MPH NEGLECT DIAGNOSIS 2.1 HANDBOOK (as of February, the 12th, 2019)

Please feel free to use and diffuse the MPH software – in any publication cite:

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For any information not contained in this file or in the website psicologia.unipv.it/toraldo/mean-position-of-hits.htm, please email: Alessio Toraldo, alessio.toraldo@unipv.it, alessio.toraldo@gmail.com; or Paolo Sommaruga, paolosom@gmail.com.

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Font conventions

Names of commands or tabs are reported in **bold**; ***definitions***, ***names of important files or objects in files*** are reported in ***blue bold italic*** on their first few occurrences; *mathematical parameters* are given in *italic*.

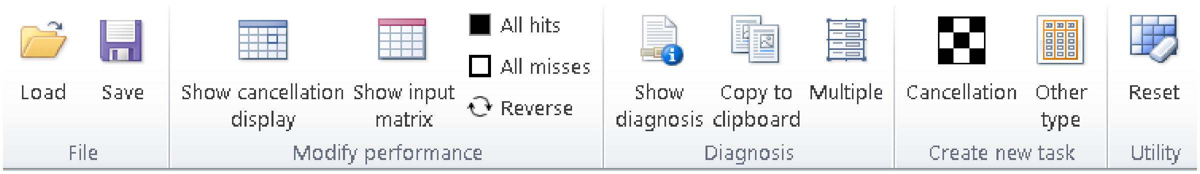
1. What is the 'MPH Neglect Diagnosis 2.1' Worksheet, and what does it do?

The 'MPH Neglect Diagnosis 2.1' Worksheet (henceforth, simply 'the ***Worksheet***') is an Excel document with macros which allows one to analyse several different neglect tasks, and produces a diagnosis of neglect and a measurement of its intensity as an output.

In general, the tasks that can be analysed via this Worksheet are all those that involve a number of stimuli in different positions in space, and a *Hit/Miss* score for each of them. Most neglect tasks are of this kind, for instance visual/haptic cancellation tasks, visual /auditory /tactile detection tasks, memory recall tasks, etc. Some neglect tasks *cannot* be analysed via this Worksheet: for instance, bisection tasks and Landmark tasks, because they do not have a detected/undetected score on each trial. Some more detail as to what tasks can and what cannot be analysed, are reported in Toraldo et al. (2017) and Section 6 in this handbook.

The input to the Worksheet is guided by dedicated, new commands that are listed below (also look at Section 4). However, consider that in specific situations the input can be given 'manually', that is, by inserting the data in a specific set of cells (see Section 5).
The dedicated commands are collected under an additional tab, **MPH neglect diagnosis**, which (usually) appears on the right side of the sequence of tabs along the upper edge of the Excel window:

If you click on it, a ***Ribbon*** appears that contains the new commands:



The meaning of each command will become obvious and intuitive when reading the practical examples presented in later Sections; here we briefly explain what each command does.

The Ribbon is divided in a few sectors, ***File***, ***Modify performance***, ***Diagnosis***, ***Create new task***, and ***Utility***. An important remark in terminology must be made here: by ***performance*** we mean the raw input data from a patient, that is, the specification of what targets were detected and what others were not; by ***diagnosis*** we mean the output, that is, the *z*-score and *p*-value that allow one to classify the patient's performance as pathological/normal and to quantify his/her deficit.

In the ***File*** sector, the **Load** command allows one to import an old performance (that was previously saved as an INI file) into the Worksheet, in order to analyse it. The **Save** command allows one to save a new performance (as an INI file), in order to be able to analyse it later.

The ***Modify performance*** sector allows one to change or update the performance of a patient, and allows one to do so either by looking at the ***Cancellation display*** (if the task is cancellation) or by looking at the ***Input matrix*** – the list of target positions and of *Hit/Miss* scores. **All hits**, **All misses**, **Reverse** allow one to quickly change the pattern of detected/undetected targets: by pressing All hits, all targets are turned into the 'detected' state; by pressing **All misses**, all targets are turned into the 'undetected' state; by pressing **Reverse** targets that are in the 'undetected' state are turned into 'detected' and vice versa. This latter command is very useful if the examiner, by mistake, confused detected with undetected.

The ***Diagnosis*** sector allows one to look at the diagnosis of the performance being analysed (**Show diagnosis**), or to export it (**Copy to clipboard**), or to compute multiple diagnoses, at once, on multiple performances that were saved previously (**Multiple**).

Create new task allows one to import a new cancellation display (**Cancellation**) or to insert a new set of target positions (**Other type** of task).

Reset allows one to clean the Worksheet from all data: the current performance, cancellation display, and list of multiple diagnoses will all be erased – the Worksheet will be brought back to its initial (empty) condition. This command is useful (e.g.) when one needs to run a new analysis, or when one inadvertently saved the Worksheet with some data in it (in ordinary circumstances, the Worksheet should always remain *unsaved* – indeed performances are saved as INI files, see the use of the Save command in e.g. Sections 4.1.1 and 5.1.1, and diagnoses can be exported, see e.g. text relative to Tables 1, 6 and 8).

If one is visualizing the ***Cancellation Display***, some of the commands that we just introduced are replicated and directly accessible from it. These are **File** – **Save**, **Edit** – **All hits**, **All misses**, **Reverse**; **Diagnosis** – **Show diagnosis**, **Copy diagnosis** (the latter performs the same operation as **Copy to Clipboard**).

The functioning of the Worksheet is much easier to explain by showing some concrete examples of application rather than by listing more details on the use of specific commands. Thus in the following Sections we report the step-by-step procedure the user should follow when facing typical clinical/experimental situations, in order to achieve a sensible goal in each case. Commands will be explained in the process.

2. Starting the Worksheet

2.1. Before you begin: software requirements

The MPH Neglect Diagnosis 2.1 Worksheet requires a Windows PC with Excel 2007 or later versions installed. The MPH 2.1 version does not work on other systems – in this case, try the MPH 1.0 version (which, however, is less straightforward to use with cancellation tasks and the like).

2.2. Program download

You can find the latest version of the Worksheet online (http://psicologia.unipv.it/toraldo/mean-position-of-hits.htm, or run an internet search with 'MPH Toraldo' as keywords). Download the ZIP file ***MPH Neglect Diagnosis 2.1*** and unzip it on your PC. A folder will show up containing a number of INI files, a number of image (JPG) files, and the Worksheet, which is an Excel document named ***MPHND-2-1-*-build**** (the '*' numbering specifies the exact versions of the file). Importantly, ***the Worksheet and all the files with which it will work (INI and image files) must be in the same folder.*** Thus, it is a good choice to leave all the files in the unzipped folder. Open the Worksheet.

2.3. Troubleshooting Excel startup

Excel is usually protected against unknown macros, so there could be a few issues in the first activation.

Excel 2010 or more recent When you open the Worksheet for the first time (or in a new folder), a yellowish warning message might appear (according to the specific settings of your Excel) named 'Protected View'. If so, just click on **Enable editing** (do it, otherwise the Worksheet will not work); if a window pops out with 'Run-time error '91'', just click on **End** and the file should be ready to work. If the folder where the file is kept or used is frequently changed, you might consider disabling the Protected View function in the Excel settings.

Excel 2007

When you open the Worksheet fort the first time (or in a new folder), you might get the warning message 'Security Alert – Macro'. If so, just check the **Enable this content** option.

The file is ready to work if you see the new tab **MPH Neglect Diagnosis**:

If the tab does not appear, the level of protection of your Excel against macros might be too high for the Worksheet to work properly (indeed it contains many – safe – macros). Thus, try to set the protection to a lower level, and try again.

3. How to use the Worksheet

There are two main ways to use the Worksheet. The first is when one wishes to diagnose neglect on grounds of a *cancellation* task – the patient physically marked a number of targets on a piece of paper. The second is when any task that *differs* from a classical cancellation task has been used – for instance, a memory recall task, or an auditory perception task, etc. We will use illustrate both modes by means of practical examples: Section 4 reports examples from cancellation tasks, Section 5 reports an example from an auditory detection task. Another Section, 6, explains with what tasks the Worksheet should be used with caution, or not used at all. Section 7 shows how old data (which were previously saved as INI files) can be analysed, and further Sections (8, 9) illustrate more technical points, including warning messages and troubleshooting.

4. Cancellation tasks

There are two sub-cases here: (i) the cancellation task is one of those that have been downloaded with the Worksheet, or (ii) the cancellation task the user is wishing to analyse is *not* in that list. We will show these subcases in turn.

4.1. Cancellation tasks provided with the Worksheet

The Worksheet was downloaded together with some of the most common cancellation displays in JPG format, ready to be uploaded and analysed (some of them were taken from Rorden and Karnath's website http://www.mccauslandcenter.sc.edu/crnl/tools/cancel). These are: ***Albert-Line*** (Albert, 1973), ***Gauthier-Bell*** (Gauthier et al., 1989), ***Weintraub-Letter***, ***Weintraub-Shape*** (Weintraub & Mesulam, 1985), ***Diller-Letter*** (Diller & Weinberg, 1977), ***Diller-V*** (Toraldo, unpublished work), ***BIT-Letter***, ***BIT-Star*** (Wilson et al., 1987). If one wishes to print them out and present them to patients, s/he can download their PDF versions from the usual website http://psicologia.unipv.it/toraldo/mean-position-of-hits.htm. Each PDF contains both the cancellation display to be printed out on paper, and a page that only contains target positions, to be printed out on a transparency. The latter can be useful for the examiner to find targets when cancellation displays are quite cluttered (e.g. the Bell test): by placing the transparency over the paper the patient cancelled on, targets will be easier to find.

4.1.1. An example with Albert's (1973) Line Cancellation task

We will now show how to analyse the performance of a patient on a version of the Albert (1973) Line Cancellation task (Fig. 1).

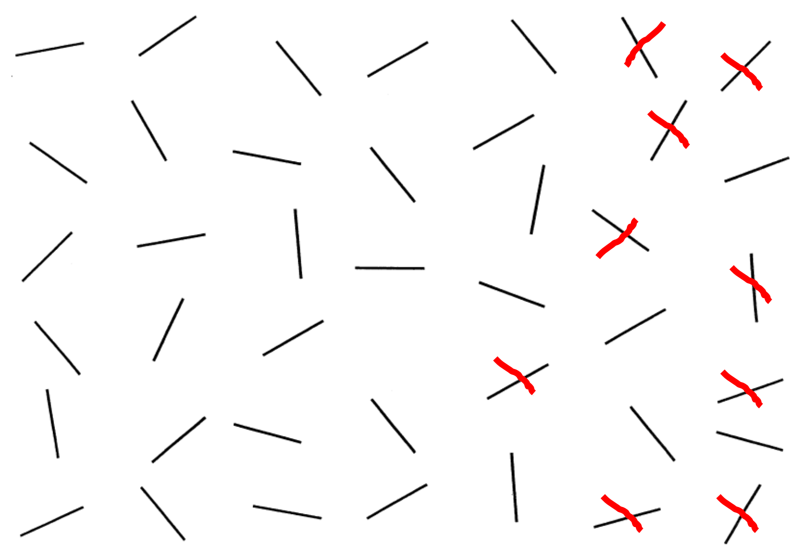


Fig. 1 *Performance by a neglect patient on the Albert's (1973) Line Cancellation task.*

To diagnose neglect, click on the **MPH Neglect Diagnosis** tab on the top bar; this will open the ***Ribbon***; in the Ribbon, click on **Load**. Search for the 'Albert-Line.ini' file, and double-click on it.

The Albert display will then be shown, with small square boxes signalling each target. Light-grey boxes indicate a Missed target, black boxes indicate a Hit target. The status of a target can be changed by clicking on it. Hence, to analyse the performance of Fig. 1, the following boxes need to be turned into black (Fig. 2):

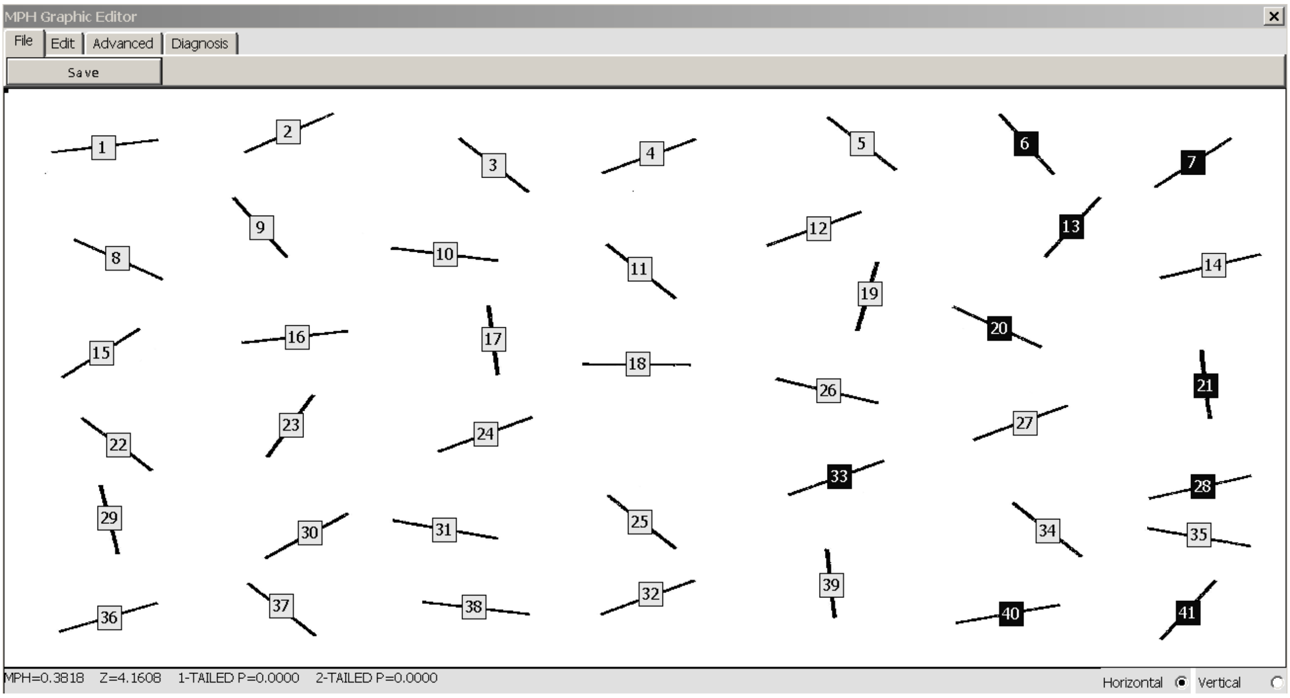
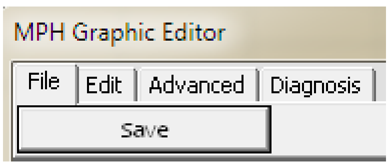


Fig. 2 *The* ***Cancellation Display*** *showing the performance in Fig. 1. The size and ratio of the Cancellation Display are automatically tuned on your screen; thus the image might look a bit distorted with respect to the original (Fig. 1). If you wish to see a less distorted image, try to compensate by adjusting the size and shape of the Excel window. If one inadvertently closed (or lost track of) the Cancellation Display, a command in the Ribbon is available to go back to it:* ***Show cancellation display****.*

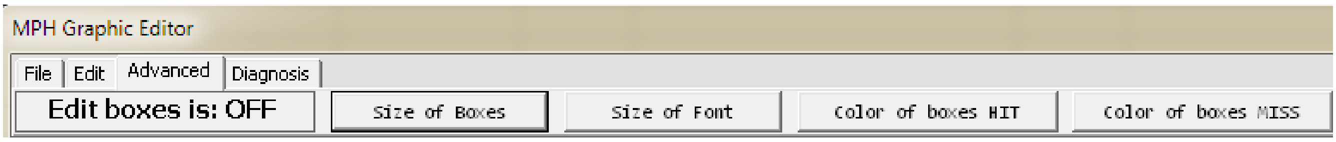
The lower border of the display already gives crucial diagnostic details: the ***Mean Position of Hits*** (*MPH*) is reported, together with the **z-score** and the ***one-tailed*** and ***two-tailed p-values*** for diagnosis. In the example, the obvious left neglect is diagnosed with MPH=+0.3818, z=+4.1608, and p<0.0001. Mind the choice in the bottom-right corner of the window: it tells you which dimension the *MPH* results are shown for. In the example of the figure, **Horizontal** is checked meaning that the reported *MPH* is the horizontal one. Check **Vertical** if you are interested in the other dimension. More details as to how to interpret these results are shown in the later Section 4.1.2.

There are several other functions that can be accessed from this ***Cancellation Display***, which are presented below.

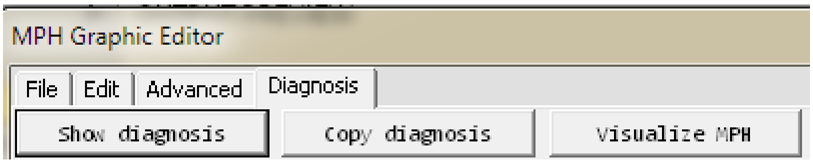


-The **Save** button allows one to save a new INI file containing the performance of the patient (i.e. what targets were hit, what targets were missed, in what cancellation test), which can be uploaded again later if necessary. Recall that to be uploaded again, the INI file needs to be in the same folder as the Worksheet. This choice of saving the performance as an INI file is by far the most convenient in terms of storage, as an INI file, which contains all of the input data (and also the details as to how the Cancellation Display should be visualized) is up to 5-6 Kb big. By contrast, saving a copy of the entire Worksheet takes about 1500Kb per file. If keeping a 1500 Kb Excel file per performance is your choice, use the **Save as** Excel function, as the Worksheet has been designed to always remain unsaved after use (if you inadvertently saved your master copy of the Worksheet with some data in it, just click on the **Reset** button and save it again).

-The **Edit** function allows one to check all targets (**all Hits**), to un-check all targets (**all Misses**) or to **Reverse** the checking pattern (to be used when one checked by mistake the missed targets as hits or vice-versa).



-The **Advanced** button allows for a number of operations. The first button, **Edit boxes is: (–ON– or OFF)**, allows one to change the positions of the target markers (the boxes) if necessary. By setting that button to **–ON–** (a click will do) one will be able to move the boxes by dragging-and-dropping them with the mouse (an operation that is usually done only when implementing a new cancellation task, see Section 5 below). The other buttons, **Size of boxes**, **Size of Font**, **Color of boxes HIT**, **Color of boxes MISS** allow one to choose the size of the boxes, their colours, and the size of the ID number contained in them.



-**Diagnosis** allows one to deepen his/her insight into the results. The sub-options are the following.
Show diagnosis opens a sheet of the Excel file that reports a full, detailed list of results – see later Section 4.1.2 for explanation.
Copy diagnosis allows one to export the detailed list of results somewhere else – that is, the data will be available in the clipboard, to be pasted in another Excel, or Word file, etc.
Visualize MPH allows one to see where exactly the (bivariate) *MPH* is in the display:

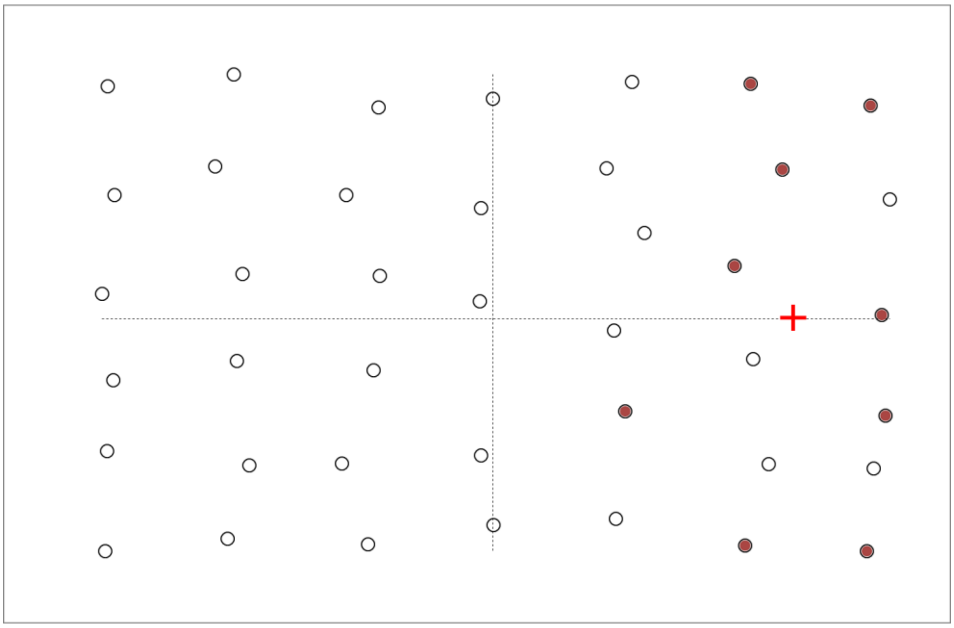
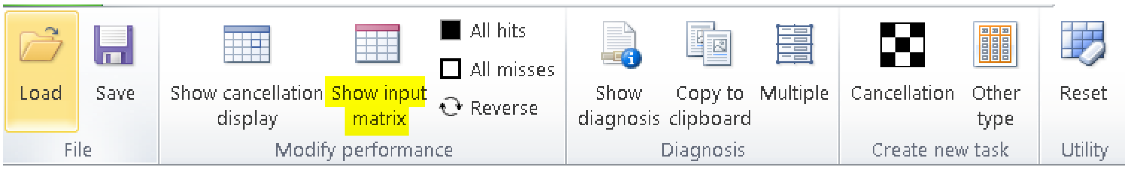


Fig. 3 *Visualization of the bivariate MPH (red cross) among the detected (dark red circles) and undetected (open circles) targets for the cancellation performance in Fig. 1.*

The circles show the position of all targets – open (white): missed targets, filled (dark red): hit targets; the red cross shows the position of the bivariate *MPH*. The dashed lines are the axes where *MPH*=0 (i.e. fully normal) either on the horizontal or on the vertical dimension – thus perfect performance corresponds to the crossing between the dashed lines. The same plot can be accessed by simply opening the ***MPH in the display*** sheet. A version of the plot with additional ID labels close to the targets is also available: see the ***MPH in display with labels*** sheet.
If you wish to export this plot, just right-click on it, then press CTRL+C to copy it and CTRL+V to paste it somewhere else (e.g. in a Word file).

If one wishes to export the results in their 'compact' form – those which appear on the lower edge of the Cancellation Display window (*MPH*, *z*-score, *p*-values) – one has to click on the **Show input matrix** command in the Ribbon, or equivalently, open the ***INPUT*** sheet of the Excel file:



The sheet that will now be active reports the desired compact results in the ***OUTPUT PREVIEW*** G9:H15 cells:

OUTPUT PREVIEW	
MPH in which dimension, Horizontal or Vertical? (H/V)	
H	
MPH=	0.3818
Z=	4.1608
1-tailed p=	0.0000
2-tailed p=	0.0000

Table 1 *Results for the performance in Fig. 1, shown in the 'Output Preview' compact format in cells G9:H15 of the INPUT sheet.*

Be sure that the desired dimension, horizontal or vertical, is selected, by writing either '*H*' or '*V*' in the pink G11 cell.
Those cells can be copied and pasted elsewhere (to paste them in a new Excel file, use the **Paste Special - Values** function).

4.1.2. Interpreting the results

In this Section we explain the meaning of the full list of results reported when clicking on the **Show Diagnosis** command. Results will be visible by scrolling down in the sheet. Descriptions or names of the various outputs are given in white cells, and results are reported in coloured cells (F2:F40). The reddish ones contain warnings, the green/grey cells numerical values.

General			Targets	41
			Hits	9
Neglect	**Metric solution**	**MPH in the metric (original) scale**	value	2949.0447
			min	270.0539
			max	3309.7351
		C-adjusted MPH	value	0.3834
			min	-0.4979
			max	0.5021
		LCR-adjusted MPH (-0.5,+0.5)	value	0.3818
		Statistical test	st.dev	0.0922
			z (using C-MPH)	4.1608
			1-tailed p	0.0000
			2-tailed p	0.0000

Table 2 *Results for the performance shown in Fig. 1.*

Summary statistics are reported first and concern the overall counts of targets (41) and Hits (9) – see Table 2. After that, *MPH* is given in a number of formats. The first value is not (usually) very relevant, as it is expressed in units of the original scale (i.e. some function of the number of pixels of the electronic image being analysed). The really informative *MPH* values are the standardized ones. ***LCR-adjusted MPH*** varies in the –0.5 to 0.5 scale and gives an estimate of the degree of neglect: –0.5 means extreme leftward bias (right neglect), 0 means no neglect, +0.5 means extreme rightward bias (left neglect). The massive rightward bias shown by our patient (Fig. 1) is expressed by the LCR-adjusted *MPH*, which is +0.3818. ***C-adjusted MPH*** has similar meaning and is used in diagnosis because of its marginally better statistical properties. The C-*MPH* value (+0.3834) divided by the standard deviation estimated by our model (***st.dev*** = 0.0922) provides a classical ***z-score***, +4.1608. The sign of the *z*-score is the same as that of the *MPH*, thus positive *z*-scores mean rightward bias, negative *z*-scores leftward bias. Thus z=+4.1608 means that the performance in Fig. 1 is more than four standard deviations away from the centre of the distribution that would have been obtained if no neglect had been present (but the same number of Hits, 9 in this case, had been produced). Clearly, a *z* of more than +4 represents very strong evidence of rightward bias (left neglect). ***One-tailed*** and ***two-tailed*** diagnostic ***p-values*** associated with the *z*-score are given; not surprisingly in this case the *p*-values are infinitesimal ($p < 0.0001$).

Therefore, we obtained the (expected) clear-cut diagnosis of left neglect, and a precise quantification of the deficit: *MPH* was +0.38 in the scale going from 0, no neglect, to +0.5, maximum possible left neglect.

The results table can be easily be exported (in horizontal format – i.e., with all results in a row instead of in a column) by clicking on the **Copy to clipboard** command of the Ribbon. Just press **Paste** in some other program/file to visualize the table.

4.1.3. Advantages of the statistical method: another case with the Albert task

We will now explore a much less straightforward diagnostic case (Fig. 4).

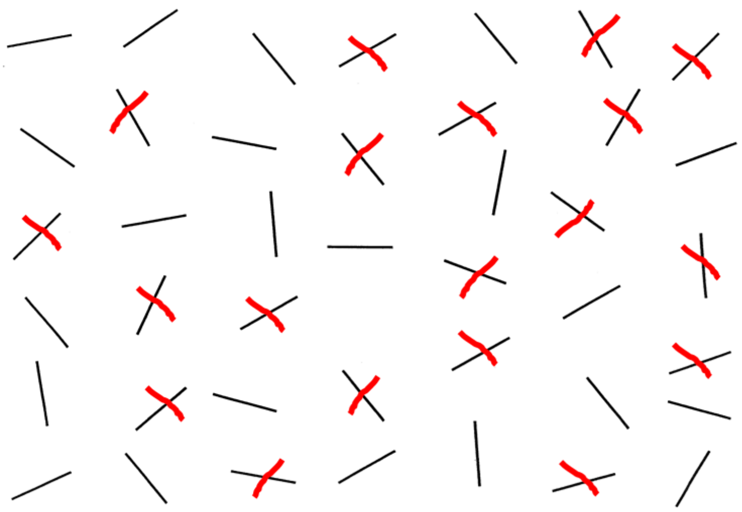


Fig. 4 *Performance by another neglect patient on the Albert's (1973) Line Cancellation task.*

Table 3 shows the results given by the Worksheet: this time z=1.4256, one-tailed p=0.077. This is insufficient evidence for a rightward bias.[1] By contrast, other criteria that are often applied to the Albert test would have diagnosed a left neglect. For instance a widespread criterion is to consider a difference of at least two Hits between the two halves as diagnostic of neglect; in this case the difference is twice as large: +4 (the central column of targets is excluded from this computation), leading to what we consider as a False Positive – a false diagnosis of neglect. This is an example of what we refer to as the problem of 'False Positive Rate Inflation' in the Toraldo et al. (2017) paper (also look at the ***Website Material*** file in http://psicologia.unipv.it/toraldo/mean-position-of-hits.htm):

[1] Note that one-tailed *p*-values are to be looked at if one has an expected direction of the deficit (generally, one expects a rightward bias – a positive *z*-score – after right hemisphere damage and a leftward bias – a negative score – after left hemisphere damage).

General			Targets	41
			Hits	19
Neglect	**Metric solution**	**MPH in the metric (original) scale**	value	2013.2868
			min	270.0539
			max	3309.7351
		C-adjusted MPH	value	0.0756
			min	-0.4979
			max	0.5021
		LCR-adjusted MPH (-0.5,+0.5)	value	0.0753
		Statistical test	st.dev	0.0530
			z (using C-MPH)	1.4256
			1-tailed p	0.0770
			2-tailed p	0.1540

Table 3 *Results for the performance shown in Fig. 4.*

4.2. Implementing a new cancellation task (not downloaded with the Worksheet)

If one wishes to implement a cancellation task that was not provided with our Worksheet (i.e., whose image and INI files are not available in the downloaded ZIP file), one just needs a JPEG or GIF image of the cancellation display. If one only owns a paper version of the task, s/he has to scan it and save the scan in JPEG or GIF format. If one has an electronic image in some different format (e.g. TIFF or PDF, etc.), s/he has to convert it to JPEG or GIF. This can be easily done by a number of programs/facilities, for instance:

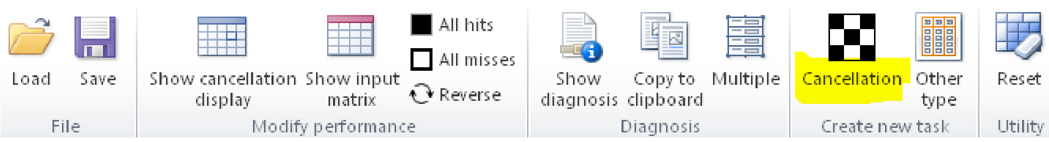
(i) ***Paint***, a very widespread basic application of Windows allows one to convert BMP, TIFF and PNG files into JPEG or GIF (through the *Save As* function).

(ii) ***Picture Manager*** (an application related to Microsoft Office) allows one to do the same (through the *Export* function).

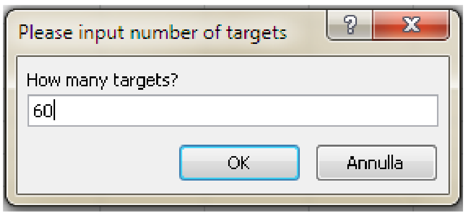
(iii) ***ImageJ***, a free software (https://imagej.nih.gov/ij/) allows one to do the same (through the *Save As* function) – you can also try ***FastStone Image Viewer 6.5*** (http://www.faststone.org/).

(iv) ***PDF-XChange Viewer*** (https://www.tracker-software.com/product/pdf-xchange-viewer) is a free software for converting PDF into JPEG. There are many other applications or online services accomplishing the same task, just run (e.g.) a 'PDF to JPEG' search.

When the JPEG/GIF file is ready and placed in the same folder as the Worksheet, click on the **Cancellation** button of the **Create new task** section of the Ribbon:



A window will then pop-out asking how many targets are present in the display. Type the number and click **OK**:



Another window will appear showing the content of the Worksheet's folder: you'll now have to select the image file, and click **Open**.

The Cancellation display will then be shown, with all target boxes lined up. Press **Advanced** in the top-left corner of the window, then click on the button **Edit boxes is: OFF**, which turns it into **Edit boxes is: –ON–**. The boxes are now moveable, and can be dragged and dropped over the centre of each target in the image, by using the mouse.

If you need to change the size and/or the colour of the boxes, perhaps to better tell them from the background, use the **Size of boxes** and **Color of boxes MISS** functions.

When all boxes nicely sit on the centre of each target, turn the **Edit-boxes is-** button to **OFF**, and click **Save** to store a new INI file, named after the task, which will contain the exact coordinates of the targets.
When a real performance will have to be entered, follow the steps detailed in the above Section 4. In short, **Load** the INI file, click on the boxes over the targets that were detected by the patient, and then **Save** the new performance in a new INI file with the name of the patient, and so on.

5. Tasks different from cancellation

The statistical method implemented in the Worksheet has been devised to diagnose neglect also in several other task types, as specified in Toraldo et al. (2017). Namely, all tasks producing data in the form of *XY* coordinates of a set of targets, with each target being given a 0 or 1 score (Miss or Hit) are legitimate candidates. Thus, no matter the modality of input, the modality of response, the type of task (detection memory, simultaneous or successive presentation of stimuli …) etc., the method is valid insofar the data format is the one specified above (however, see the following Section 6 for a list of task types for which this Worksheet should not be used, or used with caution).
In the following, we report an example of how the Worksheet can be used in one of the several possible cases of a no-cancellation task, that is, an auditory detection task.

5.1. An example with auditory detection

Suppose that an examiner/experimenter is wishing to evaluate auditory neglect, and asks a patient to detect sounds which are produced by 7 different loudspeakers that are arranged in a semicircle around him, from –90 to +90 deg, one speaker every 30 deg. Suppose that 5 sounds are delivered from each speaker, in random order, and with random Inter-Stimulus-Intervals (ISI) so that the patient cannot predict when the next sound will be delivered. When the patients hears a sound, s/he has to press a button. Fig. 5 shows the hypothetical performance by a patient with rather clear auditory neglect.

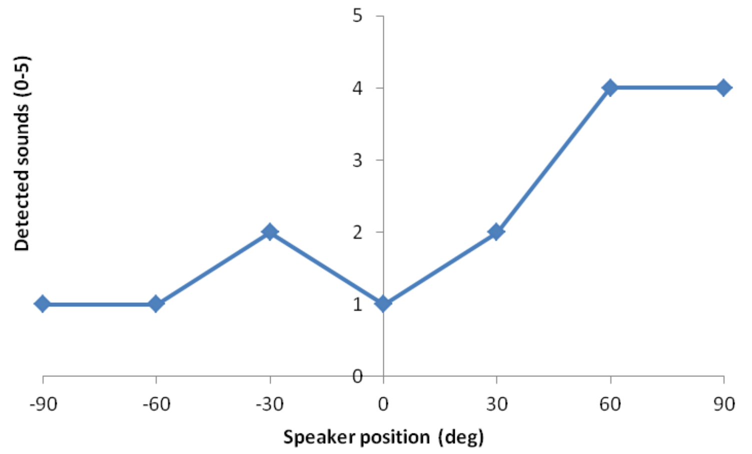


Fig. 5 *Detection of sounds coming from different positions*

While data from a cancellation task could be inserted by clicking on target positions, this time we do not have a graphic input. Rather, we have a list of trials, separate in time, each of which corresponds to a position of the stimulus – which speaker went on – and a response by the patient – detected/undetected. This corresponds to a table (likely provided by the software used for running the experiment) in which each row corresponds to a trial, and with three columns: the *X* coordinate (horizontal position of the speaker which went on), the *Y* coordinate (vertical position of the speaker – constant in this particular experiment), and *Hit/Miss*, or *1/0* score.
It is this table that needs to be used as input of the Worksheet. The Worksheet has what we shall call 'the ***Matrix***' where data of this type can be inserted.
Beware that, for the Worksheet to work properly, the *X* coordinates must increase left to right, and ***the Y coordinates must increase top to bottom*** (see Section 5.2 for explanation).

5.1.1. *How to insert data in the Matrix*

To visualize the Matrix, click on the **Show input matrix** command of the Ribbon (or, equivalently, on the **Create new task – Other type** command, if it is the first insertion of this type, or even by simply activating the ***INPUT*** sheet). The Matrix is the set of pink cells (see Table 4):

INPUT	Min 10, max 256 targets		
	Horizontal target position (increasing left to right)	Vertical target position (increasing top to bottom)	Hit=1; Miss=0
Target ID	*X*	*Y*	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			

Table 4 *The Matrix.*

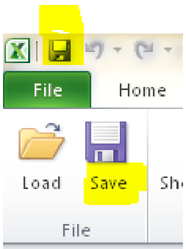
If the cells of the Matrix contain old data, just delete them, or (even better), press the **Reset** button in the Ribbon. After that, enter the input table in the *X*, *Y*, *Hit/Miss* pink columns (cells that are not pink are inaccessible). You can paste the data from another program of course.

When you insert/paste data, be sure to start from row 1, and to fill consecutive rows: in the example we had 35 targets (auditory trials), thus, rows 1-35 must be filled, and the remaining rows (36-256) must remain empty.[2] Importantly, each of the 35 rows must be filled in all three cells (*X*, *Y*, *Hit/Miss*), otherwise no output will be given. Just numbers are allowed in *X*, *Y* (beware of the decimal separator required by your Excel settings), and just 0 or 1 in *Hit/Miss*. Any mistake will be signalled in the reddish H6:H7 cells, e.g.:

General warnings
Entries in the Input Matrix must be numbers - or, check the Excel decimal separator

Insertion order is irrelevant: if one has seven targets, whose *X* coordinates are 1234567, inserting them in the Matrix in the 1234567, or 7654321, or 267315 will not matter. However, mind the overall number of targets: there must be at least 10 of them (our mathematical model was developed for target samples larger than 9) and the Worksheet allows up to 256 targets.

After having inserted all the data, saving them into a new INI file is a good idea. Just press the **Save** command of the Ribbon – beware not to confuse it with the main ***Save*** command of Excel, that is, the smaller disk-icon top-left from the former:



[2] If discontinuous data are inserted (with an empty first row or with empty rows interrupting the sequence here and there), data will be analysed correctly anyway: the output *MPH* and diagnosis will be valid. However, if one saves the performance in an INI file, this will be incomplete and will not work when re-loaded later. Hence, to have a compact table that starts from the first row is a good idea.

INPUT	Min 10, max 256 targets		
	Horizontal	Vertical	Hit=1; Miss=0
Target ID	*X*	*Y*	
1	-90.0000	0.0000	0
2	-90.0000	0.0000	0
3	0.0000	0.0000	1
4	0.0000	0.0000	0
5	-90.0000	0.0000	0
6	0.0000	0.0000	0
7	60.0000	0.0000	1
8	30.0000	0.0000	0
9	-30.0000	0.0000	0
10	90.0000	0.0000	0
11	60.0000	0.0000	1
12	60.0000	0.0000	1
13	-60.0000	0.0000	0
14	-60.0000	0.0000	1
15	-60.0000	0.0000	0
16	0.0000	0.0000	0
17	-90.0000	0.0000	0
18	30.0000	0.0000	0
19	30.0000	0.0000	0
20	-30.0000	0.0000	1
21	-30.0000	0.0000	0
22	-90.0000	0.0000	1
23	90.0000	0.0000	1
24	60.0000	0.0000	0
25	90.0000	0.0000	1
26	0.0000	0.0000	0
27	90.0000	0.0000	1
28	30.0000	0.0000	1
29	-30.0000	0.0000	1
30	-30.0000	0.0000	0
31	30.0000	0.0000	1
32	-60.0000	0.0000	0
33	90.0000	0.0000	1
34	60.0000	0.0000	1
35	-60.0000	0.0000	0

Table 5 *Worksheet input for the Auditory neglect data shown in Fig. 5.*

If one happens to inadvertently press the Excel's ***Save*** button, no problem: just press our Ribbon's **Save** button, save an INI file, then press the **Reset** command to bring the Worksheet to its original, empty state.

It is possible to save a copy of the Worksheet containing the data instead of an INI file if one wishes to. In this case the user has to click on the general ***File*** button of Excel, and then select ***Save as***. However this is in general not a good idea, as all the necessary info would anyway be contained in an INI file which is much smaller in terms of storage (an INI file is in the order of 2-3 Kb, while a Worksheet is about 500 times larger, about 1500 Kb).

Table 5 shows how the auditory detection data look like in the Matrix. In it, the trials have been inserted in time presentation order, albeit, as we explained above, this is not necessary: any order will do. As for the ***X*** coordinates, these are –90, –60, –30, 0, +30, +60, +90 degrees; however one can well use –3, –2, –1, 0, 1, 2, 3, or even 1, 2, 3, 4, 5, 6, 7 (or any other linear transformation): the Worksheet will standardize the scale anyway. Since stimuli did not vary along the vertical dimension, a list of zeros was inserted as *Y* coordinates (any constant value will be fine).

Results are visible in the compact format in the G9:H15 cells of the same INPUT sheet (see Table 6). Again, one needs to type either '*H*' or '*V*' in the pink cell in order to read diagnostic values relative to the horizontal or vertical dimension respectively.[3]

OUTPUT PREVIEW	
MPH in which dimension, Horizontal or Vertical? (H/V)	
H	
MPH=	0.1667
Z=	2.4873
1-tailed p=	0.0064
2-tailed p=	0.0129

Table 6 *Results for the performance in Fig. 5, shown in the 'Output Preview' compact format in cells G9:H15 of the INPUT sheet.*

General			Targets	35
			Hits	15
Neglect	**Metric solution**	**MPH in the metric (original) scale**	value	30.0000
			min	-90.0000
			max	90.0000
		C-adjusted MPH	value	0.1667
			min	-0.5000
			max	0.5000
		LCR-adjusted MPH (-0.5,+0.5)	value	0.1667
		Statistical test	st.dev	0.0670
			z (using C-MPH)	2.4873
			1-tailed p	0.0064
			2-tailed p	0.0129

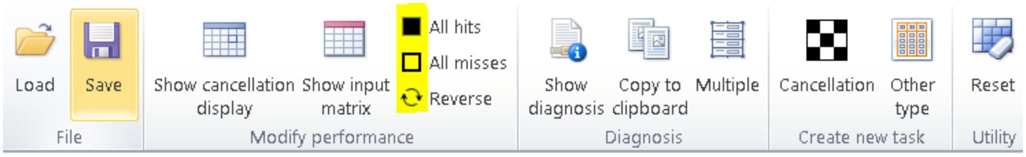
Table 7 *Results for the performance shown in Fig. 5.*

If one wishes to see a full report of the results, one has to click on the Ribbon's **Show diagnosis** button.

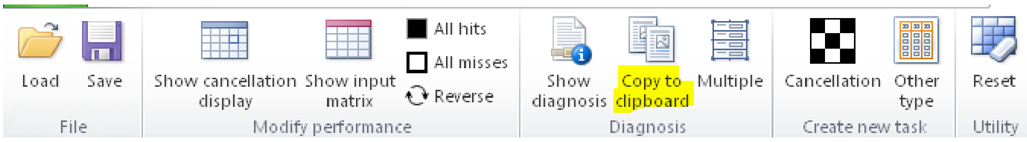
Table 7 shows the beginning of this list. *MPH* is at +30 deg, which is a significant rightward bias: C-*MPH* = +0.1667, *z*=+2.4873, one-tailed *p*=0.0064. A left auditory neglect has been diagnosed.

[3] The default value is '*Horizontal*', meaning that if a wrong entry (another letter, or number, etc.) is placed into the G11 cell, the Worksheet will assume the user is wishing to analyse the horizontal direction.

All hits, **All misses** and **Reverse** (Hits and Misses) operations are available also when working with the Matrix. The Ribbon contains the relevant commands:



If one wishes to export the diagnostic results, s/he has to press the **Copy to clipboard** command of the Ribbon:



The full list of results, in the form of a horizontal table, will then be available in the clipboard. This means that one can paste it, e.g. in another Excel file or in a Word file, etc.

If one inadvertently loses track of the Input Matrix, a button in the Ribbon is available to go back to it: **Show input matrix**.

5.2. A warning about vertical coordinates

Differently from what we required for the previous version of the Worksheet (1.0), in the new version (2.1) ***raw vertical (Y) coordinates inserted in the Matrix must increase top to bottom***, and not bottom to top. Thus if a target is above another, it must be given a *smaller*, and not a bigger, number. Albeit this might seem counterintuitive – in Cartesian plots, numbers increase the other way along the vertical axis – we were forced to require the top-to-bottom direction because this is the way most graphical programs analyse images with. Using the Cartesian bottom-to-top direction with raw data would have produced many technical difficulties, also regarding the analysis of old files (for instance, INI files produced by Rorden & Karnath's *Cancel* software all have top-to-bottom coordinates).

Thus, in order for the Worksheet to process data correctly in virtually all cases[4], raw vertical coordinates (*Y*) must increase top to bottom. However, in all diagnostic outputs, the sign of the vertical *MPH* is reversed back to Cartesian coordinates: thus, a *minus* sign means that the *MPH* is *below* the display's vertical centre, and a *plus* sign means it is *above* the display's vertical centre.

6. Tasks for which the Worksheet should not be used, or used with caution

As explained in Toraldo et al. (2017), there are a few neglect tasks for which the mathematical model implemented in the Worksheet does not apply. In a nutshell, if a Hit – the detection of a target – is possible even *without attention*, avoid using the Worksheet (no matter what version you have, 1.0 or 2.1). For example, in some psychophysical paradigms visual stimuli are delivered one at a time together with a 'prompt' signal (e.g. a 'beep' sound) and subjects have to say 'yes, I saw it' or 'no, I did not see it'. Subjects might well guess a 'yes' response after the beep even though they failed to allocate attention over a stimulus (i.e. without 'seeing' it). Such tasks typically have catch trials in which no stimulus is delivered; if some 'yes' responses are given on such catch trials (False Alarms, FA) the current version of the Worksheet (February 2019) does not analyze the data properly. The problem is that the *MPH* can be massively underestimated: if FA rate=.2, *MPH* is underestimated by 33.5%; if FA rate=.4, by 57.3%, and so on.[5] This in turn can cause an important reduction in diagnostic

[4] One exception is when one is using data that were loaded in the previous version of the worksheet, MPH Neglect Diagnosis 1.0 (which has been the only one available online from about January 2017 to about June 2018). If one saved Excel files containing the matrix-format data from that version, the *Y* coordinates should be increasing bottom-to-top, because that was the indication at the time. Hence, when importing data from an old Excel table used with MPHND 1.0 into the Matrix of the 2.1 version, remember to either reverse the sign of all the *Y* coordinates, or to reverse the sign of the (output) vertical *MPH*.

[5] If most of the patient responses are due to guessing behaviour of the kind that produces FAs, clearly the estimate of *MPH* is very instable/unreliable, and in the extreme case of guessing behaviour on each and every trial, it is impossible to obtain.

sensitivity. A general classification of tasks with respect to this problem is available in the ***Website Material*** file (http://psicologia.unipv.it/toraldo/mean-position-of-hits.htm); in short, the critical tasks are those in which a *single* target is delivered on each trial, response is *symbolic* (e.g. vocal response or button press), it is over *very few* categories (e.g., 2: yes/no), and is *prompted* on each trial. Albeit the combination of these four features makes the critical tasks relatively rare, future work will address the issue.
Interested readers are referred to Toraldo et al. (2017) and to the Website Material file for all the details and the assumptions of the mathematical model, which constrain its applicability to other families of tests.

7. Analysis of old data

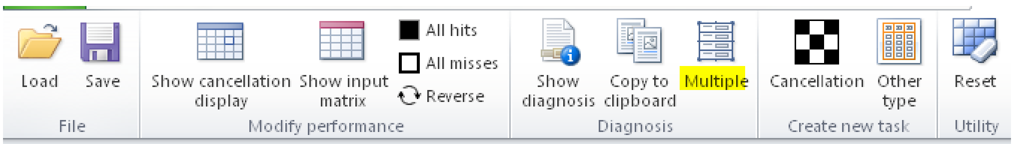
It is very often the case that one wishes to re-analyse a performance that is stored in an old INI file. The old INI file might have been produced either by the present Worksheet, or by Rorden and Karnath's ***Cancel*** software (http://www.mccauslandcenter.sc.edu/crnl/tools/cancel).
It is possible to upload and extract a diagnosis from a single INI file (Section 7.1), or from multiple INI files at the same time (Section 7.2). Section 7.3 reports further details on how to process INI files that were generated by Rorden and Karnath's Cancel.

7.1. Single old INI file

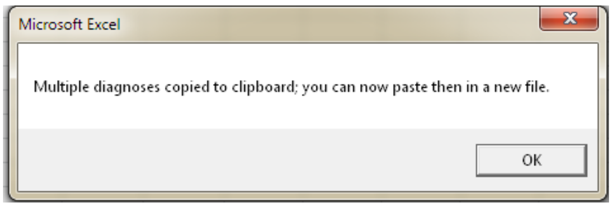
If one wishes to re-analyse a single performance, s/he just has to press the **Load** button of the Ribbon and select the relevant INI file – recall that the file needs to be in the same folder as the Worksheet. If the performance regards a cancellation task[6], and the image file is also in the same folder, the Worksheet will directly visualize the **Cancellation display**. From here on, all operations detailed in the previous Section 4 on Cancellation data can be applied. If the performance does not regard a cancellation task, all operations listed in Section 5 will be available. In both cases, a full diagnosis will be visualized by clicking on **Show diagnosis**, and this diagnosis will be exportable by clicking on either the **Copy to clipboard** button of the Ribbon, or the **Copy diagnosis** button in the Cancellation display. By later clicking on **Paste** in any other file/program, a table reporting the full list of results will be exported – this is a 76-column-long table (see Caption to Table 8). As always, if one wishes to export just a (very) compact version of the diagnosis, either for the vertical or for the horizontal spatial dimension, click on **Show input matrix** and copy the OUTPUT PREVIEW G9:H15 cells (see Tables 1 and 6 for examples).

7.2. Simultaneous analysis of multiple cases (INI files)

Suppose that the user owns a set of INI files, each of which contains a performance, and s/he wishes to extract the diagnoses from all those performances at once. As in Karnath and Rorden's Cancel, we also implemented a function allowing one to do so. As a first step, be sure all the INI files are located in the folder the Worksheet belongs to, and also, be sure you do not have unsaved data in the Matrix (if you do, save them in another INI file). Then, click on the **Multiple** button in the **Diagnosis** section of the Ribbon:



A window will open up showing the content of the folder – just select all the INI files you wish to analyse, and click **Open**. The analysis may take a while depending on the number of INI files that need to be processed. Wait till a window appears:



[6] I.e., the text of the INI file contains the name of a specific image file.

Just click **OK** and then **Paste** the table with all results from all INI files somewhere else (in a different Excel or a new Word file, etc.). Table 8 shows how the exported data will look like. Consider that the full set of results contains 76 columns, most of which are just technical or empty (e.g. absent warning messages).

#	If Graphical Input	*ini input file	Meaning of coordinates	General warnings		General statistics	
						Targets	Hits
1		A.ini	Metric			30	6
2		B.ini	Metric			30	2
3		C.ini	Metric			50	4
4		D.ini	Metric			20	9
5	Albert-Line.jpg	E.ini	Metric			41	12
6	Gauthier-Bell.gif	F.ini	Metric			35	26
7	Diller-V.jpg	G.ini	Metric			35	24

Table 8 *Example of output from the* ***Multiple*** *function. Data from 7 different *.ini files have been analysed simultaneously, and results are given in separate rows . Only the first few of an overall set of 76 columns are reported here.*

Results from each INI file are reported in a single row (see Table 8 for an example). The name of the origin-file is reported in the third column; if this was associated to an image (it was a cancellation task) the name of the image file is given in the second column. All other columns report the statistics and diagnostic outcomes in detail.

7.2.1. An optimal strategy for data insertion and analysis

Given the functionality of the Worksheet, one good strategy to optimize time when inserting data from multiple performances is the following. First, the user produces all the INI files, each one corresponding to one performance; then, the user runs the **Multiple** commands to obtain all diagnoses at once.

Suppose that the user needs to obtain neglect diagnoses for a set of patients who were all administered with the Albert cancellation task. The user can stack the paper sheets with the cancellation performances on the desk close to the keyboard, **Load** the 'Albert Line.ini' file, click on the targets detected by patient A in the Cancellation display, **Save** a file naming it 'A.ini', then *directly* click on the targets detected by patient B in the Cancellation display, **Save** a file naming it 'B.ini', and so on. The use of the **All hits** and **All misses** functions can be useful here. Suppose that patient A cancelled just a few targets while patient B just *omitted* a few targets. Before entering patient A's performance, the user can press **All misses**; in this way, clicking on the few targets detected by Patient A (thus turning them into Hits) will be fast. Before entering patient B's performance, the user will instead press **All hits**, so that clicking on the few *omitted* targets (thus turning them into Misses) will be fast. If the scene of the cancellation display is particularly cluttered (e.g. the Bell test) the transparency we provided with the test's PDF can be particularly useful in the process.
After having saved each patient's performance in a separate INI file, all those files can be entered in the **Multiple** procedure and generate a complete list of diagnoses.

The same logic, of course, can be applied when data originate from a task that is not cancellation. This time it is the Matrix that is used repeatedly to generate INI files. Suppose a researcher ran a memory recall tests on several patients; the user would thus have a master INI file with the coordinates of the targets to be recalled, which should be **Load**ed; the user would then organize (say) a stack of paper sheets (one per patient) with each one reporting the *Hit/Miss* (recalled – not recalled) responses by a patient, and enter the *1/0* scores in the Matrix's last column (also in this case the **All hits** – **All misses** functions might help speed up the process); of course if the responses by all the patients have already been encoded as *1/0* in some Word or Excel file, those data can directly be pasted into the Matrix's last column. After the responses from one patient have been inserted, an INI file will be saved and named after him/her, and so on, till a complete set of INI files has been obtained, to be entered in the **Multiple** procedure to obtain diagnoses.

In this case, item order is critical. If all paper (or electronic) tables report the to-be-recalled items in the same order, just the last column of the Matrix (*Hit/Miss*) will be changed every time data from a new patient is to be inserted. However, if different tables/reports from different patients show items in *different* orders, also *X* and *Y*, the coordinates of each target, need to be updated each time in the Matrix.
The same issue would arise in a test in which targets were randomized differently in each administration. Suppose that in an auditory detection task like that described in Section 5.1, every patient is given the stimuli in a different, randomized order: the user must ascertain that all the tables (each of which contains the *Hit/Miss* data from one patient) have the same item order before entering them in the Matrix. If such order-standardized tables are not available, the user must insert *X*, *Y*, and *Hit/Miss* from each new patient in the Matrix, and not just the *Hit/Miss* score.

7.3. *How to analyse INI files produced by Rorden and Karnath's Cancel software*

Users might possess INI files that have been generated by Rorden and Karnath's ***Cancel*** software. 'Cancel' provides a punctual estimate of the degree of neglect (on cancellation), which is named *CoC* (Centre of Cancellation) and corresponds to our C-*MPH*; however Cancel does not implement a statistical model for diagnosis, hence one might need to run our Worksheet on data saved by Cancel to classify a patient's performances as pathological/normal. This can be done by simply **Load**ing the INI files generated by Cancel in our Worksheet. One exception is with the Cancel INI files generated with cancellation tasks of the 'Ota' series (these are tests which simultaneously assess viewer-centred and object-centred neglect): the format of these files is different from the standard one so our Worksheet does not analyse them (yet). Another possible issue is with the visualization of the Cancellation Display, because our Worksheet only welcomes JPG or GIF images (while Cancel allows one to upload different formats, like PNG). There are different options in this case.

(i) Ignore the visualization. While **Load**ing the INI, the user gets a warning message stating that something is the matter with the image file ('Image file not available'). The user can just ignore the message, skip the **Debug** option if it pops up, and s/he will have the raw data uploaded in the Matrix anyway. Thus, s/he will be able to process the performance as explained in Section 5, obtaining a diagnosis, and so on.

(ii) Insist on the visualization. First, convert the image file into either a GIF or a JPG format (note that some of the image files that Rorden and Karnath provided in their website have already been converted by us and provided with the ZIP file you downloaded to install the Worksheet). Second, open the INI file in Windows, by double-clicking on its icon, in a way that some text reader will visualize its content. The first lines of the INI file should read like: '[STR] ImageName=***.' Just insert the name of the new, converted image file replacing the *** – for instance, if you called the converted image file 'test.jpg', just write '[STR] ImageName=test.jpg.' Save the INI file, close it, go back to the Worksheet and **Load** the new INI file. The image should now be correctly visualized. If some boxes are not nicely centred on the underlying targets, adjust their positions (see Section 4.2) and **Save** a new 'master' INI file to be used in the future.

Clearly, if the user's aim is to analyse a set of INI files at once, visualization is not an issue and the **Multiple** procedure detailed in Section 7.2 can be applied.

8. Other general functions and warnings

8.1. INPUT sheet

All the cells of the Worksheet are password-protected to avoid corruption in the formulae. Users are only allowed to change the input cells, which are conventionally coloured in pink:

It is necessary to insert both *X* and *Y* coordinates for all targets, even though the user is only interested in one of the two dimensions. For instance, if one is only interested in horizontal (left-right) neglect and not in altitudinal (top-bottom) neglect, s/he might fill the Y values with zeros or any other constant value.

Remember that *Y* coordinates must increase *top to bottom*: bigger numbers mean lower targets.

The *Hit/Miss* column needs to be filled with 1 if a target was detected, and 0 if it was not detected. No other values are accepted.

If the *X* and *Y* coordinates are not in metric units, but just express the left-to-right and bottom-to-top *ordinal* positions of targets in physical space, just write the letter '*O*' in the A3 pink cell. Otherwise, leave the default '*M*' letter (for *metric*).

M	If coordinates X,Y just have ORDINAL meaning (i.e. only reflecting spatial order, no metrics), write letter "O" in the A3 cell
	If coordinates X,Y have METRIC meaning (cm, mm, degrees, or other distance units), write letter "M" in the A3 cell

Clearly, data can be pasted in our pink columns C-D-E from matrices in other Worksheets or programs. **Paste as values** can be a good idea. Be careful not to overcome the 256 limit for target number; always start from row 1, and be sure there are no empty rows in the sequence of inserted data: if you have 132 targets, you must fill in rows 1-132.

8.1.1. Warning messages regarding Input

Any error or problem with data insertion is signalled in the G6:G7 reddish cells, to the right of the input cells (see Table 9).

INPUT	**Min 10, max 256 targets**				**General warnings**
Target ID	*X*	*Y*			Outlier(s) in XY coordinates, check for coordinate typing error(s) or target positioning error(s)
1	1.0000	0.0000	0		
2	2.0000	0.0000	0		
3	3.0000	0.0000	1		
4	4.0000	0.0000	0		
5	55.0000	0.0000	0		
6	6.0000	0.0000	0		

Table 9 *Example of likely typo in row 5*

Warnings can be of various types. Most of them invalidate analysis, thus correction is mandatory. Some others warn the user that something might be the matter with the coordinates, perhaps some of them were simply mistyped – in these cases correction is not mandatory and results will be given anyway. Table 9 shows the example in which the inserted coordinates are (1, 2, 3, 4, 55, 6): the system detects 55 as an outlier (a likely typo) so the user is prompted to scan the raw data in search for mistakes.
One of the warning messages signals a possible problem with decimal separators. For instance the user might have inserted coordinates with commas (e.g. 3,74) while Excel wants points (3.74) or vice versa. In these cases, the user should either replace all decimal separators, or change the default decimal separator in the Excel Settings.

8.2. 'Single test result (column)' sheet

This is the sheet that is shown if one clicks on the **Show Diagnosis** button. In it, different cell colours have different meanings. The reddish cells contain warnings, the green/grey cells numerical values. Grey cells contain the upper and lower limits of a just-mentioned parameter.
If the user wishes to export results, s/he can copy the cells, and past them in another Excel or Word file. Remember that there is a Ribbon function, **Copy to clipboard**, or, equivalently from the **Cancellation Display**, **Copy diagnosis**, which directly copies the whole set of results for you – however, it does so in 'row' format, i.e. results all placed in a row.

The '***Single test result (column)***' sheet can only be accessed via the **Show diagnosis** buttons. The reason is that results in this sheet are not automatically updated, so, if a user changes something in the input data (a coordinate, or a *Hit/Miss* score), un-updated results in the sheet would be misleading. The **Show diagnosis** button performs the updating, and makes results consistent with the input data.

Some users might notice that there is another sheet, ***OUTPUT***, which reports some results in the same form and colours as ***Single test result (column)***. OUTPUT is more of a technical sheet, and is normally not to be looked at. Indeed, it reports results from one only dimension at a time – the one that is selected in the INPUT cell G11 (write '*H*'/'*V*' there if you wish to see result for the horizontal/vertical dimension). OUTPUT is always accessible because it reports results that are automatically updated. If you wish to export results from here to another Excel file, just use the ordinary **Copy** and **Paste** Excel functions. The user can choose whether to copy results in a column (cells F2:F38) or in a row (cells H67:AR67). If you wish to paste results in another Excel file, use the Excel function **Paste values**, otherwise scores will not be visible. Anyway, consider that exporting results is much easier via the Cancellation Display's **Copy Diagnosis** and the Ribbon's **Copy to clipboard** functions.

9. Technical details

Most users will be satisfied with the Instructions listed so far, which concern the diagnosis and measurement of neglect. These indeed will suffice in virtually all ordinary cases, that is, when classical tests of neglect have been used, or when new tests have been employed in which stimuli (targets) have been carefully balanced in frequency and spacing across the studied space. The present Section is more technical and needs to be read only in rare cases, for instance when the distribution of targets is markedly asymmetrical.

9.1. Clustering index

The Worksheet also provides an ***index of clustering*** which informs the user about the organization of the target distribution. The *clustering index* goes from 0, meaning that each target occupies a separate position, to 1, meaning that targets cluster in two only positions. This index is used in the estimation of the *MPH*'s standard deviation, which varies as a function of the degree of clustering. The following values are taken from the Auditory Neglect example above (Fig. 5). In it, 35 targets were presented in 7 positions: the Worksheet detected the 7 'clusters', and computed a 0.2424 *clustering index.*

Clustering indices	N of clusters	7
	Clustering index	0.2424

9.2. Target distribution analysis

A set of cells report diagnostics of problems with the distribution of targets. If targets are not homogeneously distributed across the studied space, there might be issues with results interpretation: in these cases some of the reddish cells will 'turn on' showing some warning message.

Indices of homogeneity of target distribution	Spacing homogeneity	r' index	0.6479
		Warning	POSITIONS ARE NOT EQUISPACED - BETTER LOOK AT ORDINAL SOLUTION
	Ties' homogeneity	r' index	1.0000
		Warning	
	Overall	r' index	0.6479
		Warning	TARGETS ARE NOT HOMOGENEOUSLY DISTRIBUTED
	MPT (-0.5, +0.5)	value	-0.2759
		Warning	TARGETS ARE UNBALANCED TOWARDS ONE END OF THE DISPLAY

Table 10 *Output warning messages given when* ***X*** *coordinates = (1,2,3,4,5,6,7,8,9,30).*

The first index (***Spacing homogeneity***) informs the user about how far the distribution of target positions is from a perfect sequence of equispaced locations along the studied dimension. If the distribution is perfectly equispaced, the *r′* index is 1; values <0.95 are flagged by a warning (the *r′* index is, in essence, the correlation between the ordinal and the metric positions of targets – positions with more than one target are counted only once).

The second index (***Ties' homogeneity***) informs the user about the distribution of ties. By ***ties*** we mean multiple targets that share the same position along the studied dimension (e.g. targets that are vertically aligned in a cancellation task when one is studying the horizontal dimension; or, targets that occupy the same position in separate trials of a one-target-per-trial experiment). A *r′* index of 1 means that ties are distributed in a perfectly balanced way across positions (e.g., 3 ties per position, in all positions). Values <0.95 are flagged as indicating a rather heterogeneous distribution of ties across positions.

The third index (***Overall homogeneity***) is a combination of the previous two. It reflects, more straightforwardly, the homogeneity of the distribution of targets across the display. A *r′* value of 1 indicates perfect homogeneity, lower values indicate imperfect homogeneity. *r′* values <0.975 are flagged.

The last index, *MPT*, is the ***Mean Position of Targets*** across the display. A perfectly symmetrical set of stimuli will have the *MPT* exactly halfway between the extreme target positions (–0.5 and +0.5), that is, at 0. If targets are asymmetrically distributed (unbalanced towards one end), *MPT* will move away from 0: absolute deviations of more than 0.05 (in the –0.5 to 0.5 scale) are flagged, as they might rise concerns on the validity of *MPH* – if this is the case, the user is warned that solutions are unreliable, or that s/he should rely on *MOH*, the 'ordinal' version of *MPH*, which is discussed below.[7]

The interested user can have a grasp of the targets' distribution by looking at the plots, ***Equispacing plots 1*** and ***2***, and ***Ties distribution plot*** (Figs. 6, 7, and 8).

9.3. The 'ordinal' solutions

MOH (***Mean Ordinal position of Hits***) is the 'non-parametric' version of *MPH* and is informative when there are serious concerns with target position spacing (see above). While *MPH* tells you where the Hits produced by the patient are located with respect to the studied physical interval, *MOH* tells you where they lie in the abstract space of target order [(1, 2, 3, …, *T*), where *T* is the overall number of targets]. The scale is again normalized to (–0.5, 0.5). This *MOH* index is insensitive to violation of the target equispacing assumption (*MPP* index) – however it is sensitive to violations of the ***Ties homogeneity*** assumption.

Table 11 shows the example in which targets are definitely not equispaced [$\boldsymbol{X}$ = (1, 2, 3, 4, 5, 6, 7, 8, 9, 30)]. Hits are the last three targets $\boldsymbol{X}_h$ = (8, 9, 30). The ***Metric solution*** reports the *MPH* values, which are very distorted and cannot be interpreted (note the warning messages 'Look at ordinal solution'). The only statistically interpretable values are the *MOH*, which are reported in the sector ***Ordinal solution***. The difference between *MPH* and *MOH* can easily be spotted in the example. While *MPH* is 15.6667 in the physical scale going from 1 (the leftmost target) to 30 (the rightmost target), *MOH* is 9 in the scale going from ordinal position 1 (the leftmost target) to ordinal position 10 (the rightmost, tenth target). The standardized C-*MOH* equals +0.3889, which is evidence of a strong rightward bias (the standardized scale goes from –0.5 to +0.5 as usual) that is diagnostic of left neglect (z=2.459, one-tailed p=0.007).

[7]In turn, *MPT* is a combination of two components, *MPP* and *TIES*. When *MPP* (the ***Mean Position of Positions*** – scale –0.5 to +0.5) is non-zero, this indicates that positions containing targets are not equispaced along the studied spatial dimension, but rather, are denser in one half of the display; a *TIES* index far from zero (again the scale is –0.5 to 0.5) indicates that the target counts across positions are unbalanced towards one end.

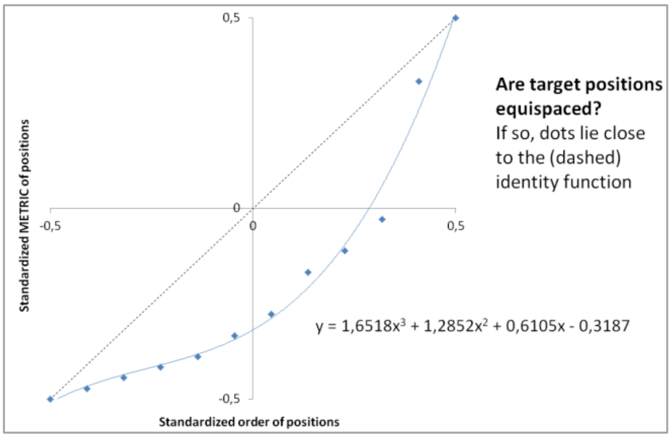


Fig. 6 ***Equispacing plot 1*** *answers the question of whether target position are equispaced. In this example, they clearly are not – dots lie well away from the dashed identity function. The spacing markedly increasing when moving from left to right.*

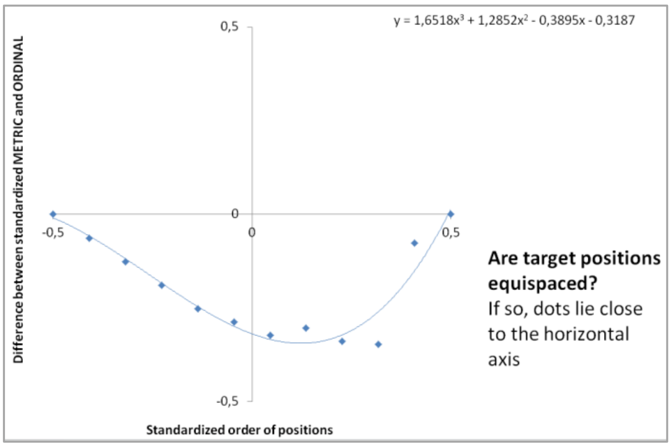


Fig. 7 ***Equispacing plot 2*** *answers the same question as 'Equispacing plot 1' (Fig. 6) – this time perfect equispacing corresponds to the horizontal axis and not to the identity function.*

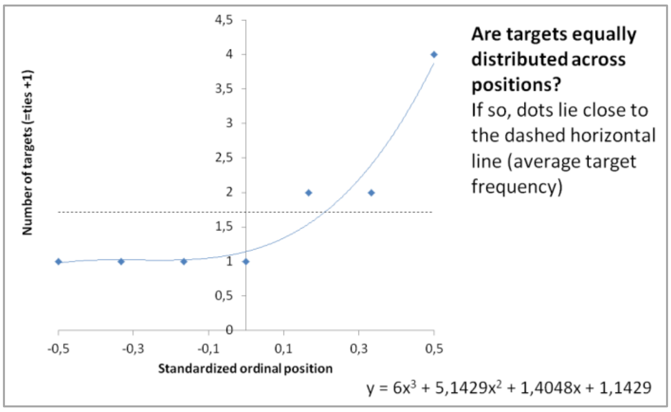


Fig. 8 ***Ties distribution plot*** *shows whether target frequency is homogeneous in different positions. In this example, while the four leftmost positions all have just one target each, the three rightmost positions are over-represented with 2, 2 or 4 targets each. Perfect homogeneity is represented by the horizontal dashed line.*

Neglect diagnosis	**Metric solution**	**MPH in the metric (original) scale**	value	15.6667
			min	1.0000
			max	30.0000
		C-adjusted MPH	value	0.2816
			min	-0.2241
			max	0.7759
		LCR-adjusted MPH (-0.5,+0.5)	value	0.1815
		Statistical test	st.dev	Look at ordinal
			z (using C-MPH)	Look at ordinal
			1-tailed p	Look at ordinal
			2-tailed p	Look at ordinal
	Ordinal solution	**MOH in the ordinal scale**	value	9.0000
			min	1.0000
			max	10.0000
		C-adjusted MOH	value	0.3889
			min	-0.5000
			max	0.5000
		LCR-adjusted MOH (-0.5,+0.5)	value	0.3889
		Statistical test	st.dev	0.1582
			z (using C-MOH)	2.4589
			1-tailed p	0.0070
			2-tailed p	0.0139

Table 11 *Output when* ***X*** *coordinates = (1,2,3,4,5,6,7,8,9,30) and Hits are in the last three positions.*

Please note that the effects of violations of target distribution homogeneity on the diagnosis error rates are currently (February 2019) under investigation. So, the limits we currently use for flagging target distributions as 'anomalous' (and which hide some diagnostic results in the doubt of unreliability) are intuitive, and probably on the prudent side. For the time being the 2.1 Worksheet implements the following limits: correlation coefficients *r'* must be higher than 0.95, with the exception of *r'* (Overall Homogeneity) which must be higher than 0.975; $|MPT|<0.05$; *MPT*'s subcomponents, *MPP* and *TIES* need to be lower than 0.1 in absolute value (see the Website Material file for details).

9.3.1. When coordinates are intrinsically ordinal

There are cases in which the coordinates are not in metric units (cm, mm, pixels…) but just express the spatial order in which stimuli were presented. For instance, suppose that stimuli were presented in three sectors of space, Left, Centre, and Right, and that the exact position within each sector was lost, or was never recorded. In this case one can insert each target's broad coordinate: Left=1, Centre=2, and Right=3. Clearly these numbers only have an ordinal meaning and do not contain any information whatsoever as to the exact metric positions.
If this is the case, the user must write the letter '*O*' in the A3 pink cell of the INPUT sheet.[8] This will take into account the ordinal-only nature of the coordinates in all computations, and give consistent results. Clearly, the 'metric solution' involving *MPH* will not be available, and only the 'non-parametric', 'ordinal solution' involving *MOH* will be made available. Follow the warnings also in this case: if the Ties homogeneity condition is violated – the only condition that is relevant for the validity of *MOH* – statistical results will be obscured.

Ordinal coordinates are usually inserted in natural formats, like 1, 2, 3 …, or …–3, −2, −1, 0, 1, 2, 3…, which lead to proper computations by the Worksheet. However, cases might in principle exist in which the user inserts numbers that are very close to each other with respect to the overall number range – we must warn such users that because of the way the Worksheet's inner gears work, numerical differences between positions must be larger than 1/10,000 of the full range of numbers in order for those positions to be considered as separate. For instance, if the minimum *X* coordinate number is 10 and the maximum is 40, the ***X*** range is (40−10)=30, and two positions will be considered as distinct if they differ by more than 30/10,000 = 0.003.

9.4. Avoid working on the Cancellation Display and on the Matrix at the same time

Never work in parallel on the ***Cancellation Display*** and on the ***Matrix*** – work on either the former or the latter. The program has not been designed for working on both at the same time, so we are not sure what the consequences might be.

10. References

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[8] Any other value will give the coordinates a metric meaning, by default.