## Install CriticalSpacing

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**CriticalSpacing.m** is a MATLAB program developed by Denis Pelli at NYU, with help from Hörmet Yiltiz. You can read more about this program and its purpose in our 2016 article:

Pelli, D. G., Waugh, S. J., Martelli, M., Crutch, S. J., Primativo, S., Yong, K. X., Rhodes, M., Yee, K., Wu, X., Famira, H. F., & Yiltiz, H. (2016). **A clinical test for visual crowding.** *F1000Research* 5:81 (doi: 10.12688/f1000research.7835.1) <http://f1000research.com/articles/5-81/v1>

To run CriticalSpacing on your machine (running Mac OS X, Windows, or Linux), you need software (MATLAB, Psychtoolbox, and CriticalSpacing) and a few physical accessories (a measuring tape, perhaps a wireless keyboard, and possibly a mirror). Please follow the steps below:

### A. Install MATLAB

1. *Member of NYU? Download* MATLAB. Use one of the links below to download the MATLAB installer file that is appropriate to your computer. If there’s a choice, take the most recent version.   
   **Macintosh OS X**:

<http://localweb.cns.nyu.edu/unixadmin/mat-distro-12-2014/mac/>

**Windows**:

<http://localweb.cns.nyu.edu/unixadmin/mat-distro-12-2014/win/>

**Linux**:

<http://localweb.cns.nyu.edu/unixadmin/mat-distro-12-2014/linux/>

These links only work locally. You must be on the NYU network, connected either directly, or, if you’re off campus and you have an NYU net id, through a VPN connection to campus via the internet, using a free program called “Cisco AnyConnect” that you can get from NYU here:   
[**http://www.nyu.edu/life/resources-and-services/information-technology/getting-started/network-and-connectivity/vpn.html**](http://www.nyu.edu/life/resources-and-services/information-technology/getting-started/network-and-connectivity/vpn.html)

1. *Member of Pelli lab?* Borrow our thumb drive to copy the MATLAB installer onto your computer. If you need to do it from home, contact Denis for special instructions.
2. *Rest of world?* Unless your university has a site license (as NYU does), you’ll need to buy MATLAB. The student version is fine, and costs $99/year: <https://www.mathworks.com/programs/nrd/buy-matlab-student.html>
3. *Install* *MATLAB*. Double-click to unpack the archive and reveal the installer. Double click the installer file, and install with the default options. You should end up with a MATLAB app with the familiar rust-colored icon.
4. *NYU-license for MATLAB.* Have an NYU net id? Connect to NYU. NYU has a site license for MATLAB. Your installation of MATLAB has a license file inside your MATLAB that checks the NYU license server every time you use MATLAB. That works when you’re connected to the NYU network, either directly (in an NYU building) or indirectly by a “virtual private network” (VPN). If you’re off campus, you can make a VPN connection to campus via the internet, using a free program called “Cisco AnyConnect” that you can get from NYU here:   
   [**http://www.nyu.edu/life/resources-and-services/information-technology/getting-started/network-and-connectivity/vpn.html**](http://www.nyu.edu/life/resources-and-services/information-technology/getting-started/network-and-connectivity/vpn.html)
5. *Pelli-lab standalone license for MATLAB.* Member of Pelli Lab? Get a stand-alone license. If you are working in the Pelli Lab, you may be eligible for a stand-alone license that works without an internet connection to NYU. In that case you should send Denis an email with key information identifying your computer. We need your computer’s MAC Address (Media Access Control). Note that “MAC” has nothing to do with “Macintosh”. Here’s how to discover your computer’s MAC number:

* If you are in OS X, use Spotlight to search for terminal, then, in the Terminal application, type ifconfig, and press Enter. Copy all the output to send to Denis, below.
* If you are in Windows, press Win+R and enter cmd in the dialog box. Press enter to open the cmd application. In cmd (a black window), insert ipconfig then press enter. Copy all the output to send to Denis, below.
* Email [denis.pelli@nyu.edu](mailto:denis.pelli@nyu.edu), specifying your full name, the *specific kind of computer* you have, and the text you copied above that includes your computer’s MAC number.
* If eligible, you will be provided with a stand-alone MATLAB license and instructions on how to install it into your MATLAB. (In Mac OS X, the license file must be placed in your /Applications/MATLAB.app/licenses/ folder. To get there you must Control-click to open the MATLAB application package, in which you’ll find the licenses/ folder. It’s similar in Windows.)

1. *Rest of world?* You’ll need a license from Mathworks to run MATLAB. The student version is fine, and costs $99/year:   
   <https://www.mathworks.com/programs/nrd/buy-matlab-student.html>
2. *License trouble?* If you’re using an NYU license (on or off campus) please contact denis.pelli@nyu.edu. Contact Mathworks only if you bought your license from them.
3. *Mac OS X: Give your computer permission to open* MATLAB*.* Before you try to open MATLAB for the first time, go to System Preferences: Security and Privacy: General tab. Click the lock (lower left corner) to open it, providing your password. Set “Allow apps downloaded from anywhere.” Click the lock again to close it. If you try to open MATLAB without that permission, you’ll get a mysterious message from the Finder, saying it’s “Verifying”, which never goes away." [The old trick of control-click opening MATLAB no longer works.] Once MATLAB has been opened once, it should be ok to go back to Security and Privacy and restore the old restriction.
4. *Mac OS X: Set the MATLAB path.* MATLAB is normally installed in the Applications folder. Alas, that folder is normally write-only, which prevents you from saving the [path](http://www.mathworks.com/help/matlab/matlab_env/what-is-the-matlab-search-path.html) in MATLAB, e.g. to include Psychtoolbox. If you skip this step, you’ll get a warning about this below, when you run DownloadPsychtoolbox. We suggest you eliminate this pesky nuisance by granting write permission to the pathdef file:

* OS X: Using Finder, Cntrl-click to open the MATLAB app to get inside the package. Then select the pathdef file and hit Cmd-I to open the Get Info window. At the bottom of the Get Info window, expand “Sharing and permissions”. Give everyone permission to read and write the pathdef file.

### B. Install Psychtoolbox

We use Psychtoolbox in our MATLAB programs to control the display. Follow this link to install Psychtoolbox:

<http://psychtoolbox.org/download/>

1. Carefully follow the instructions at the Psychtoolbox website. It is not entirely automatic. It needs your help to finish the installation. For example, you may need to install additional software such as svn and Gstreamer, depending on your Operating System. svn is included in Apple's free XCode developer software, so if you don’t have svn, when DownloadPsychtoolbox tries to use svn, you’ll get a dialog box from OS X asking if you want to download XCode from the App Store, for free. Say “yes”. The documentation provides all the details. So just follow their instructions.
2. Try running GratingDemo to confirm that Psychtoolbox is installed and can control your display.
3. Type this line of code into MATLAB’s Command Window to confirm that sound works.

Snd('Play',MakeBeep(256,1));

It should beep for one second. If you encounter problems, get advice by typing “help PsychPortAudio” in the MATLAB Command Window.

1. Try typing Speak('hello') to confirm that speech synthesis works.

### C. Install CriticalSpacing

1. *Download* the CriticalSpacing software: <https://github.com/denispelli/CriticalSpacing/archive/master.zip>
2. *Unpack* the “zip” archive, producing a folder called CriticalSpacing.
3. *Only for Macintosh OS X: Allow MATLAB to control your computer.* Open the System Preferences: Security and Privacy: Privacy tab. Select Accessibility. Click to open the lock in lower left, providing your computer password. Click to select MATLAB, allowing it to control your computer. Click the lock to close it.
4. *Allow remote typing.* A normally sighted observer must be many meters away from the screen, and thus will be unable to reach a laptop keyboard attached to the screen. The quickest way to overcome this is for the experimenter to type what the observer says. A more convenient solution is to get a wireless or long-cable keyboard.
5. *Measure distance.* The viewing distance will usually be more that 2 meters. You’ll need a tape measure, with centimeters, or a laser measure.
6. *Choose a font*. We recommend Pelli for threshold spacing and Sloan for threshold size.
7. *Show the alphabet*. While running CriticalSpacing, once the testing has begun, you can press the shift key at any time to see a full-screen display of the alphabet of possible targets, in the target font. Before running the experiment, we recommend that you get a paper display of the alphabet by printing the appropriate PDF for your font. Look inside the the CriticalSpacing/pdf/ folder, e.g. Pelli.pdf and Sloan.pdf. Print the appropriate page and give it to your observer. The alphabet page shows the possible letters, e.g. DHKNORSVZ or 1234567889. Observers will find it helpful to consult this page while choosing an answer when they have little idea what letter the target(s) might be. And children may prefer to point at the target letters, one by one, on the alphabet page.
8. *Run a script.* To test an observer, double click runCriticalSpacing or your own modified script. They're easy to write. Say "Ok" if MATLAB offers to change the current folder. The program automatically saves the data to the CriticalSpacing/data/ folder. The test takes 10 min to test one observer (with 20 trials per threshold), measuring four thresholds. (You can increase o.trials in your script from 20 to 40 for a more precise threshold estimate.)
9. *Type “help CriticalSpacing”* in the MATLAB Command Window for advice on running CriticalSpacing.