

MPH NEGLECT DIAGNOSIS 1.0 WORKSHEET INSTRUCTIONS (as of August, the 9th, 2017)

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

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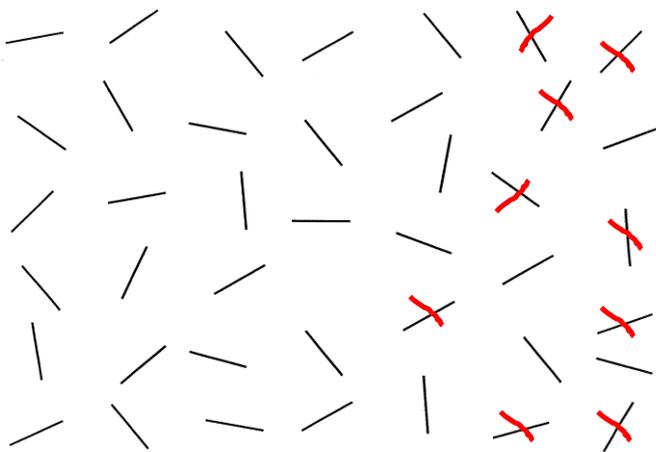
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To explain how the Worksheet (version 1.0) works, we will use some practical examples. Performances by patients on target cancellation tasks and on an auditory detection task will be shown and analysed by means of the software and results will be explained and discussed.

EXAMPLE 1: ALBERT CANCELLATION

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



The operations one needs to perform are (i) to find the XY coordinates of all targets; (ii) to identify omitted and hit targets; (iii) to insert the data (coordinates and hit/miss scores) in the Worksheet.

Results will then be automatically available from the Worksheet.

The different (i-iii) operations will be treated below under separate headings.

Consider that we plan to upload a number of Excel files which already contain the coordinates of targets for a number of popular cancellation tests, so step (i) will be skipped if those tests are being used.

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

Finding the coordinates of targets

This operation must be carried out just once because, of course, the positions of targets do not change from patient to patient.

Retrieval of coordinates can be done manually, by setting an arbitrary reference point (0,0), the axes' origin, and measuring the positions of the targets' centres along both dimensions with a ruler. However a simpler way to accomplish this task is to use one of the many applications that show the coordinates of objects (like the mouse pointer) on screen. For instance if one owns Microsoft Office, Publisher (one of the applications along with Word, Excel etc.) is an option. One has to scan the test display, open the image file in Publisher, and just move the mouse pointer over the different targets: the coordinates of the pointer will appear on the bottom-left corner of the window. A free application that allows one to carry out the same operation is ImageJ, <https://imagej.nih.gov/ij/>; just upload the image, click on 'Analyze', then 'Measure', and the coordinates of the mouse pointer in pixels will appear on the ImageJ toolbar. Any of these applications will do the trick – indeed the units of measurement (pixels, cm, mm, inches etc.) are entirely irrelevant to our Worksheet, as is the position of the (0,0) reference point (Fig. 2). The only relevant detail is that the Worksheet requires ordinary Cartesian coordinates: numbers must increase left to right over the horizontal X axis and bottom to top along the vertical Y axis. By contrast in most of the applications we are aware of (e.g. Publisher, ImageJ, etc.) the vertical dimension is reversed, thus values increase top to bottom. Thus if one of those programs are used,

beware of reversing the Y coordinates (e.g. by adding a minus sign in front of them) before entering the data in the Worksheet.¹

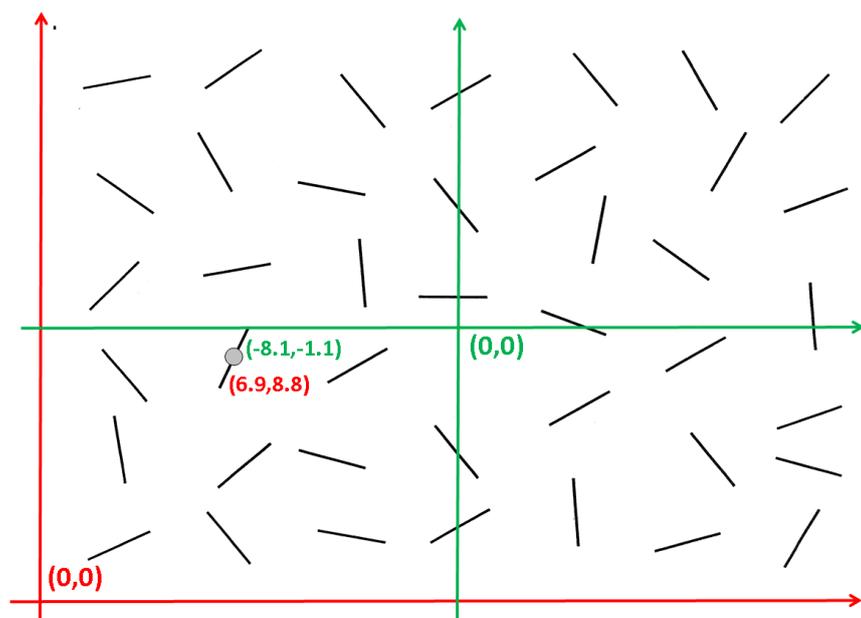
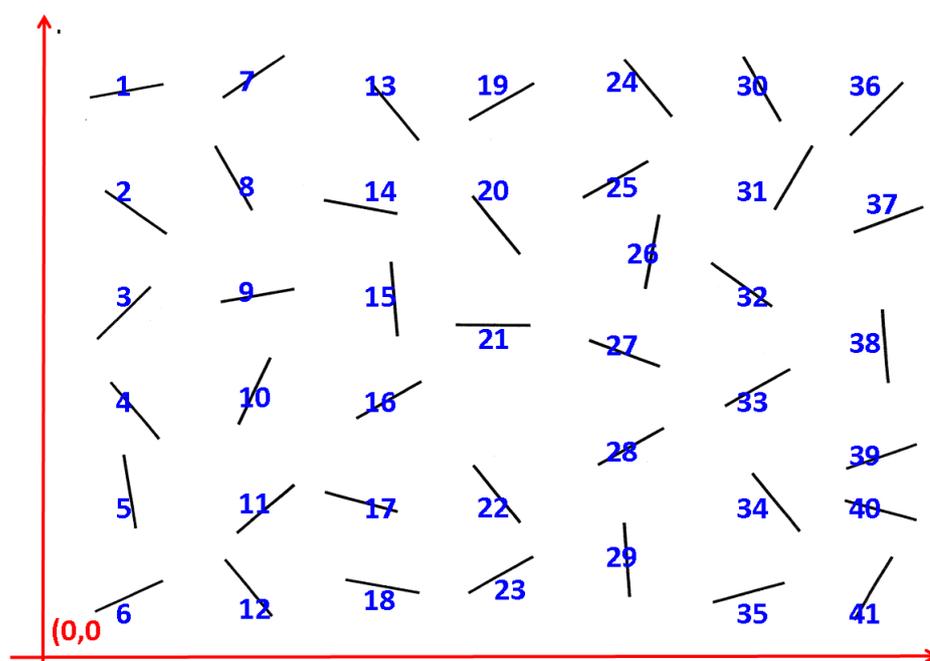


Fig. 2 The XY coordinates (cm on an A4 sheet) of the centre of one target (grey circle) are shown with respect to two reference frames, the red one whose origin is in the bottom-left corner and the green one whose origin is at display centre. The position of the origin is irrelevant, as the unit of measurement (the Worksheet will give identical results). The only relevant feature is that X numbers must increase rightwards, and Y numbers must increase upwards.

Once the process of coordinates-finding is concluded, the list of coordinates of all targets, each identified by an ID number, can be saved in a table (e.g. an Excel file), ready to be used for diagnosing neglect in patients. Fig. 3 reports the ID for all targets and the list of coordinates for our Albert example.



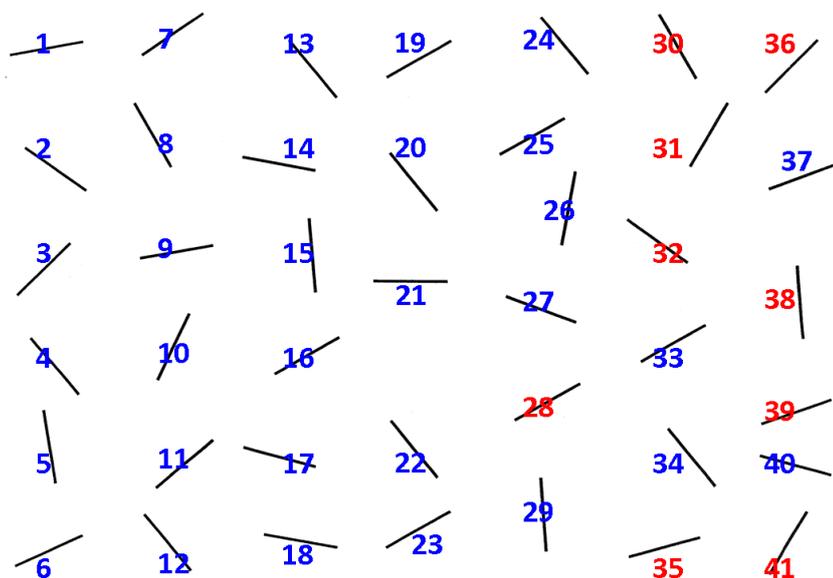
ID	X	Y
1	2.55	18.81
2	3	14.74
3	2.5	11.51
4	2.9	8.28
5	2.76	5.55
6	2.76	2.09
7	6.79	19.29
8	6.12	15.95
9	7.05	12.06
10	6.84	8.89
11	7.24	5.03
12	6.65	2.41
13	11.39	18.18
14	10.3	14.97
15	11.39	11.93
16	11.26	8.6
17	10.38	5.24
18	11.07	2.43
19	14.99	18.49
20	14.72	14.39
21	14.72	11.14
22	14.83	5.45
23	14.93	2.83
24	19.8	18.94
25	18.8	15.95
26	19.91	13.41
27	19.06	10.24
28	19.25	7.09
29	19.09	7.23
30	23.51	18.89
31	24.65	15.87
32	22.9	12.27
33	23.43	8.85
34	24.1	5.07
35	23.23	2.1
36	27.23	18.15
37	27.73	14.45
38	27.55	10.27
39	27.48	6.65
40	27.45	4.85
41	27.27	2.22

Fig. 3 ID for targets are shown in blue; coordinates (cm on an A4 sheet) with respect to the reference (0,0) point (red) are reported in the Table.

Identifying omissions and hits

¹ Else, insert them the way they are, but reverse the interpretation of the Worksheet Output: a negative MPH for the vertical dimension will then mean an upward, and not a downward, bias of exploration.

We can now proceed and analyse the performance of a specific patient – namely the one shown in Fig. 1. One has to simply add a column to the table and mark a ‘1’ if the target was hit, and a ‘0’ if it was missed. Fig. 4 shows the resulting Hit/Miss column. Hits are highlighted in red, both in the table and in the display. In practice, this is an easy visual task if the targets are well-visible as in the Albert test. If displays are much more crowded, like in cancellation tasks with distractors (e.g. the Letter, Star, or Bell cancellation tasks), finding the ID of a target might be more challenging (e.g. look at Fig. 6). One suggestion is to print out the display on a transparency and write the ID of each target close to it with a coloured crayon. The transparency will look like the display in Fig. 3. The transparency can then be overlapped to the sheet used by the patient, and identification of the cancelled targets will be much easier.



ID	X	Y	Hit/Miss
1	2.55	18.81	0
2	3	14.74	0
3	2.5	11.51	0
4	2.9	8.28	0
5	2.76	5.55	0
6	2.76	2.09	0
7	6.79	19.29	0
8	6.12	15.95	0
9	7.05	12.06	0
10	6.84	8.89	0
11	7.24	5.03	0
12	6.65	2.41	0
13	11.39	18.18	0
14	10.3	14.97	0
15	11.39	11.93	0
16	11.26	8.6	0
17	10.38	5.24	0
18	11.07	2.43	0
19	14.99	18.49	0
20	14.72	14.39	0
21	14.72	11.14	0
22	14.83	5.45	0
23	14.93	2.83	0
24	19.8	18.94	0
25	18.8	15.95	0
26	19.91	13.41	0
27	19.06	10.24	0
28	19.25	7.09	1
29	19.09	7.23	0
30	23.51	18.89	1
31	24.65	15.87	1
32	22.9	12.27	1
33	23.43	8.85	0
34	24.1	5.07	0
35	23.23	2.1	1
36	27.23	18.15	1
37	27.73	14.45	0
38	27.55	10.27	1
39	27.48	6.65	1
40	27.45	4.85	0
41	27.27	2.22	1

Fig. 4 The IDs of targets that were found by the patient (Fig. 1) are depicted in red. In the Table, a ‘1’ is reported for Hits, a ‘0’ for Misses, in the Hit/Miss column.

We are now ready to insert the raw data in the Worksheet. The raw data are nothing else than the last three columns of the table we just built, with X coordinates, Y coordinates, and Hit/Miss scores (right side of Fig. 4).

Input to the Worksheet

After having opened the Excel file (you’ll need Microsoft Excel 2010 or more recent), select the ‘INPUT’ sheet. You will see an empty table with four columns: ID, X coordinate, Y coordinate and Hit/Miss. You need to paste the X, Y, Hit/Miss values you just prepared into the pink cells of the last three columns (cells that are not pink are inaccessible).

INPUT	Min 10, max 256 targets		
	Horizontal target position (increasing left to right)	Vertical target position (increasing <u>bottom to top</u>)	Hit=1; Miss=0
Target ID	X	Y	
1	2.5500	18.8100	0
2	3.0000	14.7400	0
3	2.5000	11.5100	0
4	2.9000	8.2800	0
5	2.7600	5.5500	0
6	2.7600	2.0900	0
7	6.7900	19.2900	0
8	6.1200	15.9500	0
9	7.0500	12.0600	0

10	6.8400	8.8900	0
11	7.2400	5.0300	0
12	6.6500	2.4100	0
13	11.3900	18.1800	0
14	10.3000	14.9700	0
15	11.3900	11.9300	0
16	11.2600	8.6000	0
17	10.3800	5.2400	0
18	11.0700	2.4300	0
19	14.9900	18.4900	0
20	14.7200	14.3900	0
21	14.7200	11.1400	0
22	14.8300	5.4500	0
23	14.9300	2.8300	0
24	19.8000	18.9400	0
25	18.8000	15.9500	0
26	19.9100	13.4100	0
27	19.0600	10.2400	0
28	19.2500	7.0900	1
29	19.0900	7.2300	0
30	23.5100	18.8900	1
31	24.6500	15.8700	1
32	22.9000	12.2700	1
33	23.4300	8.8500	0
34	24.1000	5.0700	0
35	23.2300	2.1000	1
36	27.2300	18.1500	1
37	27.7300	14.4500	0
38	27.5500	10.2700	1
39	27.4800	6.6500	1
40	27.4500	4.8500	0
41	27.2700	2.2200	1
42			
43			

Table 1 Data of performance in Fig. 1 inserted in the Worksheet

Table 1 shows how the insertion of the data we prepared will look like in the Worksheet. Importantly, all cells relative to the targets need to be filled (in the example, the first 41 rows, ID 1-41) and all *other* cells need to remain empty (in Table 1 you can see empty rows 42 and 43). Note that inserting data starting from the first row of the Excel matrix (ID=1) is comfortable, but not necessary. If one inserts data in the 11-51 instead of 1-41 rows, or in any other set of 41 rows (even non-consecutive) results will be identical. Insertion order is also completely irrelevant: if one has seven targets, whose X coordinates are 1234567, inserting them in the matrix in the 1234567, or 7654321, or 267315 order does not matter. However, mind the 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.

We are now ready to look at the diagnostic outcome.

Output reading

Results are visualized in the 'OUTPUT' sheet.

When accessing this sheet, the user has to choose whether s/he wishes to visualize results for the horizontal or for the vertical dimension of physical space. This choice is made by writing 'h' or 'v' in the OUTPUT sheet's B1 cell, and pressing 'ENTER' (or any arrow key) to go out of the cell. Suppose we are interested in the horizontal component of neglect in Fig. 1, so we type 'H':

Show results for the HORIZONTAL (H) or for the VERTICAL (V) dimension? H

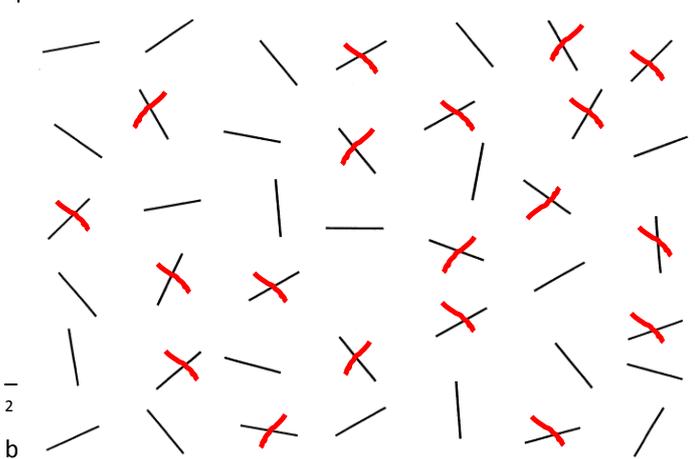
Results will be visible by scrolling down in the sheet. Descriptions or names of the various outputs are given in white cells, and results are reported in coloured cells (F2:F40). The reddish ones contain warnings, the green/grey cells numerical values.

General statistics		Targets	41		
		Hits	9		
Neglect diagnosis	Metric	MPH in the metric (original)	value	24.7856	
			min	2.5000	
			max	27.7300	
		C-adjusted MPH	value	0.3834	
			min	-0.4999	
			max	0.5001	
		LCR-adjusted MPH (-0.5,+0.5)	value	0.3833	
			Statistical test	st.dev	0.0926
				z (using C-MPH)	4.1401
				1-tailed p	0.0000
		2-tailed p	0.0000		

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

The output of the Worksheet (shown in Table 2) gives us overall counts of targets (41) and Hits (9). The important values concern the Mean Position of Hits, *MPH*, in the 'Metric solution' sector. *MPH* is first given in the original scale – since we measured the coordinates in cm from the (0,0) point located in the bottom-left corner of the A4 Albert display (Fig. 2), *MPH*=24.7856 means that the Hits lie, on the average, 24.7856 cm from the left border of the (29.7-cm) page. This absolute value of course is little informative. 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 +0.3833. 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 = 0.0926) provides a classical z-score, +4.1401. 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 $z=+4.1401$ 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 ($p < .001$).

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.



We will now explore a much less straightforward diagnostic case (Fig. 5). We just need to replace the Hit/Miss (1/0) values in the last column of the INPUT sheet with the new ones obtained from this different performance.

Table 3 shows the results given by the Worksheet: this time $z=1.4136$, one-tailed $p=0.0787$. This is insufficient evidence for a rightward bias.² By contrast, other criteria that are often applied to the Albert test would have diagnosed a left

expected direction of the deficit (generally, one expects a rightward leftward bias – a negative score – after left hemisphere damage).

Fig. 5 Performance by another neglect patient on the Albert's (1973) Line Cancellation task.

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 +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 paper and in the ‘Website Material’.

General statistics		Targets	41	
		Hits	19	
Neglect diagnosis	Metric	MPH in the metric (original)	value	17.0121
			min	2.5000
			max	27.7300
		C-adjusted MPH	value	0.0753
			min	-0.4999
			max	0.5001
		LCR-adjusted MPH (-0.5,+0.5)	value	0.0753
		Statistical test	st.dev	0.0533
			z (using C-MPH)	1.4136
			1-tailed p	0.0787
2-tailed p	0.1575			

EXAMPLE 2: LETTER CANCELLATION

In this Section we show another example on cancellation. In Fig. 6 (top panel) a version of the Diller & Weinberg (1977) Letter Cancellation task is shown that was developed by one of us (AT) some years ago. Targets are 108 V letters, homogeneously distributes across six rows and intermixed with twice as many distractors. This test is very sensitive to even mild forms of neglect due to the closely spaced letters, and for the same

Table 3 Results for the performance shown in Fig. 5.

reason, is also unnerving for the examiner in the scoring stage. The lower panels of Fig. 6 show how helpful the use of a transparency is in this case. The middle panel shows the transparency alone, and the bottom panel shows the overlap. Finding cancelled and omitted targets becomes an easy task – the boxes are numbered so an easy ID labelling is possible.

In tasks of this type, where equispaced letters are used which are also vertically aligned across rows (in essence, a rectangular matrix of cells), coordinates are easily obtained even without a ruler, by simply counting the columns (starting from the leftmost) or rows (starting from the lowest).

D V X O H V N O H V K V D V N V O H V N U V X O V D X V N U V O V N X V G N V X V G D H D V N G V G G V
H K K V U G V H N G V N V X X N V G V X V X O V H V H G V G K V X V H V G U X V K V D O V K N V U X N V
K V G V G X K V G V X D H K V H V X V H O V H U V O X V K G D O V K V U V X V U N V U V D X U N V U V U
V G N N V H N O V G X O V K G V O V D X V N V G N V X D O V K N U V H V N U V X V H H G V U V K V O G V
G K G K V O V N V H V N D V K V D V U V N X K V D H X V U H V H V K K V O K V H K G N V O G V D V X O V
V U V O V H V O G V H O D H V N O H V U X G V N V H V G H V G V K V H V X X V D V O D O H V U V X G O D

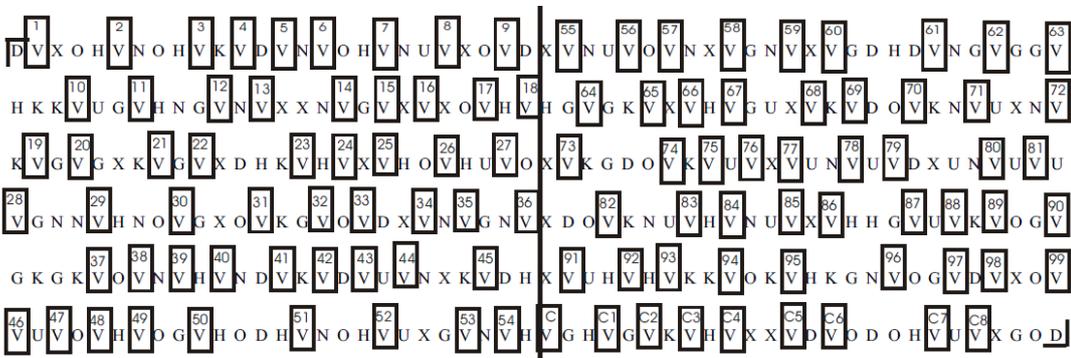
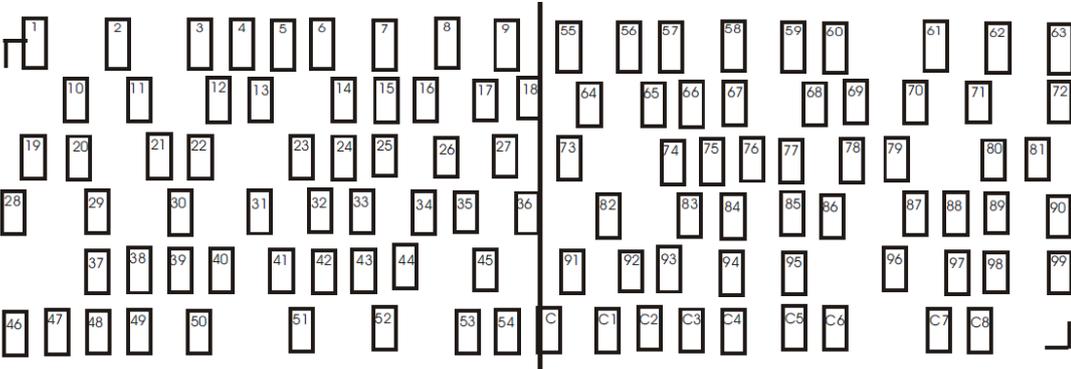


Fig. 6 Top panel: Diller-V cancellation sheet; middle panel: the transparency to be printed out and used for finding targets (and Hits/Omissions); bottom panel: overlap between cancellation sheet and transparency.

Readers who are interested in this task can download a printable PDF with both the display and the transparency ('Diller-V Letter Cancellation.pdf') as well as a specific Worksheet ('Diller-V MPH') which already contains all targets' coordinates from the Website <http://psicologia.unipv.it/toraldo/mean-position-of-hits.htm>.

EXAMPLE 3: AUDITORY DETECTION

Suppose that an examiner 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. 7 shows the hypothetical performance by a patient with rather clear auditory neglect.

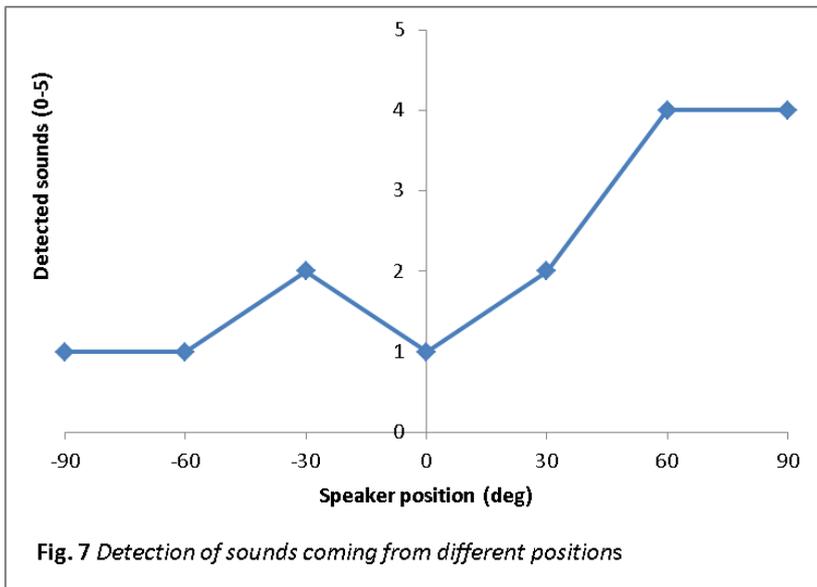


Table 4 shows the data that have been inserted as an input in the Worksheet. Note that trials have been inserted in presentation order (the order is entirely irrelevant for the Worksheet). As for the X coordinates, these are -90, -60, -30, 0, +30, +60, +90 degrees; however one can well use -3, -2, -1, 0, 1, 2, 3, or even 1, 2, 3, 4, 5, 6, 7: 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).

General statistics		Targets	35
		Hits	15
Neglect diagnosis	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 5 Results for the performance shown in Fig. 7.

INPUT	Min 10, max 256 targets		
	Horizontal target position (increasing left to right)	Vertical target position (increasing bottom to top)	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 4 Worksheet input for the Auditory neglect data shown in Fig. 7.

Table 5 shows the results given by the Worksheet. MPH is at +30 deg, which is a significant rightward bias: C-MPH = +0.166, z=2.487, one-tailed p=.0064. A left auditory neglect has been diagnosed.

OTHER DETAILS/INSTRUCTIONS ABOUT THE WORKSHEET

INPUT sheet

The Worksheet's 1.0 version does not contain Macros, so there is no need to enable them.

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:

The user can enlarge some columns or rows in order to better read their content (e.g. warning messages). However, for most users this will not be necessary or relevant.

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.

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 target positions are just ORDINAL (1, 2, 3...), without metric meaning, write 'o'.
	If target positions are METRICS (mm, cm, or any other form of physical distance), write 'm'.

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.

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 6).

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 6 Example of likely typo in row 5

Recall that if the content of the warning message is not fully visible, the columns/rows can be reshaped (e.g. enlarged) by the user.

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 6 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.

OUTPUT sheet

Different colours of the output cells 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.

Results can be copied and pasted elsewhere. If the user wishes to paste results in another Excel file, s/he should use the Excel function 'paste values'. The user can choose whether to copy results in a column (cells F2:F40) or in a row (cells H67:AT67).

If the user wishes to export results from both the horizontal and the vertical spatial dimension, s/he has to set the B1 cell to 'h', copy results and paste in them in a separate file, then set the B1 cell to 'v' and repeat the procedure. We are working towards a 2.0 version of the Excel file which will much simplify these operations.

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.

Clustering index

The program also provides an index of ‘clustering’ which informs the user about the organization of the target distribution. The ‘clustering’ index goes from 0 – each target occupies a separate position, to 1 – 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. 7). In it, 35 targets were presented in 7 positions: the Worksheet detected the 7 ‘clusters’, and computed a 0.2424 clustering index.

Clustering indices	Metric solution	N of clusters	7
		Clustering index	0.2424

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

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

The first index (‘Equispacing’) 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’ balance’) 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 *r*<0.95 are flagged as indicating a rather heterogeneous distribution of ties across positions.

The third parameter (‘Overall balance’) 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*<.0975 are flagged.

The last index, *MPT*, is the Mean Position of Targets across the display. A perfectly balanced set of stimuli will have the *MPT* exactly halfway between the extreme target positions (-0.5 and +0.5), i.e., at 0. If targets are 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 raise 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 the ‘ordinal’ version of *MPH*, i.e. *MOH*, which is discussed below.³

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’.

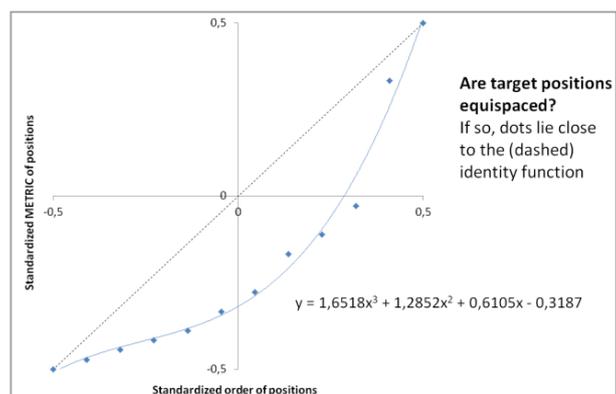


Fig. 8 ‘Equispacing plot 1’ answers the question of whether target position are equispaced. In this example, they clearly are not – dots lie well away from the dashed identity function. The spacing markedly increasing when moving from left to right.

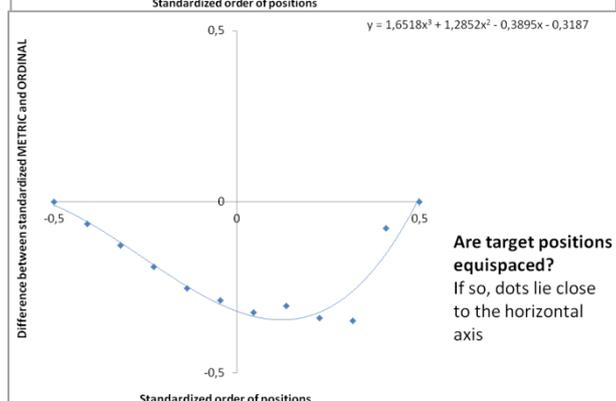


Fig. 9 ‘Equispacing plot 2’ answers the same question as ‘Equispacing plot 1’ (Fig. 8) – this time perfect equispacing corresponds to the horizontal axis and not to the identity function.

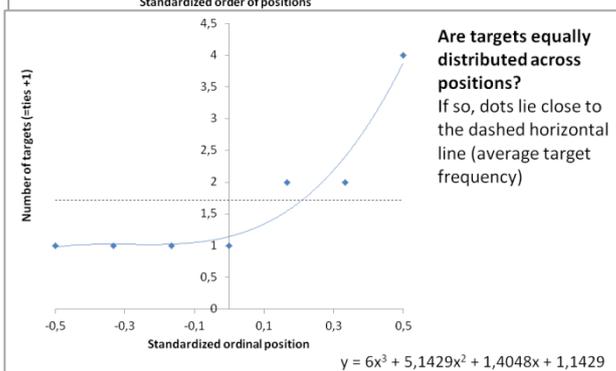


Fig. 10 ‘Ties distribution plot’ shows whether target frequency is homogeneous in different positions. In this example, while the four leftmost positions all have just one target each, the three rightmost positions are over-represented with 2, 2 or 4 targets each. Perfect homogeneity is represented by the horizontal dashed line.

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 equispacing (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.

³In 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.

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 solution	
			z (using C-MPH)	Look at ordinal solution	
			1-tailed p	Look at ordinal solution	
			2-tailed p	Look at ordinal solution	
		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-	2.4589	
1-tailed p			0.0070		
2-tailed p		0.0139			

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

Table 8 shows the example in which targets are definitely not equispaced ($X = 1,2,3,4,5,6,7,8,9,30$). Hits are the last three targets $X=8,9,30$). 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 15.666 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 +.3889, which is evidence of a strong rightward bias (the standardized scale goes from -.5 to +.5 as usual) that is diagnostic of left neglect ($z=2.459$, one-tailed $p=.007$).

Please note that the effects of violations of target distribution homogeneity on the diagnosis error rates are currently (August 2017) 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 (August, the 9th, 2017) the 1.0 Worksheet implements the following limits: correlation coefficients r' must be higher than 0.95, with the exception of r' 'Overall balance' which must be higher than 0.975; $|MPT| < 0.05$; MPT's subcomponents, MPP and TIES (see Website Material for details) need to be lower than 0.1 in absolute value.