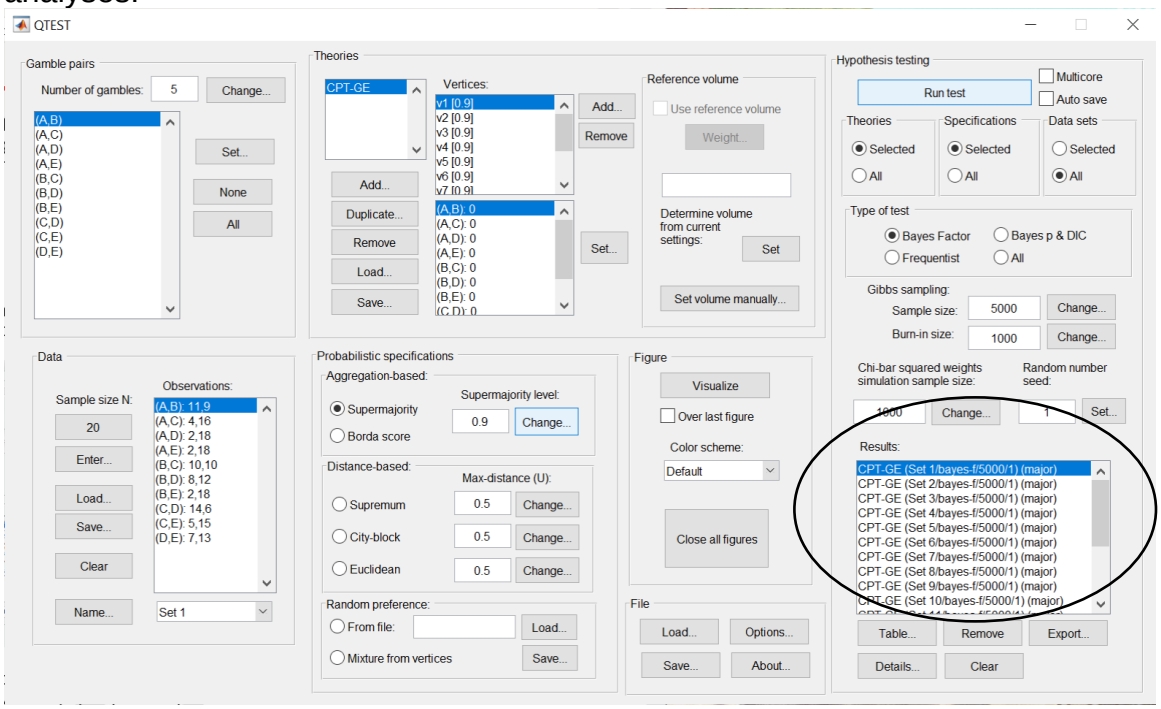
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes Factor”.



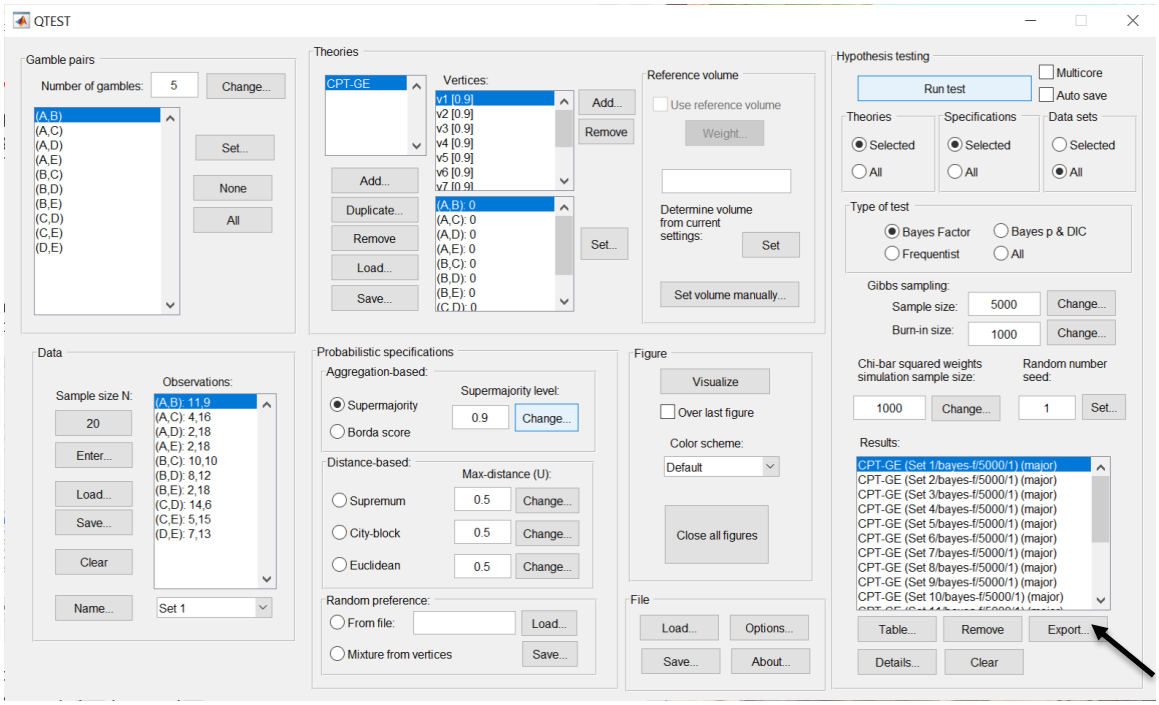
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



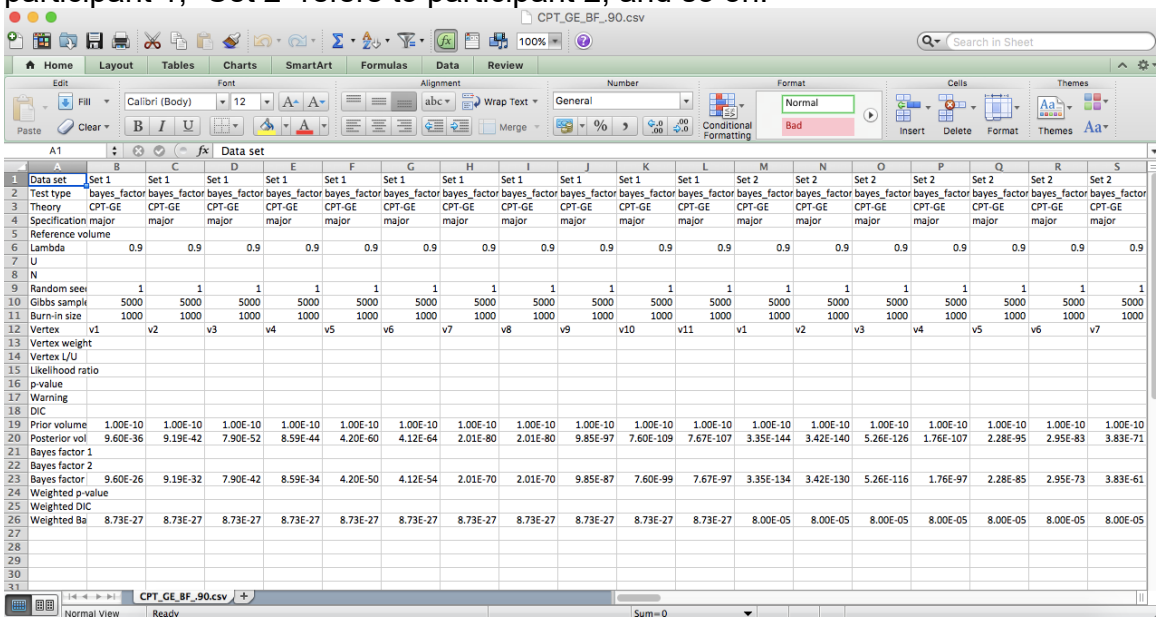
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “GQ” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2
2	Test type	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor
3	Theory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
4	Specification	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference volume																		
6	Lambda	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7	U																		
8	N																		
9	Random seed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sample	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v1	v2	v3	v4	v5	v6	v7
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value																		
17	Warning																		
18	DIC																		
19	Prior volume	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10
20	Posterior vol	9.60E-36	9.19E-42	7.90E-52	8.59E-44	4.20E-60	4.12E-64	2.01E-80	2.01E-80	9.85E-97	7.60E-109	7.67E-107	3.35E-144	3.42E-140	5.26E-126	1.76E-107	2.28E-95	2.95E-83	3.83E-71
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor	9.60E-26	9.19E-32	7.90E-42	8.59E-34	4.20E-50	4.12E-54	2.01E-70	2.01E-70	9.85E-87	7.60E-99	7.67E-97	3.35E-134	3.42E-130	5.26E-116	1.76E-97	2.28E-85	2.95E-73	3.83E-61
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Ba	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.73E-27	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05	8.00E-05
27																			
28																			
29																			
30																			
31																			

The weighted Bayes factor values are in row 26 of the spreadsheet. Notice the same Bayes factor repeats for all the columns “B” through “L” listed as “Set 1”—this is where the Bayes factor for participant 1 can be found, listed under “0.90 Supermajority” and “GE” in Table 3 of QTBC2. Notice the same holds true for all the columns “M” through “W” listed as “Set 2”, for participant 2, and so on.

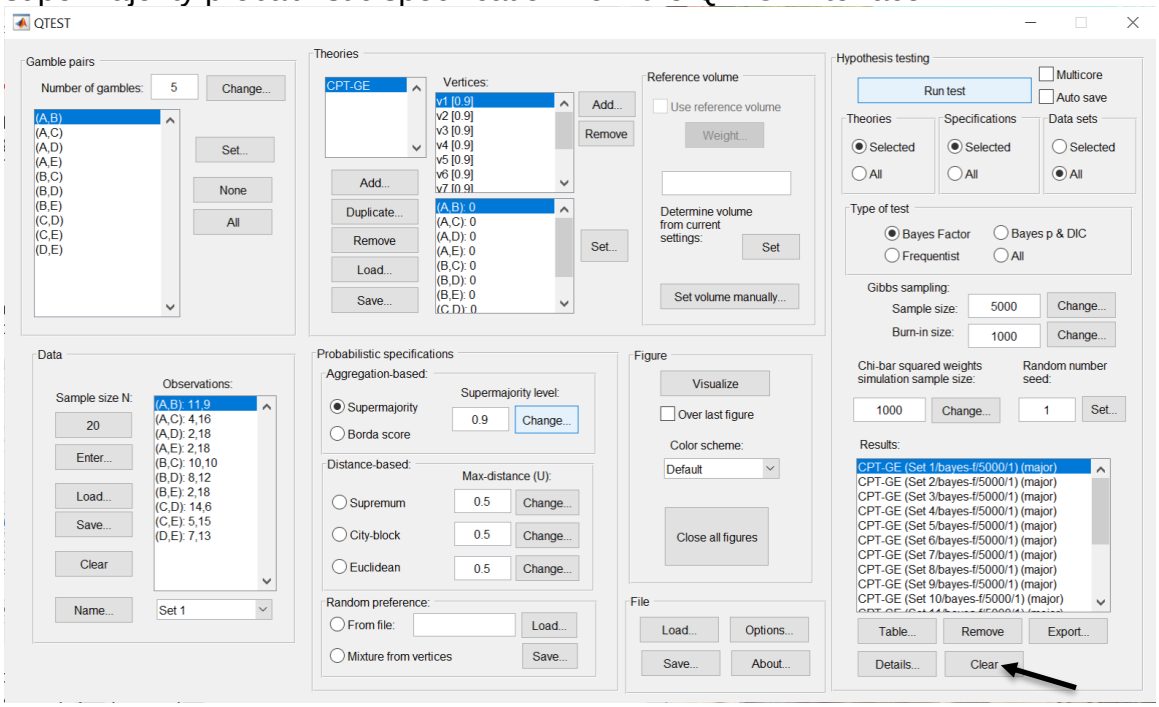
Note, however, that the weighted Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select “Change…” next to “Sample size:” under “Hypothesis testing” and “Gibbs sampling:”. Then, in the “Gibbs sampling” dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column “GE” under “0.90 Supermajority” of Table 3 can be replicated.

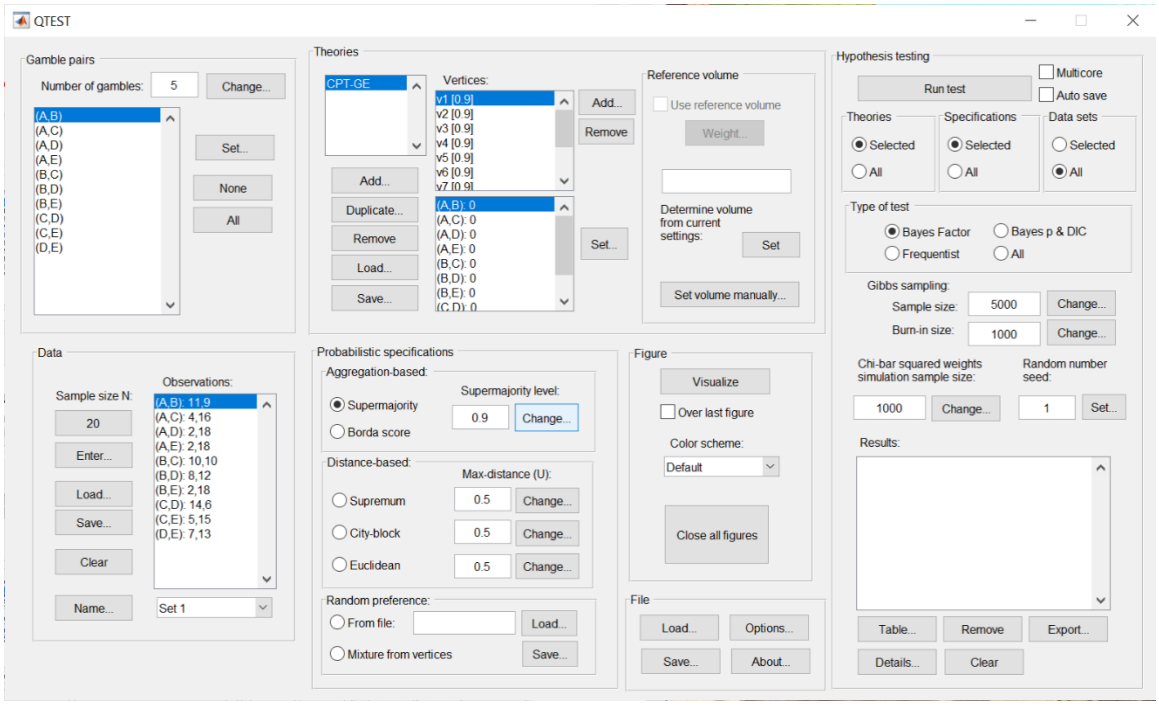
This completes the analysis for Cash I data for the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{GE}$ .90-supermajority probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{GE}$, but now with a random preference probabilistic specification in the following two sections, M.3.7 and M.3.8.

M.3.7 Probabilistic Specification: Cash I, *CPT-GE*, Random Preference

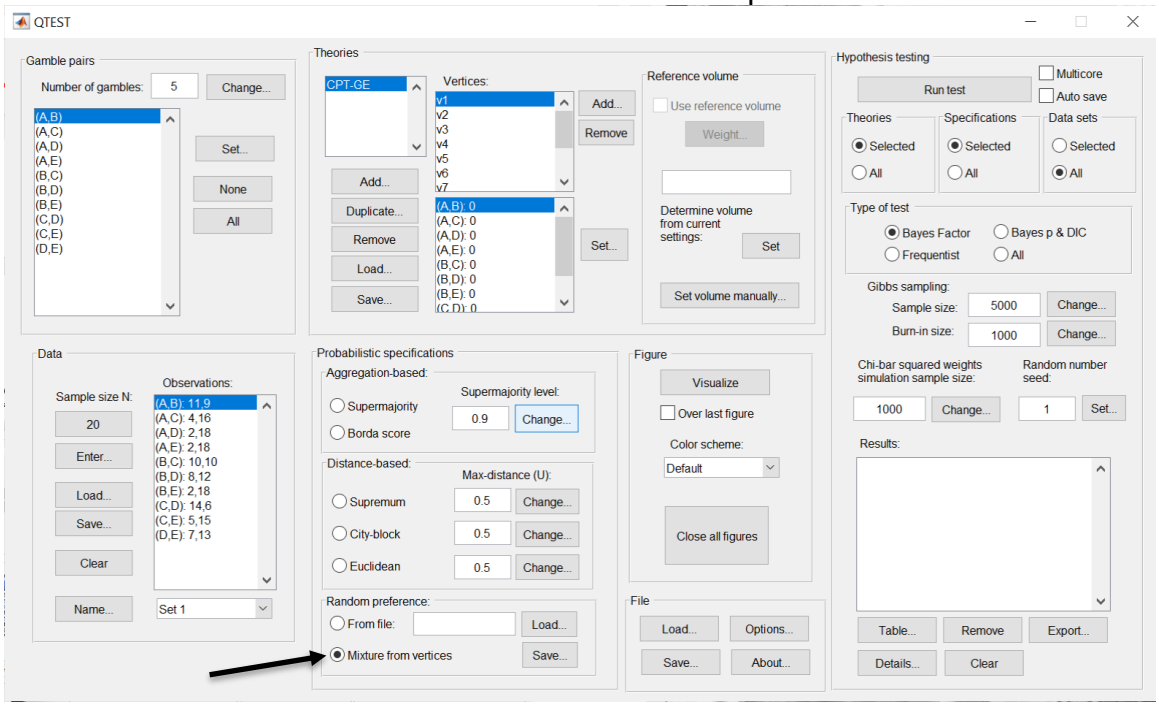
If continuing from section M.3.6, click “Clear” under “Hypothesis testing” and “Results:”. This step clears the results of the Bayes Factor test of *CPT-GE* .90-supermajority probabilistic specification from the QTEST interface.



Whether the user is continuing from section M.3.2 or M.3.6, the QTEST interface should match the screenshot below.



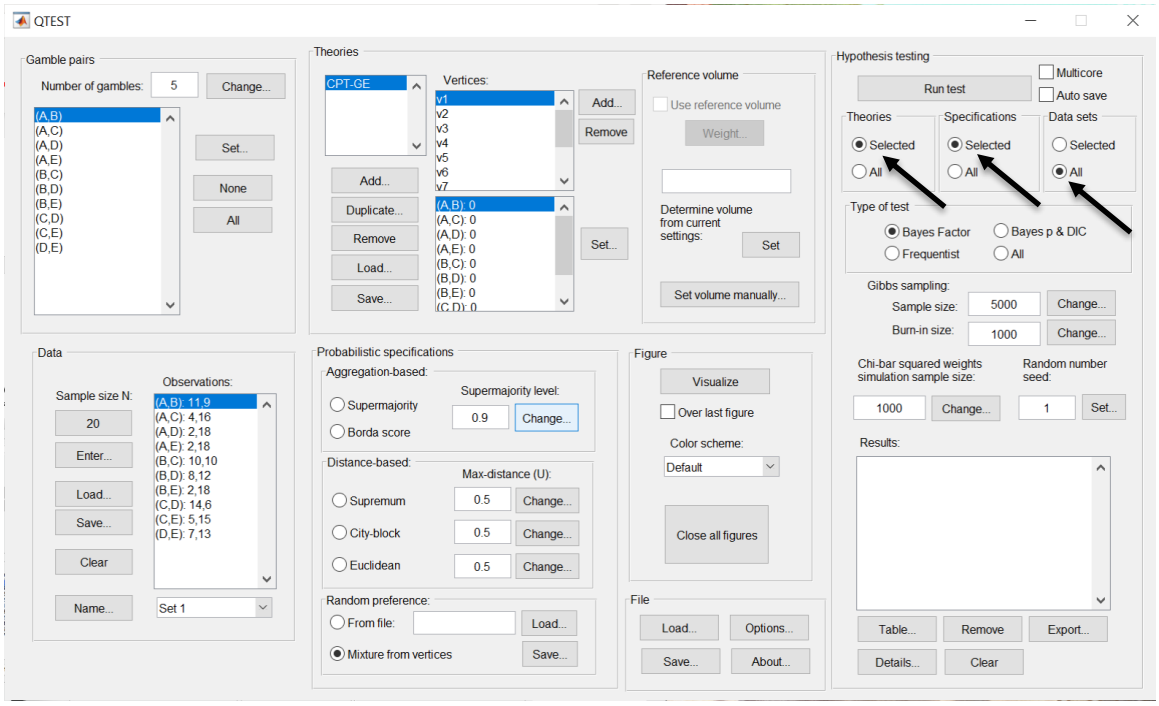
To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Mixture from vertices” under “Random preference:” is selected.



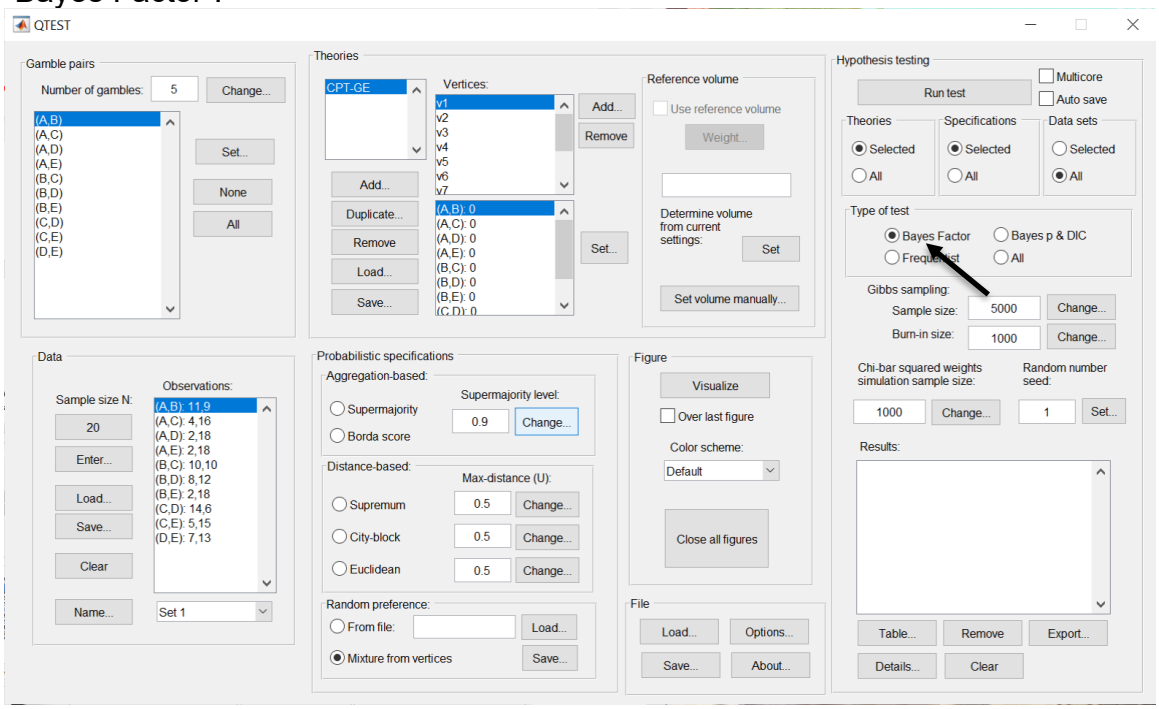
M.3.8 Hypothesis Testing: Cash I, *CPT-GE*, Random Preference

We are now ready for the Bayes Factor test of *CPT-GE* random preference probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

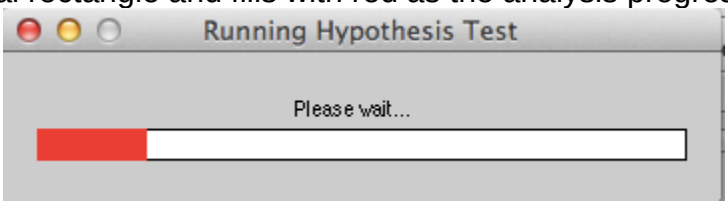
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



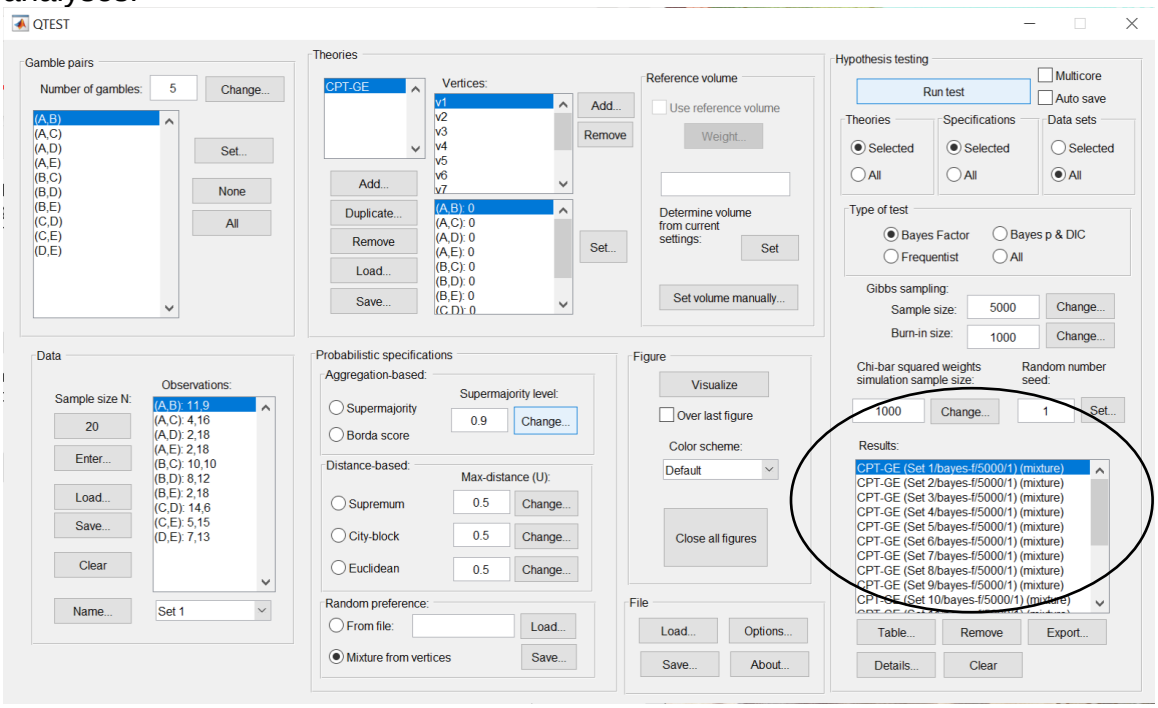
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes Factor”.



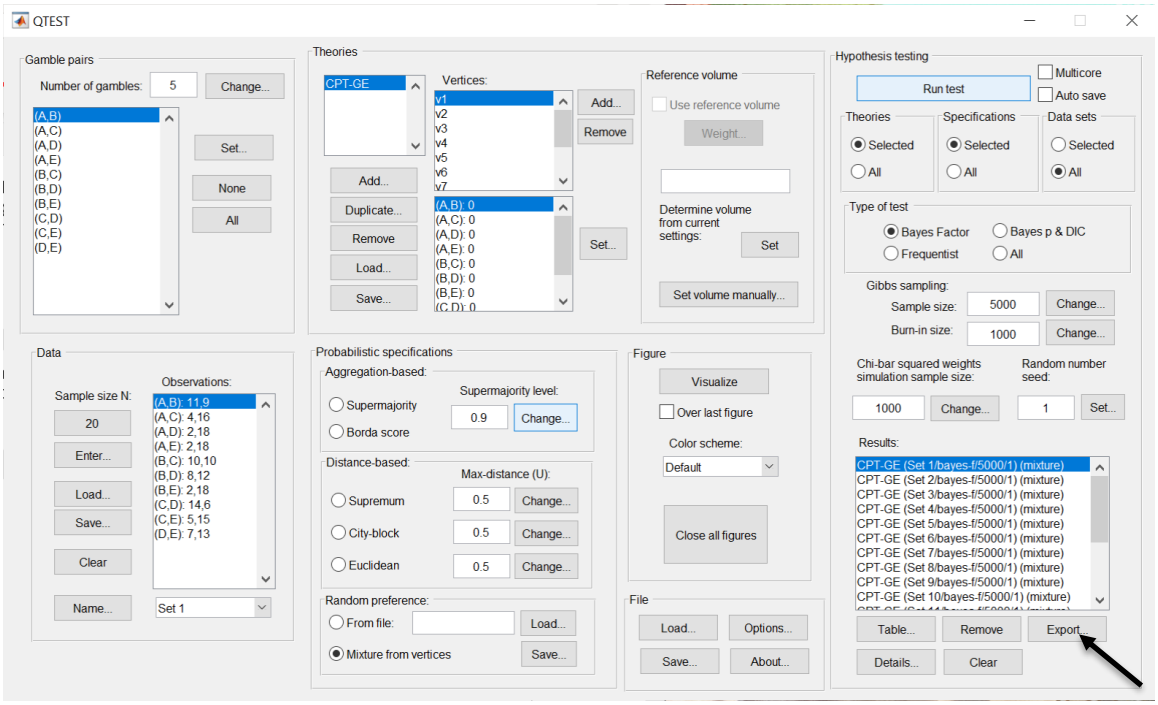
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



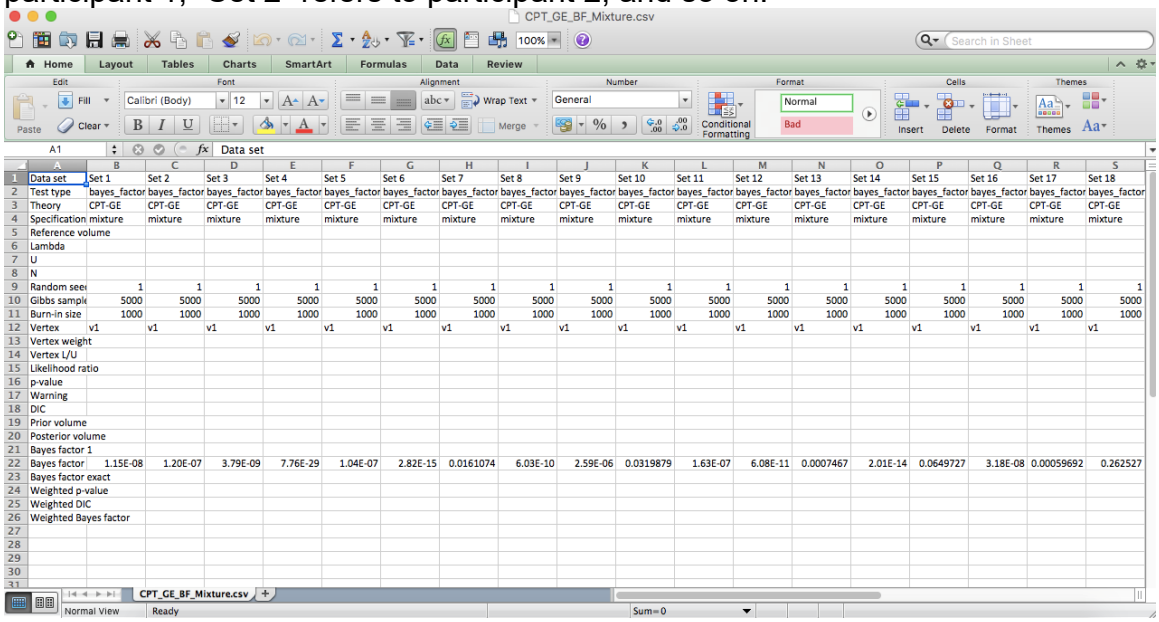
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “S” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor
3	Theory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
4	Specification	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture
5	Reference volume																		
6	Lambda																		
7	U																		
8	N																		
9	Random see	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sampl	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value																		
17	Warning																		
18	DIC																		
19	Prior volume																		
20	Posterior volume																		
21	Bayes factor 1																		
22	Bayes factor	1.15E-08	1.20E-07	3.79E-09	7.76E-29	1.04E-07	2.82E-15	0.0161074	6.03E-10	2.59E-06	0.0319879	1.63E-07	6.08E-11	0.0007467	2.01E-14	0.0649727	3.18E-08	0.00059692	0.262527
23	Bayes factor exact																		
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Bayes factor																		

The Bayes factor values are in row 22 of the spreadsheet. The Bayes factor in column “B” listed as “Set 1” is where the Bayes factor for participant 1 can be found, listed under “Mixture” and “GE” in Table 3 of QTBC2. Notice the same holds true for column “C” listed as “Set 2”, for participant 2, and so on.

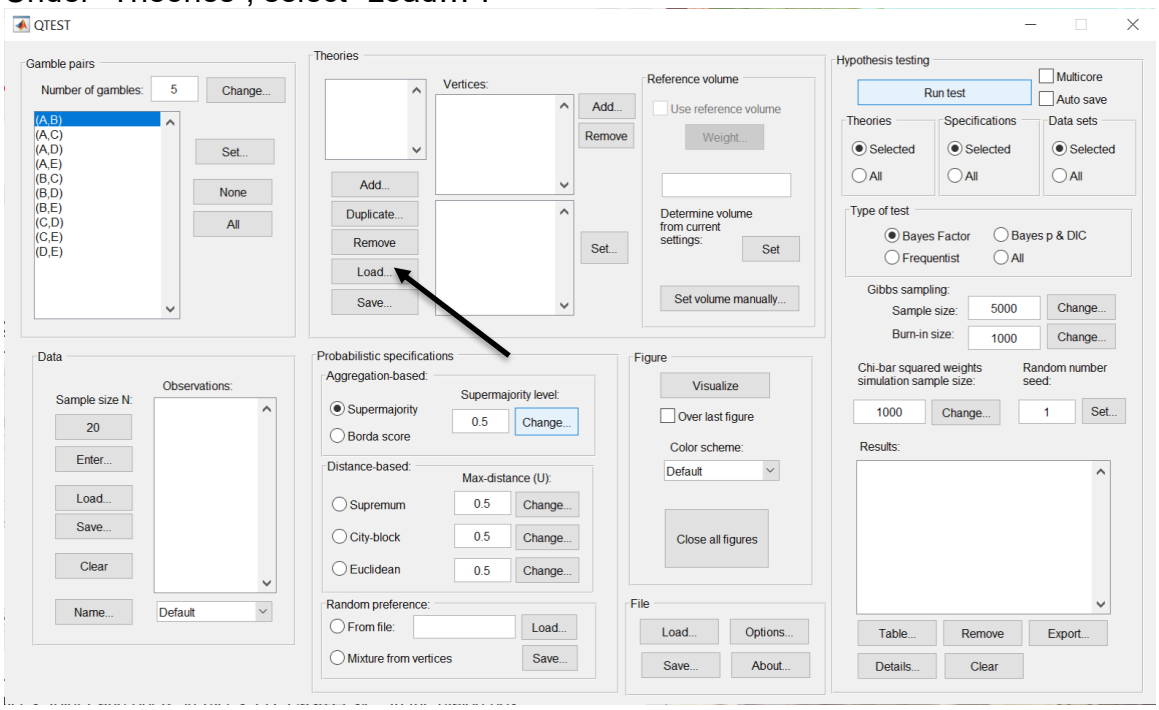
Note, however, that the Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select “Change…” next to “Sample size:” under “Hypothesis testing” and “Gibbs sampling:”. Then, in the “Gibbs sampling” dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column “GE” under “Mixture” of Table 3 can be replicated.

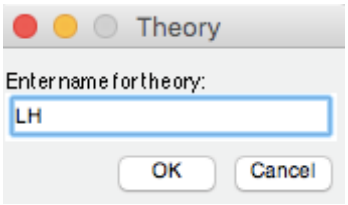
This completes the analysis for Cash I data for the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{GE}$ random preference probabilistic specification.

M.4.1 Theory and Vertex: Cash I, $\mathcal{LH}$

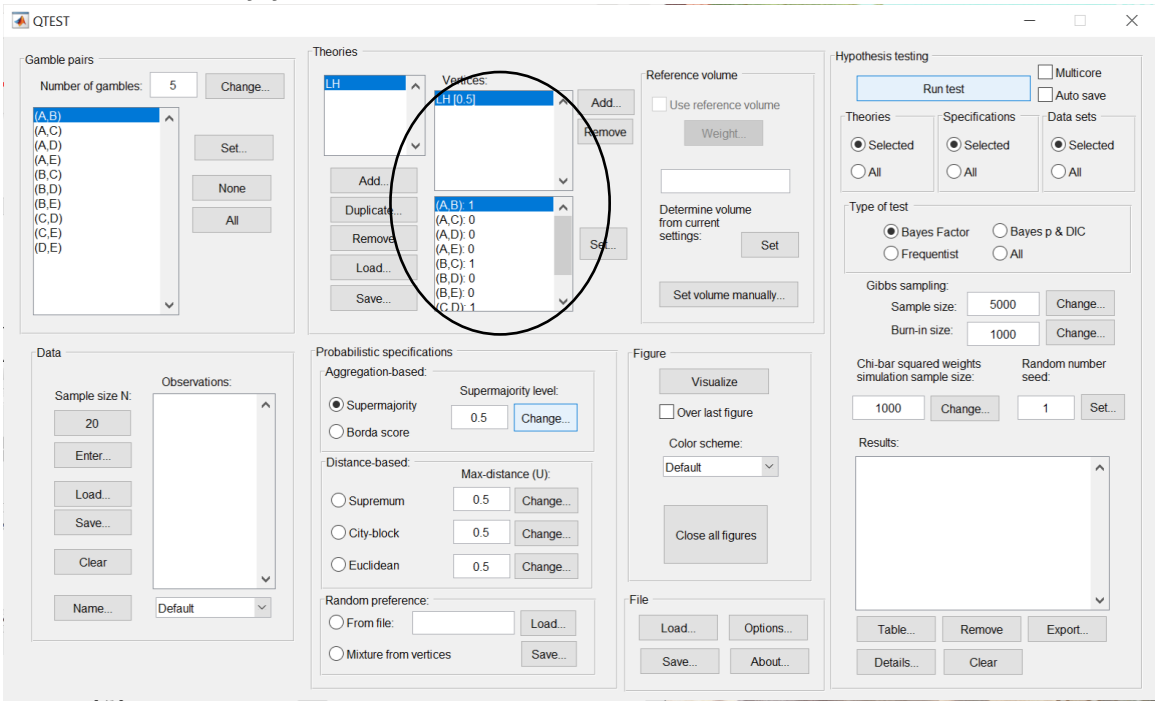
Under “Theories”, select “Load…”.



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “TheoriesVertices” folder and open “Vertices_LH_Cash1.csv”. In the dialog box, type “LH” and select “OK”.

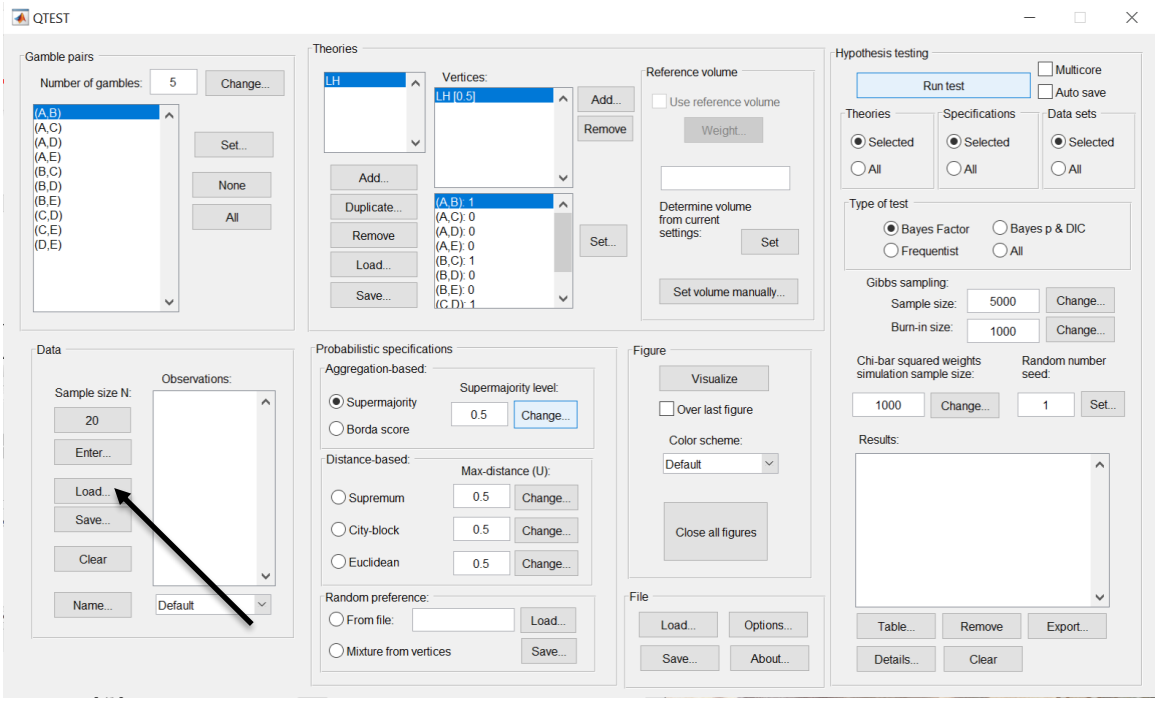


On the QTEST interface there should now be a list of 1 vertex for $\mathcal{LH}$ under "Theories". Verify your screen matches the screenshot below.



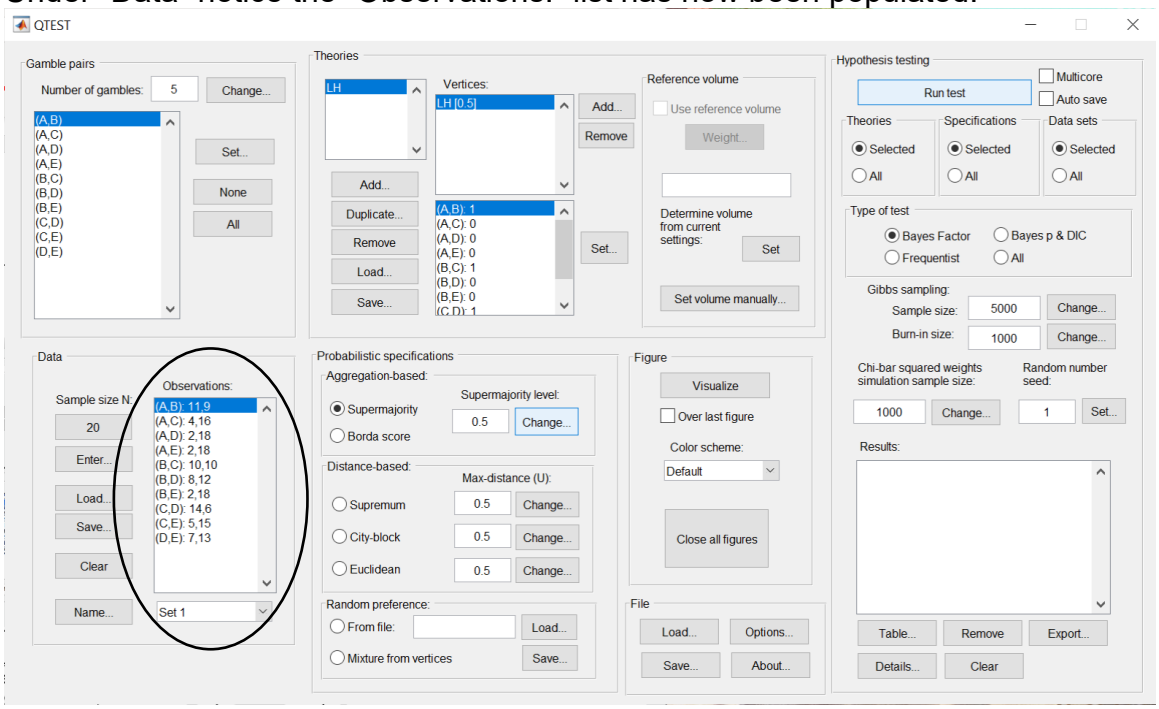
M.4.2 Data: Cash I, $\mathcal{LH}$

Under "Data", select "Load…".



Navigate to the “SectionJ_Table5” folder of the tutorial files, and then to the “DataSets” folder and open “Cash1.txt”.

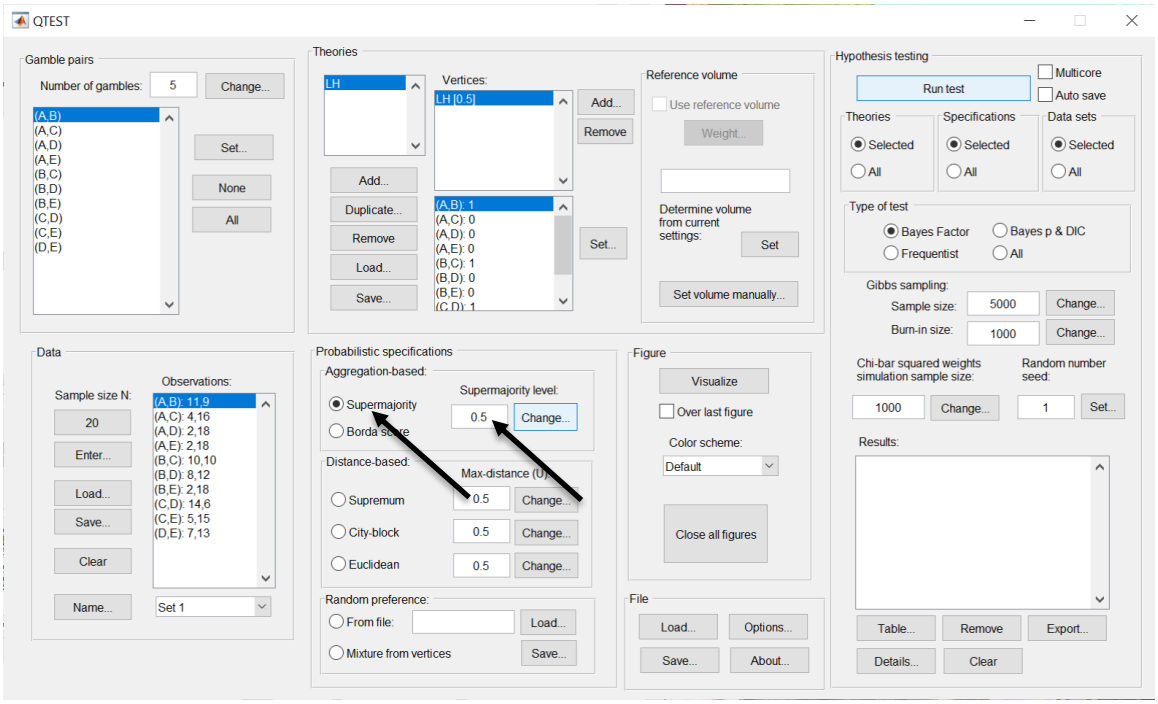
Under “Data” notice the “Observations:” list has now been populated:



Under “Data”, select the dropdown menu next to “Name…” to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

M.4.3 Probabilistic specification: Cash I, $\mathcal{LH}$, 0.50-Majority/modal choice

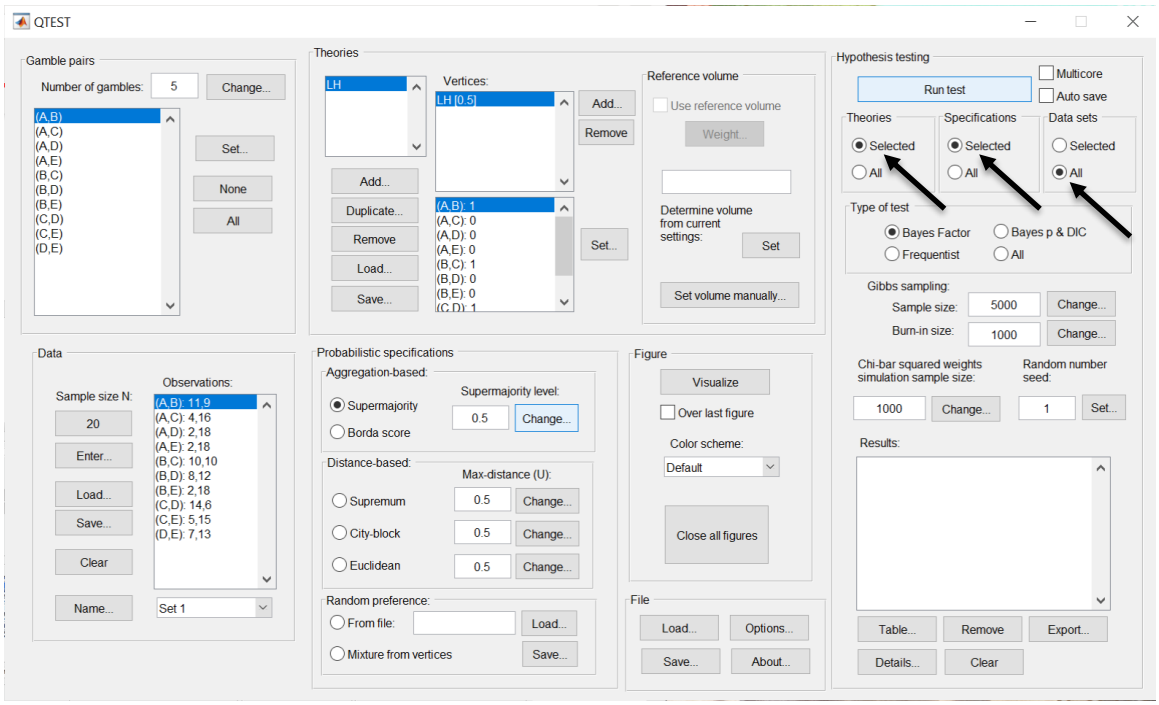
To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected and that the “Supermajority level:” is set to “0.5”.



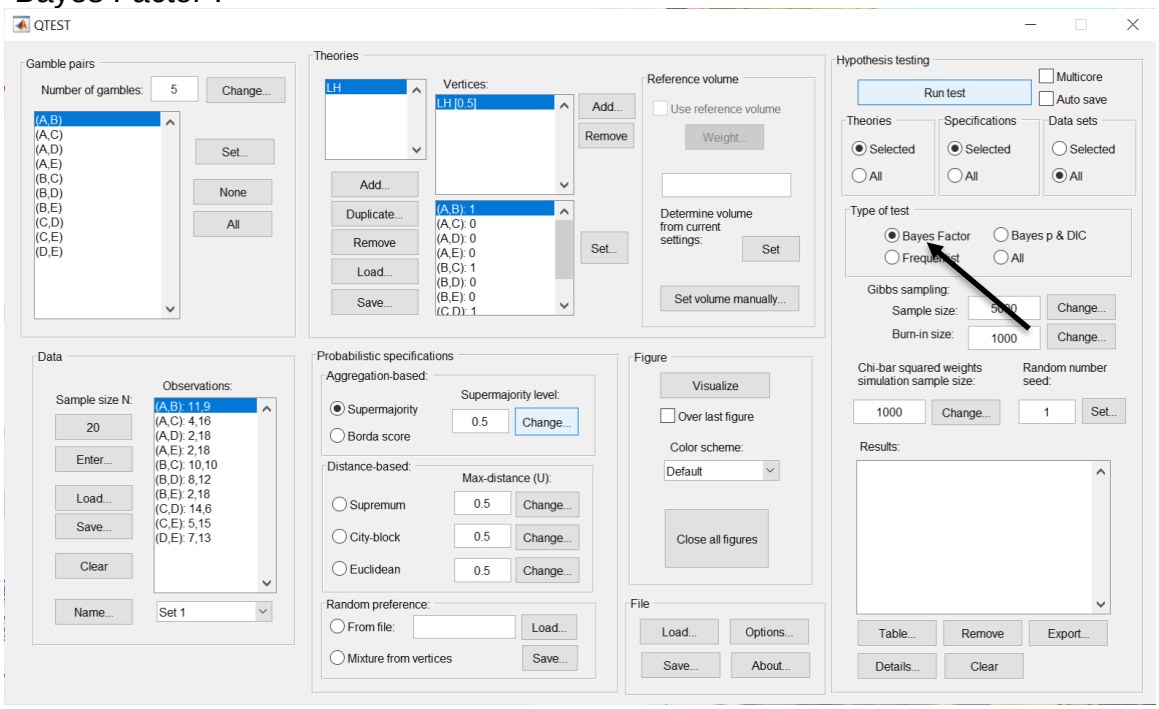
M.4.4 Hypothesis Testing: Cash I, $\mathcal{LH}$, 0.50-Majority/modal choice

We are now ready for the Bayes Factor test of $\mathcal{LH}$ .50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under "Hypothesis testing", under the "Run test" button, there are 3 columns: "Theories", "Specifications" and "Data sets". For each of these, the user must choose the radio button next to either "Selected" or "All". For more information on these settings, as well as the inputs for "Chi-bar squared weights simulation sample size:" and "Random number seed:", see section G.5.

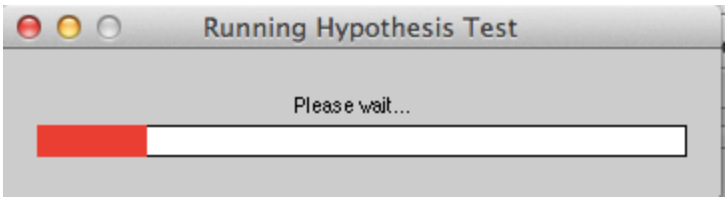
Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".



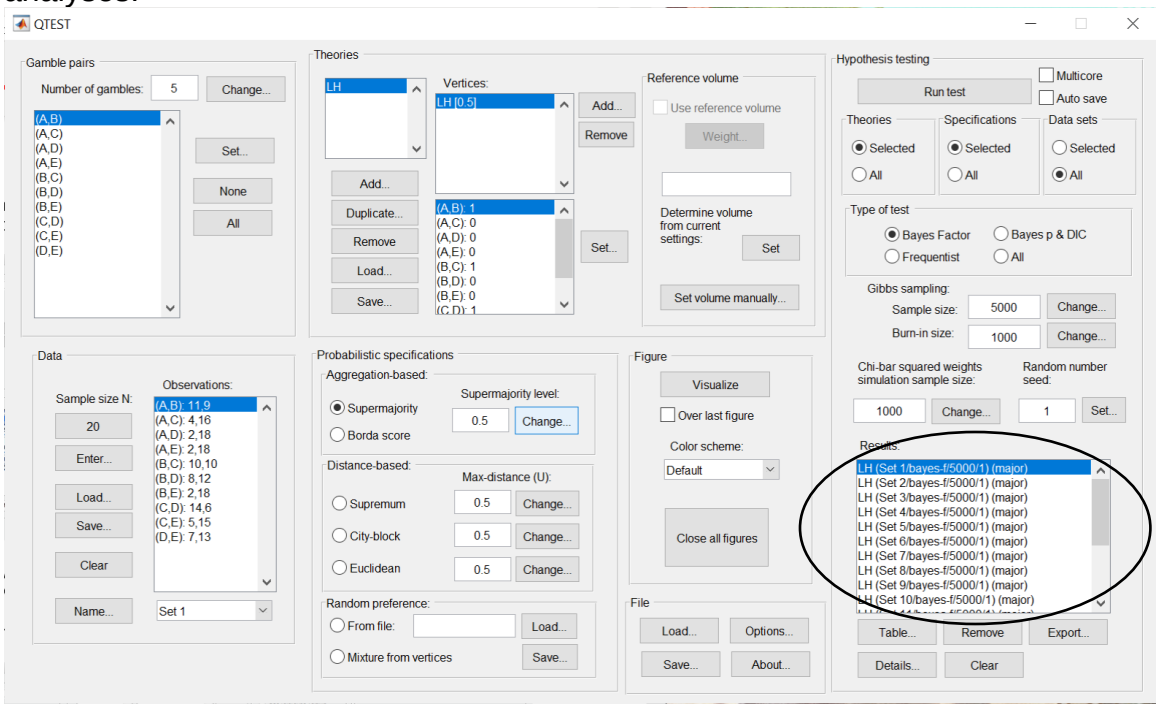
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes Factor”.



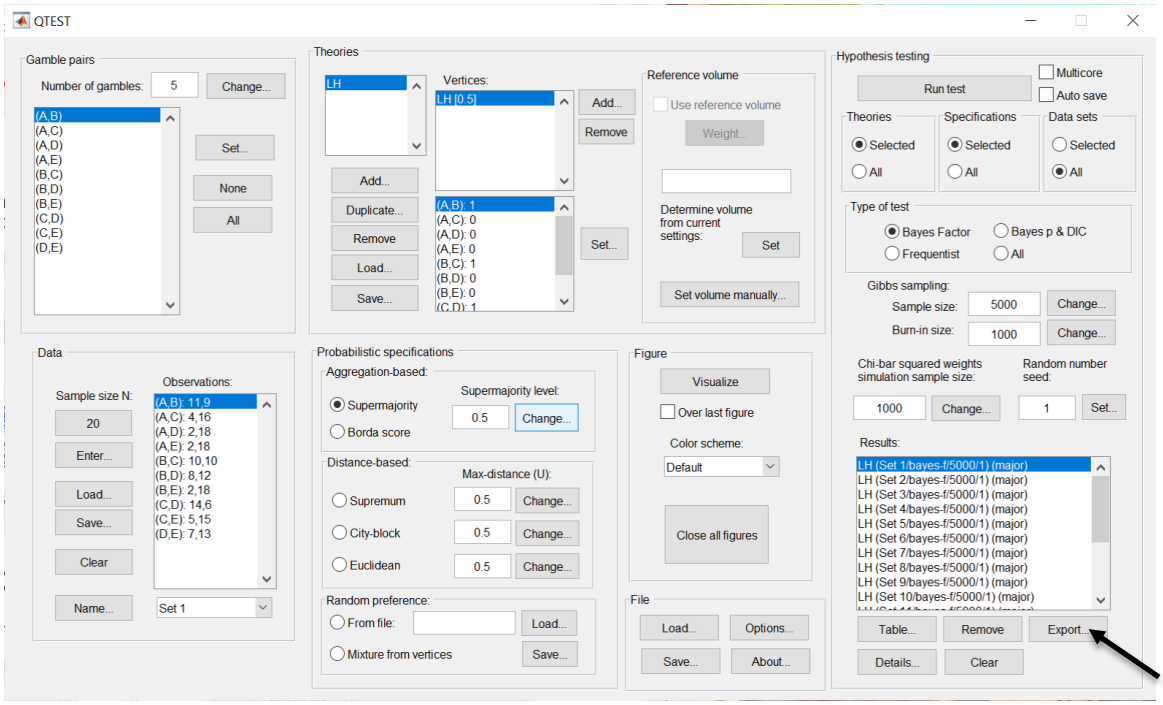
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



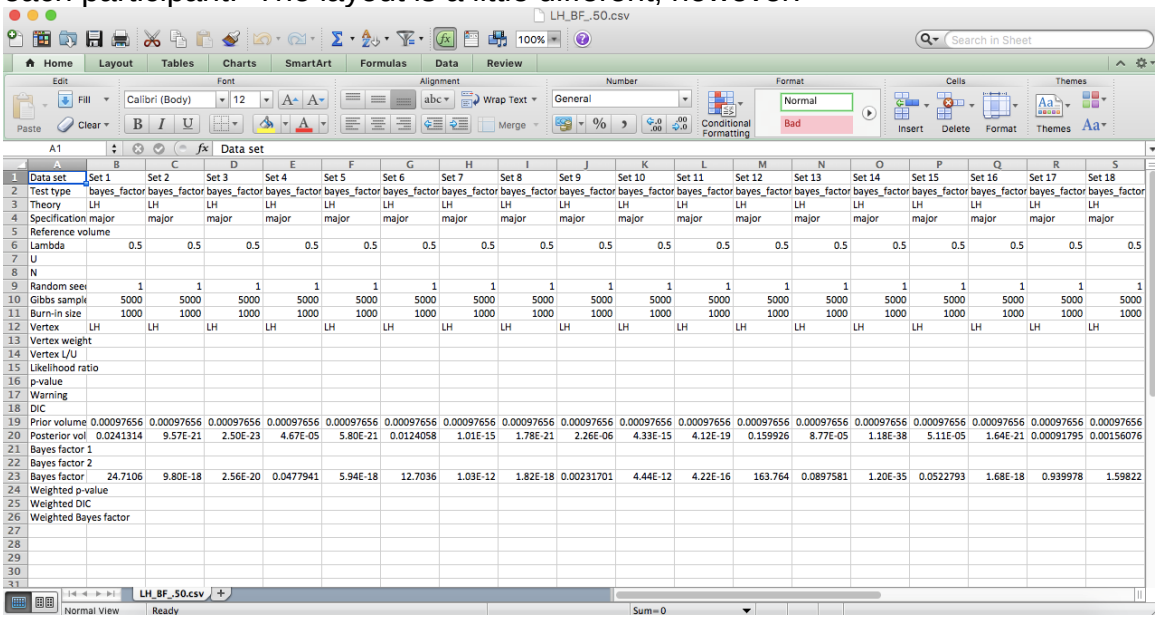
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory. Therefore, under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file. For more information on other ways a user can view the results, see section G.5.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “S” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on. All the information in this spreadsheet is identical to what one would see if they selected “Details…” for each participant. The layout is a little different, however.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor
3	Theory	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
4	Specification	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference volume																		
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																		
8	N																		
9	Random seed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs sample	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
13	Vertex weight																		
14	Vertex L/U																		
15	Likelihood ratio																		
16	p-value																		
17	Warning																		
18	DIC																		
19	Prior volume	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656
20	Posterior vol	0.0241314	9.57E-21	2.50E-23	4.67E-05	5.80E-21	0.0124058	1.01E-15	1.78E-21	2.26E-06	4.33E-15	4.12E-19	0.159926	8.77E-05	1.18E-38	5.11E-05	1.64E-21	0.00091795	0.00156076
21	Bayes factor 1																		
22	Bayes factor 2																		
23	Bayes factor	24.7106	9.80E-18	2.56E-20	0.0477941	5.94E-18	12.7036	1.03E-12	1.82E-18	0.00231701	4.44E-12	4.22E-16	163.764	0.0897581	1.20E-35	0.0522793	1.68E-18	0.939978	1.59822
24	Weighted p-value																		
25	Weighted DIC																		
26	Weighted Bayes factor																		
27																			
28																			
29																			
30																			
31																			

The Bayes factor values are in row 23 of the spreadsheet. The Bayes factor in column “B” listed as “Set 1” is where the Bayes factor for participant 1 can be found, listed under “.50 Majority Choice” and “LH” in Table 3 of QTBC2. Notice the same holds true for column “C” listed as “Set 2”, for participant 2, and so on.

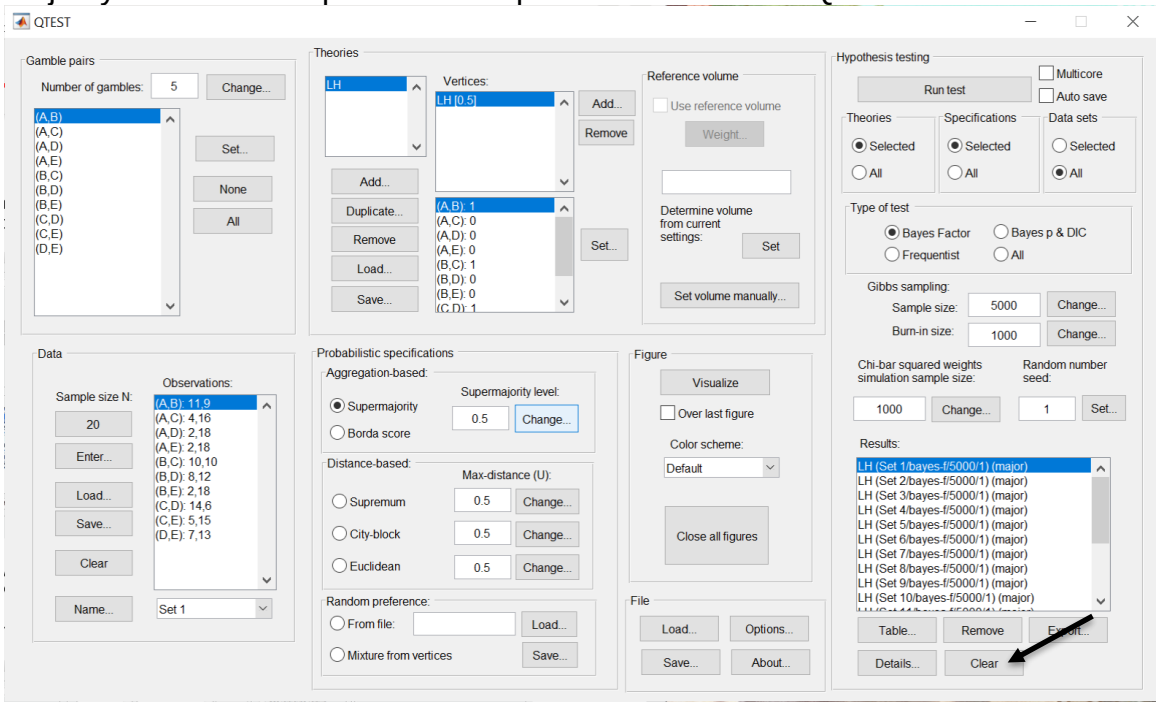
Note, however, that the Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select “Change…” next to “Sample size:” under “Hypothesis testing” and “Gibbs sampling:”. Then, in the “Gibbs sampling” dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column “LH” under “.50 Majority Choice” of Table 3 can be replicated.

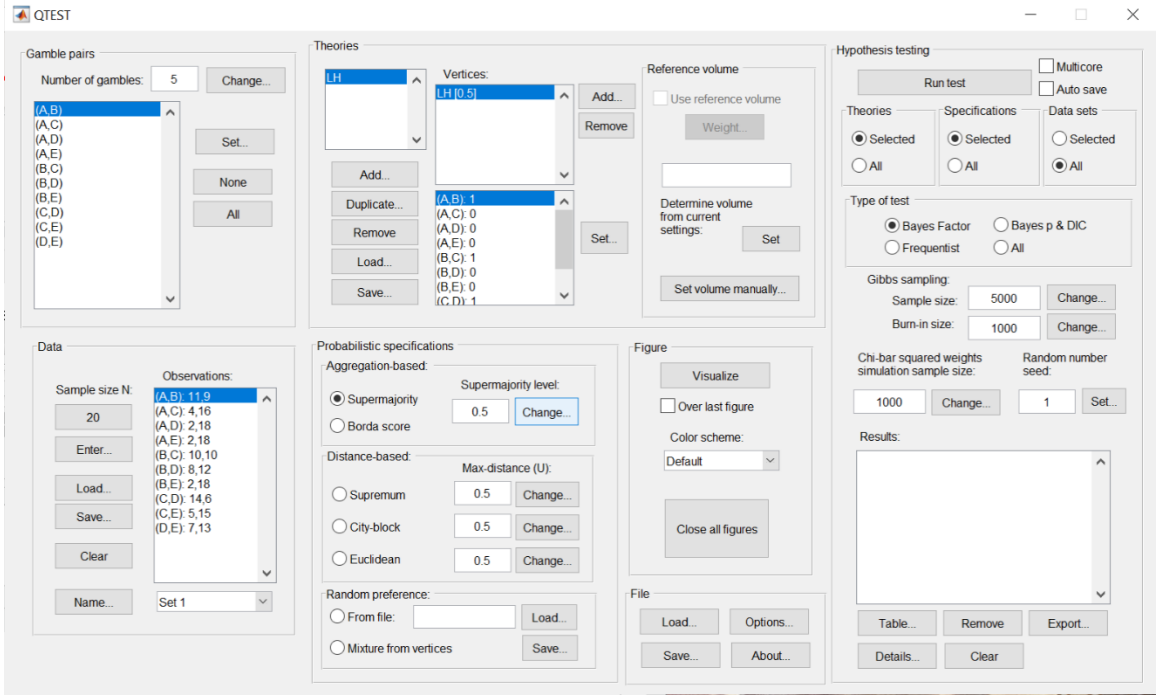
This completes the analysis for Cash I data for the Bayes Factor test of $\mathcal{LH}$ .50-majority/modal choice probabilistic specification. We will, again, demonstrate the analysis for the Cash I data for the Bayes Factor test of $\mathcal{LH}$, but now with a .90-supermajority probabilistic specification in the following two sections, M.4.5 and M.4.6.

M.4.5 Probabilistic specification: Cash I, $\mathcal{LH}$, 0.90-Supermajority

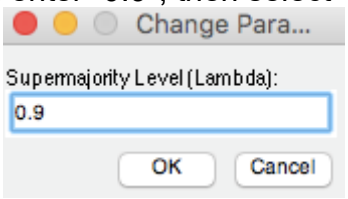
If continuing from section M.4.4, select “Clear” under “Hypothesis testing” and “Results:”. This step clears the results of the Bayes Factor test of $\mathcal{LH}$ .50-majority/modal choice probabilistic specification from the QTEST interface.



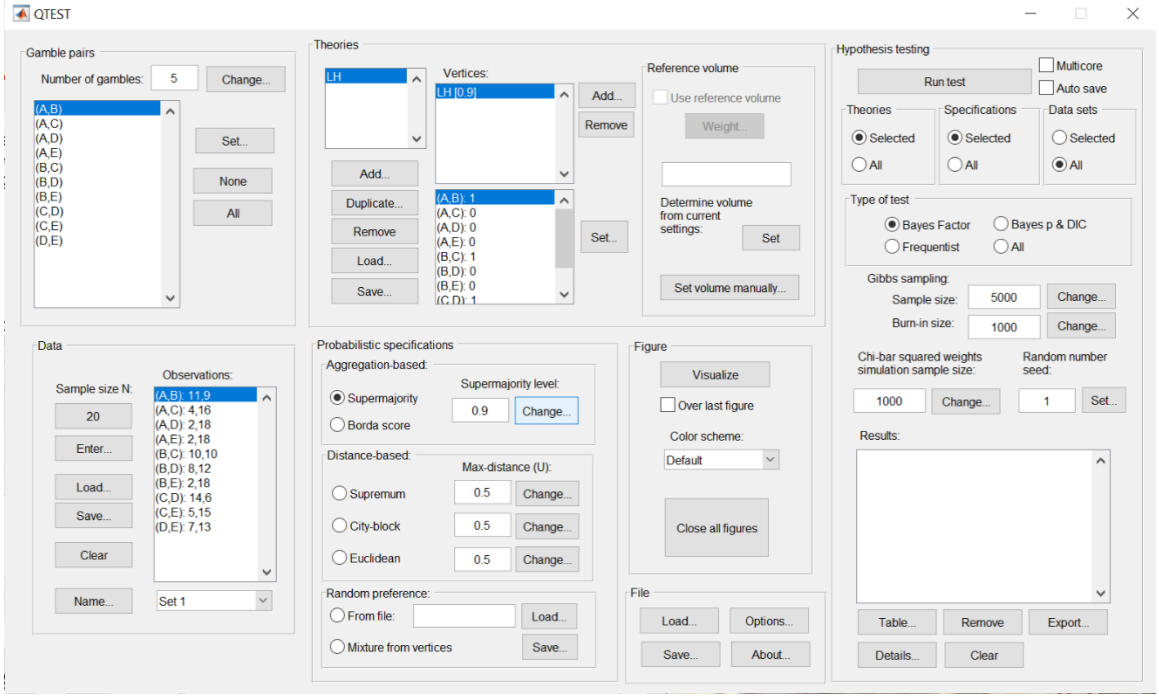
Whether the user is continuing from section M.4.2 or M.4.4, the QTEST interface should match the screenshot below.



To set this specification, under “Probabilistic specifications”, make sure the radio button left of “Supermajority” is selected. To set the “Supermajority level:” to “0.9”, select “Change…” and enter “0.9”, then select “OK.”



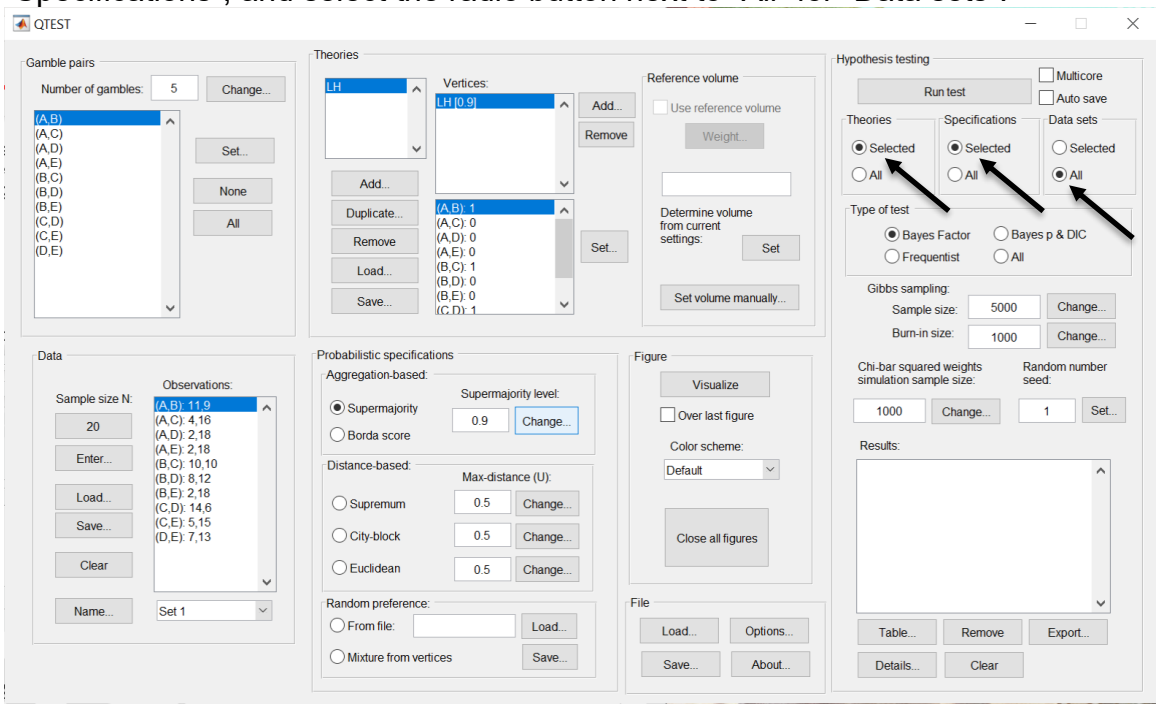
The QTEST interface should now match the screenshot below.



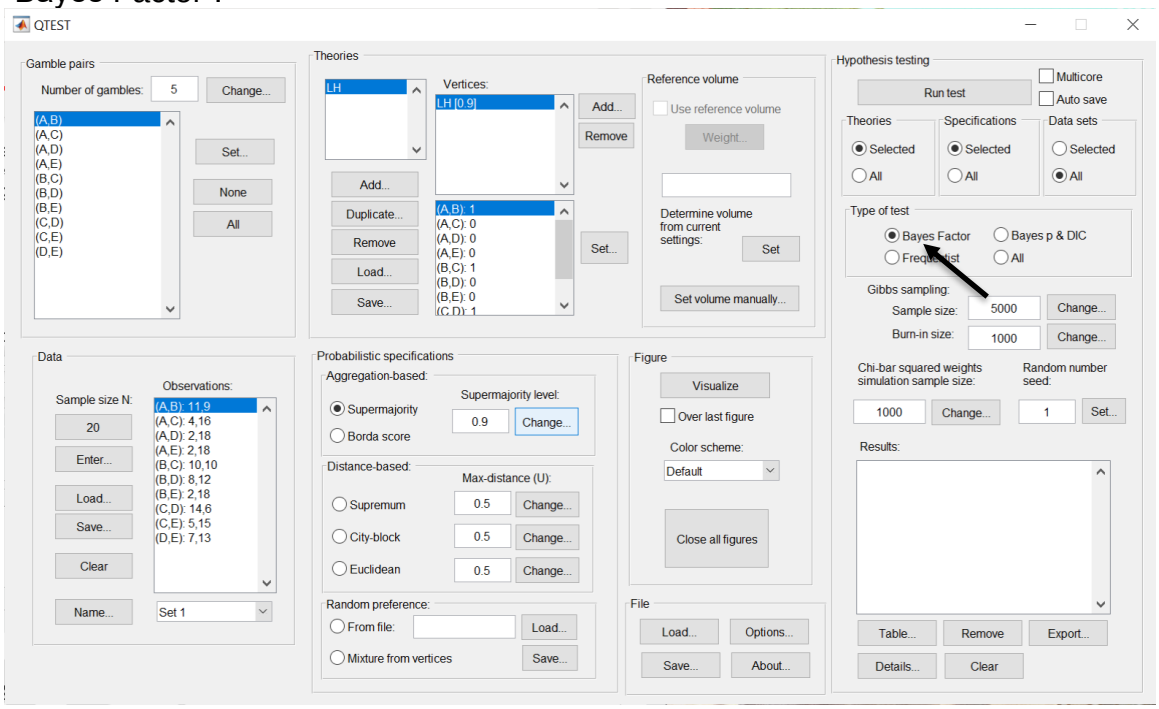
M.4.6 Hypothesis Testing: Cash I, $\mathcal{LH}$, 0.90-Supermajority

We are now ready for the Bayes Factor test of $\mathcal{LH}$ .90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

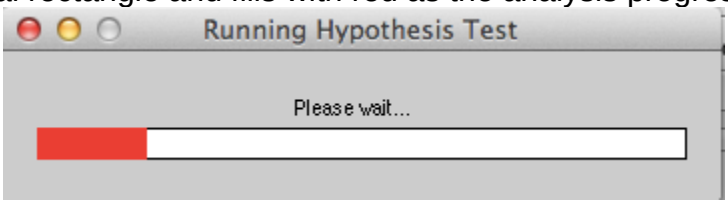
Under “Hypothesis testing”, verify the radio button next to “Selected” is selected under “Theories”, the radio button next to “Selected” is selected for “Specifications”, and select the radio button next to “All” for “Data sets”.



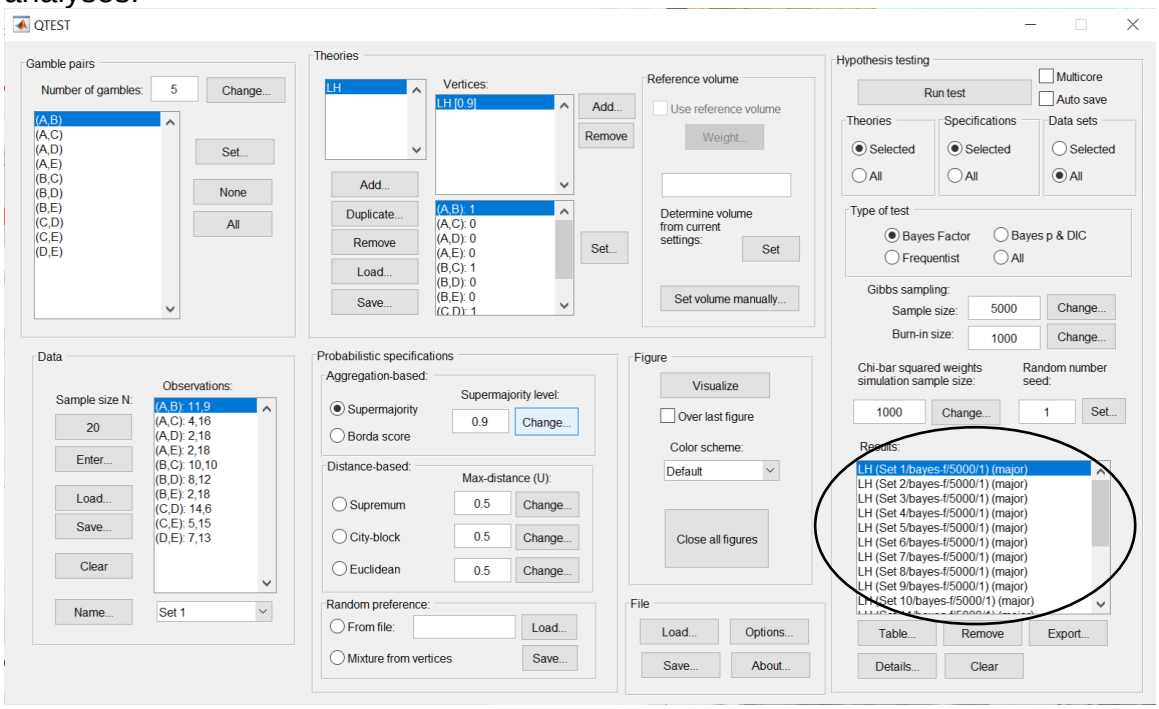
Under “Hypothesis testing” and “Type of test”, select the radio button next to “Bayes Factor”.



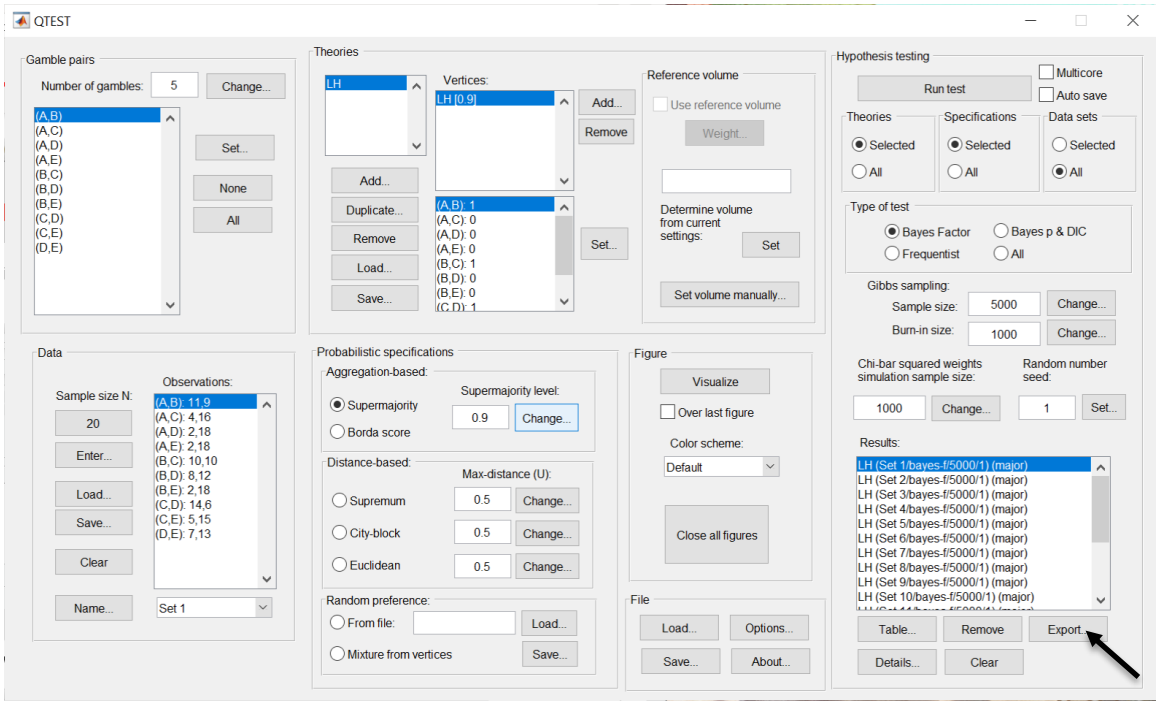
Now that all the settings under “Hypothesis testing” are correct, select “Run test”. The “Running Hypothesis Test” window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



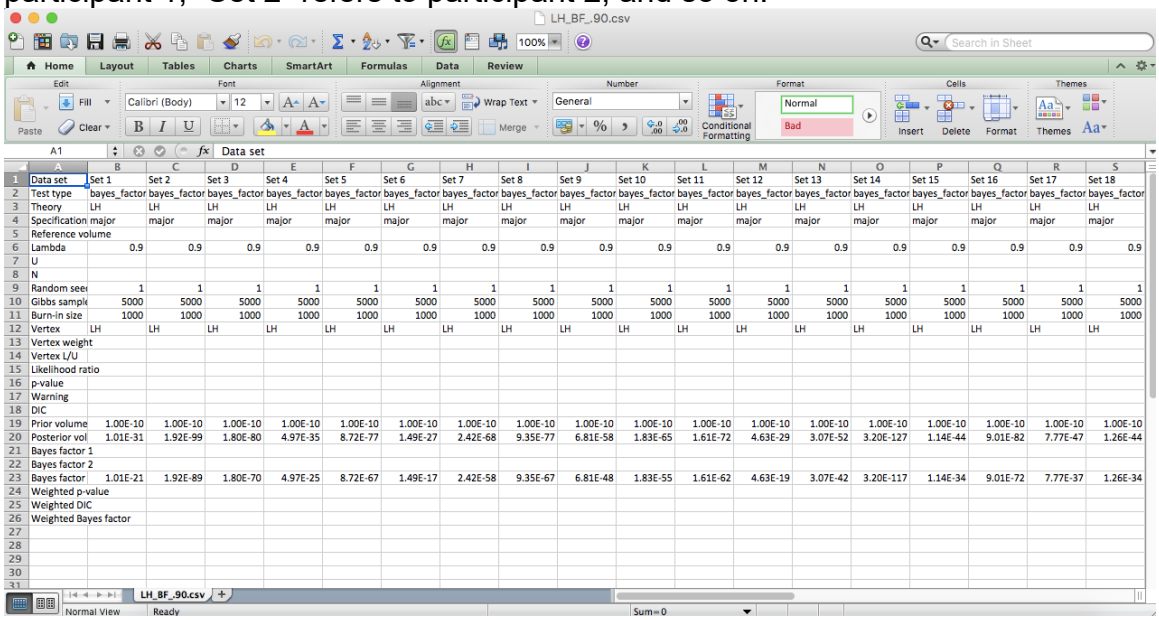
Once the analysis is complete, QTEST will now look like the following screenshot. Under “Hypothesis testing”, under “Results:”, you will see a list of completed analyses.



Under “Hypothesis testing”, under “Results:”, select “Export…”. An “Export Results As” window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled “Set 1” through “Set 18” in columns “B” through “S” of the spreadsheet. The columns represent different participants; “Set 1” refers to participant 1, “Set 2” refers to participant 2, and so on.



Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
Test type	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor
Theory	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
Specification	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
Reference volume																		
Lambda	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
U																		
N																		
Random seed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Gibbs sample	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Vertex	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
Vertex weight																		
Vertex L/U																		
Likelihood ratio																		
p-value																		
Warning																		
DIC																		
Prior volume	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10
Posterior vol	1.01E-31	1.92E-99	1.80E-80	4.97E-35	8.72E-77	1.49E-27	2.42E-68	9.35E-77	6.81E-58	1.83E-65	1.61E-72	4.63E-29	3.07E-52	3.20E-127	1.14E-44	9.01E-82	7.77E-47	1.26E-44
Bayes factor 1																		
Bayes factor 2																		
Bayes factor	1.01E-21	1.92E-89	1.80E-70	4.97E-25	8.72E-67	1.49E-17	2.42E-58	9.35E-67	6.81E-48	1.83E-55	1.61E-62	4.63E-19	3.07E-42	3.20E-117	1.14E-34	9.01E-72	7.77E-37	1.26E-34
Weighted p-value																		
Weighted DIC																		
Weighted Bayes factor																		

The Bayes factor values are in row 23 of the spreadsheet. The Bayes factor in column “B” listed as “Set 1” is where the Bayes factor for participant 1 can be found, listed under “.90 Supermajority” and “LH” in Table 3 of QTBC2. Notice the same holds true for column “C” listed as “Set 2”, for participant 2, and so on.

Note, however, that the Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under “Hypothesis testing” and “Random number seed:”.

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select “Change…” next to “Sample size:” under “Hypothesis testing” and “Gibbs sampling:”. Then, in the “Gibbs sampling” dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column “LH” under “.90 Supermajority” of Table 3 can be replicated.

This completes the analysis for Cash I data for the Bayes Factor test of $\mathcal{LH}$ .90-supermajority probabilistic specification.

Now the user should have replicated all the Cash 1 Bayes factor values of Table 3 in QTBC2. To summarize, section M.2 demonstrated the steps in running the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{KT}$ for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications. Then,

section M.3 demonstrated the steps in running the Bayes Factor test of $\mathcal{CPT}$-$\mathcal{GE}$ for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications. Lastly, section M.4 demonstrated the steps in running the Bayes Factor test of $\mathcal{LH}$ for the .50-majority/modal choice and the .90-supermajority probabilistic specifications.

PART IV: Online Supplements

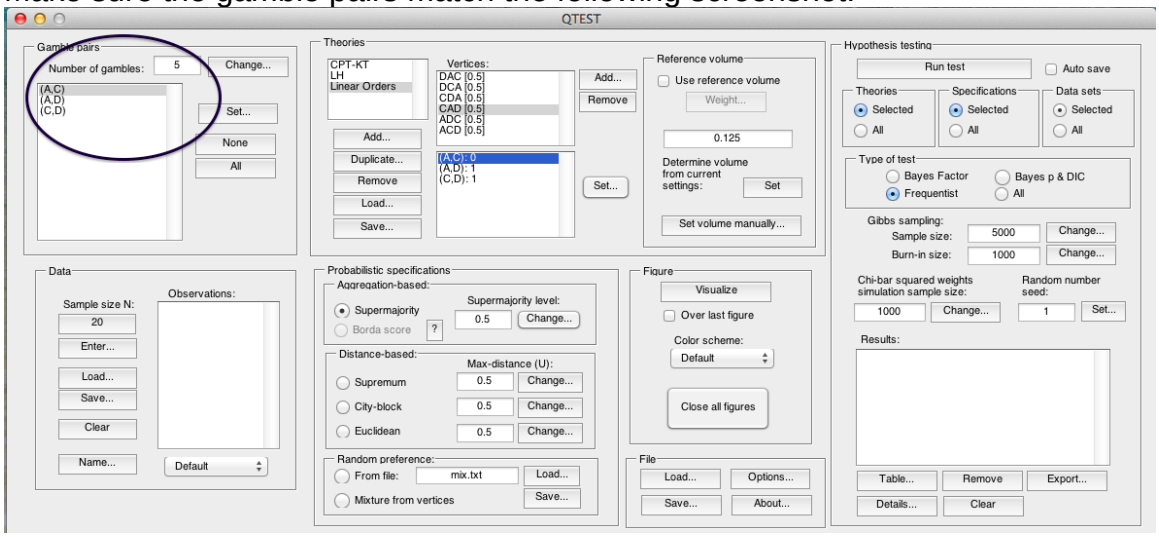
In this part of the tutorial we recreate Figures 2, 3 and 4 of Online Supplement 1.

N. Figure 2 of online supplement 1

Figure 2 of online supplement 1 is the mixture model specification for the Linear Ordering Polytope.

N.1 Create the gamble pairs

Make sure the gamble pairs match the following screenshot.



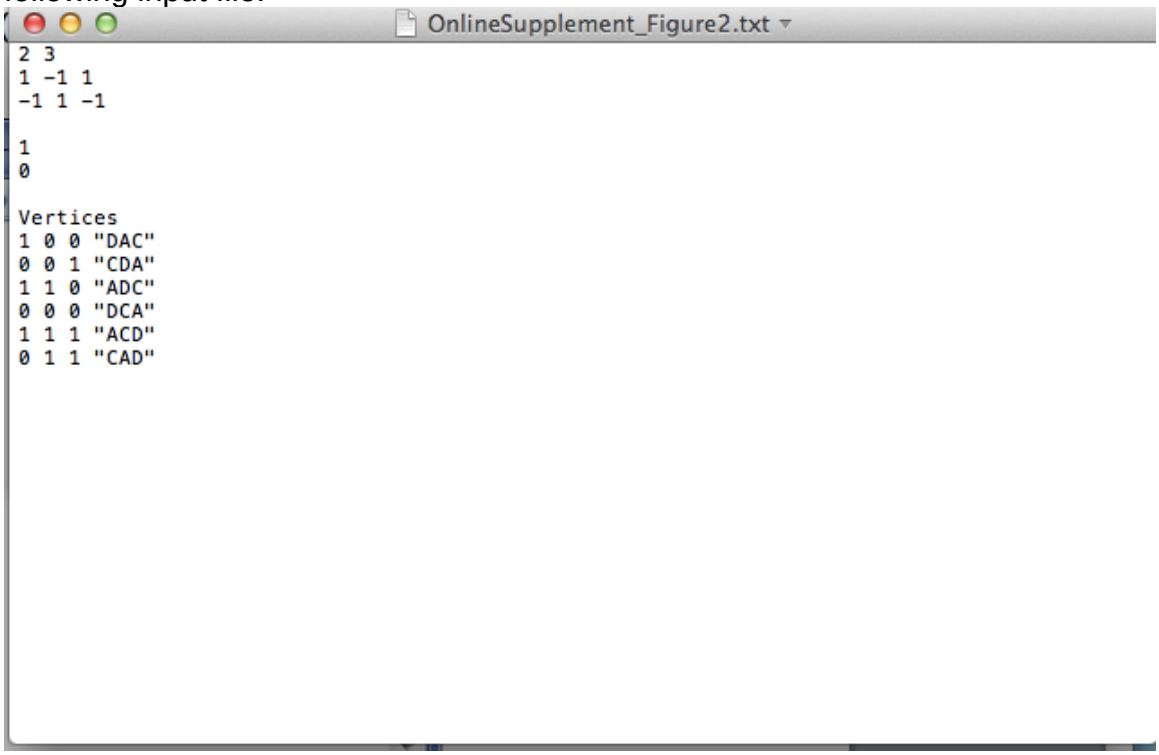
N.2 Create the input file

The linear ordering polytope is based on the following system of facet-defining inequalities in 3-dimensional space. These inequalities are:

$$\theta_{AC} - \theta_{AD} + \theta_{AD} \leq 1$$

$$-\theta_{AC} + \theta_{AD} - \theta_{AD} \leq 0$$

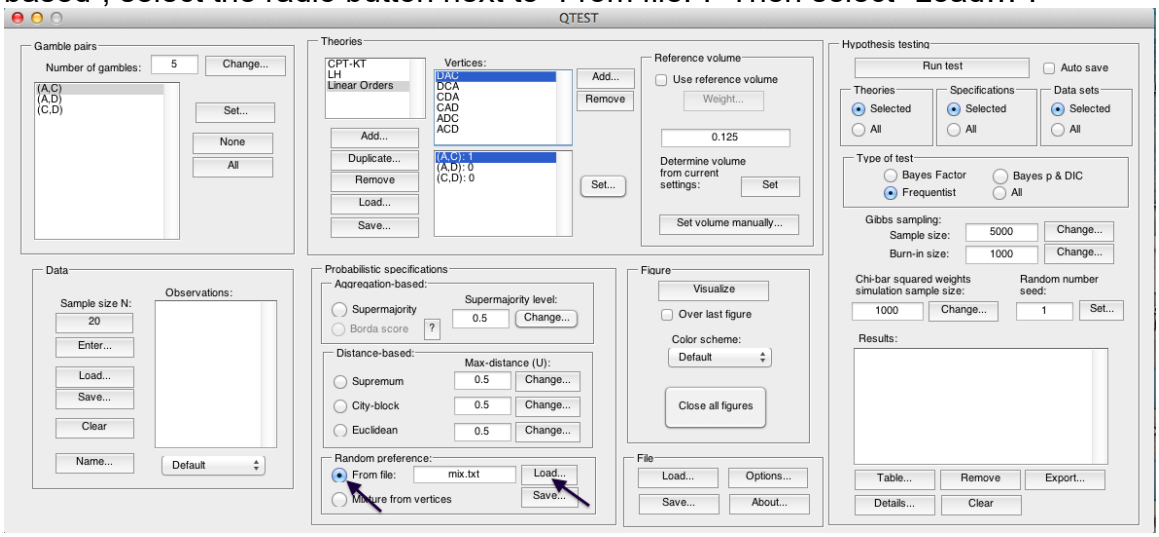
These inequalities, as well as prior literature about them, were also discussed in Regenwetter, Dana, and Davis-Stober (2010, 2011). These inequalities yield the following input file.



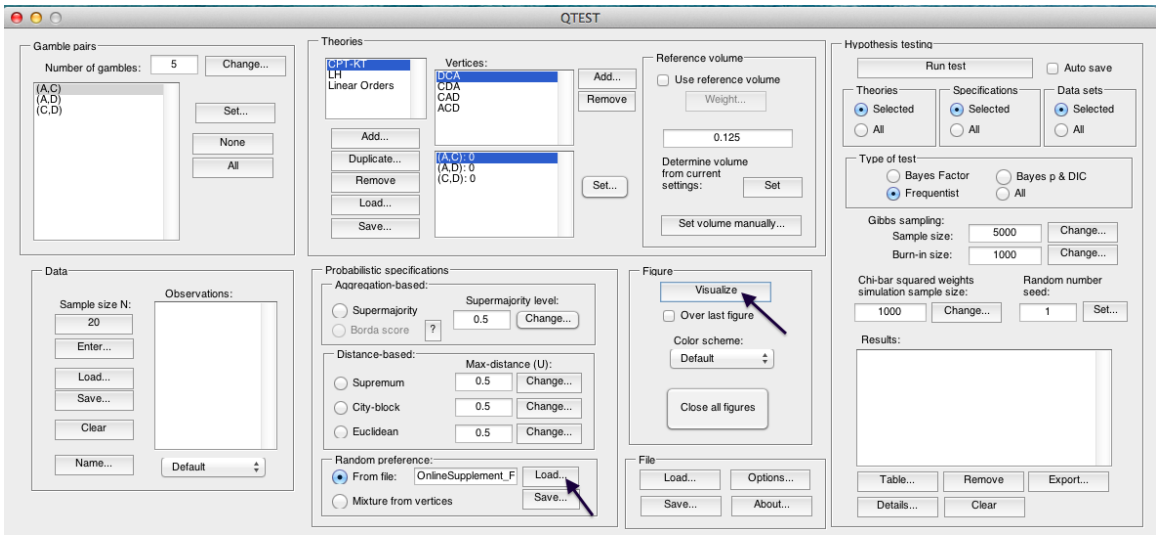
This is all the information QTEST needs to analyze this mixture model. Save this file as “OnlineSupplement_Figure2.txt”. We now return to the QTEST interface to complete the analysis.

N.3 Mixture model analysis of the Linear Ordering Polytope

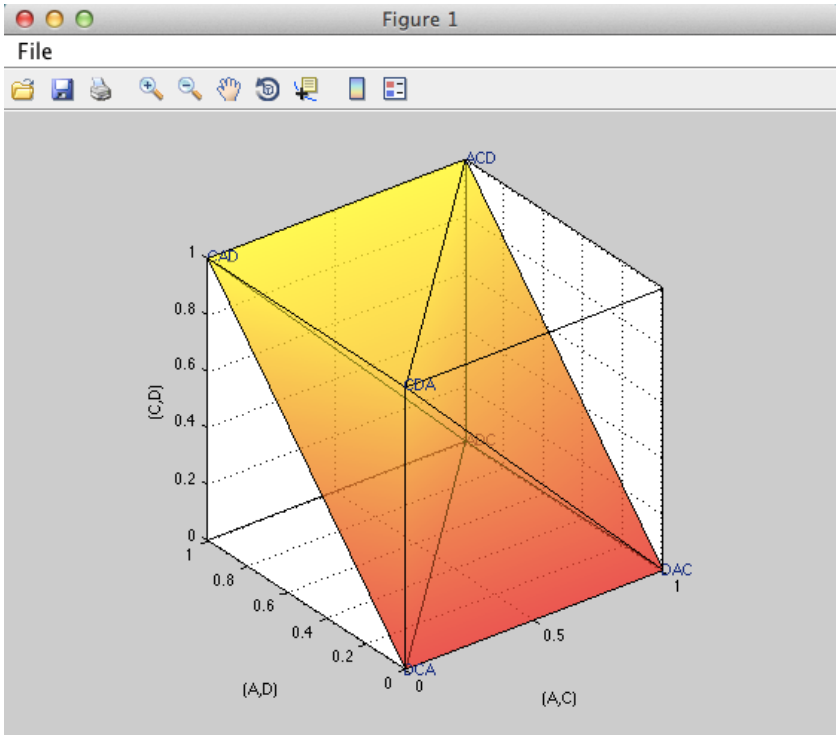
In the QTEST interface, under “Probabilistic specifications”, under “Mixture-based”, select the radio button next to “From file:”. Then select “Load…”.



In the “Load Specification” dialogue box that pops up, change the “Files of type:” to “Text files (*.txt)” and then navigate to the location of the “OnlineSupplement_Figure2.txt” file. Then select “Open”. Under “Figure”, select “Visualize”.



The figure that pops up is a version of Figure 2 of Online Supplement 1 of QTBC1.



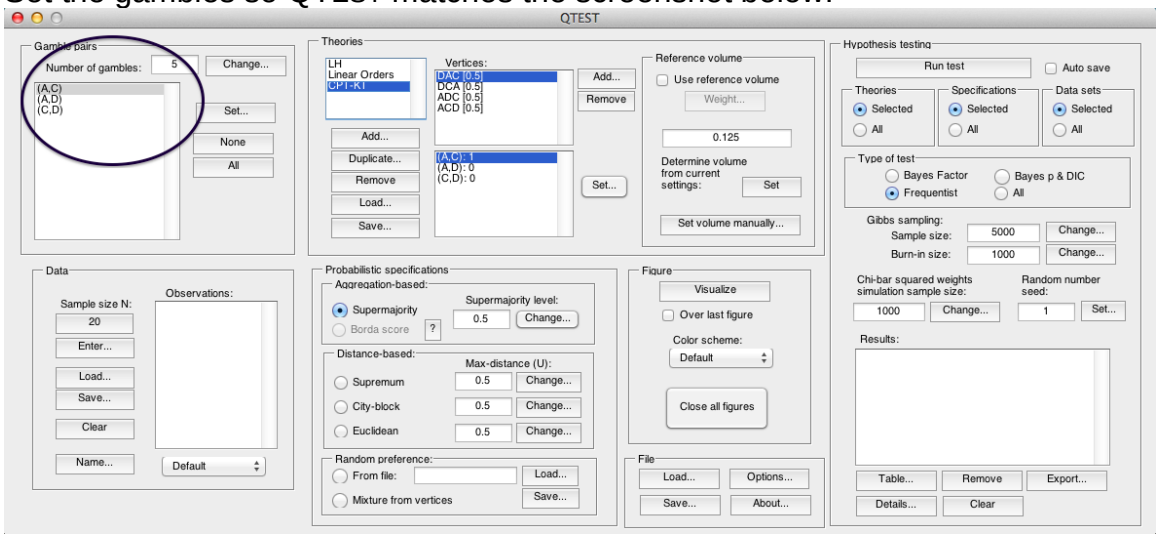
This completes the 3-D example for the mixture model specification of the Linear Ordering Polytope.

O. Figure 3 of Online Supplement 1: $\mathcal{CPT}$-$\mathcal{KT}$ with constant volumes vs. $\mathcal{LH}$

Figure 3 of online supplement 1 is like Figure 8 of QTBC1, in that they both compare $\mathcal{CPT}$-$\mathcal{KT}$ and $\mathcal{LH}$ in the same 3-D space. However, Figure 8 of QTBC1 created a 0.50-majority/modal choice specification (or a 0.90-supermajority specification) of these theories. In generating Figure 3 of online supplement 1, we start with a 0.50-majority/modal choice specification of the predictions for $\mathcal{CPT}$-$\mathcal{KT}$ and $\mathcal{LH}$. But then weight the volumes of each cube comprising the predictions of $\mathcal{CPT}$-$\mathcal{KT}$ so that the total volume of all its cubes equals the volume of the cube for the single prediction of $\mathcal{LH}$. The reason for this weight, as described in online supplement 1, is to place the theories on an equal footing geometrically, so that $\mathcal{CPT}$-$\mathcal{KT}$ is not favored over $\mathcal{LH}$ simply because it has more predictions and occupies a larger volume in the geometric space. Here, volume serves as a measure of model complexity for an order-constrained probability model. After completing this section, we will have created Figure 3 of Online Supplement 1.

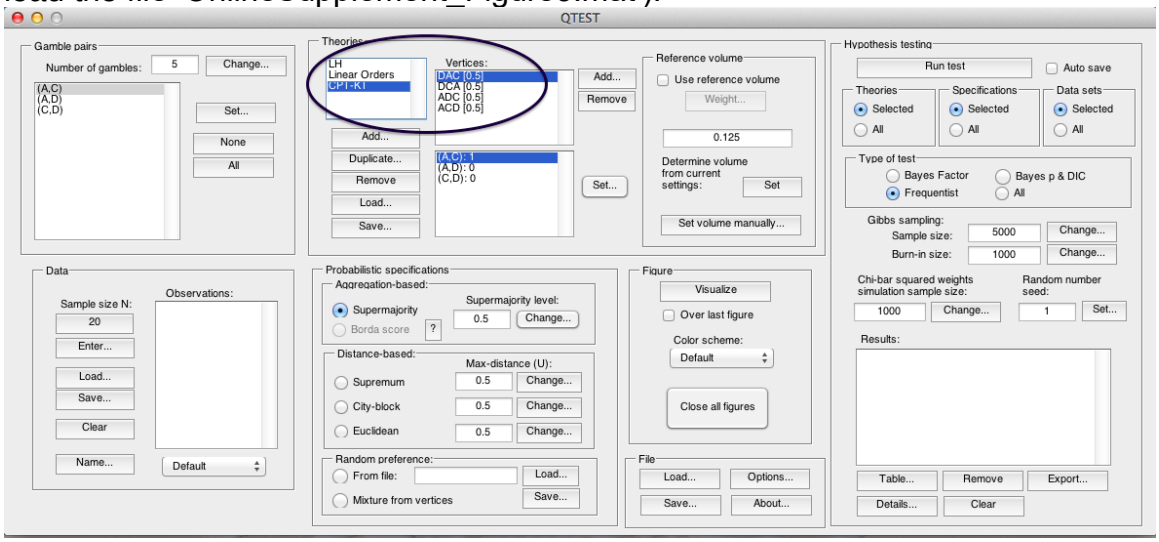
O.1 Create the gamble pairs

Set the gambles so QTEST matches the screenshot below.



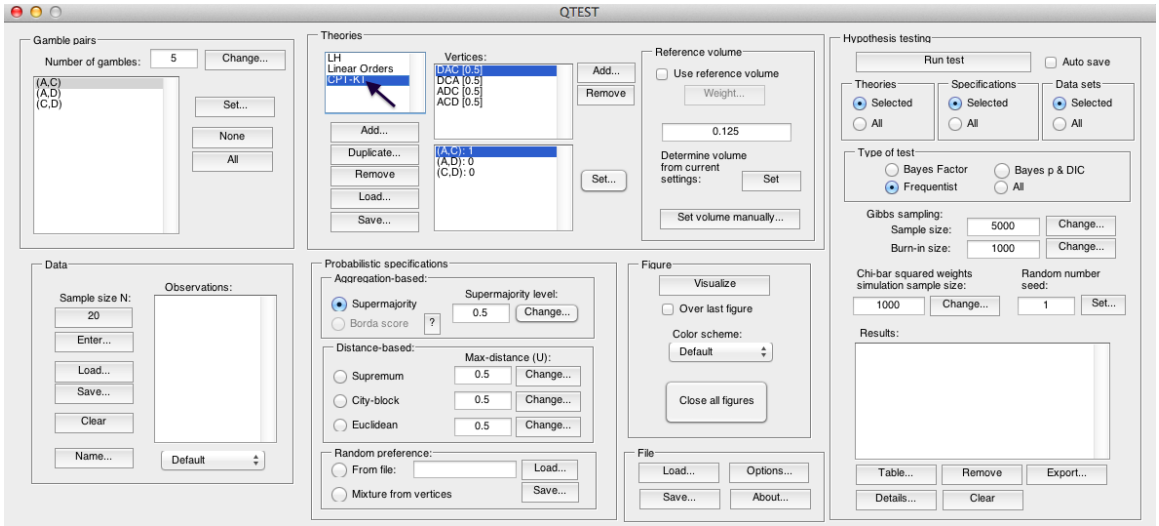
O.2 Define two decision theories, *CPT-KT* and *LH*

To create theories “CPT-KT” and “LH”, please see Section E above (or you can load the file ‘OnlineSupplement_Figure3.mat’).

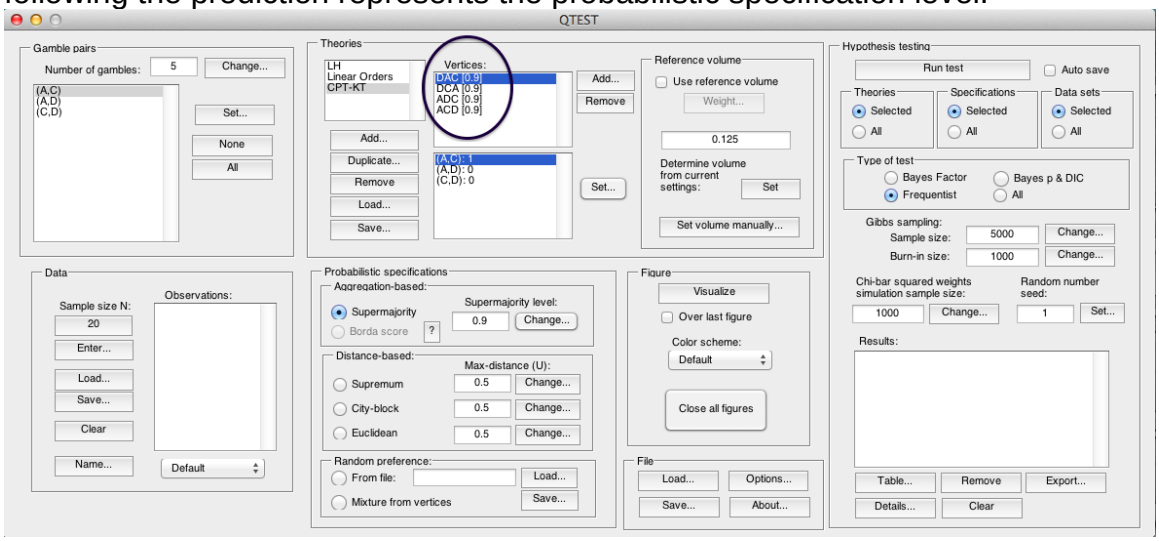


O.3 Specify the predictions of theories *LH* and *CPT-KT*

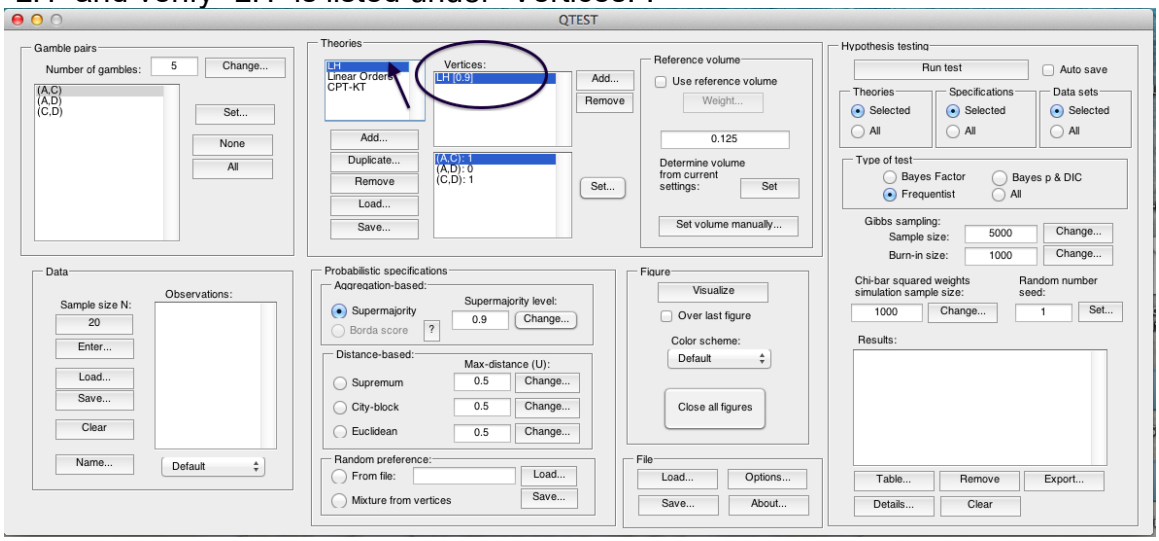
In Section E.3, we specified the predictions for *LH* and *CPT*. You may return to Section E.3 or create them as indicated below.



Under “Theories”, under “Vertices:”, verify the predictions “DAC”, “DCA”, “ADC” and “ACD” are listed in any order. The number contained in the square brackets following the prediction represents the probabilistic specification level.

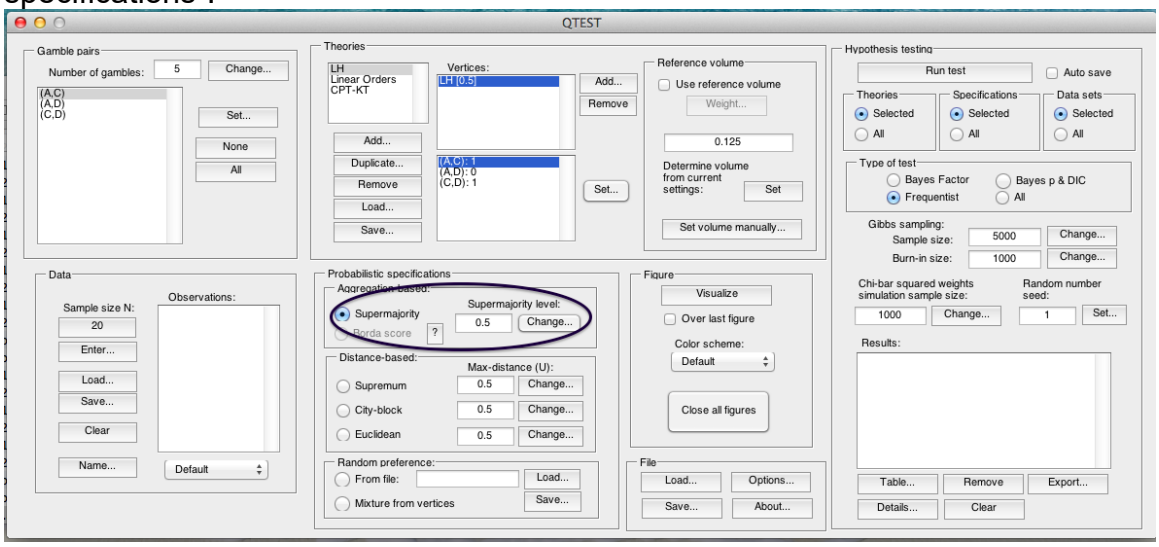


Next, verify that LH has the correct prediction listed. Under “Theories”, select “LH” and verify “LH” is listed under “Vertices:”.

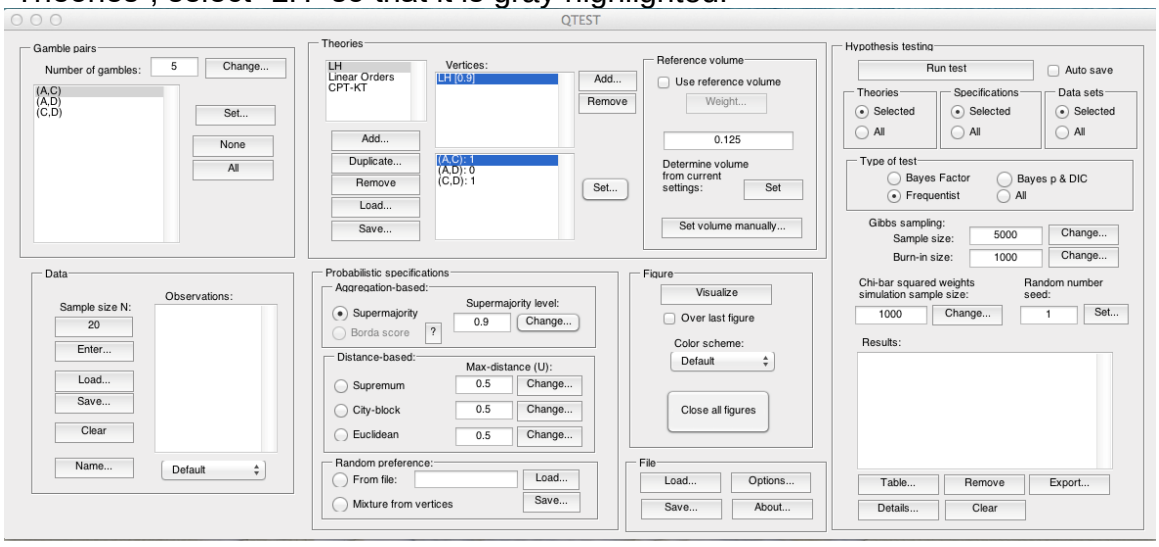


O.4 *CPT-KT* with constant volumes vs. *LH*

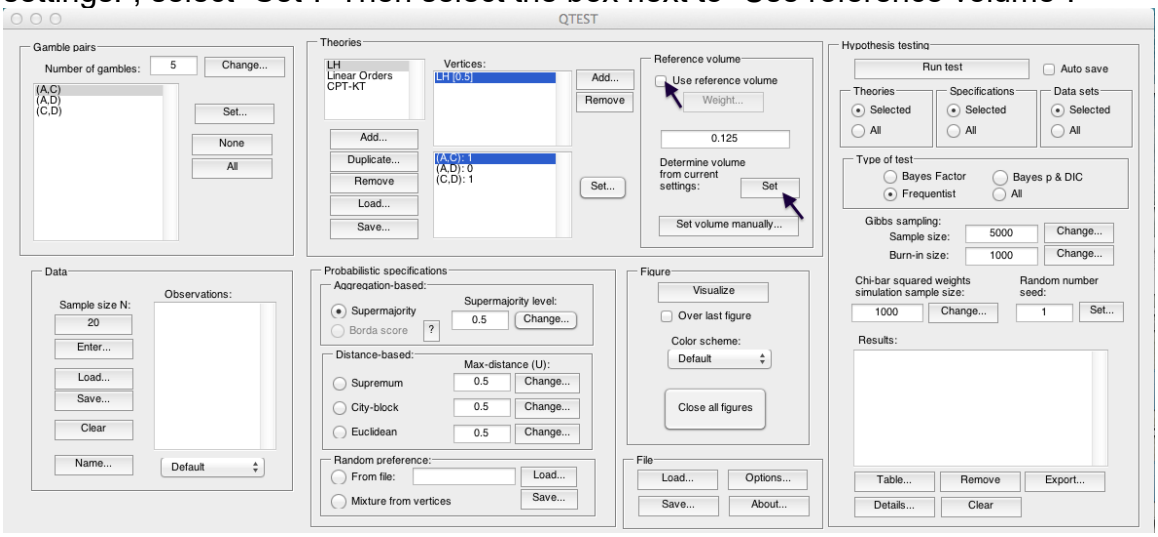
First verify the “Supermajority level:” is set to “0.5” under “Probabilistic specifications”.



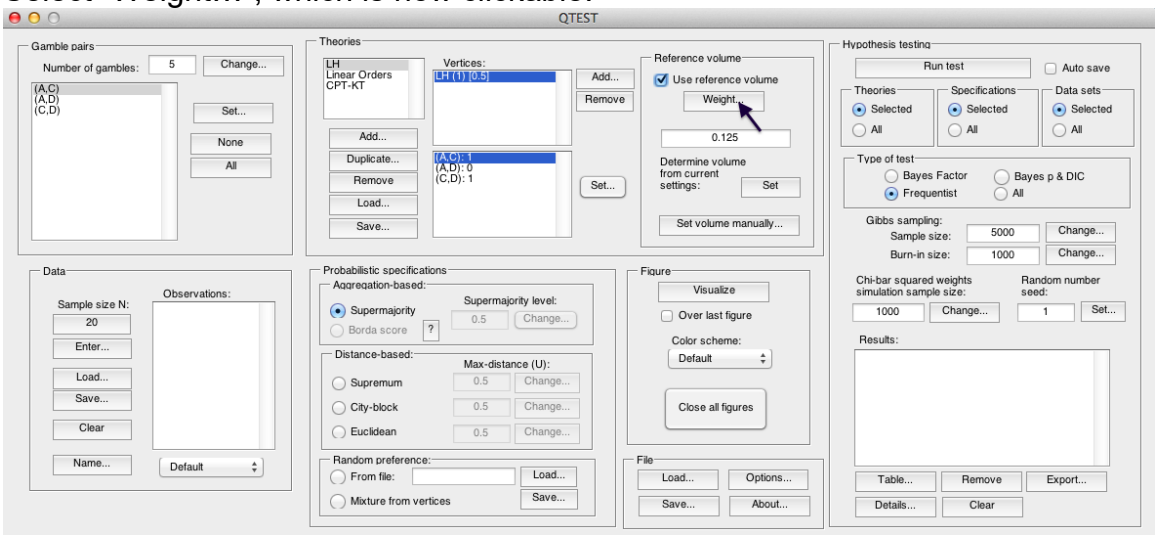
Weighting *CPT-KT* and *LH* is a two-step process. First, we will use the single prediction of *LH* as the reference volume. In the QTEST interface, under “Theories”, select “LH” so that it is gray highlighted.



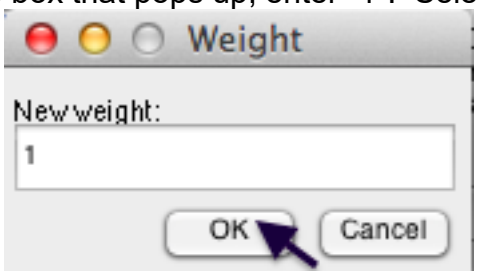
Under “Reference volume”, next to “Determine the volume from current settings:”, select “Set”. Then select the box next to “Use reference volume”.



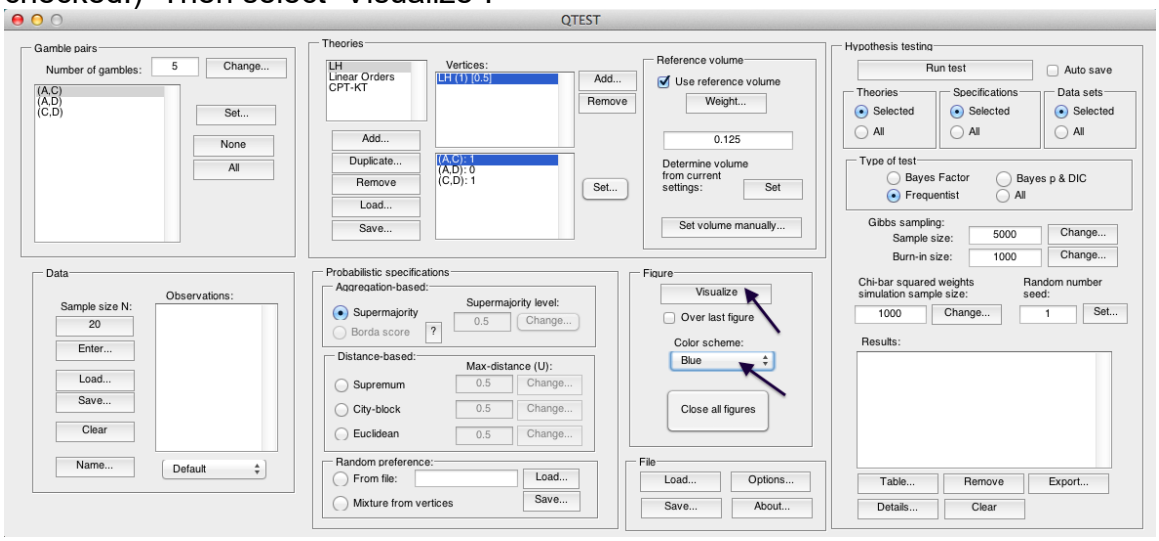
Select “Weight…”, which is now clickable.



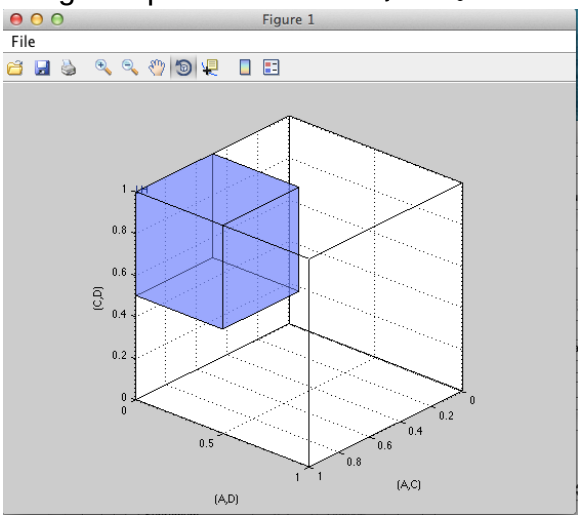
In the “Weight” dialogue box that pops up, enter “1”. Select “OK”.



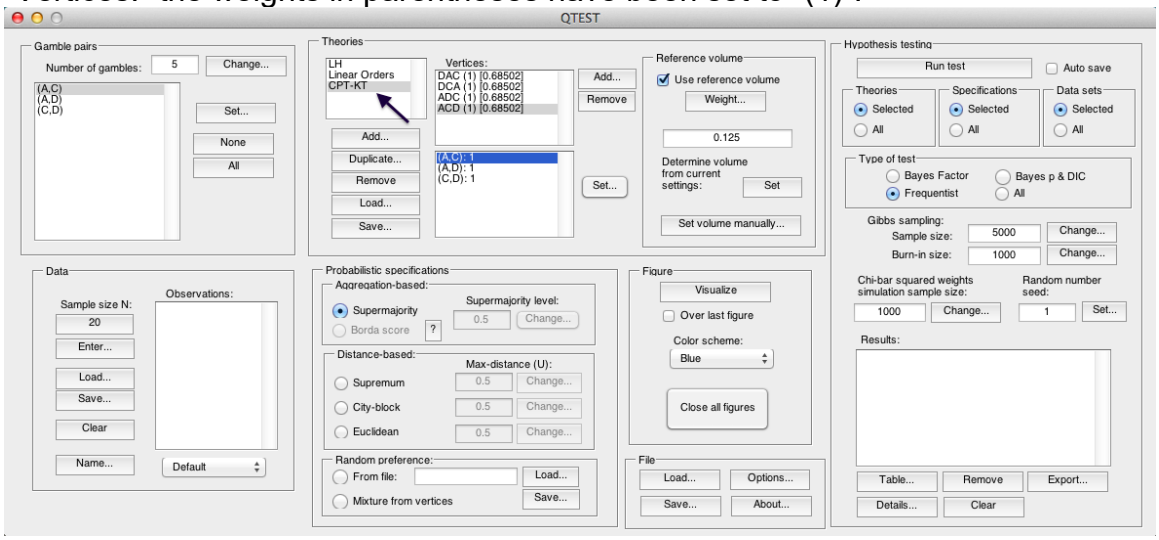
We now generate an intermediate figure. Under “Figure”, change “Color scheme:” to “Blue” from the dropdown menu. (Deselect “Over last figure if it is checked.) Then select “Visualize”.



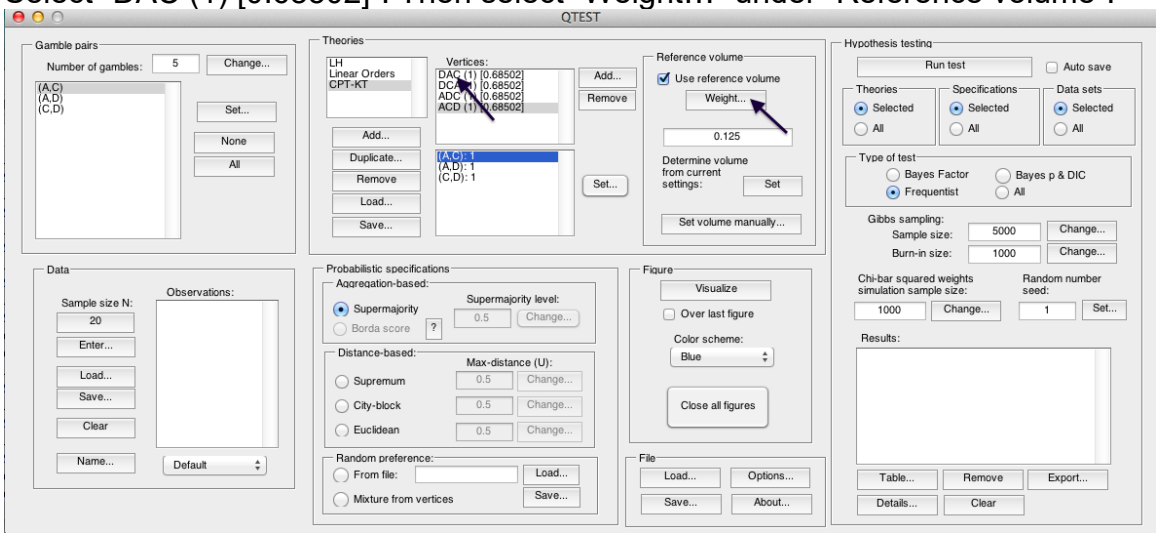
A rotated version of the resulting figure is below. Do not close this figure window. We will visualize the weighted predictions for $\mathcal{CPT}$-$\mathcal{KT}$ within this same window.



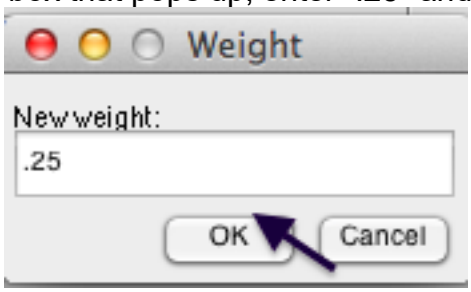
In the second step we weight $\mathcal{CPT\text{-}KT}$ so its total volume matches $\mathcal{LH}$. Under "Theories" select "CPT-KT" so that it is gray highlighted. By default, under "Vertices:" the weights in parentheses have been set to "(1)".



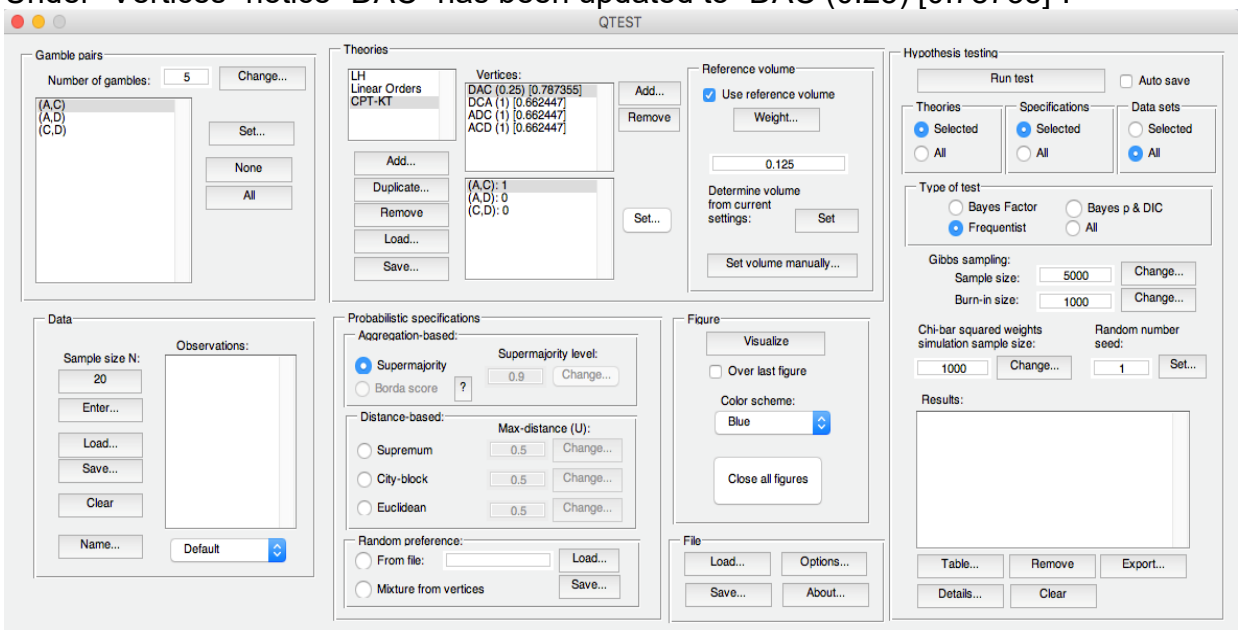
Select "DAC (1) [0.68502]". Then select "Weight…" under "Reference volume".



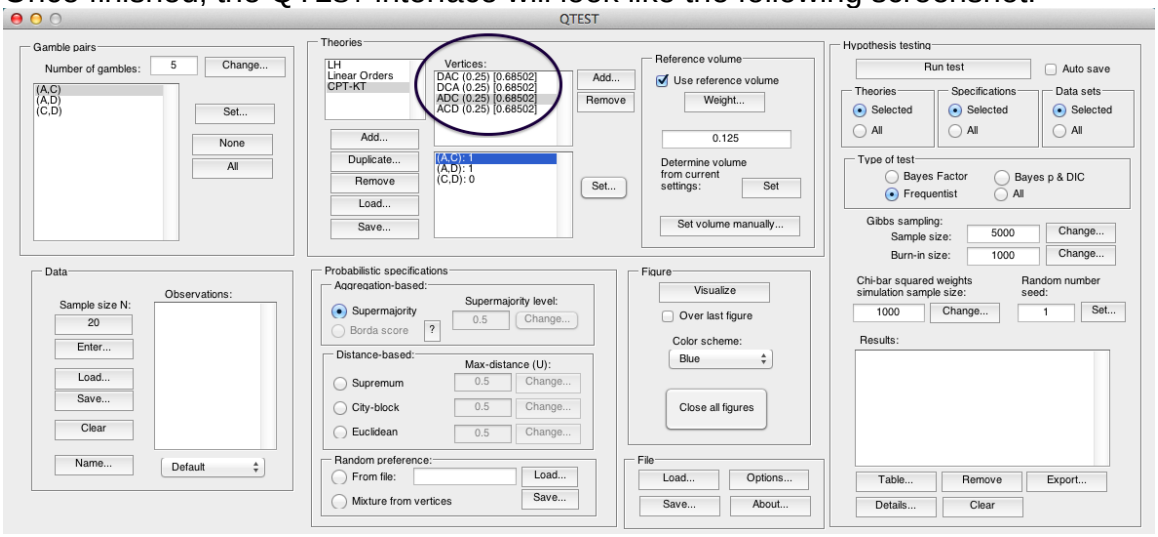
In the “Weight” dialogue box that pops up, enter “.25” and then press “OK”.



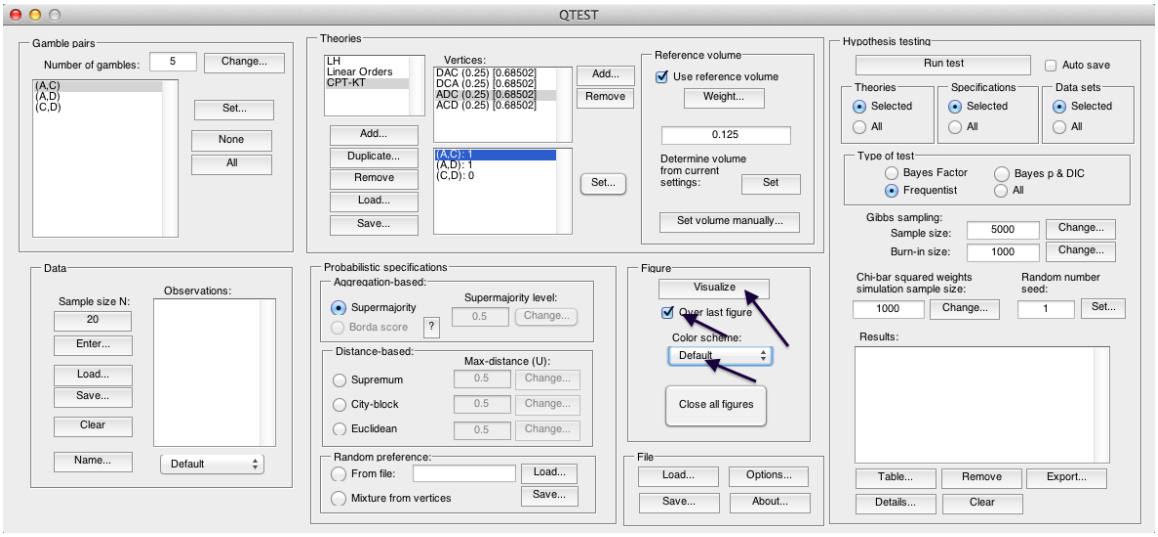
Under “Vertices” notice “DAC” has been updated to “DAC (0.25) [0.78735]”.



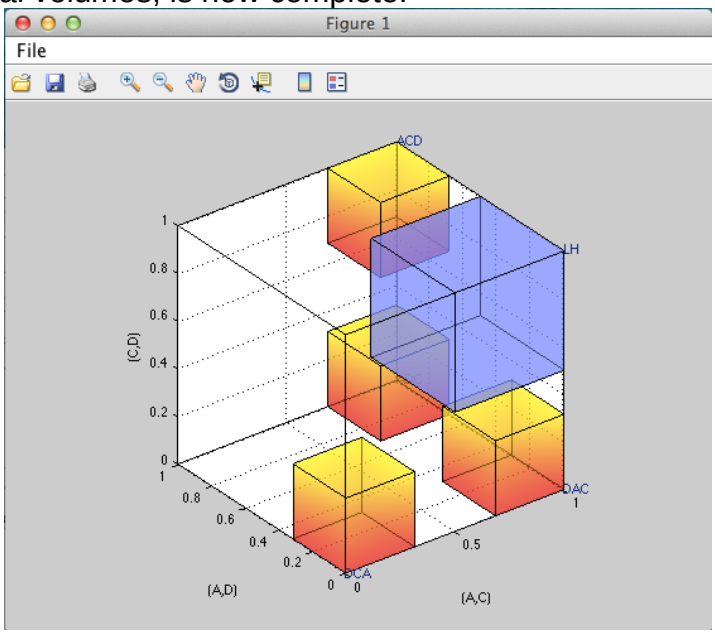
Repeat this procedure for “DCA“, “ADC” and “ACD”. Set all weights to “.25”. Once finished, the QTEST interface will look like the following screenshot.



The 4 predictions of $\mathcal{CPT\text{-}KT}$ sum to the same volume as the 1 prediction of $\mathcal{LH}$ with a 0.50-majority/modal choice specification. We can visualize this weighted version of $\mathcal{CPT\text{-}KT}$. Under “Figure”, select “Default” from the “Color scheme:” and make sure the box next to “Over last figure” is checked. Then select “Visualize”.



The resulting figure, which is a version of Figure 9 of QTBC1, is reproduced below. The coloring scheme is a little different in Figure 9 of QTBC1. But the goal of Section F, to place $\mathcal{CPT}$-$\mathcal{KT}$ and $\mathcal{LH}$ on an equal footing by giving their predictions equal volumes, is now complete.

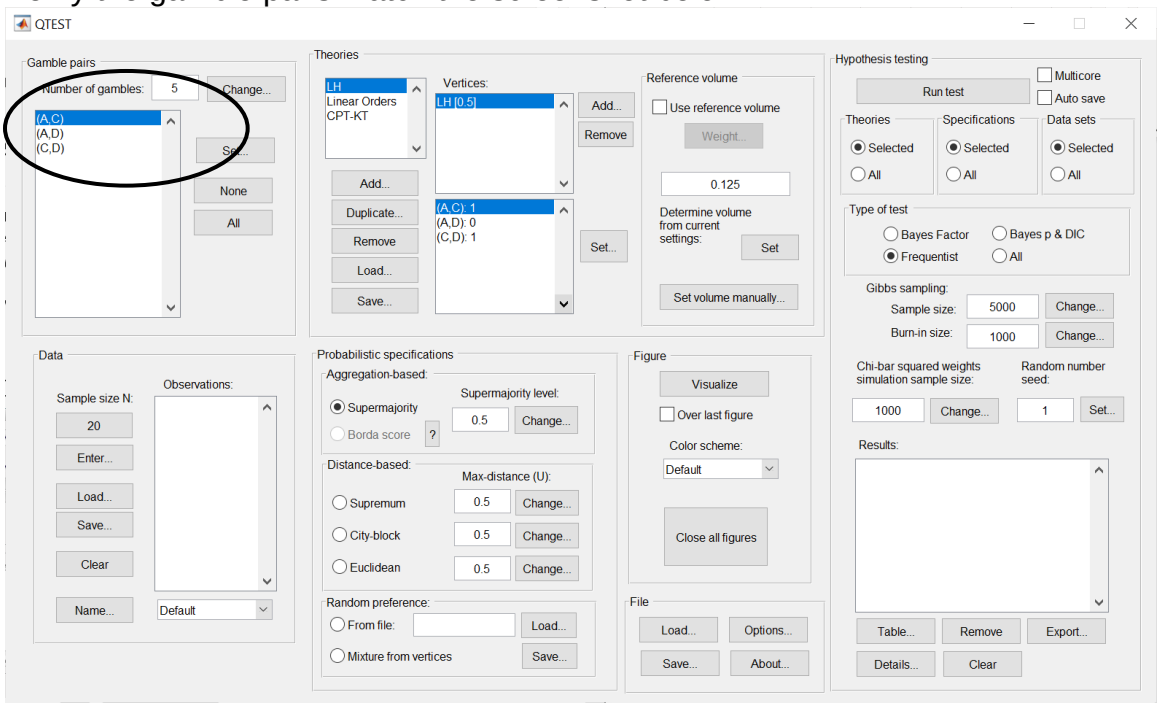


P. Figure 4 of Online Supplement 1: $\mathcal{CPT}$-$\mathcal{KT}$ with proportional volumes vs. $\mathcal{LH}$

In the previous section, M, each volume was weighted by .25 and the total volume of the 4 predictions of $\mathcal{CPT}$-$\mathcal{KT}$ equaled the volume of the single prediction of $\mathcal{LH}$ under a 0.50-majority/modal choice specification. However, it is also possible to differentially weight each prediction. After completing this section, we will have created Figure 4 of Online Supplement 1, which gives different weights to each of the predictions of $\mathcal{CPT}$-$\mathcal{KT}$.

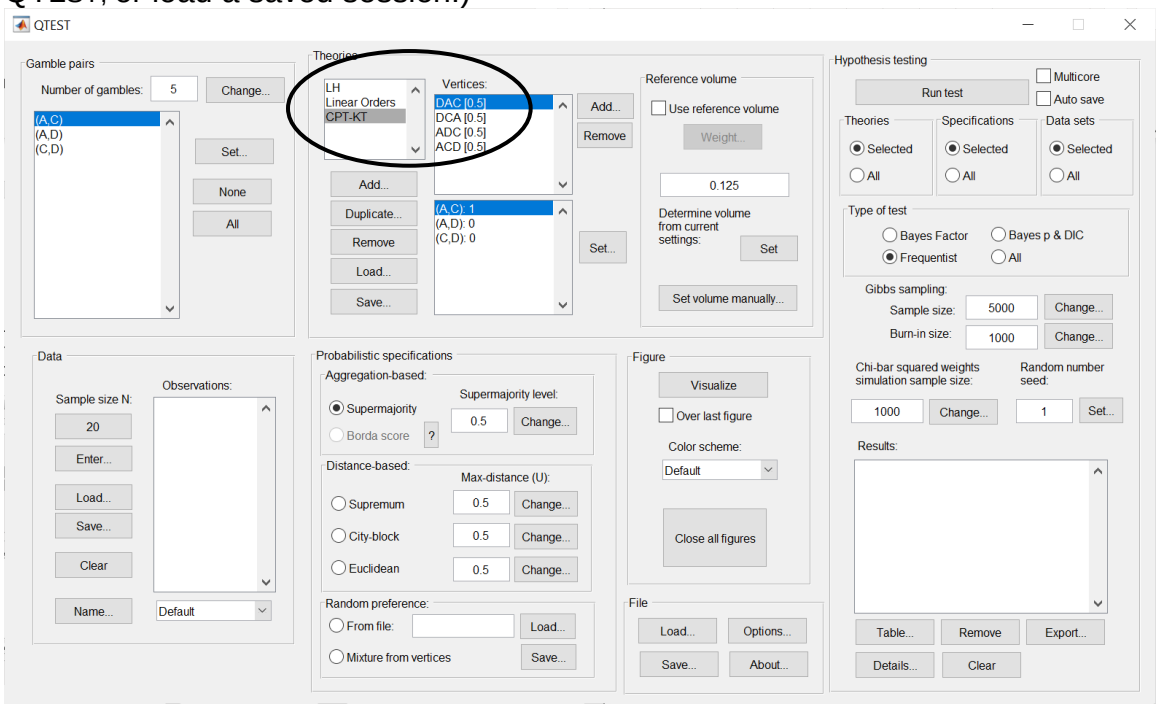
P.1 Create the gamble pairs

Verify the gamble pairs match the screenshot below.



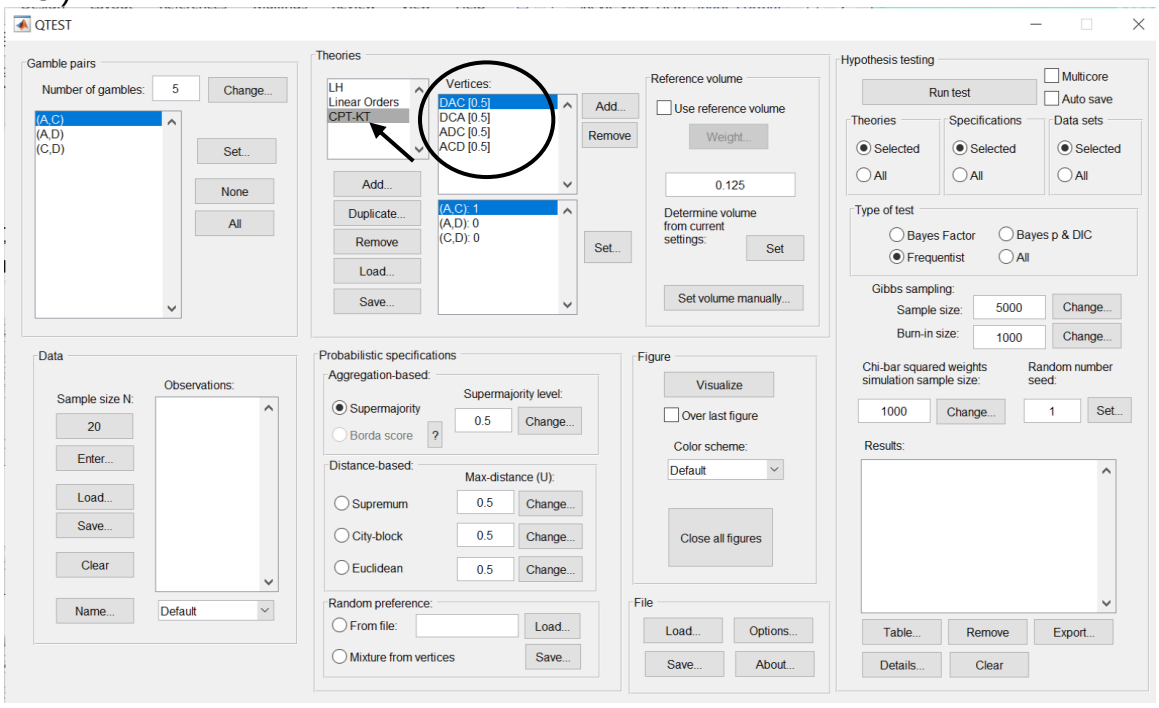
P.2 Define two decision theories, *CPT-KT* and *LH*

Under “Theories”, both “CPT-KT” and “LH” should be listed. (If you do not see “CPT-KT” and “LH” listed, return to Section C.2 to define these theories in QTEST, or load a saved session.)

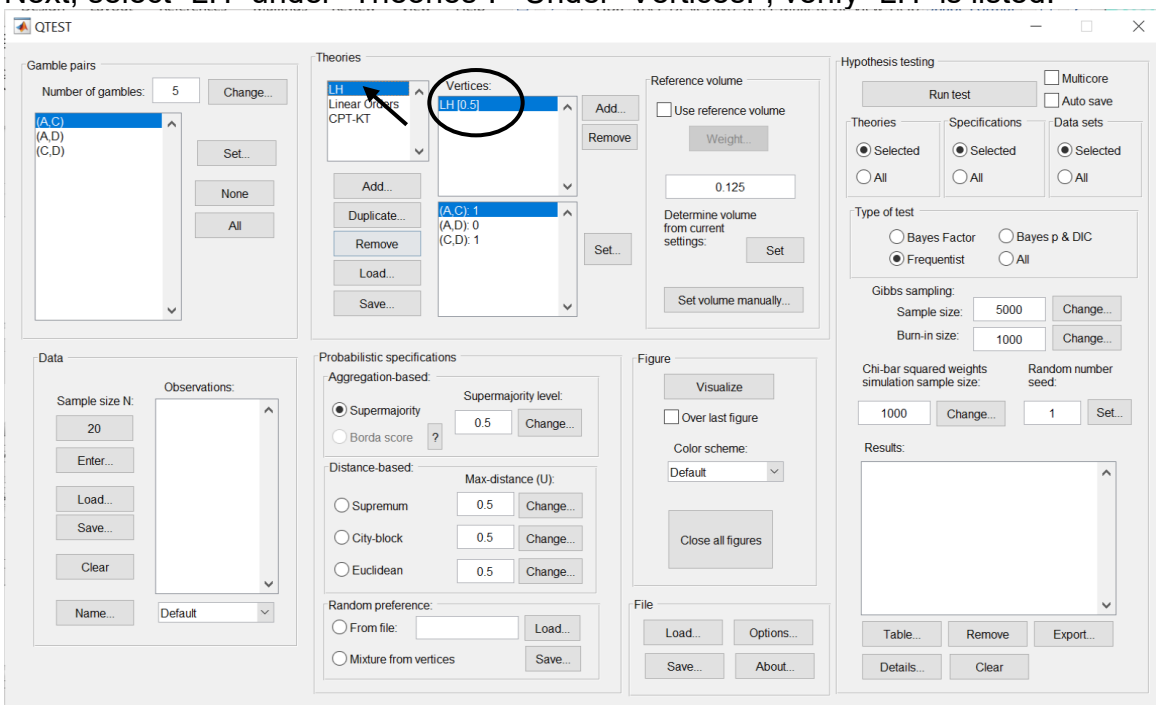


P.3 Specify the predictions of theories *LH* and *CPT-KT*

Under “Theories” select “CPT-KT” so it is gray highlighted. Under “Vertices:”, verify that the following 4 predictions are listed in any order: “DCA”, “DAC”, “ADC” and “ACD”. (If you need to specify these predictions, return to Section E.3.)

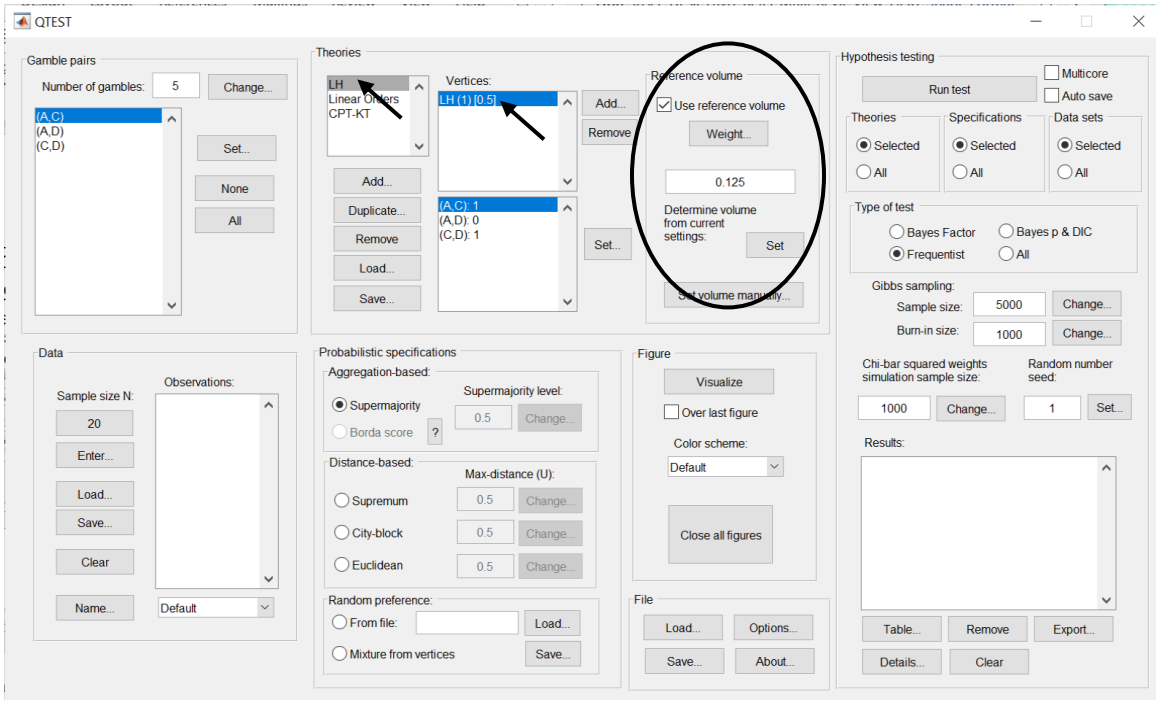


Next, select “LH” under “Theories”. Under “Vertices:”, verify “LH” is listed.

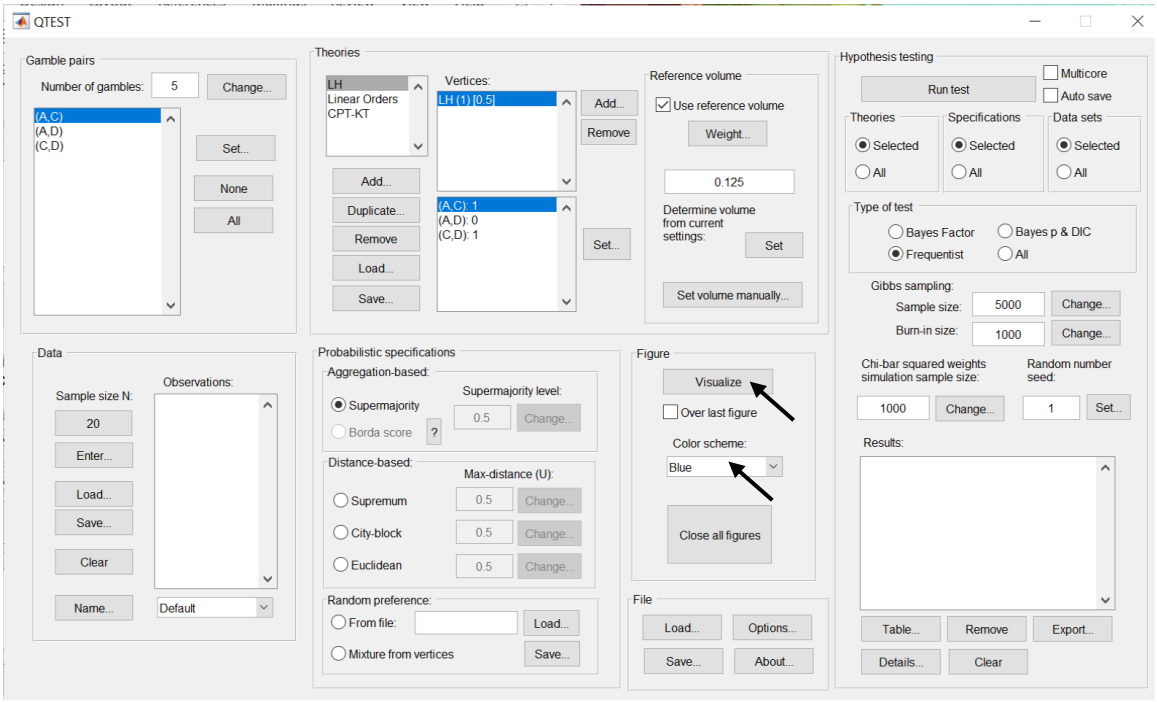


P.4 Giving *CPT-KT* proportional volumes (which sum to the total volume of *LH*)

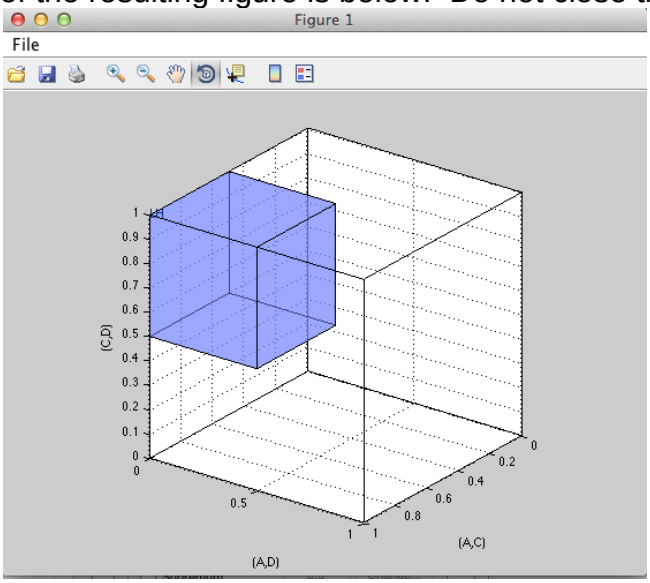
In the QTEST interface, under “Theories”, select “LH” and under “Vertices:”, select “LH (1) [0.5]”. These will both be highlighted. Select “Use reference volume” if not already checked.



As an intermediate step, we will generate the current figure. Under “Figure”, change “Color scheme:” to “Blue” from the dropdown menu and uncheck “Over last figure” if it is checked. Then select “Visualize”.



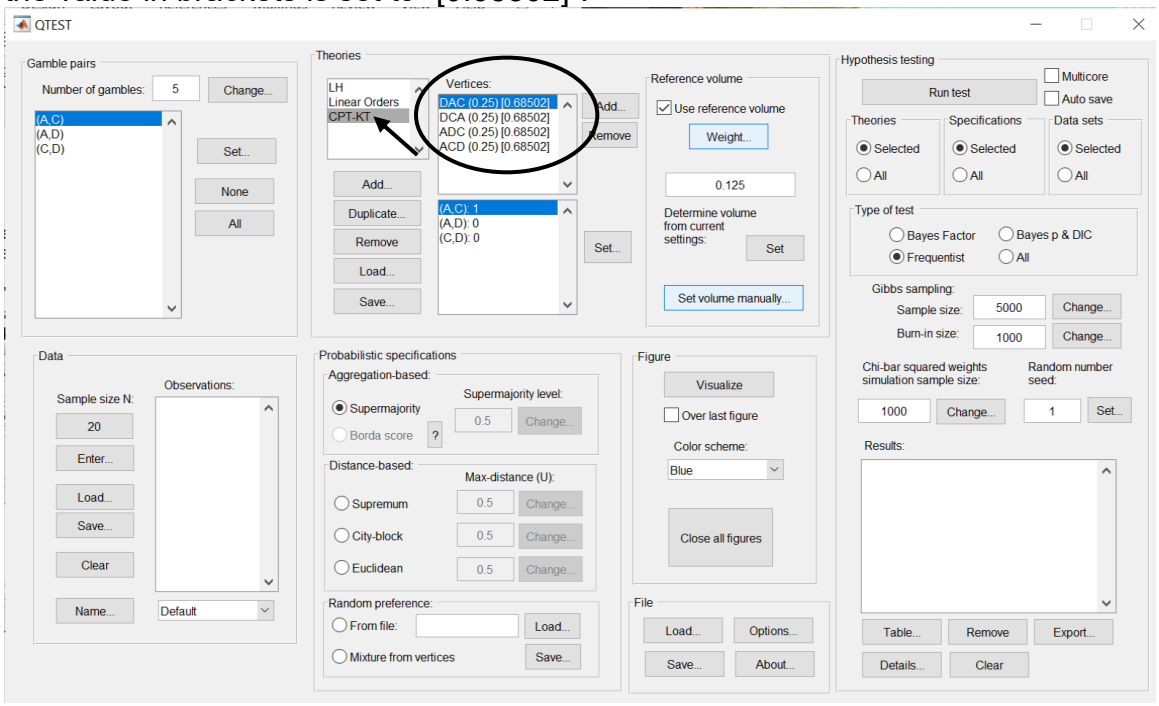
A rotated version of the resulting figure is below. Do not close this figure window.



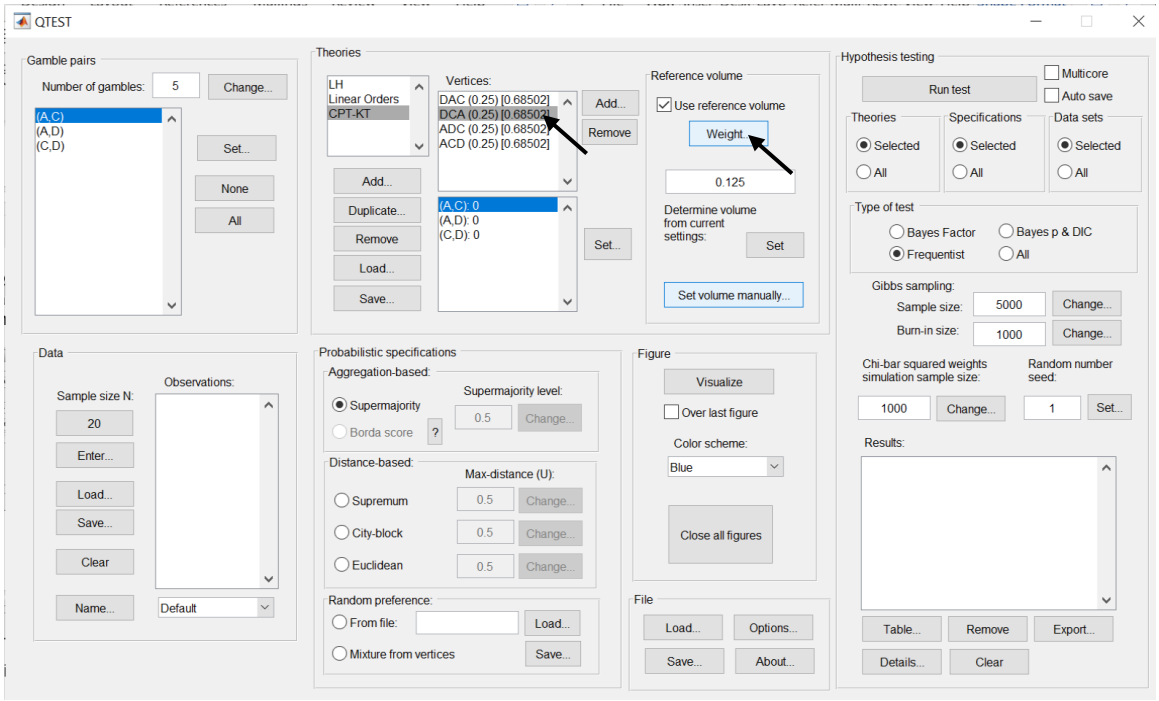
We now weight $\mathcal{CPT}$-$\mathcal{KT}$ so its total volume matches that of $\mathcal{LH}$. The weights of each prediction for $\mathcal{CPT}$-$\mathcal{KT}$ are different, unlike Section F where the weights for each prediction of $\mathcal{CPT}$-$\mathcal{KT}$ were the same. While those weights were constant,

these weights are proportional to the portion of the algebraic parameter space associated with each corresponding vertex.

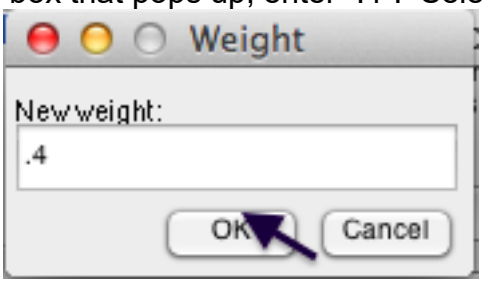
Under “Theories” select “CPT-KT” so that it is gray highlighted. Notice that, under “Vertices” all the weights in parentheses have been set to “(0.25)”. And the value in brackets is set to “[0.68502]”.



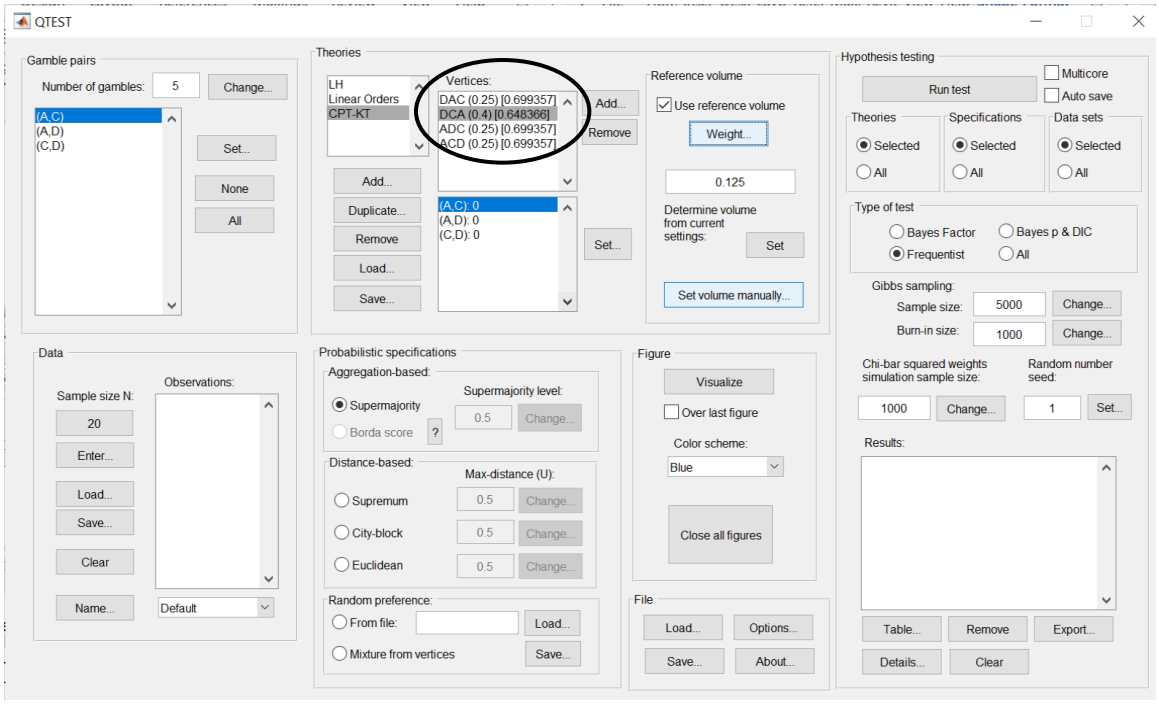
In Figure 10 of QTBC1, DCA is weighted by .4. So, click on “DCA (.25) [0.68502]” so that it is gray highlighted. Then select “Weight…” under “Reference volume”.



In the “Weight” dialogue box that pops up, enter “.4”. Select “OK”.



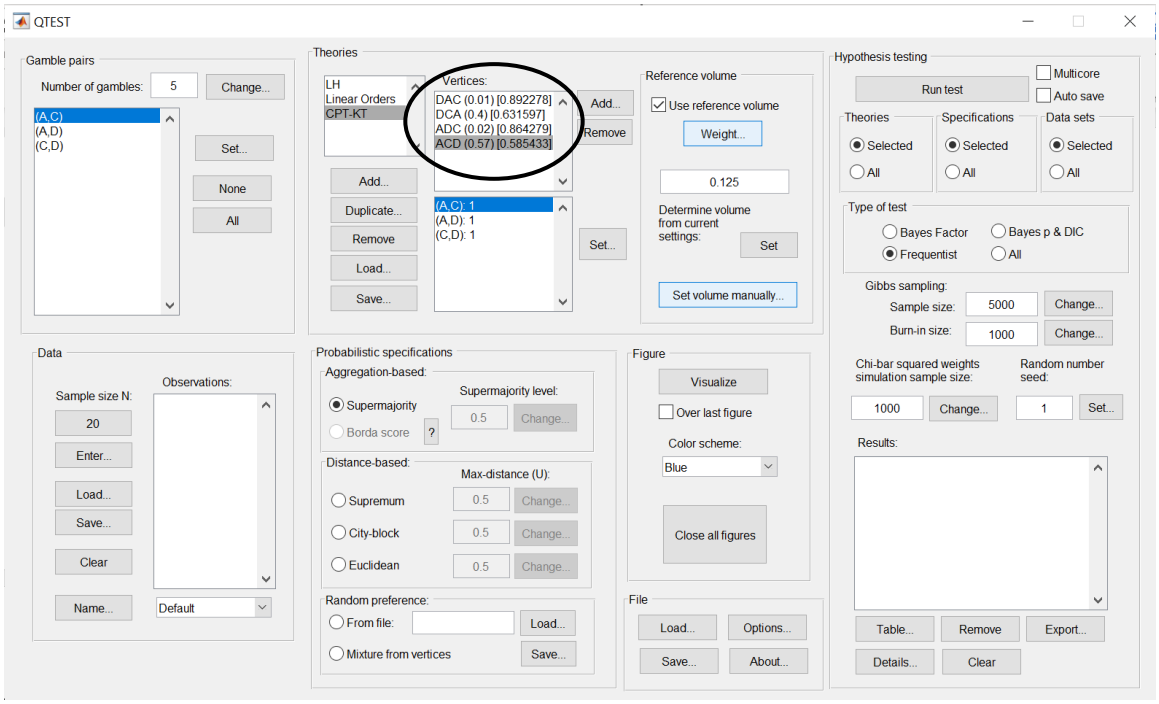
Under “Vertices” notice “DCA” has been updated to “DCA (0.4) [0.648366]”.



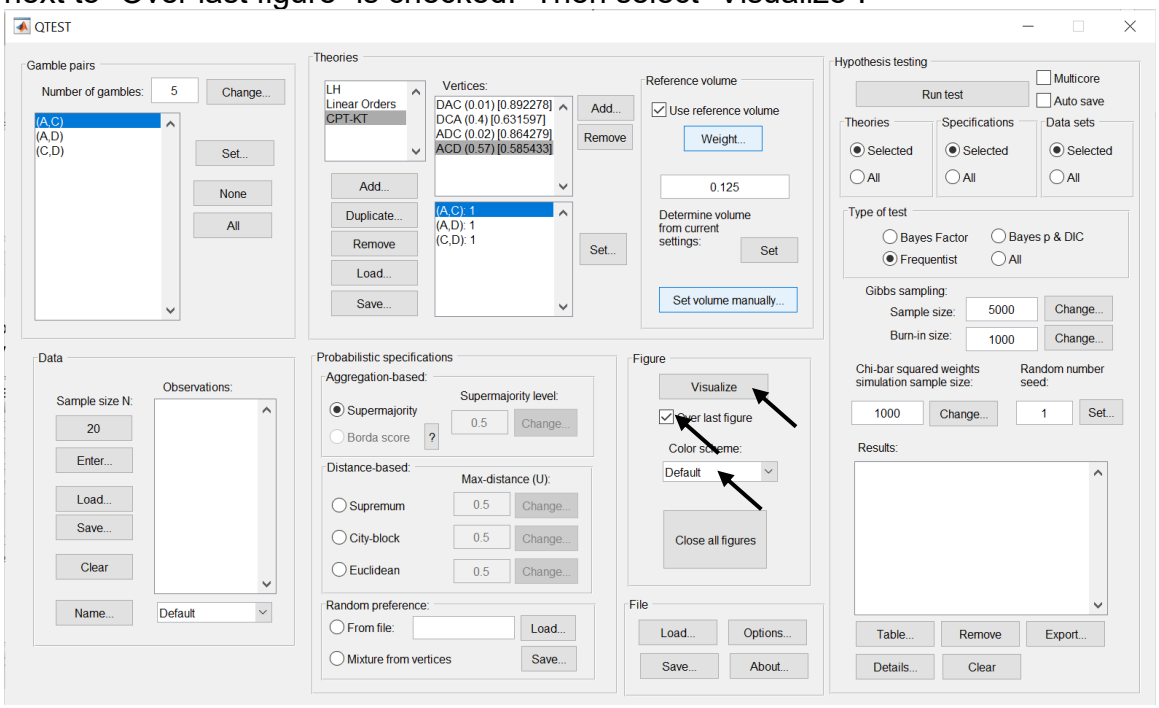
Repeat this procedure for the 3 remaining vertices, using the following weights:

“ADC” with weight “.02”
“DAC” with weight “.01”
“ACD” with weight “.57”

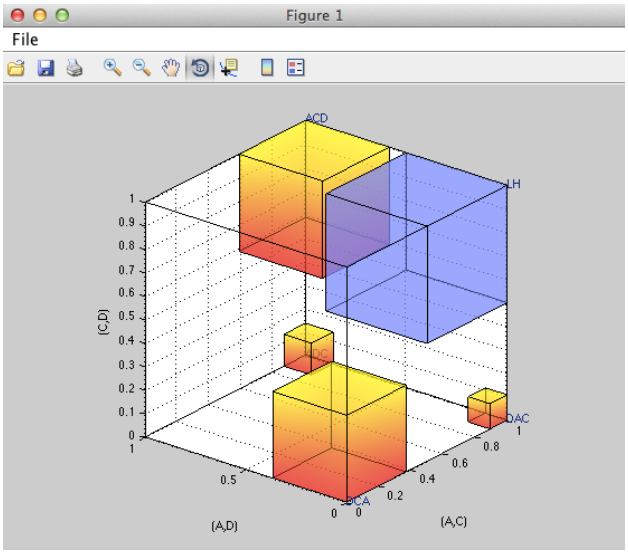
Once these steps are completed “Vertices:” of the QTEST interface should look like the following screenshot.



Each of the 4 predictions has a different weight and volume. The weights sum to one. We can visualize this weighted version of $\mathcal{CPT}$-$\mathcal{KT}$ and compare it to $\mathcal{LH}$. Under “Figure”, select “Default” from the “Color scheme:” and make sure the box next to “Over last figure” is checked. Then select “Visualize”.



The resulting figure, which is a version of Figure 4 of Online Supplement 1, is reproduced below. The goal of placing $\mathcal{CPT}$-$\mathcal{KT}$ and $\mathcal{LH}$ on an equal footing by giving their predictions equal total volumes while also setting the individual volumes proportional to the portion of the algebraic parameter space generating each prediction, is now complete.



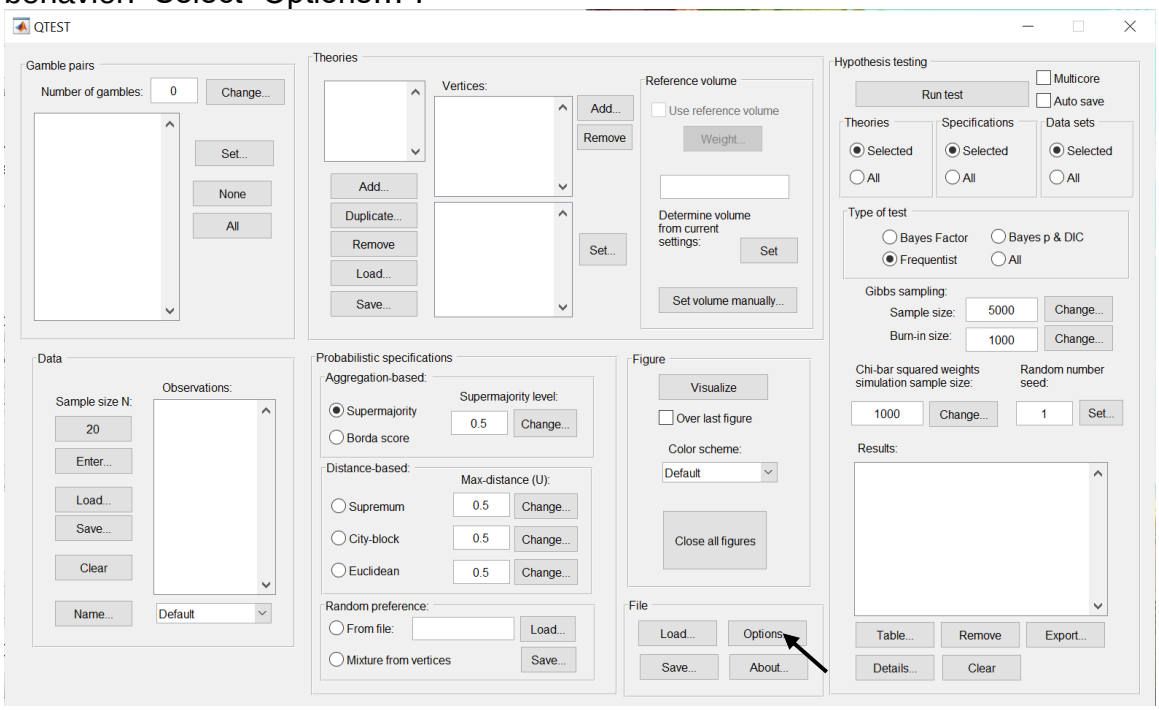
PART V: QTEST Options

Q. Warnings, Options and Miscellaneous Items

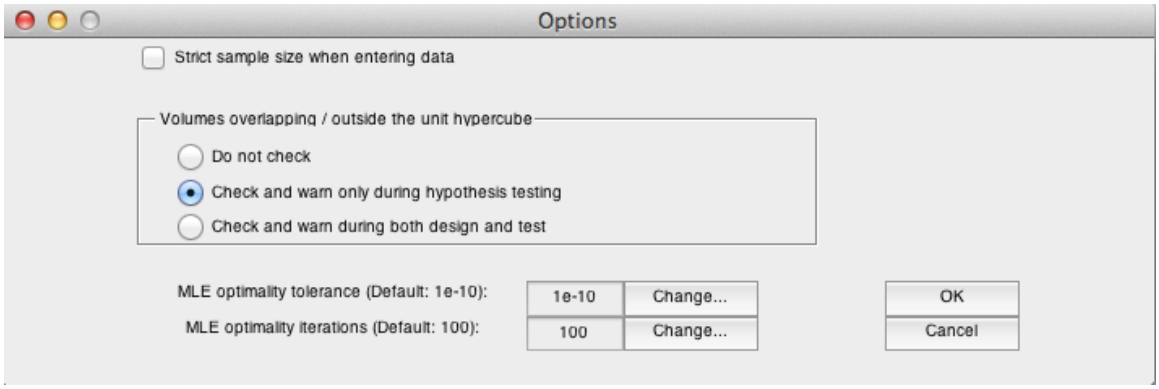
Section O contains information about QTEST not covered elsewhere in the tutorial. These include warning messages one might encounter, different options and some other details.

Q.1 Options

The "Options…" button in the "File" section allows more control of QTEST behavior. Select "Options…".



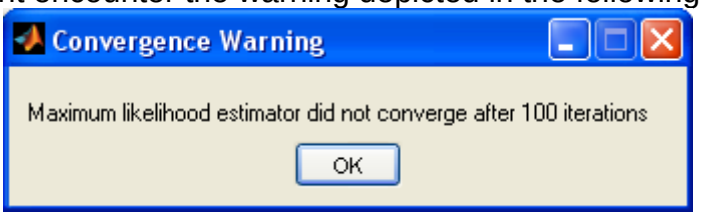
The following "Options" window pops up, the details of which are discussed after the screenshot.



By default, in the “Data” section, QTEST does not restrict the total number of observations for each gamble pair to the stated sample size N. If indeed a fixed sample size per gamble pair is used, then checking “Strict sample size when entering data” can prevent mistakes in entering data.

QTEST can check and warn about overlapping volumes and volumes that fall outside the unit hypercube. However, this check can be computationally costly. Exactly when this check is performed can be set by choosing among the three options.

The last two pieces of the “Options” concern optimality. In running an analysis in QTEST, one might encounter the warning depicted in the following screenshot.



If this warning occurs, first note that the result may still be meaningful. One might want to inspect the data to see if the QTEST results seem reasonable based on where the data lies relative to the model. If one continues to get the same warning message, even after repeating the analysis and suspects the results may not be accurate, one can adjust the optimality parameter settings.

First, one can try to increase, or even decrease, the “MLE optimality tolerance”.

Second, the default number of “MLE optimality iterations” is 100. This is the number of retries before gives up. Another strategy to deal with the “Convergence Warning” is to increase or decrease the number of iterations.

In very rare cases, when a data point is very close to the model, but yields a p-value exactly equal to 0, redo the analysis in QTEST.

Q.2 Warning messages

When one is doing an analysis in QTEST and sets the reference volume manually, an error message might appear, indicating that at least two of the polytopes overlap. This does not mean the results are wrong but in these cases, one should not interpret the p-values as exactly correct. (One might also get this warning message if the distance-based specification is larger than 0.5.)

Another warning message one might see is the following: “WARNING: non-full rank polyhedral cone!”. This message concerns the facet-defining inequalities near the maximum likelihood (ML) point. And it can be due to too many possible

facet-defining inequalities near the ML point. Proceed with caution; but usually such a warning is not problematic, especially if the polytope is full-dimensional.

Q.3 Data recommendation

We recommend that *at least* 20 observations per gamble pair, per person be used in any QTEST analysis. This ensures the assumptions of the asymptotic distributions are reasonably met. Of course, one may use more than 20 observations. But with less than 20 observations the results may be compromised. However, see Online Supplement 1 to QTBC1 for exceptions (i.e. mixture models) and further details.

Q.4 About

Selecting “About”, under “File”, will bring up a window with the following information regarding the release notes of QTEST.