CogToolbox - version 2.4 (09.30.17)

MATLAB functions from the MAPLE Lab at the University of Pittsburgh.

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I. *Introduction*

The CogToolbox is a set of functions for MATLAB and Psychophysics Toolbox 3 for cognitive psychology experiments.

The toolbox includes some standard cognitive tasks such as cued and free recall tasks, self-paced reading, visual world eye-tracking, Likert scale questionnaires, and reading span and other working memory tasks. There are also functions for more general tasks such as selecting and verifying participant numbers, taking a screenshot of the experiment, and getting a keyboard or mouse response within a specific window of time.

Most of these functions were just written in the course of assembling our own experiments. So, they might not include particular functionality that you want or need for your own experiments. But, they may help you out, and you can always modify them for your own purposes!

Functions in the CogToolbox were written by Scott Fraundorf, Michael Diaz, Jason Finley, Molly Lewis, Kristen Tooley, Angie Isaacs, Tuan Lam, Alison Trude, Sarah Brown-Schmidt, and Laurel Brehm.

II. *Installing the Cog Toolbox*

Installation instructions for current versions of MATLAB:

1. Download and install Psychophysics Toolbox 3 for MATLAB if you don't already have it.
2. Put the toolbox folder somewhere on your computer. (Many of the functions in the toolbox require other functions in the toolbox, so it is important to copy the *entire* folder.)
3. In MATLAB, go to the **Home** tab.
4. In the **Environment** block of that tab, choose **Set Path...**
5. Click **Add with Subfolders** and then select the toolbox folder. This adds all of the subfolders to MATLAB. You should see them all listed in the Set Path window. (If you just click ***Add Folder*** and not ***Add with Subfolders***, MATLAB will not see all the subfolders.)
6. Click **Save** and then **Close**.
7. ???
8. Profit!

If you don't have a Home tab and an Environment block, you have an older version of MATLAB. Here are slightly different instructions that will work just fine for those versions:

1. Download and install Psychophysics Toolbox 3 for MATLAB if you don't already have it.
2. Put the toolbox folder somewhere on your computer. (Many of the functions in the toolbox require other functions in the toolbox, so it is important to copy the *entire* folder.)
3. In MATLAB, pull down the **File** menu and choose **Set Path...**
4. Click **Add with Subfolders** and then select the toolbox folder. This adds all of the subfolders to MATLAB. You should see them all listed in the Set Path window. (If you just click ***Add Folder*** and not ***Add with Subfolders***, MATLAB will not see all the subfolders.)
5. Click **Save** and then **Close**.

Many of the functions in the CogToolbox rely on functions in the Psychophysics Toolbox 3 (Brainard, 1997; Kleiner, Brainard, & Pelli, 2007; Pelli, 1997). **The CogToolbox will not work if you don't already have MATLAB and the Psychophysics Toolbox 3**.

III. *Contents of the Toolbox*

For an exact description of how to use any of the functions, type **help functionname** in MATLAB, except replace **functionname** with the name of one of the functions. (e.g. **help makeValidPath**)

Distractor Tasks

AdditionDistractorTask	Presents 2-digit addition problems for a specified duration.	MD
DivisionDistractorTask	Presents 2-digit division problems for a specified duration.	MD
MathDistractorTask	Presents 2-digit addition *and* subtraction problems (mixed) for a specified duration.	MD
Multiplication DistractorTask	Presents 2-digit multiplication problems for a specified duration.	MD
Subtraction DistractorTask	Presents 2-digit subtraction problems for a specified duration.	MD

File Reading and Saving

BWtoRGB	Converts a black-and-white or grayscale image to RGB format. (This doesn't colorize the image; it just changes the format so you can do color-related operations on it.)	SHF
changeFolder	Updates MATLAB's active directory to the directory where the current script is.	SHF
csvToStruct	Opens a comma-separated spreadsheet with a set of named columns and converts it to a struct … slowly	SHF
dualfprintf	Prints using fprintf both to the MATLAB Command Window and to a file	SHF
getSubjectNumber	Gets a valid subject number from the experimenter and verifies it hasn't already been used. Optionally, can also rotate	SHF

	subjects through a set of lists.	
imageToTexture	Loads an image from a file and puts it in a new texture.	SHF
loadimage	Loads an image from a file and puts it in a new offscreen window. This window can then be quickly copied to another using PTB's Screen("CopyWindow") function	SHF
makeValidPath	Ensures that a path is a properly formatted folder name, and creates that folder if needed.	SHF
openValidFile	Repeatedly prompts the user for a filename until a valid file is opened	SHF
picturetester	Displays a folder of pictures one at a time to make sure they look good in your experiment.	SHF
save_triang	Saves the upper- or lower-triangular part of a matrix	SHF
Screenshot	Takes a screenshot of the current experiment display and save it in a file that you can use to demonstrate your experiment.	SHF
textFileToCellArray	Reads a text file into a cell array, with each line as one entry in the cell array. Optionally, can read just a limited # of lines.	SHF

Keyboard and Mouse

allKbNames	Display the numerical code corresponding to each keyboard key. For use in programming only.	MD
getKeys	Waits for the user to press a key and determines what key was pressed. Unlike PTB functions, this ignores keys already been held down. Optionally, can end after a maximum time has elapsed with no keypress.	MD, SHF
Wait4Key	Waits for the user to press one of a *particular* set of a keys and returns the RT and key pressed.	MD
Wait4KeyTimed	Same as Wait4Key, but can force the user to respond with a particular time limit.	SHF
Wait4Mouse	Waits for the user to click one of a particular set of regions on the screen. Returns RT and area clicked.	MD
Wait4MouseTimed	Same as Wait4Mouse but with a time limit.	SHF

List Creation

listmaker	Creates sets of experimental lists using Latin Square designs. Can include multiple factors and filler trials.	SHF
makeLagList	Creates a presentation list for an experiment in which the stimuli vary in lag between 1st and 2nd presentation. Can also include non-repeated stimuli.	MD, SHF

Math and Matrices

containsDuplicates	Tests if any value is repeated more than one in a matrix.	SHF
countValue	Counts how many times a specified value appears in a matrix.	TQL, SHF
fitROC	Fits an ROC curve to some data.	MD
horizshift	Shifts elements horizontally within each row of a matrix.	SHF
hourmin	Returns a nicely formatted version of the current time (optionally, with seconds)	SHF
InscribeCircle	Finds the x, y coordinates for a point inscribed in a given circle.	MD
iseven	Determines whether a given number is an even integer	SHF
IsInBounds	Determines whether a particular point would be within the bounds of a N-dimensional matrix.	SHF
isodd	Determines whether a given number is an odd integer.	SHF
modrz	Performs modular division (remainder of X divided by Y), but replaces outputsof 0 with Y.	SHF
nth	Performs a given function, and returns the Nth element of the result of that function	SHF
RaggedCellArrayToMatrix	Converts a cell array of vectors, which may be of uneven length, into a matrix.	SHF
randorder	Puts the elements of a vector in random order.	SHF
reversescore	Reverse score a Likert scale response.	SHF
reversevector	Puts the elements of a vector in reverse order	SHF

Matlab Demos

CenterOnScreen	Demo of how to make your own functions in Matlab.	SHF, ML, KT
graphicsdemo	Demo of how to do graphics in Psychophysics Toolbox.	SHF, ML, KT
InstructionsScreenDemo	Demo of how to use the InstructionsScreen function.	SHF
matlabbasics	Demo of how to do basic operations and run an experiment in Matlab.	SHF, ML, KT
RSVP	Demo of stimulus display, in the context of a simple rapid serial visual presentation task.	SHF, ML, KT
selfpaced	Demo of stimulus display and user response, in the context of a simple self-paced reading task.	SHF, ML, KT
sounddemo	Demo of how to play & record sound in Psychophysics Toolbox.	SHF, ML, KT

visualworld	Skeleton of a visual world eye-tracking experiment that provides accurate timing measurements and flicker-free picture display and movement. It has to be filled in with the details of your experiment ⋯ it does not run on its own.	SHF, SBS, AT, AMI

Memory Tests and Scoring

freerecall	Performs a free recall test. Allows for a particular minimum and maximum number of responses. Can return the words recalled and RTs, or save them to a file.	JRF, SHF
FreeRecallScore	Scores the data from a free recall test against a list of targets. Allows the user to decide how to score particular intrusions, misspellings, etc.	SHF
GetEchoStringCuedT4	Prompts the subject to enter a word and returns the word & time taken. Optionally, a cue may be specified for cued recall.	JRF, SHF
lenientcompare	Calculates a score from 0-100 of how similar two strings are; can be used to score recall data that might contain misspellings, etc.	JRF
lenientcompareset	Uses lenientcompare to compare one string to a SET of possible matches and find the best match.	SHF

Perceptual Speed Tests

LetterComparison	Task in which participant must make speeded judgments as to whether sets of consonants are identical or not.	SHF
LetterSetCreate	Used internally by LetterComparison only.	SHF
PatternComparison	Task in which participant must make speeded judgments as to whether line patterns are identical or not.	SHF
PatternCreate	Used internally by PatternComparison only.	SHF

Prefab Screens & Tests

AdjustVolume	Screen to allow users to adjust the volume before an experiment.	SHF
antisaccade	Antisaccade task in which participants must saccade in the opposite direction of a peripheral cue.	SHF
colordemo	Demo what various colors look like on this monitor.	SHF
doIndividualDifferences	Used internally by IndividualDifferences.m only	SHF
flanker	Classic flanker task.	SHF
IndividualDifferences	Runs a battery of individual differences measures.	SHF
InitExperiment	Start an experiment by defining colors and pixel size, and seeding random number generator.	MD
InstructionsScreen	Displays an instruction screen with the specified text. Forces	SHF

	the subject to spend time reading the instructions before they can advance.	
shipleyvocab	40 item forced-choice vocab test. Auto-scored.	SHF
Stroop	Short Stroop test with 2 blocked conditions: reading words, and then color naming. Automatically paced.	SBS, AT, SHF
StroopRT	Long Stroop test with 2 blocked conditions: naming colors of patches and words. Paced by participants, collects RT.	SBS, AT, SHF
vocab	Administers a multiple-choice vocabulary test. Test items not included.	SHF

Pseudowords

gupta	Pseudoword repetition task from Gupta (2003)	LB, SHF

Questionnaires

BinaryQuestion	Asks a question with 2 choices.	AMI
Likert	Asks a Likert scale question with a varying number of response options.	AMI, ML, SF
OpenResponseQuestion	Asks a question with free response by participant.	AMI
Questionnaire	Asks 2 basic demographics question: hometown & languages spoken.	AMI
YesNoQuestion	Asks a yes/no question.	AMI

Reading

compQ	Asks a reading comprehension question.	SHF
movingwindow	Performs a self-paced moving window reading task on a sentence.	SHF, KT
movingwindowQ	Do a moving window item followed by a comprehension question.	SHF
movingwindowTester	Tests the screen layout of moving window items by displaying the entire item on the screen at once.	SHF
ResidReading	Calculate residual reading times from the output of movingwindow.	SHF

Shape Drawing

CenterInRect	Returns the coordinates that would center a shape within a given region.	SHF
DrawArrow	Draws an arrow from one point to another.	SHF

DrawLineAnimated	Draw a line incrementally.	SHF
FilledPoly	Draws a polygon filled with a color.	SHF
FilledRect	Draws a rectangle filled with a color.	MD
FilledRectWText	Draws a colored rectangle and writes text in it.	MD
FramedRect	Draws the outline of a rectangle.	MD
FramedRectWText	Draws the outline of a rectangle and writes text in it.	MD
makeRadialGrid	Draws circles evenly arranged radially around the center of the screen.	TQL
snapToBorder	Snaps an image to the border of a larger region.	SHF

String and Text Processing

analyzeMarkupCode	Reads an HTML-style markup code and determines what code it is.	SHF
asPercent	Converts a proportion to a percent.	SHF
divideSentenceInTwo	Splits a string in half so that each half has an equal number of *words*.	SHF
doubleToSingleSpacing	Converts double- and triple-spacing to single-spacing.	SHF
extractNumbers	Extracts all the numbers from a string of text.	SHF
extractTextFromLines	Given a cell array of lines of text, can extract a string that may span multiple lines.	SHF
findInCellMatrix	Searches a cell array for a particular string, and returns a matrix indicating the location of all the matches.	SHF
findUtteranceStart	Within a block of text, finds where a particular sentence started.	SHF
getClosingTag	Determines the closing tag for a markup tag.	SHF
getNextComplete Sentence	Reads the next complete sentence from an open file.	SHF
initialsCapsOnly	Capitalizes the first letter of every word in a string, and puts everything else in lowercase.	SHF
makeTextWidth	Adds space or truncates a string to make it fit a particular width.	SHF
matchesInStringSet	Compares a string (or set of strings) to a cell array of strings and determines where a match is.	SHF
num2strLZ	Converts a number to a string and adds leading zeros to force it to be a particular length.	SHF
parseNumberList	Allows you to create a vector by describing it in a string, e.g. "1-3,5" -> [1 2 3 5]	SHF
randTokens	Takes in a string that contains tokens separated by spaces and returns string that randomizes the order of the tokens (e.g., “This is a sentence” could return “is This sentence a”)	TQL

stripLeadingCharacter	Removes any instances of a particular character at the start of a string.	SHF
stripManyStrings	Removes several different substrings from a given string.	SHF
stripPunctuation	Removes all punctuation from a string.	SHF
stripString	Removes all cases of a substring from a string.	SHF
stripStringNum	Removes a portion of a string defined by its numerical starting and ending point.	SHF
strrepMany	Within a string, makes multiple replacements of different substrings with other substrings.	SHF
strrepNum	Replaces part of a string with something different, defined (unlike strtok) by numerical position.	SHF
strtokMultiple	Completely divides a string into multiple tokens, based on a delimiter.	SHF
wordCount	Counts the number of words in a string.	SHF

Text Display

File2Screen	Prints the contents of a text file to the screen.	MD
optimalTextSize	For a moving window experiment, finds the largest text size that allows every sentence in the experiment to fit on one line.	SHF
WriteCentered	Writes text on the screen, centered at a particular point. Now runs onto multiple lines if needed.	MD, SHF
WriteLeft	Write left-aligned text on the screen.	MD
WriteLine	Write text on the screen, with word wrap. Includes options for paragraph breaks, double-spacing, and various font effects (e.g. boldface, italics, highlighting certain words in color).	MD, SHF
WriteRight	Write right-aligned text on the screen.	MD

Text Input

GetEchoStringDisplay	Get text from the user, and display it as they're typing. Unlike PTB-3's GetEchoString, this can preserve what's *already* on the screen when you call the function.	SHF
GetEchoStringFreeResponse	Asks a free response question to the participant	SHF
inputnumber	Has the Matlab user enter a number within a particular minimum and maximum.	SHF
inputstring	Forces the Matlab user to enter a non-empty string.	SHF
inputyn	Gets an answer to a yes/no question from the Matlab user.	SHF

Window and Monitor Management

CreateOffWin	Open a new offscreen window and set its font and color	MD

	properties.	
GetRefresh	Returns your monitor's refresh rate.	SHF
monitorsize	Calculates the physical dimensions of your monitor.	SHF
pixels2visangle	Converts a measure of pixels from center to visual angle.	SHF
visangle2pixels	Converts a measure of visual angle to pixels from center.	SHF
visangle2width	Converts a measure of visual angle to physical distance.	SHF
width2visangle	Converts a measure of physical distance to visual angle	SHF

Working Memory Tasks

alphabetspan	Subject must recall words in alphabetical order.	SHF
listeningspan	Listen to sentences, make true/false judgments, and recall the last word from each sentence.	SHF
lspan	Listen to sentences, make true/false judgments, and recall intervening letters.	SHF
minus2span	Recall a set of numbers in order while subtracting 2 from each	SHF
ospan	Judge the answers to arithmetic equations and recall intervening letters.	SHF
readingspan	Read sentences aloud, make judgments, and recall the last word from each sentence.	SHF
rspan	Read sentences aloud, make judgments, and recall intervening letters.	SHF
wmbattery	Administers the alphabetspan, listeningspan, minus2span, and readingspan tasks. Automated scoring.	SHF

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V. *Troubleshooting*

Q. It doesn't work / The computer crashes when I get to a particular part of my experiment / MATLAB says a particular function isn't found.

A. My experience is that the vast majority of errors with the CogToolbox stem from not having everything fully installed. First, make sure you've installed the Psychophysics Toolbox 3; it's required to use the CogToolbox! Then, make sure you've set up the entire CogToolbox following the instructions above. Trying to copy and use a single function from the CogToolbox on its own probably won't work; many of those individual functions rely on other functions in the CogToolbox and won't work in isolation.

VI. *Citing the Toolbox*

If you use the CogToolbox in your research, a citation is always appreciated! You can cite the CogToolbox instruction manual:

- Fraundorf, S. H., Diaz, M. I., Finley, J. R., Lewis, M. L., Tooley, K. M., Isaacs, A. M., Lam, T. Q., Trude, A. M., Brown-Schmidt, S., & Brehm, L. (2014). CogToolbox for MATLAB [computer software]. Retrieved from http://www.scottfraundorf.com/cogtoolbox.html

The CogToolbox relies on Psychophysics Toolbox 3, so *please also cite your use of the Psychophysics Toolbox*. As of this writing, the instructions for citing the Psychophysics Toolbox include the following citations:

- Brainard, D. H. (1997). The Psychophysics Toolbox. Spatial Vision, 10, 433-436.
- Pelli, D. G. (1997). The VideoToolbox software for visual psychophysics: Transforming numbers into movies. Spatial Vision, 10, 437-442.
- Kleiner, M., Brainard, D., & Pelli, D., (2007). What's new in Psychtoolbox-3? Perception 36 ECVP Abstract Supplement.