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WRITING DISTURBANCES IN ACUTE CONFUSIONAL STATES

FRANÇOIS CHÉDRU* and NORMAN GESCHWIND

Neurological Unit, Boston City Hospital and Department of Neurology, Harvard Medical School;
Aphasia Research Center, Department of Neurology, Boston University School of Medicine†

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Abstract—Studies of writing ability were carried out in 34 acutely confused patients. Their performances were compared to those of 10 controls and, in 24 of the cases, to their own performance after recovery from confusion.

Writing was impaired in 33 of the 34 cases. The writing disorder could involve the motor and the spatial aspect of writing as well as spelling and syntax. It was the most constant and the most striking linguistic disorder seen in these patients. It disappeared when the confusion cleared. The spelling disorder had the following features: high error rate in consonants and of small grammatical words in their entirety, high rate of omission and substitution, high involvement of the last letters of the words.

The problem of pure agraphia is discussed in the context of these findings.

Writing disturbances in focal brain lesions are well recognized, (MARCE, [1]; BENEDIKT, [2]). In general, such disturbances are associated with aphasic, alexic or apraxic signs (for a recent review, see LEISCHNER, [3]). In a few cases, however, writing impairment has appeared to be isolated. This isolated defect in graphic expression has been called "pure agraphia" (P.A.). In these cases the lesion has most often been considered to be localized in the left frontal area, (GORDINIER, [4]; HENSCHEN, [5]). For these authors, such cases represent a confirmation of the cerebral writing center postulated by EXNER, [6] to be in the foot of the left second frontal convolution.

Many neurologists have however been reluctant to accept the existence of such a center, (DEJERINE, [7]; WERNICKE, [8]; RAWAK, [9]; RUSSELL and ESPIR, [10]; HECAEN, ANGELERGUES and DOUZENIS, [11]). The present study was in part motivated by our own skepticism concerning the existence of pure agraphia on the basis of an isolated destructive lesion in the left frontal lobe. We had been struck first by the difficulty of finding such cases (either personal or in the literature). Secondly we had found that, in contrast to our failure to find cases of pure agraphia with focal vascular disease, we had seen many cases of agraphia, with little or no other language disorder, in patients with toxic or metabolic confusional states. Thirdly, we had noted that the cases of P.A. in the literature, although often attributed to focal disease, frequently had tumors and were often stated to show general mental impairment.

We therefore decided to explore methodically the question as to whether isolated writing disturbance could be found in cases suffering from acute confusional states (A.C.S.).

* Present address for reprints: Service de Neurologie et de Neuropsychologie, Hôpital de la Salpêtrière, 47, boulevard de l'Hôpital, Paris (13e)—France.

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For the purposes of our study, we have characterized the principal features of the A.C.S. as follows. The main characteristic is a reduction and/or a ready shifting of attention. Other symptoms, (e.g. disorientation, changes in mood, hallucinations), are not essential for the diagnosis. A.C.S. may occur in any kind of toxic or metabolic disorder, especially of rapid onset, as well as in cases of head injury, subarachnoid hemorrhage or increased intracranial pressure, especially when of rapid onset. The type of pathogenic agent involved appears to have little bearing on the clinical picture of the A.C.S., (BONHOEFFER, [12]).

In this report we will describe the writing impairments we observed in 34 acutely confused patients. On the basis of these observations, we will reconsider the problem of P.A.

METHODS

1 Subjects

Four groups of subjects were examined: 1. Patients presenting with "natural" A.C.S., 2. Patients recovering from electro-convulsive therapy, 3. Patients receiving barbiturates during the induction of general anesthesia, 4. Controls. For the pathological groups, the following requirements were set: (a) reduction and/or shifting of attention of recent onset related to a well defined toxic or metabolic disorder. The attention disorder was evaluated on the basis of clinical examination. (b) absence of signs of focal brain lesions and of chronic intellectual deterioration. (c) age below 60 years. (d) ability to carry out the test battery.

Every patient—but 3 of group 2—demonstrated some disorientation for time and place. On another hand, every patient of groups 1 and 3 performed abnormally on one or both of two tests generally considered as "attention tasks": digit span and a test of auditory-motor attention (patients of group 2 were not submitted to these tasks).

Group 1. Patients presenting with "natural" A.C.S. The etiologies were: delirium tremens (10 cases), hepatic encephalopathy (6), Wernicke's encephalopathy (4), acute alcoholic intoxication (1), barbiturate intoxication (1). In several cases more than one disorder was present.

Group 2. Patients undergoing electro-convulsive therapy (E.C.T.). These patients were examined during the short confusional state following E.C.T. Before E.C.T., each patient received barbiturates and the subsequent A.C.S. may have been related both to medication and E.C.T.: 9 patients were suffering from psychotic depression and 1 from schizophrenia.

Table 1. Group characteristics (number of Ss, age, educational background). Educational levels were defined as follows: Level 1: Ss having had no high school education. Level 2: Ss with more than 1 year in high school, but not graduates. Level 3: high school graduates.

	Number of Ss	Age (mean age and range)	Educational background levels		
			1	2	3
Group 1 ("natural" A.C.S.)	22	44 (28-55)	11	3	8
Group 2 (E.C.T.)	10	46 (24-60)	3	3	4
Group 3 (general anesthesia)	2	42 (37-44)	1		1
Group 4 (Controls)	10	41 (24-59)	3	3	4

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Group 3. Patients undergoing general anesthesia. Two patients were studied while under the effect of I.V. barbiturates (total doses: 400 and 500 mg of Amytal), administered as normal premedication before surgical anesthesia. They remained under the effect of Amytal throughout the interview.

Group 4. Controls. The Ss were chosen from the medical wards. They met requirements (b), (c) and (d) above and were not confused. No attempt was made to exclude alcoholics.

The characteristics of the 4 groups in regard to number of Ss, age and educational background are given in Table 1.

2. Procedure

The writing tasks consisted of the following:

(a) *writing to command*: patients were given the command to compose and write two sentences, one about the weather, another about their jobs.

(b) *writing to dictation*: six words (business, president, finishing, experience, physician, fight) and two sentences ("the boy is stealing cookies", "if he is not careful the stool will fall") were presented. Several presentations were often necessary.

(c) *writing to copy*: the patient had to copy in script a sentence written in printed letters ("the quick brown fox jumps over the lazy dog").

Self-correction was discouraged but could not always be prevented. Occasionally the Ss were given block letters and asked to compose 2 of the words that had been dictated. No time limit was set.

This study was carried out within the framework of a larger study on disorders of higher cortical functions in A.C.S. (Chédru and Geschwind, in preparation). Other language tests were thus given including spontaneous speech, naming, comprehension, spelling, repetition, and a word-list test. In addition, evaluations were made of behavior, affect, attention, the other components of the Gerstmann syndrome and praxis.

Subjects of groups 2 and 3, as well as 12 subjects of group 1 were tested twice, once during the A.C.S. (examination A), and a second time when the confusion cleared (examination B).

DATA

Writing was frequently impaired in regard to its motor, spatial and linguistic aspects. The high rate of writing impairment is shown by the fact that, of the 34 confused patients, only one did not demonstrate any abnormality in writing while in A.C.S.

1. Motor impairment

Of the 34 subjects with A.C.S., there were 10 who wrote the letters normally but with a mild tremor (e.g.: cases 4 and 20—see Figs. 1 and 2). In 5 cases, writing was reduced to an illegible scribble (e.g.: cases 6 and 8—see Fig. 1). In the remaining 19 cases, writing performance fell between these two extremes and manifested some or all of the following disorders: letters clumsily drawn; absence of loops of the l, f, g, and o; reduplication of strokes in letters such as m, n, w, and u; no dots on the i's; letters overlapped or not linked. Sometimes contamination from a neighboring letter produced curious "néo-graphisms" (e.g.: case 22—see Fig. 1). To be noted is the absence even in the severest impairments seen by us, of reiterated drawing of curves, loops and circles, such as is frequently reported in cases of P.A., (GORDINIER, [4]; CAMPBELL, [13]).

Printed letters appeared to be easier to write. In some cases, the Ss improved when switching from script to print. In 6 cases, the Ss either could not switch to script when asked or mixed script and printed letters (e.g.: case 4—see Fig. 2). Micrographia was present in 3 cases. In most of the performances no punctuation marks were used.

2. Spatial disorders

Twenty-three Ss could not align letters properly and oriented the lines upward or downward. Some wrote close to the margin of the sheet, demonstrating something comparable to the "fear of emptiness" mentioned in focal parietal brain lesions, (CRITCHLEY, [14]). In copying words, 4 patients wrote in close proximity to the model, sometimes overlapping their letters with those of the model.

3. Reluctance to write

19 of the confused Ss consistently demonstrated reluctance to write, alleging: "I never could write well, you know . . .", "I am not much of a writer", "without the proper glasses, it's difficult . . .".

4. Syntactical disorders

Fourteen Ss, although having been asked repeatedly to write in *full* sentences, and apparently having understood what the examiner meant, wrote "headline" type sentences such as "weather fair", "making rugs", "sell T.V." . . . Such agrammatic answers were in striking contrast to the normal grammatical structure of the oral expression of the same patients.

A similar discrepancy between oral and written grammar has been described by HECAEN *et al.* [11] in conduction aphasia.

5. Spelling and other linguistic errors

These were found in most cases even when there was no motor or spatial difficulty (e.g.: cases 4 and 20—see figures).

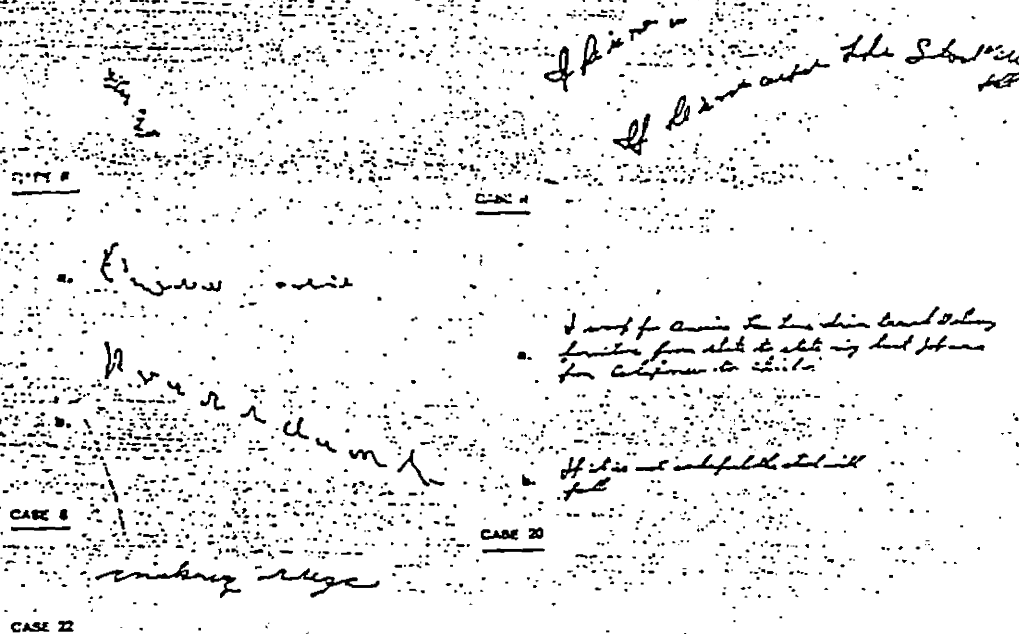


FIG. 1. Samples of writing performances of acutely confused subjects.

Case 6: "finishing" (dictation). Case 8: "president" (dictation). (a) first attempt; (b) second attempt; the patient had been told at this time that he could write in print if he wished. Case 22: description of the patient's job (to command). Case 11: "if he is not careful, the stool will fall" (dictation). Two attempts were necessary because the subject was writing too close to the margin of the sheet. Case 20: (a)—description of the job (to command); (b)—"if he is not careful . . ." (dictation).

Writing to command means the composition by the patient of a sentence on a specific subject set by the examiner.

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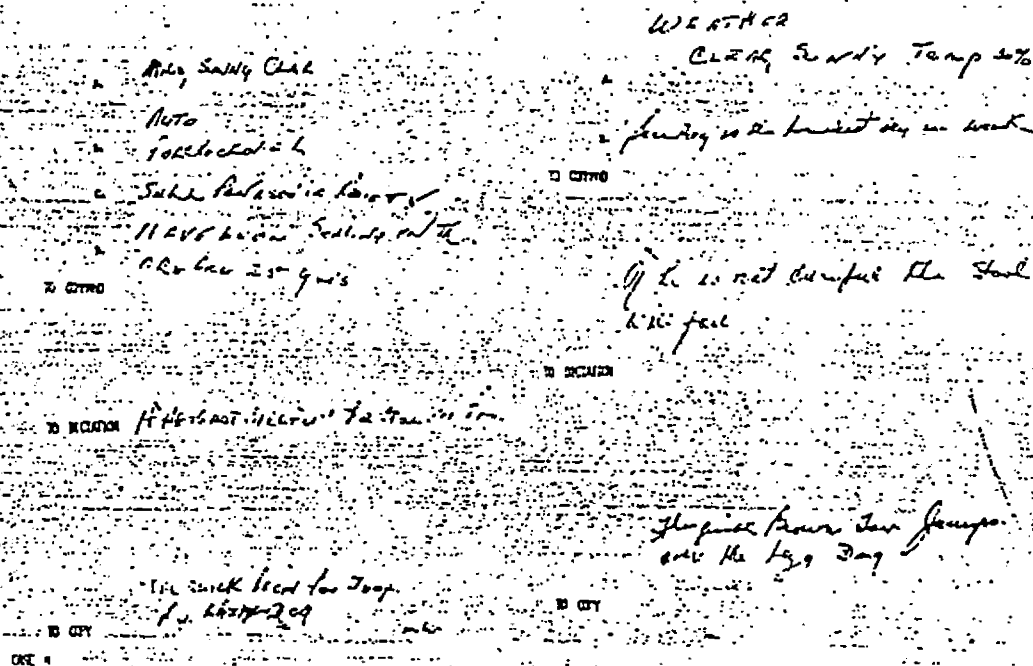


FIG. 2. Samples of the writing performances of a patient (case 4) during (left of illustration—21 January 1970) and out of (right of illustration—28 January 1970) an acute confusional state.

Comparisons of the written spelling performances during and after A.C.S. were carried out for 21 Ss (10 Ss of group 1, 9 of group 2 and the 2 subjects of group 3). These comparisons are summarized in tables 2 and 3. During A.C.S. Ss made about three times as many errors as they did after A.C.S. An increase in errors occurred in each of the three writing tasks: writing "to command", dictation and copying. The increase in errors in writing "to command" is not, however, statistically significant.

When we turn to the *grammatical category* of the misspelled word, we find an increase in spelling errors mainly in verbs and small grammatical words (prepositions; pronouns; articles), designated in the table as "other words", and, to a lesser degree, nouns. Misspelling of verbs often consisted in the modification of auxiliary verbs or of the grammatical endings of regular verbs (e.g.: -ed, -s). Small grammatical words were either omitted or substituted for by other words. On the whole, grammatical words and endings, though highly familiar, appeared to be very fragile. Difficulties in these categories are, of course, well known in some varieties of aphasics.

Errors were also analyzed according to the "transformation" leading from the target word to the word actually written. We adopted the following classification of misspelling: *omission* ("clar" for "clear"), *addition* ("carefull" for "careful"), *substitution* ("lan lin" for "Van Line") and *inversion* ("liberty" for "liberty") (LECOURS [15]). Often, an erroneous word contained more than one type of error. Such errors could involve isolated letters, as well as groups of letters ("arearea" for "area") and whole words ("if it is" for "if he is"). The nature of the "transformation", the element involved (consonant, vowel, syllable or word) and the location of the misspelling in the word were noted.

The data pertaining to this part of the study are reported in Table 3. When we consider the *nature* of the "transformations", we find that the increase of written misspelling during

Table 2. Written spelling errors in controls, in 21 patients in A.C.S. (examination A) and in the same patients out of A.C.S. (examination B). Comparison of the mean values.

	Controls (10 Ss)	During A.C.S. exam. A (21 Ss)	Post A.C.S. exam. B (21 Ss)	<i>t</i> (A/B)	<i>t</i> (B/C)
Total spelling errors	5.10	15.00	5.5	3.15***	0.42 Ns
Writing to command	1.10	10.45	1.9	1.71 Ns	0.51 Ns
Writing to dictation	8.00	19.83	9.98	3.94***	0.42 Ns
Copying	0.00	7.86	2.10	2.14*	0.99 Ns
Nouns	14.00	20.95	10.98	2.29*	0.37 Ns
Verbs	2.00	19.38	4.71	3.38***	1.00 Ns
Adjectives	5.00	15.62	7.38	1.74 Ns	0.54 Ns
Other words	0.00	5.12	1.10	2.88***	1.25 Ns

(1) total percentage of misspelled words (expressed in per cent of the total number of written words).

(2) percentage according to the writing task (in per cent of the number of words of the task considered).

(3) percentage according to the grammatical form class (in per cent of the number of words from the considered form-class).

"Writing to command" means the composition by the patient of a sentence on a specific subject.

The A/B comparison was made by a *t*-test for paired data; the B/C comparison by a regular *t*-test.* $p < 0.05$; *** $p < 0.01$.

Table 3. Analysis of the spelling errors in regard to the type of "distortion", the involved element and the location of the error in the word (see text)

	Controls (C) (10 Ss)	During A.C.S. exam. A (21 Ss)	Post A.C.S. exam. B (21 Ss)	<i>t</i> (A/B)	<i>t</i> (B/C)
Omission	1.50	8.60	3.10	3.46***	0.75 Ns
Addition	1.10	5.43	3.74	0.81 Ns	1.08 Ns
Substitution	1.70	4.90	1.67	3.44***	0.02 Ns
Inversion	0.40	0.36	0.76	1.09 Ns	0.72 Ns
Consonants	1.90	10.50	3.52	3.01***	0.72 Ns
Vowels	2.30	4.74	2.48	1.63 Ns	0.10 Ns
Syllables	0.40	1.74	0.81	1.17 Ns	0.68 Ns
Whole words	0.20	3.36	0.62	3.48***	0.69 Ns
First 2 letters	0.00	0.97	0.33	1.06 Ns	Ns
Last 2 letters	0.90	5.97	1.85	2.56*	1.49 Ns
Middle of word	1.10	7.87	4.79	1.69 Ns	1.26 Ns

Errors are expressed in percentages of the total number of written words.

The A/B comparison was made by a *t*-test for paired data; the B/C comparison by a regular *t*-test.* $p < 0.05$; *** $p < 0.01$.

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A.C.S. appears to be related to an increase in omission and substitution errors. Addition and inversion errors did not change significantly. There was, however, a trend to reduplication of the last letters of the word (e.g.: "falll", "businesss" ...) or to reduplication of whole words (e.g.: "if if he is"). An increase in omission errors is not surprising in a disorder the main feature of which is an attention defect. Less expected is the stability of inversion errors. Our patients are thus different from cases of developmental dysgraphia (LECOURS [15]).

The study of the transformed elements revealed a high degree of involvement of consonants and of whole words (generally small grammatical words). The high error score for consonants reflects particularly an increase in omissions, and to a lesser degree, other types of transformation. It is in striking contrast to the low error rate for vowels, a difference which remains even when we balance for the unequal distribution of vowels and consonants in the test material.

The location of the "transformation" was studied only for errors in single letters in words having five letters or more. We computed the number of errors involving the two first letters, the two last letters and the middle of the word. As demonstrated in Table 3, errors involving the last two letters increased significantly while errors in the other categories did not.

The written spelling errors of the subjects seen after recovery from A.C.S. (examination B), were similar in every respect to those of the control group (see Tables 2 and 3); some minor spatial or motor errors were found in only 3 patients of group 1 after recovery.

6. Writing disturbances in relation to other disorders of higher cortical functions (H.C.F.)

The dysgraphia demonstrated by our patients was far more severe and constant than any other concomitant disorder. In spoken language, there were some word-finding difficulties and a few errors in reading aloud and repetition, but the overall pattern of spontaneous speech was normal. On the other hand, oral spelling did not change significantly between the two testing sessions; furthermore, although this was not formally studied, we had the impression that an acutely confused patient could spell a word aloud better than he could write it; and when a patient was asked to compose a word with block letters, he made fewer errors than when he wrote it (we gave him only the letters composing the word). In regard to the other H.C.F., there was impairment in the drawing tasks and minimal difficulty with right-left orientation, finger recognition and calculation.

During the A.C.S. (examination A), the rate of misspelled words covaried with the motor difficulties in writing ($r=0.39$; $d.f.=28$; $p<0.05$), as well as with disturbances in drawing* ($r=0.62$; $d.f.=28$; $p<0.001$). When the scores obtained out of A.C.S. (examination B) were considered, the disturbances on written spelling were correlated with the oral spelling score ($r=0.63$; $d.f.=23$; $p<0.01$), and to a lesser degree, with the educational background ($r=0.39$; $d.f.=23$; $p<0.10$).

DISCUSSION

These results indicate that a writing disorder may be associated with an A.C.S. regardless of the etiology. This writing disorder has common characteristics which vary only in

* Motor difficulties in writing and drawing difficulties were scored according to a three point scale by two independent judges.

severity and which involve the motor and the spatial aspect of writing, as well as spelling and syntax. It is a transient phenomenon which disappears when the A.C.S. has cleared. This dysgraphia is the most striking and the most constant linguistic disorder seen in A.C.S.

The spelling disorder has the following features: a high error rate in consonants and of small grammatical words in their entirety, a high rate of omission and substitution, a high rate of involvement of the last letters of the words.

The fact that a widespread acute cerebral disorder can lead to a relatively isolated dysgraphia seems, to us, to be the most interesting conclusion of this study and may throw a new light on the old problem of pure agraphia (P.A.).

We will review the cases which have been claimed to be examples of P.A. We will not discuss here the "P.A. cases" in which agraphia was associated with disorder of oral language, (ESKRIDGE and PARHILL [16]), reading (MARCUS [17]), or of fine hand movements, (MAHOUDEAU *et al.* [18]). The agraphia, in these cases, was part of a wider syndrome and cannot be considered "pure".

If we focus on the cases in which agraphia was the sole or the most prominent symptom, we are struck by the high proportion of reports in which mention is made of "mental deterioration", "obtundation", "brain atrophy", "increased intra-cranial pressure". Thus, the patient of MCCONNELL [19] was said "to fix his attention and keep his mental machinery in action with difficulty". The patient of SINICO [20] is reported as being in a state of "demenziale progressivo". In the first of HECAEN's series (in which the agraphia is not actually described as "pure" but as a "symptôme privilégié"), 4 out of 7 patients had brain tumors and were obtunded, 2 had cortical atrophy and 1 had been operated on for a frontal epileptogenic scar and was reported as both mentally deteriorated and illiterate, (HECAEN and ANGELERGUES [21]). In HECAEN's second series, 4 patients out of 6 had intellectual impairments, a fifth patient was said to be alert but had a brain tumor; only the last patient, examined only one month after a cerebrovascular accident, was said not to be deteriorated or confused, (DUBOIS, HECAEN and MARCIE [22]).

The famous case of GORDINIER [4] is, to us, no more conclusive: 1—there was an extensive frontal lobe tumor with signs of increased intracranial pressure (diplopia, papilledema); 2—the writing performances demonstrated by his patient (reiterated drawing of curves) might be considered as showing frontal perseveration rather than agraphia. We raise similar objections to the cases of CAMPBELL [13] and the first case of MAHOUDEAU [23].

The case reported by PENFIELD and ROBERTS [24] was a young man, alert preoperatively, who was operated on for a frontal epileptogenic scar and presented an agraphia on the 9th day after the operation. The fact that the agraphia was a delayed and transitory phenomenon at least raises the possibility of a confusional state on the basis of edema. The same problems arise in the case of MORSELLI [25].

The case of NIELSEN [26] was a left-handed man who had always written with the right hand. He developed an agraphia of the right hand alone in association with a right hemiplegia affecting primarily the leg. This clinical picture strongly suggests an anterior cerebral occlusion with probable infarction of the callosum in a patient with speech in the right hemisphere. Although we have much less information about the case of PITRES [27], the same analysis may well apply. These cases thus resemble the case of GESCHWIND and KAPLAN [28] who manifested a left unilateral agraphia. This patient showed other signs of callosal disconnection and subsequent post-mortem confirmation of an infarction of the corpus callosum without any lesion in the right hemisphere.

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In summary, most of the cases in the literature support the idea that an isolated disorder of writing occurs primarily in the presence of a diffuse brain dysfunction. We assume that, with the possible exceptions of one of Hecaen's cases and HENSCHEN's [5] personal case, in which the lesions were vascular, the so called "P.A. syndromes" were the expressions of general brain dysfunctions, not of specific language output disturbances.

DUBOIS, HECAEN and MARCIE [22] have called attention to a relative increase in P.A. in left handed subjects. The reasons for this phenomenon are not clear, and we will therefore not discuss this problem here. We wish to point out that our preceding comments may perhaps not apply to this group, since the possibility of pure agraphia in left-handers on the basis of a different cerebral organization cannot be ruled out at this time.

We do not imply that the dysgraphia found in A.C.S. patients is necessarily identical to the one described in cases of P.A.: (1) impairment of the spatial aspect of writing is more marked and more frequent in A.C.S. than in cases of P.A. These spatial disturbances are similar to those described by MARCIE *et al.* [29] in cases with right-sided tumors. If we assume that an A.C.S. results in a global dysfunction of the cerebrum, the spatial defect we have observed can indeed be accounted for by the right hemisphere involvement. (2) the written spelling disorder in A.C.S. is, on the whole less severe than the ones reported in cases of P.A., in Hecaen's cases, for example. It is possible that a lesion of the left hemisphere might play a role, possibly through involvement of the cortical language areas, in "magnifying" a writing disorder provided by a superadded diffuse brain dysfunction. We would wish, however, to point out that the relatively lower degree of written spelling disorder in our cases may not reflect a true difference but may be a result of patient selection. Since patients were excluded from the study unless they could cooperate for the entire test battery, some more severely involved subjects were almost certainly omitted. We have, in fact, seen clinically patients in A.C.S. with even more severe writing disorders than those described here.

Writing thus appears to be a very delicate, fragile task. Such fragility has been pointed out in the past. DAVIS and DAVIS [30], in an experimental study of hypoxemia in normal subjects, noted that handwriting changed simultaneously with the E.E.G. when the subjects were oxygen deprived; they stated that writing seemed to be "a very delicate indicator of consciousness impairment". BENTON and ABRAMSON [31], in their studies of the GERSTMANN syndrome in patients recovering from electro-convulsive therapy, mentioned the presence of dysgraphia but did not point out any discrepancy between this symptom and the other components of the syndrome.

Why is writing so fragile? It is possible that writing is readily disturbed because it depends on so many components (motor, praxic, visuo-spatial as well as kinetic and linguistic). Furthermore, most normal humans exercise their speaking abilities and their comprehension of spoken language constantly. Many people, although fewer, exercise their reading comprehension abilities very extensively. It is, however, only a minute fraction of the population, even among the highly educated, who use their writing abilities extensively. Writing is therefore very rarely, if ever, an overlearned and automatic skill.

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Résumé—Une étude de l'écriture a été entreprise chez 34 malades en état confusionnel aigu. Les réalisations graphiques de ces malades ont été comparées à celles de 10 sujets témoins ainsi que, pour 24 d'entre eux, à leurs propres réalisations, après régression de l'état confusionnel.

L'écriture était altérée dans 33 cas sur 34. L'altération pouvait concerner les aspects moteur et spatial de l'écriture aussi bien que l'orthographe et la syntaxe. Le trouble de l'écriture constituait chez ces malades le désordre linguistique le plus constant et le plus marqué. Il avait disparu lorsque l'état confusionnel était dissipé. La dysorthographe avait les caractères suivants: fréquence des erreurs concernant les consonnes et les petits mots

grammaticaux dans leur totalité, fréquence des omissions et des substitutions, fréquence des erreurs touchant les dernières lettres des mots.

Le problème de l'agraphie pure est discuté dans le contexte de ces résultats.

Zusammenfassung—Das Schreibvermögen von 34 akut verwirrten Patienten wurde untersucht. Die Ergebnisse wurden mit denjenigen von 10 Kontrollpersonen und von 24 Fällen nach Aufklaren aus dem Verwirrheitszustand verglichen. 33 von 34 Pat. waren schreibgestört. Die Schreibstörung konnte Motorik und Raumgliederung, aber auch Buchstabenordnung und Syntax betreffen. Die konstanteste und ausgeprägteste linguistische Störung bestand hierin. Sie verschwand, wenn die Verwirrtheit behoben war. Die Gliederungsstörung bot folgendes Bild: Starke Fehlerrate bei Konsonanten und bei kurzen grammatischen Wörtern in ihrer Gesamtheit, hohe Auslassungs- und Substitutionsrate, besonders häufiges Betroffensein der letzten Buchstaben im Wort.

Das Problem der reinen Agraphie wurde im Zusammenhang mit den Untersuchungsergebnissen diskutiert.