

AMAT: a meta-analysis toolbox

developed by Antonia Hamilton, beta version April 2005
comments to antonia.hamilton@dartmouth.edu
released under GNU general public license

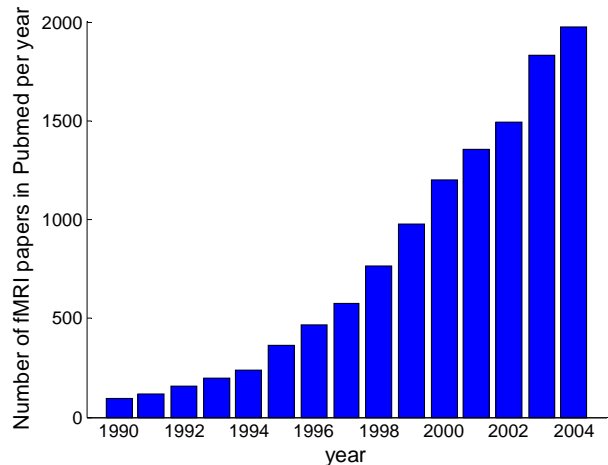
Table of Contents

What is AMAT?.....	2
How does it work?	2
Some quick disclaimers.....	2
How do I use AMAT?.....	2
How do I add my papers to the AMAT database?	2
Bugs, comments etc.....	3
What does the A stand for?	3
Acknowledgements	3
How to install AMAT	3
How to use AMAT.....	4
Adding data and database management issues.....	8
Copyright	10

What is AMAT?

AMAT is a matlab toolbox for meta-analysis of fMRI data. The number of fMRI papers examining cognitive functions is increasing far too fast for anyone to read them all, and with a variety of naming conventions for brain areas it is increasing difficult to obtain useful results from a general search data base like Pubmed. However, one common convention in fMRI papers is a results table which reports in a standard coordinate frame where activations were found in a particular task.

AMAT just takes these tables and makes them searchable. This means that when you do your fMRI study and look at your results in SPM and thinks 'what the hell does [-44 10 26] do?' AMAT can give you an answer.



How does it work?

Very simply. The core of AMAT is a big database which duplicates the results tables from hundreds of published papers and links them to a short description of the task and the paper's Pubmed ID number. AMAT is then able to look up pubmed to get the rest of the details of the paper (author, journal etc), so that when you search for a particular brain coordinate, AMAT can tell you which other papers have found results nearby.

Some quick disclaimers

The information in the AMAT database is very minimal – just a coordinate, an area name and a description of the functional task in a couple of words. You might think this is not enough information, but this is deliberate. AMAT is not meant to replace careful reading original papers, it is just there to help you find which papers you should read. Keeping the database entries short also makes it easier to add to the database and to maintain it. AMAT is not meant to let you do detailed meta-analysis of the details of papers. For that you need an in depth database like the fMRI Data Centre at Darmouth (<http://www.fmridc.org/>), which has far more information than AMAT can ever hope for.

How do I use AMAT?

AMAT is a matlab toolbox which builds on many of the graphics functions used in SPM2, which is available from the good folks at the FIL in London. To use AMAT, you will need a working version of Matlab (6.5 or 7) and SPM2. Then download the AMAT files and start playing. Full installation and usage instructions are found below.

How do I add my papers to the AMAT database?

I hoped you'd ask. It takes about 15 minutes to add each paper, less if you have the data in a favourable format (for example, if you are the author and have the word files). But that means it would take me almost 500 hours to add all the papers for 2004, which is time I don't really have. So if everyone who uses AMAT can add just one or two papers, the database will grow much faster. As soon as you add a paper, that data is

available for you to search, so it really is worth your time – just 15 minutes. See page 8 for details.

Bugs, comments etc

AMAT is still a beta version, meaning that it is not exhaustively tested yet. I have used it on a Windows XP computer with Matlab 7.0 and a linux computer with Matlab 6.5 without any major problems, but I'm sure there are still bugs. When you find them, please let me know. Help, ideas, comments, suggestions and improvements are also welcome, just e-mail antonia.hamilton@dartmouth.edu

What does the A stand for?

Well, it gets too confusing to have a program called MAT when you are working with matlab files all day, so the A is for A or Antonia's or Amazing or Awful or whatever you want.

Acknowledgements

All of the graphics in AMAT are dependent on the graphics routines developed as part of spm2, so my thanks to the SPM developers for making their code freely available for people like me to hack.

I have also made use of some data from the Brede database:

Finn Årup Nielsen. The Brede database: a small database for functional neuroimaging. NeuroImage, 19(2), Presented at the [9th International Conference on Functional Mapping of the Human Brain](#), June 19--22, 2003, New York, NY. Available on CD-Rom.

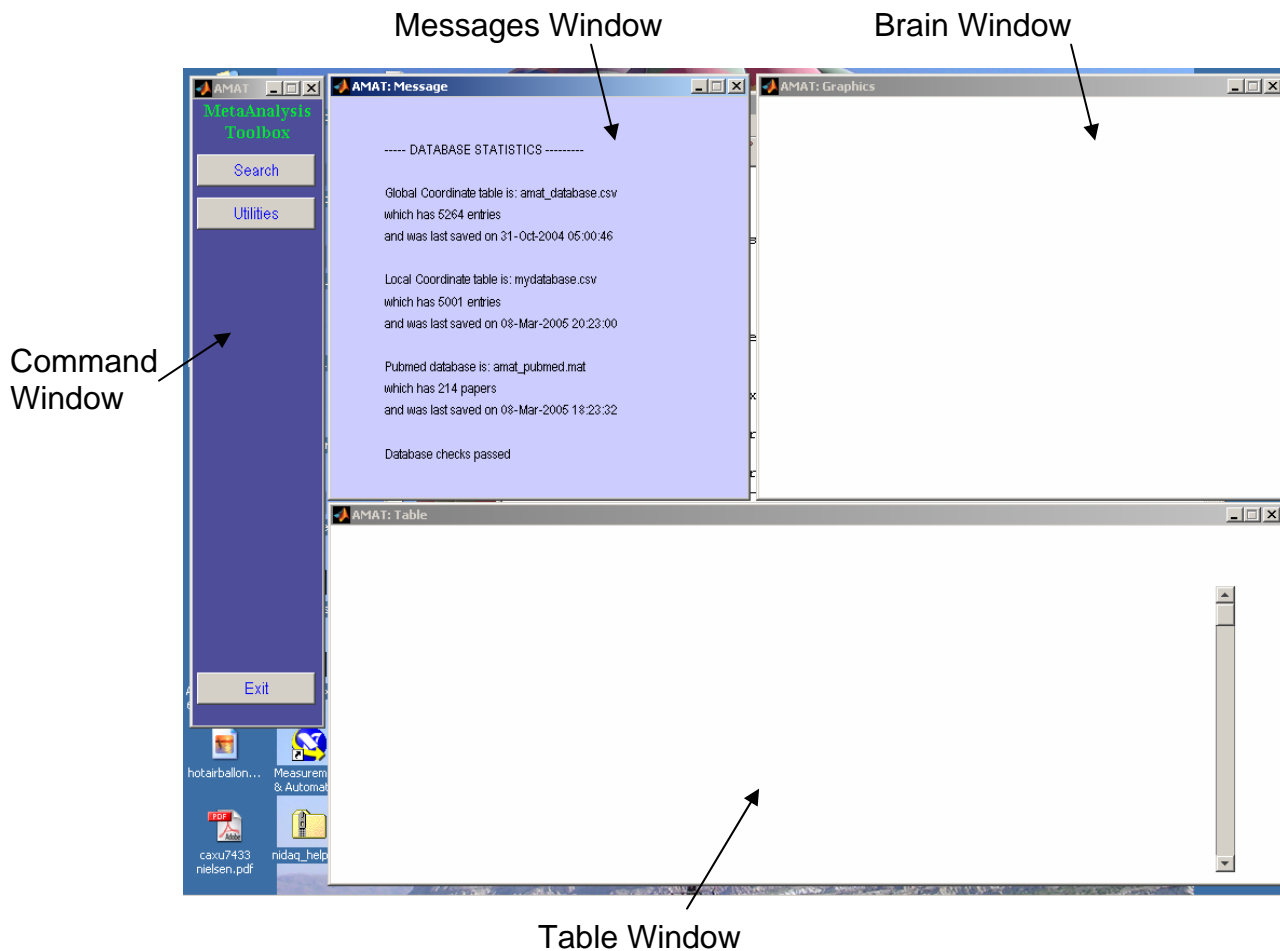
How to install AMAT

1. You will need the basic functions for Matlab 6.5 or Matlab 7 installed on your computer, but you shouldn't need any extra toolboxes.
2. If you haven't already got it, download spm2 from the FIL (<http://www.fil.ion.ucl.ac.uk/spm>) and install it. Make sure the paths are set up so that if you type `spm` at the matlab prompt, you get spm2.
3. Download amat.zip and amat_databases.zip from <http://www.dartmouth.edu/~antonia/amat.html>
4. Create a folder called amat
5. Unzip all the files into that folder
6. In matlab, change directories into the amat folder
7. At the matlab command prompt, type `amat`

and that is it!

How to use AMAT

When amat is installed and you are in the right directory, typing **amat** will open up 4 windows like this:



The **command window** is your menu bar – it lets you select the functions you want AMAT to do.

The **messages window** will start off telling you about the databases AMAT has loaded up. It will let you know if there is a database problem or if you need to get new information from Pubmed to update the database.

The **brain window** will be used to show you a sliced brain with the activation centres of the papers you are interested in

The **table window** will be used to show you the results of your searches in detail.

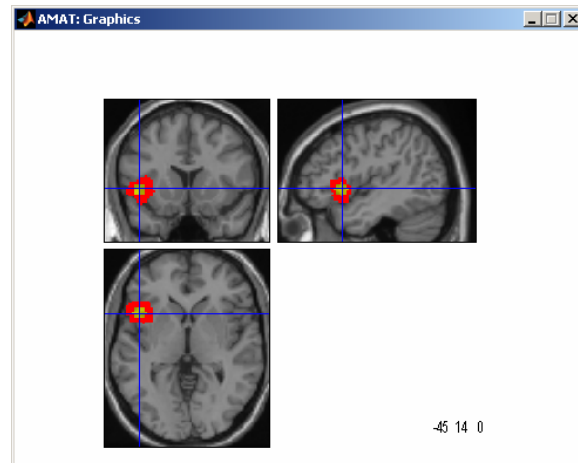
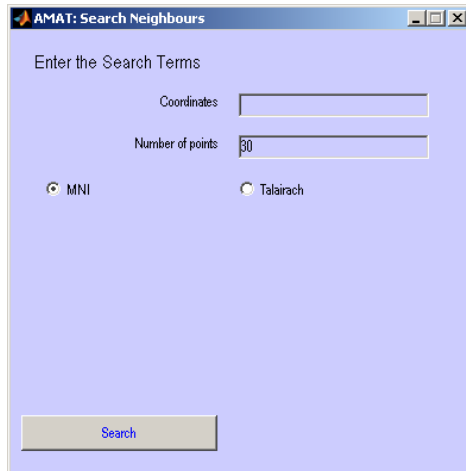
Click on the **search button** to see the search options. You can search for specific **papers** in the database, or you can search for the nearest **neighbours** nearest to a specific point in the brain.

To start with, try searching for **neighbours**.

AMAT will ask you for the **coordinates**, which must be 3 integers in the order x y z. You must indicate if these are MNI or Talairach coordinates. The default number of results to show is 30.

For this example, enter 44 15 0 as coordinates.

When you click **search**, the table window will list the database points nearest [44, 15, 0] in order of distance. Each point in the table is shown in red on the brain, and the search point is shown in green (or yellow).



AMAT: Table

Search Criteria = Nearest 30 neighbours to -44 15 0 (MNI)

Distance	X	Y	Z	Area	Descrip	Authors	Year	PMID
2.55	-46	14	0		discrete movement with rests - rhythmic movement	Schaal S Sternad D Osu R Kawato M	2004	15452580
3	-46	16	2	Left inferior frontal cortex	Decrease in obsessive-compulsive disorder ...	Hansen ES Hasselbalch S Law I Bolwig TG	2002	12057027
3.98	-40	16	1	Left insula	subtraction of single digit number > letter naming	Simon O Mangin JF Cohen L Le Bihan D ...	2002	11832233
4.45	-42	17	-4	Left inferior frontal gyrus	Evaluative judgment from visually sentences with	Zysset S Huber O Ferstl E von Cramon DY	2002	11906238
4.45	-42	17	-4	Left inferior frontal gyrus	Evaluative judgment from visually sentences with	Zysset S Huber O Ferstl E von Cramon DY	2002	11906238
4.45	-42	17	-4	Left BA 47	word memory encoding increase	Turk DJ Barfield JF Walling BR Heatherton TF ...	2004	15219600
4.45	-42	17	-4	left inferior frontal cortex	self word memory encoding	Turk DJ Barfield JF Walling BR Heatherton TF ...	2004	15219600
4.49	-43	19	-2	L IFG	remember 6 of 3 letters from uninformative cue > rest	Zhang JX Feng CM Fox PT Gao JH Tan LH	2004	15498409
4.58	-48	16	2	Left inferior frontal cortex	Comelation with obsessive-compulsive ...	Hansen ES Hasselbalch S Law I Bolwig TG	2002	12057027
4.83	-43	17	4	Pars triangularis	tone discrimination	Muller RA Basho S	2004	15068915
5.87	-48	13	-3	left insula	pain self & other	Singer T Seymour B O'Doherty J Kaube ...	2004	14976305
5.92	-39	11	1	Ant/insula	block transition	Konishi S Donaldson DI Buckner RL	2001	11162276
6.15	-39	15	4	inferior frontal gyrus	single subject action recognition	Hamzei F Rijntjes M Dettmers C Glauche ...	2003	12880794
6.75	-44	18	-6		discrete movement - rhythmic movement	Schaal S Sternad D Osu R Kawato M	2004	15452580
6.75	-44	18	-6		discrete movement with sound > rhythmic ...	Schaal S Sternad D Osu R Kawato M	2004	15452580
6.94	-38	15	4	Right inferior frontal	Viewing of dots in one of four displayed boxes ...	Casey BJ Cohen JD O'Craven K Davidson RJ ...	1998	9758739
7.27	-38	20	0	Insula	prepare to make finger mvmt not imitation	Buccino G Vogt S Ritzl A Fink GR Zilles ...	2004	15091346
7.48	-51	18	-3	L lateral PFC	encoding activity in memory for structured v. ...	Bor D Cumming N Scott CE Owen AM	2004	15217392
7.63	-38	14	5	Left insula*	somatic hallucinations in schizophrenia	Shergill SS Cameron LA Brammer MJ Williams ...	2001	11606687
7.81	49	14	8		visual anticipation	David C Eslinger Y Dapré S Craighero	2004	15376813

Clicking on a line in the table will move the cursor to that point in the brain and bring up more information about the database entry in the messages window, see right.

It will also give you the option to see just the coordinates of that particular paper, just as if you had searched for the paper itself.



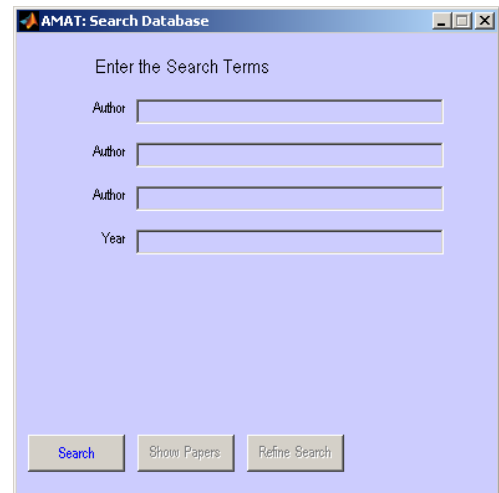
Now if you go back to the Menu bar and select the **papers** option, you can search for a particular paper. The message window will ask you to enter the search terms – up to three authors and a publication year are allowed.

Enter your terms and click **search**

AMAT will tell you how many papers it found so you can decide whether to look at them or to refine your search

When you click **show papers**, the AMAT table window will show the results of your search. The terms you used to search are listed at the top.

Clicking on a line in the table will display more information about that paper in the messages window, and will give you the option of seeing the database entries for one particular paper.

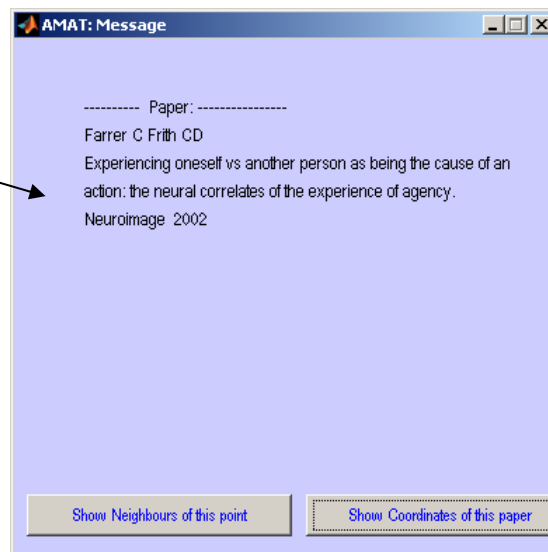


AMAT: Table

Search Criteria = Authors: frith | Year:

Authors	Year	Title	Journal	PMID
Frith CD Friston K Liddle PF Frackowiak RS	1991	Willed action and the prefrontal cortex in man: a study with PET.	Proc R Soc Lond B ...	1679944
McGuire PK Bench CJ Frith CD Marks IM ...	1994	Functional anatomy of obsessive-compulsive phenomena.	Br J Psychiatry	8038933
Jueptner M Stephan KM Frith CD Brooks DJ ...	1997	Anatomy of motor learning. I. Frontal cortex and attention to action.	J Neurophysiol	9084599
Maguire EA Burgess N Donnett JG Frackowiak ...	1998	Knowing where and getting there: a human navigation network.	Science	9572740
Buchel C Josephs O Rees G Turner R Frith CD ...	1998	The functional anatomy of attention to visual motion. A functional MRI study.	Brain	9679780
Blakemore SJ Rees G Frith CD	1998	How do we predict the consequences of our actions? A functional imaging study.	Neuropsychologia	9705062
Blakemore SJ Wolpert DM Frith CD	1999	Central cancellation of self-produced tickle sensation.	Nat Neurosci	10196573
Blakemore SJ Wolpert DM Frith CD	1999	The cerebellum contributes to somatosensory cortical activity during ...	Neuroimage	10493902
Gallagher HL Happe F Brunswick N Fletcher ...	2000	Reading the mind in cartoons and stories: an fMRI study of 'theory of mind' in ...	Neuropsychologia	10617288
Maguire EA Gadian DG Johnsrude IS Good CD ...	2000	Navigation-related structural change in the hippocampi of taxi drivers.	Proc Natl Acad Sci U S A	10716738
Jahanshahi M Dimberger G Fuller R Frith CD	2001	The role of the dorsolateral prefrontal cortex in random number generation: a ...	Neuroimage	11112403
Farrer C Frith CD	2002	Experiencing oneself vs another person as being the cause of an action: the ...	Neuroimage	11848702
Gallagher HL Jack AI Roepstorff A Frith CD	2002	Imaging the intentional stance in a competitive game.	Neuroimage	12169265
Kampe KK Frith CD Frith U	2003		J Neurosci	12832550
Singer T Seymour B O'Doherty J Kaube H ...	2004	Empathy for pain involves the affective but not sensory components of pain.	Science	14976305
Singer T Kiehl SJ Winston JS Dolan RJ Frith CD	2004	Brain responses to the acquired moral status of faces.	Neuron	14980212
Grezes J Frith CD Passingham RE	2004	Inferring false beliefs from the actions of oneself and others: an fMRI study.	Neuroimage	14980577
Maguire EA Frith CD	2004	The brain network associated with acquiring semantic knowledge.	Neuroimage	15110007

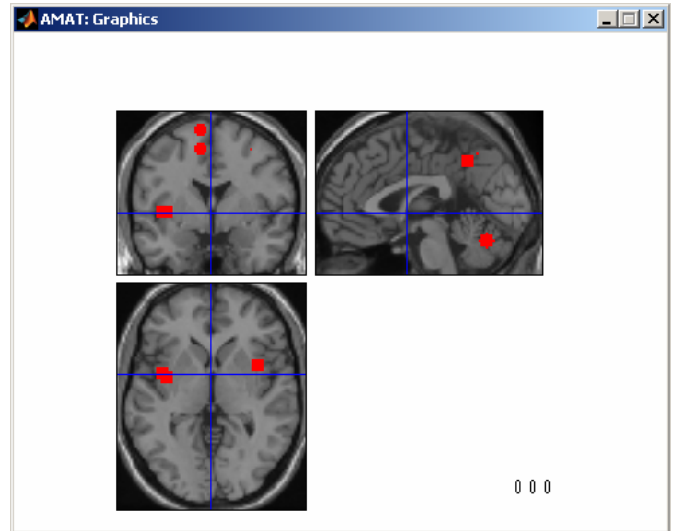
Click here to see this



So when you click **show coordinates of this paper**, the brain window will display the locations reported in the paper and the table window will list the coordinates and descriptions.

Note the the red blobs in the brain window just mark the activation focus – AMAT does not have information on the number of voxels or significance of the original activation reported, and shows all activations at the same size.

Clicking on the table window will move the cursor in the brain to that location and update the message window to show the full description of an area.



You will now also have the option to search for the nearest neighbours of the current location, so you can see what else activated this area.

The screenshot shows a window titled "AMAT: Table" with a search criteria of "Paper ID 11848702". The table below lists search results with columns for Distance, X, Y, Z, Area, Description, Authors, Year, and PMID.

Distance	X	Y	Z	Area	Descrip	Authors	Year	PMID
0	-40	2	2		joystick / computer control of cursor	Farrer C Frith CD	2002	11848702
0	-8	-4	70	Left SMA	joystick / computer control of cursor	Farrer C Frith CD	2002	11848702
0	-26	-10	62	Left lateral premotor area	joystick / computer control of cursor	Farrer C Frith CD	2002	11848702
0	34	-32	44	Right primary sensorimotor cortex	joystick / computer control of cursor	Farrer C Frith CD	2002	11848702
0	-46	-30	60	Left primary sensorimotor cortex	joystick / computer control of cursor	Farrer C Frith CD	2002	11848702
0	0	-66	-22		joystick / computer control of cursor	Farrer C Frith CD	2002	11848702
0	-8	-4	54	Left SMA	"The subject moved a joystick but a cursor on ...	Farrer C Frith CD	2002	11848702
0	34	-6	54	Right lateral premotor cortex	"The subject moved a joystick but a cursor on ...	Farrer C Frith CD	2002	11848702
0	-24	-12	58	Left lateral premotor cortex	"The subject moved a joystick but a cursor on ...	Farrer C Frith CD	2002	11848702
0	-38	-26	54	Left primary sensorimotor cortex	"The subject moved a joystick but a cursor on ...	Farrer C Frith CD	2002	11848702
0	32	-30	42	Right primary sensorimotor cortex	"The subject moved a joystick but a cursor on ...	Farrer C Frith CD	2002	11848702
0	44	-32	48		"The subject moved a joystick but a cursor on ...	Farrer C Frith CD	2002	11848702
0	-30	-44	54		"The subject moved a joystick but a cursor on ...	Farrer C Frith CD	2002	11848702
0	18	-60	32		"The subject moved a joystick but a cursor on ...	Farrer C Frith CD	2002	11848702
0	8	-68	-46		"The subject moved a joystick but a cursor on ...	Farrer C Frith CD	2002	11848702
0	16	-56	-24		"The subject moved a joystick but a cursor on ...	Farrer C Frith CD	2002	11848702
0	-22	-64	-26		"The subject moved a joystick but a cursor on ...	Farrer C Frith CD	2002	11848702
0	44	-58	32		The subject moved a joystick and a cursor on the ...	Farrer C Frith CD	2002	11848702
0	-48	-52	40		The subject moved a joystick and a cursor on the ...	Farrer C Frith CD	2002	11848702
n	6	68	60		The subject moved a joystick and a cursor on the ...	Farrer C Frith CD	2002	11848702

When you've played with AMAT a bit, you will find that you can alternate back and forth between searching for regions and searching for papers, tracking activation patterns through the brain. Which I think is quite fun.

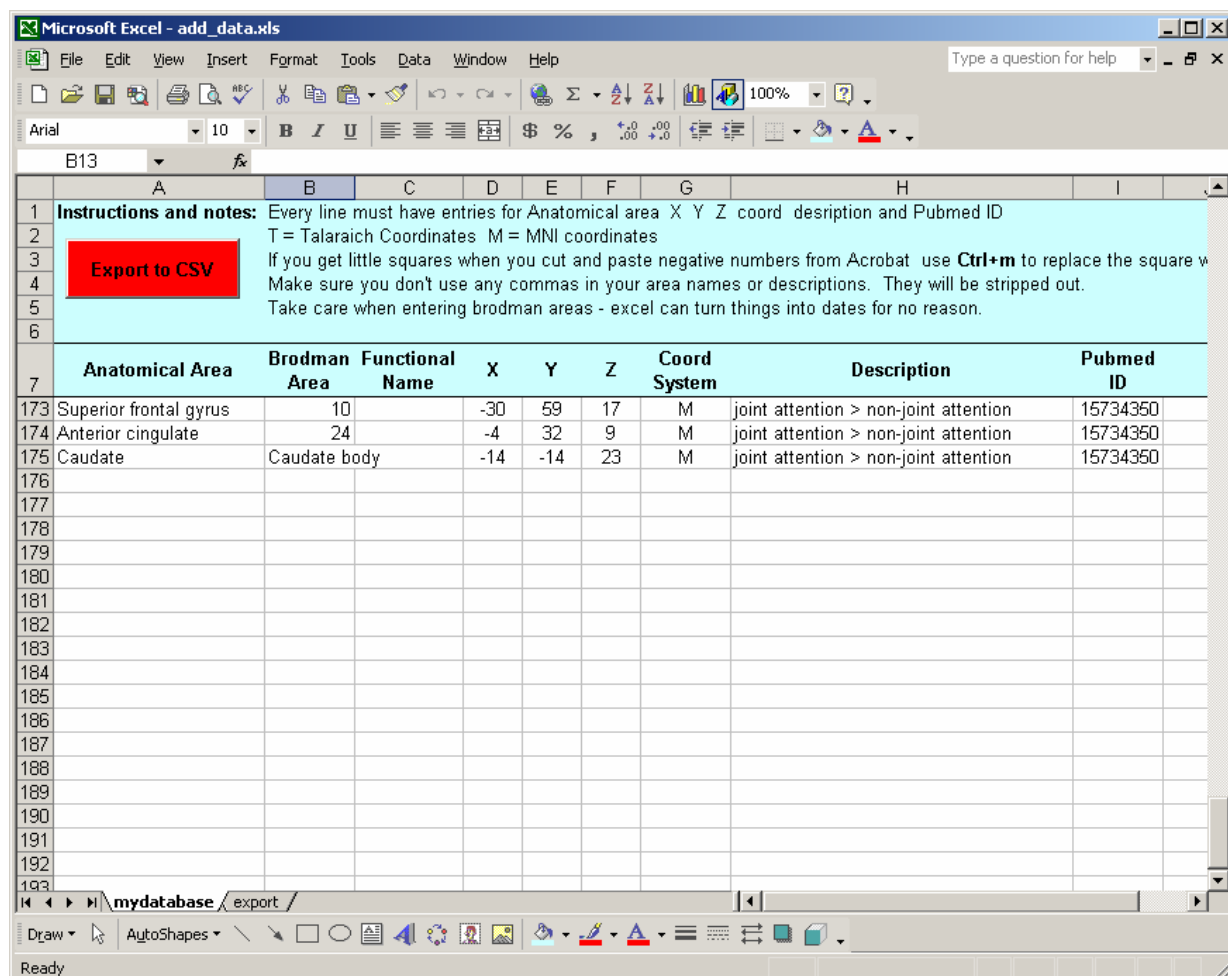
When you are done, just click **Exit** on the menu bar to quit!

Adding data and database management issues

These are the important but less fun bits about the workings of AMAT. The AMAT database is actually 3 files. The main database is **amat_database.csv**, which contains the vast majority of the data. This is supplemented by **mydatabase.csv**, which is available for the user to add data without any risk of corrupting the core dataset or forgetting which data is new and which is old. My hope is that users will gradually add to their local **mydatabase.csv** and then send me the file when it has lots of entries so I can add it to the central database for other users. The third file is **amat_pubmed.mat**, which is the file generated by AMAT when it contacts Pubmed to obtain information on the details of papers.

To make it easy to add data to your local **mydatabase.csv**, there is also an Excel file called **add_data.xls** which looks like this. You will have to enable macros when you open the file for the export functions to work.

The column headings and notes are fairly self-explanatory – all you need to do is fill in some rows of data. Entries for Brodman Area and Functional name are optional but all the other columns should be completed, and don't leave any blank rows.



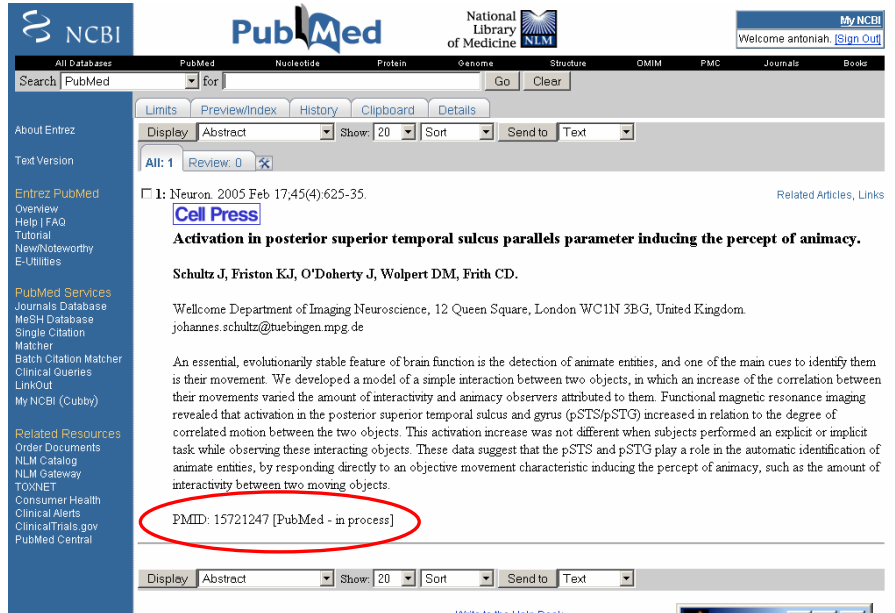
The screenshot shows a Microsoft Excel spreadsheet titled "add_data.xls". The spreadsheet contains instructions and a table for adding data to a database. A red button labeled "Export to CSV" is visible in cell B3. The table has the following columns: Anatomical Area, Brodman Area, Functional Name, X, Y, Z, Coord System, Description, and Pubmed ID. The first three rows of data are filled in, and the rest are blank.

	Anatomical Area	Brodman Area	Functional Name	X	Y	Z	Coord System	Description	Pubmed ID
173	Superior frontal gyrus	10		-30	59	17	M	joint attention > non-joint attention	15734350
174	Anterior cingulate	24		-4	32	9	M	joint attention > non-joint attention	15734350
175	Caudate	Caudate body		-14	-14	23	M	joint attention > non-joint attention	15734350
176									
177									
178									
179									
180									
181									
182									
183									
184									
185									
186									
187									
188									
189									
190									
191									
192									
193									

Most .pdf files will let you copy and paste data, often only one column at a time but that is still a lot quicker than typing. Addins for Adobe Acrobat like Jade from BCL (<http://www.bcltechnologies.com/document/products/products.htm>) make it quicker and cleaner to copy and paste data. When you copy negative numbers from a pdf, Excel will sometimes show a square instead of a minus sign. To fix this, select the affected cell (only one at a time) and press Ctrl + m. You should get your minus back.

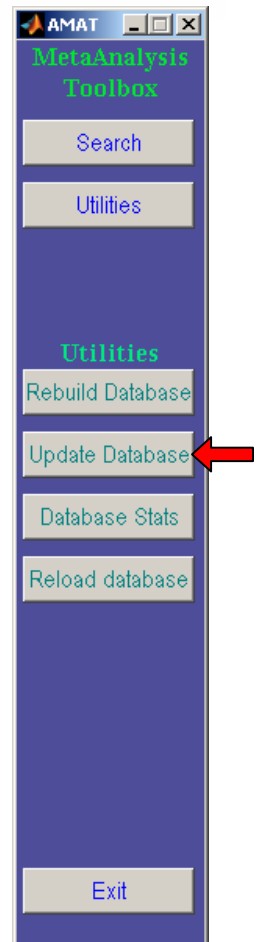
For each row, you will also need to enter an M if the coordinate system is MNI, T if it is Talaraich, a brief description of the task conditions and the pubmed ID.

The pubmed ID for a paper is the number labeled PMID below the abstract when you look for a paper on pubmed, and it provides a unique identifier for each paper. An example is shown on the right.



When you have entered a paper or two of data (or more) into Excel, click the red **Export** button. A macro will export all the data to **mydatabase.csv** for matlab to read, and will save your **add_data.xls** too. If it prompts you to overwrite the current files, you should accept.

Now you need to make your new data accessible to AMAT. If AMAT is open, restart it, otherwise just start it up. The database statistics should show additional entries in the local database and remind you to update the pubmed database. Click **Utilites - Update database**, and AMAT will connect to pubmed to obtain the author and journal information on the new data. You will have to be running matlab from a computer with an internet connection which matlab is able to use for this to work. If you have problems, type **help urlread** at the matlab prompt for more information.



Once the database has been updated, AMAT is ready to go and you can explore your new data! When your local database has more than 500 lines, please e-mail it to me so I can add it to the central AMAT database for everyone to use. Similarly, if you check the AMAT website occasionally you will find updated databases to download.

Note: For people who hate Excel, it is possible to add lines to **mydatabase.csv** using any other text / data editor you want. I just use Excel as an example because most people are familiar with it.

Copyright

AMAT is copyright, distributed under the GNU General Public Licence.

AMAT (being the collection of files found in amat.zip or amat.tar.gz file) is free but copyright software, distributed under the terms of the GNU General Public Licence as published by the Free Software Foundation (either version 2, as given below, or at your option, any later version).

For more details on "copyleft", see <http://www.gnu.org/copyleft/>

AMAT is supplied as is:
No formal support or maintenance is provided or implied.

GNU GENERAL PUBLIC LICENSE Version 2, June 1991

Copyright (C) 1989, 1991 Free Software Foundation, Inc.
59 Temple Place, Suite 330, Boston, MA 02111-1307 USA
Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public License is intended to guarantee your freedom to share and change free software--to make sure the software is free for all its users. This General Public License applies to most of the Free Software Foundation's software and to any other program whose authors commit to using it. (Some other Free Software Foundation software is covered by the GNU Library General Public License instead.) You can apply it to your programs, too.

When we speak of free software, we are referring to freedom, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish), that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs; and that you know you can do these things.

To protect your rights, we need to make restrictions that forbid anyone to deny you these rights or to ask you to surrender the rights. These restrictions translate to certain responsibilities for you if you distribute copies of the software, or if you modify it.

For example, if you distribute copies of such a program, whether gratis or for a fee, you must give the recipients all the rights that you have. You must make sure that they, too, receive or can get the source code. And you must show them these terms so they know their rights.

We protect your rights with two steps: (1) copyright the software, and (2) offer you this license which gives you legal permission to copy, distribute and/or modify the software.

Also, for each author's protection and ours, we want to make certain that everyone understands that there is no warranty for this free software. If the software is modified by someone else and passed on, we want its recipients to know that what they have is not the original, so that any problems introduced by others will not reflect on the original authors' reputations.

Finally, any free program is threatened constantly by software patents. We wish to avoid the danger that redistributors of a free program will individually obtain patent licenses, in effect making the program proprietary. To prevent this, we have made it clear that any patent must be licensed for everyone's free use or not licensed at all.

The precise terms and conditions for copying, distribution and modification follow.

GNU GENERAL PUBLIC LICENSE

TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0. This License applies to any program or other work which contains a notice placed by the copyright holder saying it may be distributed under the terms of this General Public License. The "Program", below, refers to any such program or work, and a "work based on the Program" means either the Program or any derivative work under copyright law: that is to say, a work containing the Program or a portion of it, either verbatim or with modifications and/or translated into another language. (Hereinafter, translation is included without limitation in the term "modification".) Each licensee is addressed as "you".

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running the Program is not restricted, and the output from the Program is covered only if its contents constitute a work based on the Program (independent of having been made by running the Program). Whether that is true depends on what the Program does.

1. You may copy and distribute verbatim copies of the Program's source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and give any other recipients of the Program a copy of this License along with the Program.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

2. You may modify your copy or copies of the Program or any portion of it, thus forming a work based on the Program, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:

a) You must cause the modified files to carry prominent notices stating that you changed the files and the date of any change.

b) You must cause any work that you distribute or publish, that in whole or in part contains or is derived from the Program or any part thereof, to be licensed as a whole at no charge to all third parties under the terms of this License.

c) If the modified program normally reads commands interactively when run, you must cause it, when started running for such interactive use in the most ordinary way, to print or display an announcement including an appropriate copyright notice and a notice that there is no warranty (or else, saying that you provide a warranty) and that users may redistribute the program under these conditions, and telling the user how to view a copy of this License. (Exception: if the Program itself is interactive but does not normally print such an announcement, your work based on the Program is not required to print an announcement.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Program, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Program, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Program.

In addition, mere aggregation of another work not based on the Program with the Program (or with a work based on the Program) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

3. You may copy and distribute the Program (or a work based on it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you also do one of the following:

a) Accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,

b) Accompany it with a written offer, valid for at least three years, to give any third party, for a charge no more than your cost of physically performing source distribution, a complete machine-readable copy of the corresponding source

code, to be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,

c) Accompany it with the information you received as to the offer to distribute corresponding source code. (This alternative is allowed only for noncommercial distribution and only if you received the program in object code or executable form with such an offer, in accord with Subsection b above.)

The source code for a work means the preferred form of the work for making modifications to it. For an executable work, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the executable. However, as a special exception, the source code distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

If distribution of executable or object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place counts as distribution of the source code, even though third parties are not compelled to copy the source along with the object code.

4. You may not copy, modify, sublicense, or distribute the Program except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense or distribute the Program is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

5. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Program or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Program (or any work based on the Program), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Program or works based on it.

6. Each time you redistribute the Program (or any work based on the Program), the recipient automatically receives a license from the original licensor to copy, distribute or modify the Program subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties to this License.

7. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Program at all. For example, if a patent license would not permit royalty-free redistribution of the Program by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Program.

If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply and the section as a whole is intended to apply in other circumstances.

It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system, which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

8. If the distribution and/or use of the Program is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Program under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.

9. The Free Software Foundation may publish revised and/or new versions of the General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Program specifies a version number of this License which applies to it and "any later version", you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Program does not specify a version number of this License, you may choose any version ever published by the Free Software Foundation.

10. If you wish to incorporate parts of the Program into other free programs whose distribution conditions are different, write to the author to ask for permission. For software which is copyrighted by the Free Software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this. Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

NO WARRANTY

11. BECAUSE THE PROGRAM IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY FOR THE PROGRAM, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. SHOULD THE PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

12. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR REDISTRIBUTE THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER PROGRAMS), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

END OF TERMS AND CONDITIONS

----- How to Apply These Terms to Your New Programs

If you develop a new program, and you want it to be of the greatest possible use to the public, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms.

To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

<one line to give the program's name and a brief idea of what it does.>
Copyright (C) 19yy <name of author>

This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

You should have received a copy of the GNU General Public License along with this program; if not, write to the Free Software Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA 02111-1307 USA

Also add information on how to contact you by electronic and paper mail.

If the program is interactive, make it output a short notice like this when it starts in an interactive mode:

```
Gnomovision version 69, Copyright (C) 19yy name of author
Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type `show w'.
This is free software, and you are welcome to redistribute it under certain conditions; type `show c' for details.
```

The hypothetical commands `show w' and `show c' should show the appropriate parts of the General Public License. Of course, the commands you use may be called something other than `show w' and `show c'; they could even be mouse-clicks or menu items--whatever suits your program.

You should also get your employer (if you work as a programmer) or your school, if any, to sign a "copyright disclaimer" for the program, if necessary. Here is a sample; alter the names:

```
Yoyodyne, Inc., hereby disclaims all copyright interest in the program
`Gnomovision' (which makes passes at compilers) written by James Hacker.
```

```
<signature of Ty Coon>, 1 April 1989
Ty Coon, President of Vice
```

This General Public License does not permit incorporating your program into proprietary programs. If your program is a subroutine library, you may consider it more useful to permit linking proprietary applications with the library. If this is what you want to do, use the GNU Library General Public License instead of this License.