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NOTE

UNILATERAL DYSGRAPHIA OF THE DOMINANT HAND IN A LEFT-HANDER: A DISRUPTION OF GRAPHIC MOTOR PATTERN SELECTION

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The mechanisms involved in the peripheral stages of the writing process have received increasing attention over the last 10 years. A number of authors tackled the description of plausible, functional architectures of these processes (Ellis, 1982; Margolin, 1984; Goodman and Caramazza, 1986). Thus for instance Ellis (1988) proposed a model that distinguishes three main processing stages (Figure 1): (1) The *grapheme level*, conceived as a buffer in which incoming information from the lexical route and from the phonological route is temporarily stored in the form of sequences of graphemes, (2) the *allograph level* containing spatially coded representations of letter shapes; at this level the adequate letter form must be selected and activated among several possible variants of the same grapheme (lower- vs upper-case, cursive vs script), and (3) the *graphic motor pattern level* containing allograph-specific motor programs which determine "the direction, relative size, position, and order of strokes required to form an allograph" (Ellis, 1988, p. 103). Before real-time execution several parameters such as (absolute) size and scale have to be selected and the suitable muscular groups have to be activated.

This model has been used to explain a variety of writing deficits reported in the literature. For example several patients displaying common features have been described as presenting a grapheme level impairment (Caramazza, Miceli, Villa et al., 1987; Posterano, Zinelli and Mazzucchi, 1988; Hillis and Caramazza, 1989). Their performance was characterized by qualitatively and quantitatively similar difficulties in producing written language whatever the output modality (spelling, writing, letter arranging, etc.) and the type of stimuli (words and nonwords). The letter shapes generated by these patients are usually quite well formed and errors correspond to letter substitutions, omissions, additions and transpositions. It should be noted however that these patients also differ from one another on several aspects, one of them being the distribution of errors within words.

Deficits attributed to the allograph level have also been reported. Patterson and Wing (1989) described a patient with preserved spelling abilities who experienced important difficulties in writing. Interestingly his performance was somewhat better with upper-case letters than with lower-case letters. His behavior was also characterized by extremely long preparation times (the time needed to retrieve the correct allograph) while production times were approximately comparable to those observed in normal subjects. The authors argued that this deficit could be explained in terms of difficulties in accessing the appropriate allographic information. Given the dissociation observed between lower- and upper-case letters they also suggested that there were independent codes for the two cases. Another allograph level impairment dealing with letter cases has been reported by De Bastiani and Barry (1989). Their patient's writing production was characterized among other things by letter case confusions within words (sUCh As thIS).

Finally some authors reported writing disorders which were attributed to a dysfunction of the graphic motor pattern level. In a few patients the impairment was interpreted as a deficit in accessing these representations. This deficit would essentially lead to the production

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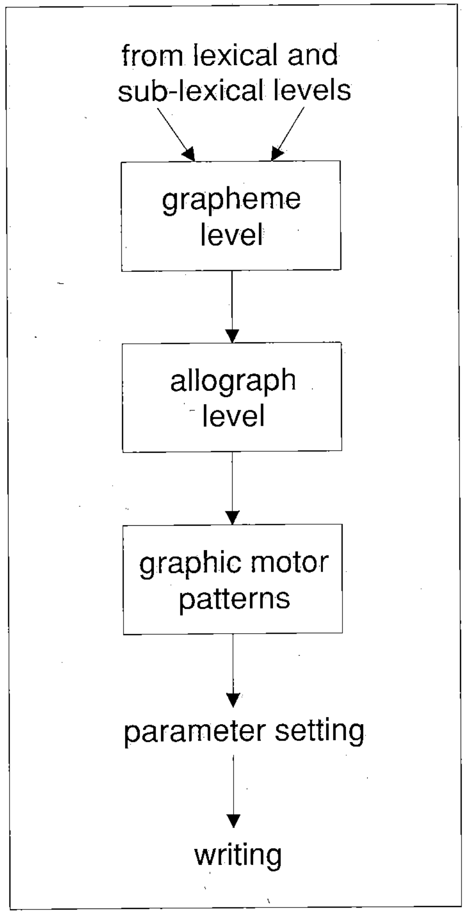

Fig. 1 – *Diagram of the processes involved in writing according to Ellis (1988).*

of letter substitutions. In one patient these letter substitutions were observed more often on low frequency letters than on high frequency ones (Black, Behrmann, Bass et al., 1989). In another patient these letter substitutions have been reported to be based on the spatial or physical similarity of the letters (Hatfield and Patterson, 1983). A different pattern of results was observed in patients displaying a loss of graphic motor patterns: Baxter and Warrington (1986) coined the term "ideational agraphia" to label the case of a patient who was producing incomplete letters and non identifiable graphic traces.

In the patients described above it is usually assumed that the writing impairments affect not only the dominant hand but the nondominant one as well. However writing disorders may also be limited to the use of one hand. Unilateral agraphia has been described ever since the end of the XIXth century (see Lebrun, 1987). These unilateral deficits are mostly associated with a lesion of the corpus callosum. Classical interpretation suggests that it is due to a disconnection between left-hemisphere language centers and right-hemisphere motor areas (Liepmann and Maas, 1907; Geschwind and Kaplan, 1962). The writing behavior displayed by patients presenting a unilateral agraphia may differ from one case to the other (Watson and Heilman, 1983; Roeltgen and Heilman, 1985). Some of them are reported to produce illegible scrawl or non-identifiable letters (Geschwind and Kaplan, 1962; Rubens, Geschwind, Mahowald et al., 1977; Yamadori, Osumi, Ikeda et al., 1980) while others are described as producing strings of well-formed letters (not necessarily related to the dictated

stimulus; Gur, Gur, Sussman et al., 1984; Guard, Graule, Bellis-Lemerle et al., 1985, case n° 10). It should be emphasized that both of these patients happened to be left handers for writing.

Zesiger and Mayer (1992) recently reported the case of a French speaking patient (MM) presenting a left unilateral writing deficit following a hemorrhage affecting part of the corpus callosum. This patient was left-handed for all activities but for writing and drawing. Premorbidly, he experienced a mild dysgraphia characterized by the production of phonologically plausible spelling errors. Shortly after onset, MM showed evidence of severe memory deficits and of most signs usually associated with a disconnection syndrome (Geschwind and Kaplan, 1962), including a massive left unilateral agraphia: His left-handed writing was characterized by the production of usually identifiable, but apparently randomly selected letter forms. Seven years post-onset, MM still experienced unusual difficulties in writing with his left hand: He produced a large number of non-phonological plausible errors ("promesse" → *niomusse*, "EXCLUSIF" → *EXCLHSIP*), particularly in the absence of visual feedback. These errors were mostly letter substitutions and were characterized by a high degree of physical (or spatial) similarity (d→*b*, B→*R*) between the produced letter and the expected one. This phenomenon appeared both for lower-case letters and for upper-case letters, although results were clearer for the former than for the latter. Zesiger and Mayer (1992) assumed that this deficit arose because of an abnormal information decay between the allographic level and the graphic motor patterns one. In this paper we report the case of a patient presenting similar characteristics as MM. However in contrast to MM this patient is fully left handed.

Case Report

The patient DS, a 36 year-old left handed (post-onset handedness measured with Bryden's [1977] questionnaire was -1.0=full left-handedness) man with university education was admitted to Geneva University Hospital in the evening of the 26 October 1990 following a subarachnoid hemorrhage (Hunt and Hess grade=3) due to the rupture of an anterior communicating aneurysm that was successfully clipped. When he left the rehabilitation unit the 22 February 1993, his neurological examination was considered normal.

Neuropsychological Assessment

DS was assessed in the Neuropsychology Unit from November 1990 (3 weeks post-operatively), through March 1991. After an initial period of disorientation, severe memory impairment, signs of frontal lobe dysfunction and dysgraphia, DS's condition became stable. By January 1991, extensive neuropsychological testing became possible. The patient was then examined regularly (approximately once a week) for short 1-2 hour sessions over the following 2 months.

Oral language and written comprehension were normal on the Boston Diagnostic Aphasia Examination for the following subtests: Auditory comprehension, naming and reading comprehension. Written expression remained however a major difficulty when carried out with the left (dominant) hand but not with the right (see Figure 2). Letter and object recognition was normal with either hand. There was no ideational or ideomotor apraxia (both hands tested). Spatial, visual and auditory gnosic capacities were preserved. On a number of frontal lobe tests (modified version of the Stroop Color-Word test, Luria's alternating geometric figures, induction of temporal order) the patient performed normally. The Wisconsin Card Sorting Test, however, showed a total of 50% perseverative errors. The Rey-Osterrieth Complex Figure was copied rapidly (2′15″) and with only one omission (score 34/36). On the WAIS, DS scored a verbal IQ of 111 and a performance IQ of 95 (Total IQ: 104). There remained a moderate memory deficit. His score on a word learning list (Rey Auditory-Verbal Learning Test) was subnormal (score: 24), as was his reproduction from memory of the Rey-Osterrieth Complex Figure (score: 13). Finally, dichhaptic identification of 3-D objects and letters, and tachistoscopic presentation of letters were normal.

To summarize, DS's difficulties in his stabilized condition were (1) a slight impairment in frontal lobe functions, which was observed only in the Wisconsin Card Sorting Test, (2) a moderate memory deficit and (3) a left unilateral dysgraphia which was the major

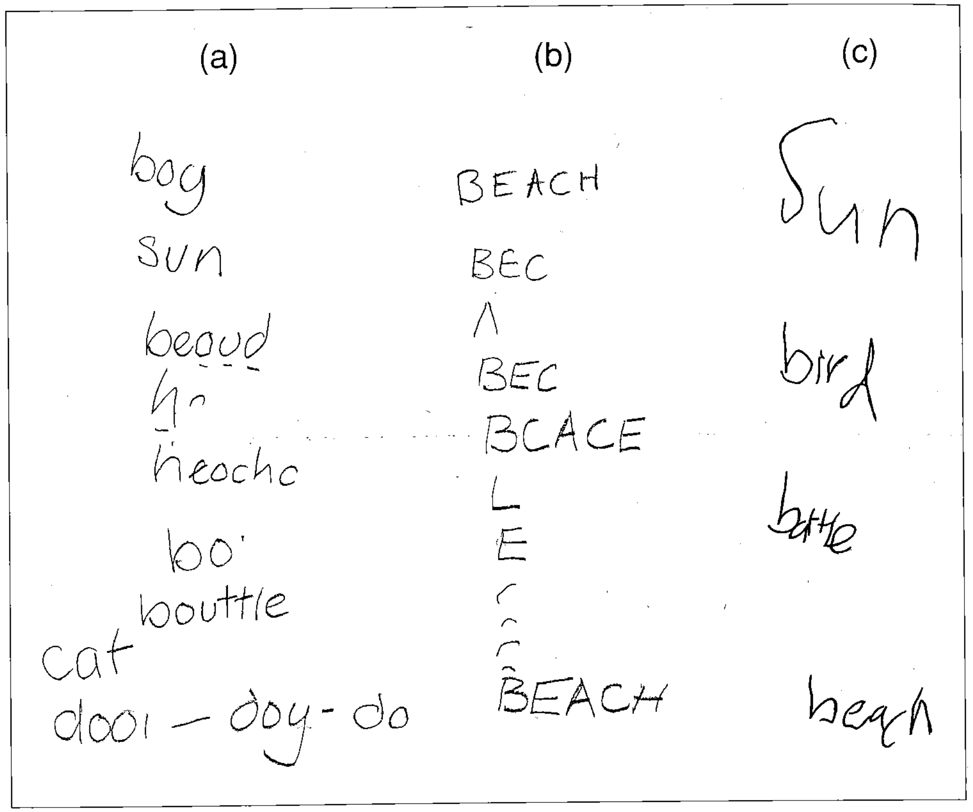

Fig. 2 – *Samples of DS's handwriting 7 weeks after onset. When wishing to correct an error the patient was instructed not to overwrite his initial production, but to start the word over the next line; (a) left-handed writing to dictation (boy, sun, beach [3 attempts], bottle [2 attempts], cat, dog); (b) left-handed upper-case copying (first line produced by the examiner); (c) right handed writing to dictation (sun, bird, battle, beach).*

impairment. These symptoms suggested, along with the frontal lobe damage, a partial callosal disconnection.

Special Investigations

The patient's writing disorder was further investigated through the administration of several spelling and writing to dictation tests. The patient was first dictated a list of 78 English words containing 39 regular and 39 exception words (Coltheart, Besner, Jonasson et al., 1979). He was asked to produce these words in the following modalities: Oral spelling (OS), dominant (left) hand writing (LHW), nondominant (right) hand writing (RHW), left-handed typing (LHT), right-handed typing (RHT). In order to evaluate the role of visual feedback on his ability to correct errors, the patient was also asked to produce the words in two additional modalities: Dominant (left) hand writing without visual feedback (LHWWVF), and nondominant (right) hand writing without visual feedback (RHWWVF). The patient performed the task at his own pace. In the modalities without visual feedback, a cloth screen was placed in between the patient's head and his writing hand.

DS's performance in oral spelling, right-handed writing with and without visual feedback was flawless, although his right-handed writing, especially in the absence of visual feedback, was a poor graphic quality. The patient also obtained a perfect score both in the right-handed and in the left-handed typing modalities.

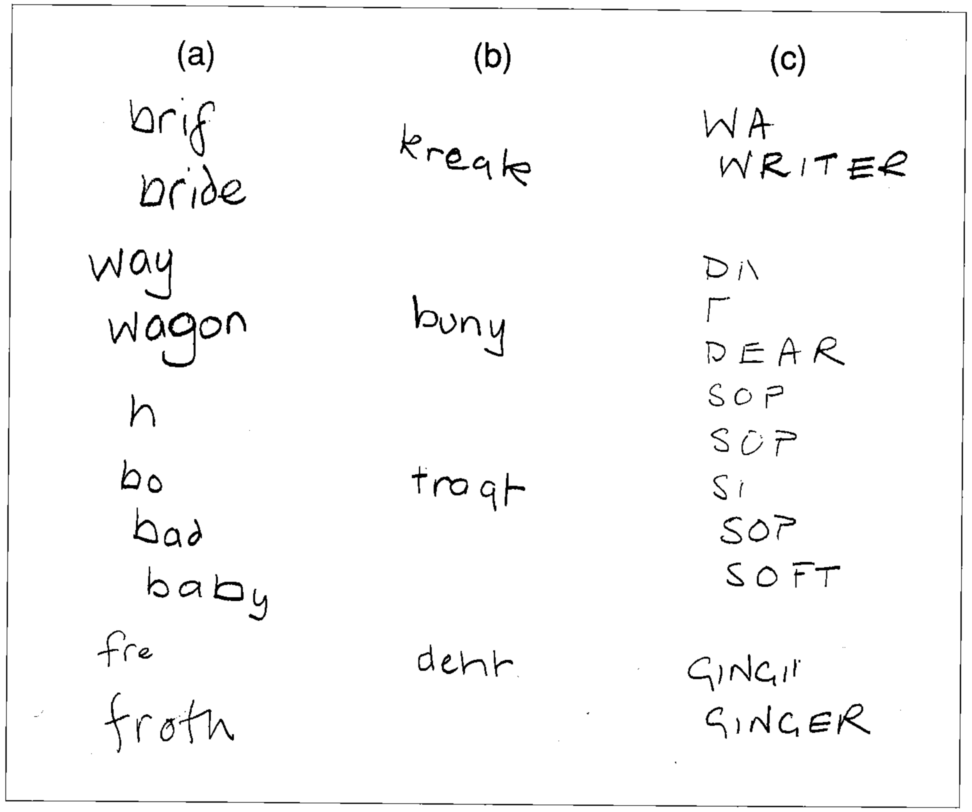

Fig. 3 – *Samples of DS's writing to dictation with his dominant (left) hand (a) with visual feedback (bride, wagon, baby, froth); (b) without visual feedback (break, bury, treat, debt); (c) with visual feedback — capital letters (writer, dear, soft, ginger).*

Conversely DS experienced difficulties in writing with his dominant (left) hand, both with and without visual feedback as shown in Table I and Figure 3. In LHW, his productions were perfectly legible, but contained a large number of self-corrections: DS needed to write

TABLE I
DS's Results with the List of Words Varying in Regularity

Modality	Response	Orthographic regularity	
		Exception	Regular
LHW (N=78)	Correct	23 (59.0%)	24 (61.5%)
	Error	0 (0.0%)	1 (2.6%)
	Self-correct	16 (41.0%)	14 (35.9%)
LHWWV (N=78)	Correct	18 (46.2%)	23 (59.0%)
	Error	12 (30.8%)	9 (23.1%)
	Self-correct	9 (23.0%)	7 (17.9%)

LHW: Left-handed writing; LHWWV: Left-handed writing without visual feedback.

about 40% of the words twice or more times in order to produce them correctly. This strategy proved efficient, as only one error was observed in the final productions. In LHWWV, the incidence of uncorrected errors was somewhat higher (26.9%); however, self-corrections were

TABLE II
DS's Results with the List of Words Varying in Grammatical Class

Modality	Response	Word class		
		Nouns	Verbs	Adjectives
Lower-case letters (N=63)	Correct	10 (47.6%)	13 (61.9%)	13 (61.9%)
	Self-correct	11 (52.4%)	8 (38.1%)	8 (38.1%)
Upper-case letters (N=63)	Correct	13 (61.9%)	14 (66.7%)	15 (71.4%)
	Self-correct	8 (38.1%)	7 (33.3%)	6 (28.6%)

also observed (20.5%) in this modality. The total number of errors (corrected and uncorrected) does not differ between the two modalities ($\chi^2(1)=0.939$, N.S.). Finally, DS's performance was not affected by word regularity neither in LHW ($\chi^2(1)=0.054$, N.S.) nor in LHWWW ($\chi^2(1)=1.285$, N.S.).

In order to investigate further the patient's handwriting disturbance with his left hand he was dictated three other lists of words for a total of 213 words. The first list contained words varying in *word class* (21 nouns, 21 verbs and 21 adjectives). Each class was composed of 7 words of letter length 4, 5 and 6. Word frequency was counterbalanced across word class on the basis of Kucera and Francis (1975). The second list contained 60 nouns varying in *frequency*: 30 words were frequent (mean frequency class per million=245.8, range 100-787) and 30 were nonfrequent (mean class=4.4, range 1-9). Each sublist comprised 10 items of letter length 4, 5, and 6. Finally the third list contained 90 nouns matched for word frequency varying in *length* from 3 to 11 letters (10 words of each length).

DS was asked to write the words using both lower-case (LOW) and upper-case (UP) letters.

TABLE III
DS's Results with the List of Words Varying in Frequency

Modality	Response	Word frequency	
		Frequent	Nonfrequent
Lower-case letters (N=60)	Correct	19 (63.3%)	21 (70.0%)
	Self-correct	11 (36.7%)	9 (30.0%)
Upper-case letters (N=60)	Correct	19 (63.3%)	18 (60.0%)
	Self-correct	11 (36.7%)	12 (40.0%)

Table II and III show that, as is expected in the case of a peripheral writing impairment, there is no effect of word class (LOW: $\chi^2(2)=1.167$, N.S.; UP: $\chi^2(2)=0.429$, N.S.) and frequency (LOW: $\chi^2(1)=0.300$, N.S.; UP: $\chi^2(1)=0.071$, N.S.) on the number of self-corrections and errors produced. In both experiments there was no difference in the total number of errors produced in lower-case and in upper-case letters (respectively $\chi^2(1)=1.212$, N.S.; $\chi^2(1)=0.326$, N.S.). By contrast inspection of Table IV indicates that the patient's performance is significantly affected by word length in both modalities (LOW: $\chi^2(2)=8.093$, $p<.02$; UP: $\chi^2(2)=11.294$, $p<.004$). The total number of errors does not differ between the two modalities ($\chi^2(1)=0.089$, N.S.). As can be observed the proportion of words containing at least one self-correction is rather stable across experiments and amounts to approximately 40%.

Error Analysis

All the errors produced in the four experiments including the initial productions which were spontaneously corrected were taken into consideration. The errors were first divided

TABLE IV
DS's Results with the List of Words Varying in Length

Modality	Response	Word length (nb. of letters)		
		3-5	6-8	9-11
Lower-case letters (N=90)	Correct	20 (66.7%)	15 (50.0%)	9 (30.0%)
	Error	0 (0.0%)	0 (0.0%)	3 (10.0%)
	Self-correct	10 (33.3%)	15 (50.0%)	18 (60.0%)
Upper-case letters (N=90)	Correct	22 (73.3%)	15 (50.0%)	9 (30.0%)
	Error	0 (0.0%)	0 (0.0%)	2 (6.7%)
	Self-correct	8 (26.6%)	15 (50.0%)	19 (63.3%)

into four categories: Letter substitutions, omissions, additions and order reversals. Whenever it was not possible to unambiguously classify an error (for instance if the stimulus word "bird" was written *br* [interrupted] *bird*, the first response may be scored either as a letter omission [*i* missing], or as a letter substitution [$i \rightarrow r$], or as the beginning of an adjacent letters order reversal [*brid*]) it was considered unclassifiable. Given the fact that the patient displayed frontal lobe disorders such as perseverations the repeated production of the same error was only scored at the first occurrence. Such a scoring method lead to the breakdown of errors depicted in Table V. Inspection of this table clearly indicates that for both letter cases substitutions are by far the most frequent errors and amount to almost 90% of the total number of errors.

A closer look at the errors globally scored as substitutions lead us to distinguish cases in which a letter was replaced by another well-formed letter ($a \rightarrow u$, $R \rightarrow B$) from the instances in which a letter was replaced either by a "non-letter" (usually an aborted letter or a non

TABLE V
DS's Errors as a Function of Error Type and Letter Case Modality

Error type	Modality	
	Lower-case	Upper-case
Substitutions	185 (88.1%)	168 (88.4%)
Omissions	5 (2.4%)	3 (1.6%)
Additions	3 (1.4%)	0 (0.0%)
Reversals	2 (1.0%)	1 (0.5%)
Unclassifiable	15 (7.1%)	18 (9.5%)
Total	210	190

decipherable graphic sign) or by an ambiguous form. This additional distinction resulted in a clear contrast between lower-case letters and upper-case letters: While the former are usually substituted by another existing letter of the alphabet (140/185 = 75.7%) the latter tend rather to be replaced by "non-letters" (92/168 = 54.8%).

The observation of the letter substitutions in which letters were replaced by other letters suggested that the letter substitutions were committed according to a physical similarity principle: The target letter and the one produced by DS usually shared common spatial features (see Appendices I and II for the full description of these errors). In order to add credit to this claim we confronted the letter substitutions with scales of inter-letter similarity. For lower-case letters we used the scale developed by Dunn-Rankin (1968) for the 21 most frequent letters of the English alphabet. We attributed a rank to each of the 140 substitutions: The most similar letter as the target letter was given rank 1 and the most different letter obtained rank 20. This procedure allowed to measure the median rank which fell between 2 and 3 (2.13 by interpolation; chance level: 20/2 = 10). The same analysis was performed with the 76 substitutions produced with upper-case letters on the basis of the inter-letter similarity computed by Gilmore, Hersh, Caramazza et al. (1979). The median rank was exactly 9 (range 1-25), falling not very far from chance level (25/2 = 12.5). On the basis of the previous analyses it seems therefore possible to conclude that substitutions occurring with lower-case letters are driven by a spatial similarity principle, whereas this principle does not seem to hold for upper-case letters. It should however be reminded that the majority of the substitutions produced in this modality resulted in the production of "non-letters" usually formed of one or two vertical or oblique strokes (64/92). For lower-case letter substitutions most of the non-letter productions resulted in single vertical or slightly oblique down-strokes (16/45), in curved segments like for instance the beginning of letter "e" or "c" (21/45). It seems thus that in both cases "non-letters" should be viewed as the first strokes of aborted letters.

Discussion

The patient described above displays a highly specific writing impairment in the absence of any other major neuropsychological symptom. Two characteristics of DS's disorder are of particular interest: First it affects only the dominant (left) hand, and second it leads to the production of qualitatively different errors as a function of letter-case.

The interpretation of the deficit relatively to the model outlined in the introduction seems rather straightforward. In his review article Ellis (1988) argues that the production of spatially (or in his term physically) similar letter substitutions is related to a deficit in selecting the appropriate graphic motor patterns on the basis of the information coming from the allographic level. This interpretation has been favored by Zesiger and Mayer (1992) in their attempt to explain the unilateral dysgraphia presented by a corpus callosum lesioned patient. In order to account for the fact that the disorder was only observed with the left hand these authors suggested that producing handwriting with the dominant hand and with the nondominant hand was mediated by the same allographic representations but not by the same graphic motor patterns, which would be hand-specific. This hypothesis rested not only on the pattern of performance displayed by the patient MM but also on studies performed in the field of motor control. Indeed it has been shown that the temporal and kinematic aspects of the movements produced in handwriting using the dominant and the nondominant hands differ dramatically whereas the spatial aspects tend to remain constant (Wright, 1990, 1993). This result has been taken to support the hypothesis of an *effector-specificity* of motor programs (or graphic motor patterns in the present context). The data gathered in the present study adds further credit to this hypothesis given the fact that DS did not present, even shortly after onset, any difficulty (not even hesitations) in producing handwriting with his nondominant right hand. Consequently what would be disrupted in DS is the access to the left-hand-specific graphic motor patterns.

With regard to the dissociation observed between the errors produced with lower-case letters and with upper-case letters additional assumptions have to be made. One simple way of looking at this dissociation is to consider that the production of lower-case letters is basically faster than the production of capital letters and consequently that chances for interrupting the movement are higher when the movement lasts longer. This would indeed account for the fact that DS produces more aborted letters with upper-case letters than with lower-case letters. Nevertheless it would not in our view explain why lower-case letter substitutions are driven by a spatial similarity principle whereas no such contingency is observed with upper-case letters. Perhaps a more adequate way of tackling this problem is to introduce a new dimension in the analysis: The degree of motoric familiarity. Indeed upper-case letter production is for most people a less automatized behavior than lower-case letter production. On these grounds one may wonder if motor representations used in both cases are similar in nature or not. In the domain of motor control of handwriting it is usually assumed that letters constitute basic production units (Teulings, Thomassen and van Galen, 1983). This means that a motor program would contain the specifications of an entire letter rather than just of one up- or down-stroke. To our knowledge however such studies involving reaction time and movement time measurement have only been performed with frequent,

lower-case letters such as *e*, *u*, *n*, etc. Consequently it seems difficult to generalize these results to all letter types. Moreover it is known that the size of a graphic motor program is highly dependent upon the degree of motoric familiarity with the form to be produced (Hulstijn and van Galen, 1988). Within this context it is possible to put forward the hypothesis that the difference between lower-case and upper-case letters would originate in differences in the degree of familiarity. The production of highly familiar lower-case letters would be mediated by graphic motor patterns which would integrate the information relative to entire letters. By contrast the production of upper-case letters would be mediated by partial representations (isolated strokes); the concatenation of these strokes would eventually lead to the generation of the entire letter.

In this perspective the access to motor representations of letters would be a differential process for lower- and upper-case letters. Consequently an impairment located at this level would also have a differential impact on the type of errors. Motorically familiar letters (mostly lower-case letters) would be accessed as units; a disruption of this process would lead to the activation of other motoric representations which share common features with the target one which would result in the production of motorically (and indeed physically) similar letter substitutions. Motorically not-so-familiar letters (mostly upper-case letters) would be accessed as sets of strokes; in this case a disrupted access would translate into the activation of partial or disorganized patterns of information. The activation of partial sets of strokes would result in the production of incomplete letters whereas the activation of disorganized sets would result either in the production of non-letters or in the production of other existing letters sharing some of the strokes with the target one, which is not a sufficient condition to guarantee that the overall letter is similar to the target letter.

A more detailed analysis of the transformations operated between target and produced letters would certainly bring additional information relatively to this claim. Although this was our initial goal we did not carry out such an analysis because the available data was too limited and it was not possible to test the patient anymore after his discharge from the hospital. Nonetheless a close look at the existing literature seems to indicate that letter familiarity (or more correctly allograph familiarity) may be a crucial variable in handwriting production. In particular it should be reminded that Black et al.'s (1989) patient displayed a letter frequency effect, which is partly responsible for allograph familiarity. Unfortunately this patient was asked to use mainly upper-case letters and thus a comparison between lower- and upper-case letters could not be performed. Interestingly these authors did not report a letter similarity effect which is in line with DS's results when using upper-case letters.

Appendix I

Substitutions Produced by DS in Lower-case Letters (T = target letter, P = produced letter, F = frequency of occurrence, R = similarity rank)

T	P	F	R	T	P	F	R	T	P	F	R	T	P	F	R
a	e	7	3	f	l	1	1	o	e	11	2	t	l	2	2
—	o	5	2	—	d	1	5	—	u	5	8	—	f	1	1
—	u	3	4	g	y	1	3	—	c	2	1	—	i	1	3
—	c	2	1	—	j	1	—	—	a	1	3	—	h	1	4
b	h	7	3	h	k	1	5	p	b	1	1	—	r	1	7
—	n	3	12	—	r	1	11	—	r	1	12	u	n	2	1
—	d	1	1	—	i	1	14	r	n	3	1	—	o	2	9
c	e	2	1	i	u	1	8	—	u	2	2	—	c	1	4
—	s	2	5	k	h	1	1	—	t	1	4	—	r	1	7
—	o	1	2	l	t	3	6	—	i	1	6	—	i	1	17
—	i	1	16	n	m	3	2	—	p	1	8	v	w	2	—
d	f	2	4	—	t	2	15	—	s	1	10	w	m	1	1
e	c	18	1	—	u	1	1	—	l	1	13	y	g	2	6
—	o	2	3	—	c	1	5	s	c	4	1	—	d	1	12
—	a	1	2	—	a	1	7	—	e	1	2	—	a	1	18
—	u	1	4	—	w	1	7	—	u	1	4				
—	s	1	5	—	y	1	13	—	o	1	7				
—	n	1	8												

APPENDIX II

Substitutions Produced by DS in Upper-case Letters (T = target letter, P = produced letter, F = frequency of occurrence, R = similarity rank)

T	P	F	R	T	P	F	R	T	P	F	R	T	P	F	R
A	P	2	13	E	A	2	19	R	B	4	2	W	N	1	2
—	M	1	2	—	I	1	17	—	A	2	1	—	T	1	25
—	O	1	8	—	H	1	23	—	C	2	18	Y	T	1	1
—	F	1	18	F	P	2	1	—	M	1	5				
—	U	1	19	G	S	1	5	—	N	1	8				
—	E	1	20	—	P	1	14	—	D	1	15				
B	E	1	3	H	T	1	22	—	O	1	16				
—	P	1	10	I	P	1	10	—	L	1	19				
C	O	1	3	—	H	1	14	—	Y	1	22				
—	D	1	4	—	C	1	19	—	r	1	—				
—	S	1	8	K	H	1	7	S	C	2	13				
—	U	1	19	M	N	6	2	T	P	2	2				
D	C	2	5	—	R	1	6	—	H	1	15				
—	P	2	6	N	B	1	8	—	t	1	—				
E	P	3	10	O	L	3	21	U	G	1	9				
—	T	3	22	P	F	1	1	V	W	1	4				
—	L	2	12												

ABSTRACT

This paper reports the case of an English speaking, fully left-handed patient (DS) with a left unilateral writing deficit occurring after a subarachnoid hemorrhage due to the rupture of an anterior communicating aneurysm. DS's performance in spelling and in right-handed writing was entirely preserved while his left-handed writing was characterized by the production of errors which could generally be spontaneously self-corrected. Errors produced with lower-case letters differed from the ones produced with upper-case letters: The former usually corresponded to letter substitutions which were characterized by a high degree of physical similarity between the target letter and the one produced. The latter tended to result in the production of aborted letters. This impairment is discussed in the context of cognitive models of writing. It is suggested that graphic motor patterns for lower-case letters and for upper-case letters are different in nature and consequently that production processes may also differ.

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