Interpreting spatial dysgraphia after stroke: straight-ahead of straight above

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Interpreting spatial dysgraphia after stroke: straight-ahead of straight above?

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Introduction

Spatial dysgraphia, frequently observed after a right hemisphere stroke (1), associates signs of spatial compression in relation to spatial neglect, and a tilted writing which remains to be explained. Here we present a case study showing that tilted writing is due to a tilted representation of the vertical.

Materials and Methods

Case presentation
JW was a 75 year-old male, right-handed, who underwent a hemorragic right hemisphere stroke causing a total left hemiplegia with pronounced hemianesthesia, left hemianopsia and signs of unilateral spatial neglect (UNS). At entry, balance disorders were particularly severe, with a pusher syndrome. Stroke also induced a spatial dysgraphia characterized by a counterclockwise tilt of the writing lines (Fig. 1).

Handwriting evaluation
- Tasks: Copy of the 5 first lines of the BHK test, at M3 and M9, and after modulation of verticality representation (M3). Several types of cueing were tested: blank paper (reference condition) and spatially indexed paper (12° or 24 upwardly or downwardly sloping lines).
- Parameters analysed: inclination of each writing line in respect to Earth vertical (°) or to the cueing lintes, inclination of the left-hand margin in respect to the Earth vertical, and the mean time to write a letter (sec).
- Statistics: comparison of JW's results with a peered healthy participant (JB).

Representation of the verticality
- Postural vertical (VP) [2]
- Visual vertical (VV) [3]
- Modulation: tilt for 10 minutes at 30° in the dark

UNS
Body and non-body UNS evaluation using a battery of well-known tests.

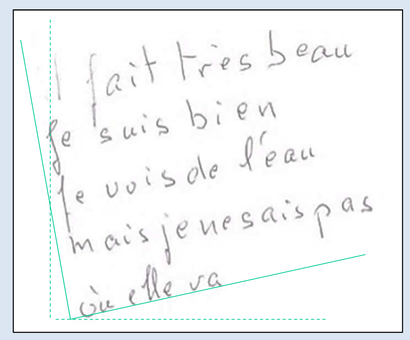

Figure 1. Sample of JW's handwriting at M3 on blank paper.

Results

	JB	JW-M3	JB vs. JW-M3	JW-M9	JB vs. JW-M9	JW-M3 vs. JW-M9
Blank paper			*p*		*p*	*p*
median (°)	**-2.1**	**-9.4**	*0.008**	**-8.8**	*0.008**	*0.08*
IQR (°)	1.2	4.6		1.4		
Lines down 24°						
median (°)	**-0.9**	**-10.2**	*0.008**	**-8.2**	*0.008**	*0.548*
IQR (°)	2	5.7		3.5		
Lines down 12°						
median (°)	**-1**	**-3.5**	*0.008**	**-4.4**	*0.008**	*0.89*
IQR (°)	1.7	3.9		1.9		
Lines up 12°						
median (°)	**0**	**-1.8**	*0.016*	**-0.6**	*0.016*	*0.08*
IQR (°)	0.7	2.1		1		
Lines up 24°						
median (°)	**-1.1**	**-0.3**	*0.548*	**-1**	*0.222*	*0.04*
IQR (°)	1.4	1.2		1.1		

Table 1. Inclination of JW's writing lines at M3 and M9 in the different conditions.

	JB	JW-M3	JB vs. JW-M3	JW-M9	JB vs. JW-M9	JW-M3 vs. JW-M9
Tilt of the left-hand margin			*p*		*p*	*p*
median (°)	**-0.1**	**-9.4**	*0.008**	**-8.5**	*0.008**	*0.416*
IQR (°)	2.2	4.6		1		
Angle between the margin and the writing lines						
median (°)	**92**	**90**	*0.102*	**91**	*0.129*	*1*
IQR (°)	1	2		1		

Table 2. Tilt of JW's left-hand margin and writing orthogonality at M3 and M9 in the 'blank paper' condition.

	JB	JW-M3	JB vs. JW-M3	JW-M9	JB vs. JW-M9	JW-M3 vs. JW-M9
Blank paper			*p*		*p*	*p*
median (sec/lett)	**0.9**	**1.7**	*0.008**	**0.9**	*0.548*	*0.008**
IQR (sec/lett)	0.3	0.7		0.4		
Lines down 24°						
median (sec/lett)	**0.7**	**1.5**	*0.008**	**0.8**	*0.151*	*0.008**
IQR (sec/lett)	0.2	0.2		0.3		
Lines down 12°						
median (sec/lett)	**0.7**	**1.4**	*0.008**	**0.8**	*0.222*	*0.008**
IQR (sec/lett)	0.3	0.8		0.2		
Lines up 12°						
median (sec/lett)	**0.7**	**1.4**	*0.016*	**0.9**	*0.095*	*0.008**
IQR (sec/lett)	0.3	0.7		0.2		
Lines up 24°						
median (sec/lett)	**0.7**	**1.1**	*0.032*	**0.8**	*0.222*	*0.222*
IQR (sec/lett)	0.3	0.5		0.4		

Table 3. JW's handwriting speed at M3 and M9 in the different conditions.

C	Before modulation	After modulation	
Postural vertical			*p*
mean (°)	**-9.8**	**0.6**	*0.001**
SD (°)	3.6	3.7	
Writing lines inclination			*p*
median (°)	**-9.4**	**-5.2**	*0.043**
IQR (°)	4.6	2.7	
Tilt of the left-hand margin			*p*
median (°)	**-9.4**	**-3.2**	*0.008**
IQR (°)	4.6	4.4	
Angle b/w the margin and the writing lines			*p*
median (°)	**90**	**92**	*0.279*
IQR (°)	2	1	
Writing speed			*p*
median (sec/lett)	**1.7**	**0.9**	*0.008**
IQR (sec/lett)	0.7	0.1	

Table 4. Spatial and temporal features of JW's handwriting after verticality normalization.

- **Inclination of handwriting** lines on blank paper and downward sloping lines, both at M3 and M9 (Tab.1)
- No significant line inclination on upwardly sloping lines (Tab.1)
- **Inclination of the left-hand margin** on blank paper at M3 and M9 and conservation of the orthogonality (Tab.2)
- **Writing speed slower than the healthly subject** at M3 but no lonter at M9 (Tab.3)
- Signs of UNS at M3 but not M9 (not shown)
- Verticality representation: altered at M3 and M9 (not shown)
- Lines inclination, margin tilt and writing speed **clearly improved after PV normalization** (Tab.4)

Discussion and Conclusion

At 3 months, JW's handwriting was slow and presented an upward tilt and an increased left-hand margin due to a global tilt of his orthogonal scheme. The spatial features of his handwriting were maintained 9 months after stroke, while his writing speed was normalized. JW's handwriting inclination was neither related to spatial neglect nor to a rotated straight-ahead, but was clearly improved by a transient modulation of JW's verticality perception.
After stroke, a tilted handwriting may thus be due to a tilted representation of the vertical.

References

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