Writing Profiles

The Effect of the Word Processor on Pausing and Revision Patterns

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This article reports the results of an investigation into how writing processes are affected by the use of the word processor, particularly with respect to patterns of pausing and revision. Eighty instances of writing processes of experienced writers in business environments were examined. Sixty of these instances involved the use of the word processor; twenty involved the use of pen&paper. The data were analyzed in terms of separate characteristics, and in terms of sets of characteristics, i.e., writing profiles. It was found that, in comparison with writers using pen&paper, writers using a word processor (i) spent more time on the first draft of a text and less on finalizing it; (ii) pursued a more fragmentary writing process; (iii) tended to revise more extensively at the beginning of the writing process; (iv) attended more to lower linguistic levels (letter, word) and to the formal properties of the text; and (v) did not normally undertake any systematic revision of their work before finishing.

By clustering the various processes with respect to twelve relevant parameters, a new typology of writing processes was developed, which distinguishes the following five writer profiles: the initial planner, the fragmentary Stage I writer, the Stage II writer, the non-stop writer, and the average writer. It emerged that the profile adopted by writers depends greatly on whether they are using a word processor or pen&paper which might affect the design of writing courses in business contexts.

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In 1750 Chevalier de Béthune, in his book *Relation du Monde du Mercure*, described an amazing little machine:

> I will now speak about the art of writing. If you wish to erase anything you have just written, you can let the words evaporate and replace them with new words. The lines will then automatically move apart and close again after the correction, if you wish. That is very useful, because after rereading once or twice a letter you have written in haste, you always find a repeated phrase that needs removing, poorly constructed sentences or words that are not expressive enough. Often, you wish to rearrange the text, if it turns out that the last part of the text would be better at the beginning, or that a particular passage would be better if it were reordered. [Translated from Weverbergh & Hobana, 1991.]

The machine was indeed amazing - but the fact that, over 200 years ago, de Béthune effectively managed to foresee today's word processor is equally so. He describes ways of adding and deleting text and distinguishes between revisions at the levels of the word, the sentence and the paragraph. Today, it is precisely this sort of flexibility in allowing revisions that many people see as the most attractive feature of the word processor. But the objective correlates of this subjective impression are unclear. In the present study[1], we seek to address this point by providing a quantitative analysis of how the word processor (or computer) affects the writing process.

Our approach has been to examine writing processes from two different angles. First, the writing behavior exhibited by people using a word processor was compared with that of those using pen and paper. (We will refer to the former mode of writing as 'computer mode' and those writing in it as

'computer writers'; the latter mode and those writing in it we will refer to as 'pen&paper mode' and 'pen&paper writers'.) Focusing particularly on differences and similarities with respect to pausing and revising, we found that certain aspects of writing behavior were affected by the mode used. We then examined this writing behavior in more detail and identified a number of basic patterns in the way writers organized the writing process. These writing profiles (as we will call them) were defined as the combination of values given to a set of variables (e.g., the length of time spent on initial planning, the number of revisions made at a particular stage of the writing process, etc.).

Before describing the study in more detail, we provide a short overview of related research into the effect of the computer on the writing process and into the nature of writing profiles.

RELATED RESEARCH

Writing research and computers

Research into the effect of the computer on the writing process has largely focused on the revision process. The hypothesis that computer writers *revise more* than pen&paper writers is confirmed in most studies (see, e.g., Arms, 1983; Bridwell et al., 1987; Case, 1985; Collier, 1983; Fitch, 1985; Gould, 1981; Lutz, 1987). Researchers who didn't register a noticeable difference (e.g., Hawisher, 1987; Kurth, 1986) or who occasionally even observed a decrease in the number of revisions by computer writers (e.g., Harris, 1985; Schriner, 1988) limited their investigation to 'between-draft' and 'after-draft' revisions, a limitation which makes comparison very difficult.

A more important question is whether computer mode influences the *level* at which revision takes place. Previous research is not unanimous on this point. Daiute's hypothesis (1985, p.137) that the word processor encourages the writer to experiment more with textual changes at a higher level is confirmed by only a few studies (e.g., Fitch, 1985; Hawisher, 1987; Schriner, 1988). Most show that it tends rather to encourage revision of formal aspects (such as spelling, punctuation, etc.) and revisions below the level of the sentence (e.g., Balkena, 1984; Bridwell & Duin, 1985; Bridwell et al., 1985; Collier, 1983; Daiute, 1986; Deming, 1987; Joram et al., 1990; Levin et al., 1985; Lutz, 1987). The expected risk-taking behavior encouraged by the ease with which the text on-screen can be manipulated does not, according to those studies, lead to a greater number of revisions at a higher level (i.e., revision of meaning). On the contrary, the greater attention paid to revision at lower levels (i.e., revision of form) apparently distracts the writer's attention from the possibility of revision at higher levels.

Several studies report that texts written in computer mode tend to contain fewer spelling and punctuation errors than texts written in pen&paper mode (Collier & Werier, 1995; Daiute, 1985; 1986; Duling, 1985; Kurth, 1986; Levin et al., 1985; Womble, 1985). This result is not surprising if we take into account that computer writers pay more attention to the formal aspects of the text than pen&paper writers.

Computer writers also tend to write *longer texts* than pen&paper writers. This is one of the few results common to most of the studies that have been carried out in this field.

Writing research and writing profiles

In one of their earliest articles on the writing process, Hayes and Flower (1980) develop an interesting starting point for further research on writing profiles. They elaborate on the distinction between 'Mozartians' and 'Beethovians'(cf. Spender, 1970 cited in Bridwell, 1987). 'Mozartians' are extensive planners who formulate and revise their texts sentence by sentence, whereas 'Beethovians' write a first draft of their text rather quickly with minimal revision, postponing the main revision until a later stage. (Musicologists, it has to be said, do not completely agree with these characterizations.)

Hayes and Flower base their writing typology on thinking-aloud protocols obtained from college students writing in pen&paper mode. They distinguish four writing profiles:

1. *Depth First* The writer tries to produce a perfect first sentence, then a perfect second sentence, and so on. That is, the writer completes the work of planning, implementing and reviewing each sentence before starting work on the next.
2. *Postponed Review* The writer writes down his/her thoughts as they occur and reviews them later.
3. *Perfect First Draft* The writer tries to generate a perfect first draft. Planning is very explicit and directed towards the text as a whole.
4. *Breadth First* A draft is planned and then written out in full before any revision is contemplated.

These writing profiles are described in very general terms. The difference between the first and third types, for instance, is not made very explicit. As far as we know, this typology has never been revised, applied or developed further, either by the authors themselves or by anyone else.

Schwartz (1983) describes another typology which shows some resemblance to that of Hayes and Flower. On the basis of 200 portfolios produced by college writers, Schwartz established a typology of nine profiles. These profiles show how content and form are generated, organized, and reassessed, from ideation to revision. They are grouped into three types:

1. *Language Production and Regeneration Profiles* The writer either writes down more than is needed and then reduces it later (the 'overwriter'); or economizes on the initial text and then adds more later (the 'underwriter').
2. *Structural Reformulation Profiles* The writer rejects the text and starts again (the 'restarter'); or rejects it, making only a few changes (the 'recopier'); or pieces together old sections into a new structure (the 're-arranger'); or builds on the original structure (the 'remodeler').
3. *Content Reassessment Profiles* The writer is concerned with the propriety of the text (the 'censor'); or with its accuracy (the 'refiner'); or with the correctness of its form (the 'copy-editor').

This typology of profiles no doubt constitutes a useful starting point for further research into writing curriculums, but it does not form an appropriate basis for describing the writing process in general. The problem is that the various categories are not mutually exclusive. For instance, a writer may be a 'restarter' when revising one paragraph but a 'rearranger' when revising another.[2]

Severinson Eklundh (1994) studied the effect that the type of writing task being undertaken has on writing strategies, particularly its effect on the linearity[3] of text production on a word processor. Her study suggests that writers change their writing profile depending on the task they are engaged in (reporting, structuring, comparing, arguing, etc.): 'Subjects who use a strictly linear style in a simple, reporting task used a more nonlinear strategy when the task required increased amounts of planning and recursivity.' (215) However, in an experimental study, Levy & Ransdell (1996) found that writing patterns (i.e., profiles) remained highly consistent both within individual writing sessions

and across writing sessions, even when the subject matter of the texts were very different: 'These patterns seem so characteristic of individuals that we have termed them *writing signatures*. Like cursive signatures, they are distinctively different between individuals. And like cursive signatures, they exhibit small and unsystematic differences within individuals across time.' (158)

The present study extends previous lines of research in two ways. First, it shows how writing profiles are affected by the mode of writing being used. Second, in contrast to the qualitative nature of earlier studies[4], it adopts a quantitative approach to the definition of writing profiles.

DESCRIPTION OF THE RESEARCH

The study compared writing produced in two primary modes - pen&paper mode and computer mode - with the latter being further subdivided into a mode involving use of a normal screen (25 lines of text) and another involving use of a DIN A4 format screen (66 lines of text), making a total of three modes. The word-processing software used was WordPerfect 5.1.

To be able to compare writing performance in the three modes, two experiments were set up, in which participants were asked to write two texts, each in a different mode. Forty participants took part in all, twenty in each experiment. In the first experiment, participants were asked to write one text on a computer with a 25-line screen and the other on a computer with a 66-line screen. In the second experiment, 20 different participants wrote one text in pen&paper mode and the other on a computer with a 25-line screen. These experiments generated a total of eighty separate writing processes and some 200 hours of writing.

Participants

The participants were university faculty and graduate students, 27 males and 13 females. All used the computer for word processing on an almost daily basis and had had at least two years' experience in doing so. All wrote a great deal for their work, writing comprising 15% or more of their total work load. They all wrote the texts in the experiments in their mother tongue, which was Dutch.

Writing tasks

Participants were set two tasks, each of which involved writing a report. In one case they had to write a report about the introduction of a new system of bank charges; in the other, they had to write a report about company regulations for in-service training. The resulting text had to be two to three pages of typescript.

Two days before they were required to undertake each task, participants were provided with an outline of the communicative context of the report on the topic in question, plus certain data relating to the contents of the report.

In each experiment, the participants were divided into four groups of five and the tasks were offered sequentially crosswise, spread over the two writing conditions (Latin square design). This was in order to eliminate any effect of the order in which participants used the modes or performed the tasks.

Under experimental conditions, participants were then allowed between two and three hours to complete the task. Participants writing in pen&paper mode were asked to produce a text that could immediately be typed out by a secretary without the need for further instruction. Participants writing in computer mode had to print out their final text. These participants were also free to print their text out at any intermediate stage of the writing process, and were also free to make notes with pen and paper at any time.

Observation

The method used to observe the writing processes had to meet three principal requirements:
- it should yield as detailed a picture of the writing process as possible;
- its results should be quantitatively comparable; and
- it should not affect the writing process itself.

Accordingly, the performance of each participant writing in pen&paper mode was recorded on video; while that of each participant writing in computer mode was recorded using automatic keyboard registration linked to a resident computer program (Keytrap[5]). This program registered every key stroke and also the time lapse between strokes (1/18 sec) and enabled the exact reconstruction of the on-screen writing process and automatic analysis of certain data. These observations were supplemented by interviews held before and after the experiment.

In order to create a basis upon which the data thus obtained could be easily compared and analyzed, the pen&paper performance was transferred letter by letter from the video recording to a process log file in WordPerfect macro format. The pauses were subsequently inserted manually by the researchers into the linear data storage.

These methods of observation enabled full and exact reconstruction of the writing process (from the first letter to the final revision) which was pursued by each participant during each task and in each mode.

Analysis

The analysis of the data focused on variables relating to three aspects of the writing process. These variables were later used to construct writing profiles. The three aspects and their associated variables are listed below.

1. Time taken and final product
Total duration of the writing process
Duration of each stage of the process
A distinction was made between Stage I (from initiation to the completion of the first draft) and Stage II (from the completion of the first draft to the completion of the final version).

Ratio of time spent pausing to time spent actively writing
Number of words in final text

2. *Pausing behavior*

Duration of pauses

Number of pauses

Type of pause

A distinction was made between pauses followed the formulation of new text ('formulation pauses') and those followed by the revision of existing text ('revision pauses'). (see Matsuhashi, 1987, p.208)

Linguistic location of pauses

Three locations were selected as relevant: within the sentence; at sentence boundaries; and at paragraph boundaries.

Temporal location of pauses ·

The total time spent on the task was divided up as follows: functionally, into Stage I and Stage II (see above); absolutely, into 10-minute segments; and relatively, into ten equal units, whereby units 1-5 and units 6-10 are also referred to as Part 1 and Part 2, respectively.

3. *Revision behavior*

Number of revisions

Type of revision

Addition, deletion, substitution, reordering

Level of revision

Letter, word, phrase, sentence, paragraph; lay-out, punctuation.

Purpose of revision

Correction of typing errors, revision of form, revision of content.

Location of revision

Title, first paragraph, first sentence of paragraph, elsewhere

Remoteness of the revision

Measured in terms of the number of lines above/below the point of inscription

Temporal location of revision

Stage, segment, unit (see above).

The result of the observation and analysis described above was a highly detailed account of the differences in writing behavior between the modes investigated, for the participants as a group and as individuals. The method was shown to be reliable by a comparison of two experiments whose participants were from two corresponding subgroups (n=20).

WRITING CHARACTERISTICS AND COMPUTER MODE

The principal results of the analysis of the variables (combining the results of both experiments) are given below, grouped in accordance with the threefold division made above.[6]

Time taken and final product

The 24-line computer mode and the pen&paper mode do not differ significantly with respect to the duration of the writing process as a whole (see Table 1). However, there is a significant difference with respect to the time spent on each Stage. The time spent on Stage I by computer writers was half that which was spent on the same stage by pen&paper writers. Texts written in computer mode were also approximately 20% longer than those written in pen&paper mode.

Table 1: Writing time and mean number of words in final text (computer vs. pen&paper)

| | Average duration (min.) | | Column % | | |
	Computer	P&P	Computer	P&P	sign°
Stage I	102.05'	74.45'	84.9	65.7	*
Stage II	18.20'	38.95'	15.1	34.3	*
Total duration	120.25'	113.40'			NS
No. of words	843	695			*

° p-value calculated with the Wilcoxon Matched-pairs Signed-rank Test based on average values per participant
* $p < 0.05$

Pausing behavior

Analysis of pauses longer than 3 seconds revealed a clear difference between the modes with respect to pausing behavior. The results are shown in Table 2. Computer writers paused approximately 70% more often than pen&paper writers. This suggests that use of a word processor tends to result in a more fragmented writing process.

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Table 2: No. of pauses (computer vs. pen&paper)

| | Average | | Column % | | |
	Computer	P&P	Computer	P&P	sign°
Type of pause					
Formulation pause	171.5	90.3	54.7	50.1	NS
Revision pause	142.2	89.9	45.3	49.9	NS
Linguistic location of pause					
Within sentence	245.9	108.6	78.4	60.2	*
At sentence boundary	41.8	41.1	13.3	22.8	*
At paragraph boundary	25.9	30.5	8.3	16.9	*
Total	313.7	180.2			*#

° p-value calculated with the Wilcoxon Matched-pairs Signed-ranks Test based on column percentages per participant
p-value calculated with the Wilcoxon Patched-pairs Signed-ranks Test based on average/mean numbers per participant
* $p < 0.05$

Revision pauses constitute 45-50% of all pauses. However, the distribution of formulation and revision pauses over the two modes differs. In pen&paper mode, the proportion of formulation pauses to revision pauses in Stage I is 70:30, compared to 60:40 in computer mode. In Stage II, the proportion of the two types of pause in each mode is more or less reversed.

The two modes also differ clearly with respect to the location of pauses. Computer writers tended to pause more within the sentence than pen&paper writers. Pen&paper writers paused at sentence and paragraph boundaries twice as often as computer writers, with approximately 40% of their total number of pauses occurring there, as against 20% for computer writers.

The two modes differ even more strikingly with respect to the average length of the pauses made. The results of the analysis are given in Table 3. Pen&paper writers, as we saw above, tend not pause as often as computer writers. Now we see that when they pause they tend to pause longer. In fact, as can be seen from Table 3, pauses made by pen&paper writers were anything up to twice as long as those made by computer writers.

Table 3: Duration of pause (computer vs. pen&paper)

	Computer	P&P	sign°
Type of pause			
Formulation pause	12.48 sec	25.59 sec	*
Revision pause	11.36 sec	16.71 sec	*
Linguistic location of pause			
Within sentence	9.59 sec	11.40 sec	NS
At sentence boundary	16.19 sec	20.85 sec	*
At paragraph boundary	27.78 sec	56.28 sec	*
Total	11.97 sec	21.16 sec	*

° p-value calculated with the Wilcoxon Matched-pairs Signed-ranks Test based on average length per participant
* $p < 0.05$

The table shows that, both with respect to pause type and linguistic location, pause length differs significantly between the two modes. In all categories except one (Within sentence), pauses made in pen&paper mode were significantly longer than those made in computer mode. Formulation pauses made by pen&paper writers, for example, were on average twice as long as those made by computer writers; and their pauses at paragraph boundaries were also much longer. Taking these data together with the higher percentage of pauses at paragraph boundaries exhibited by pen&paper writers, it can be seen that almost half (45%) the total time spent pausing in pen&paper mode was spent at paragraph boundaries. By contrast, computer writers paused there only 20% of the time.

Revision behavior

A total number of 6,434 revisions were recorded. Approximately 30% of these were typing errors. Since this type of error naturally only appears in computer mode, it was excluded from further analysis.

The results of the analysis of revision behavior are given in Table 4. In general, they show that computer writers do not revise significantly more often than pen&paper writers. However, analysis of the sub-categories revealed the existence of more clear-cut differences between the two modes. The following account is restricted to those findings which indicate significant differences between the two modes.

Table 4: No. of revisions per writing process according to level, purpose, remoteness and distribution (computer vs. pen&paper; typing errors excluded)

	Average		Column %		
	Comp	P&P	Comp	P&P	sign°
LEVEL					
Letter	14.1	2.5	11.4	2.6	*
Word	46.6	41.9	37.7	44.1	*
Phrase	36.7	37.6	29.7	39.5	NS
Sentence	6.3	5.5	5.1	5.8	NS
Paragraph	2.5	2.3	2.0	2.4	-
Lay-out	10.5	2.4	8.5	2.5	*
Punctuation	6.7	2.9	5.4	3.1	*
PURPOSE					
Content	94.8	81.0	76.8	85.1	*
Formal	28.7	14.1	23.2	14.9	*
REMOTENESS					
Within the line	75.0	58.6	60.8	61.0	NS
2-10 lines	36.4	30.6	29.5	31.8	NS
11-24 lines	5.3	3.6	4.2	3.7	NS
≥25 lines	6.8	3.4	5.5	3.5	NS
DISTRIBUTION					
Stage I	101.7	47.9	82.4	50.3	*
Stages II	21.7	47.2	17.6	49.7	*
Part 1 (Units 1-5)	57.3	34.7	46.4	36.3	*
Part 2 (Units 6-10)	66.1	60.4	53.6	63.7	*
TOTAL	123.4	95.1	56.5	43.5	NS#

° p-value calculated with the Wilcoxon Matched-pairs Signed-ranks Test based on column percentages per participant.
p-value calculated with the Wilcoxon Matched-pairs Signed-ranks Test based on the average number of revisions per participant.
* $p < 0.05$

Level of revisions

The two modes differed clearly with respect to the preferred level of revision. Computer writers tended to revise more at the level of the letter, whereas pen&paper writers tended to revise more at the level of the word. With respect to the revisions made above word level, although in absolute terms the two modes are similar, in proportional terms they clearly differ. In computer mode, revisions at the higher levels constitute 42.8% of the total, compared with 50.6% in pen&paper mode, suggesting that pen&paper writers tend to revise at a higher level than computer writers.

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Purpose of revisions

In analyzing the purpose of the revisions, a distinction was drawn between revisions which directed toward changing content, and those which were directed toward changing form (e.g., spelling, layout, concord, etc.). A comparison of the modes with respect to this aspect revealed that almost one in four revisions made by computer writers were form-oriented, compared with only one in seven in the case of pen&paper writers. This greater attention paid to formal revision by computer writers turned out to be essentially cosmetic in effect, as it did not result in any reduction in the amount of revision at the level of content.

Remoteness of revisions

The remoteness of a revision was expressed in terms of the number of lines intervening between the point of inscription and the point of revision. A distinction was made in the vertical direction of the revision operation between upward (+) and downward (-) movement.

Analysis showed that in both modes revisions were distributed evenly over the various categories: approximately 60% of the revisions took place within the line being composed and could therefore be classified as 'immediate' or 'non-remote' revisions. However, some 10% of the revisions were made more than 10 lines away from the point of inscription.

The even distribution noted above implies that computer writers tend to revise more across the whole range of distances: they revise more within the line, and more at greater distances. They made twice as many revisions in the most remote category (a distance of 25 lines or more) than pen&paper writers, for instance.

Further analysis taking into account also the vertical movement of the revision operation reinforces this conclusion. Pen&paper writers, especially at Stage II, were inclined to read and revise their text systematically, starting at the beginning and working through to the end. This systematic, sequential revision process is reflected in the fact that the downward movement proceeded through the text in relatively small steps.

With respect to the vertical direction of the revision, pen&paper writers had a clear preference in Stage II for revisions within the line and revisions involving downward movement of less than 5 lines. Computer writers also performed this type of revision but, unlike the pen&paper writers, they tended to use them evenly throughout writing process.

Distribution of revisions

The modes differed with respect to the distribution of the revisions over the two stages. Pen&paper writers, for instance, made approximately 50% of their revisions during Stage II, compared with computer writers' 17%. This clearly confirms the impression gained from the analysis of temporal considerations and pausing behavior. Pen&paper writers reserve plenty of time for a second stage, during which they subject their text to quite elaborate revision.

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WRITING PROFILES[7]

The quantitative analysis of the writing processes described above was then taken as the basis for developing a typology of writing profiles in which the interplay of planning and revision behavior was central. Variables were selected from the above analysis and supplemented by others taken from the typology of Hayes & Flower (1980, see above).

The resulting typology is described below, preceded by an account of the statistical methods used to construct it and followed by a discussion of how the profiles are affected by the use of the word processor.

Method

The first step in developing the typology was to perform a cluster analysis[8]. Cluster analysis, although a useful tool for detecting structure in data, does not itself determine structure, and the method used here should therefore be seen as providing no more than a guideline to possible writing typologies.

The construction of the typology proceeded according to the following steps:
1. Selection of the variables for cluster analysis;
2. Cluster analysis;
3. Discriminant analysis.
A detailed account of the process cannot be given here for reasons of space, but the various steps may be described briefly as follows. We started with as many variables as possible and then eliminated those that showed a high correlation, since such variables, being linked in the same dimension, might skew the clustering. This process led to the selection of a total of 12 variables which were deemed to characterize relevant aspects of the writing process. These variables are listed in Table 5.

Table 5: Variables used in the cluster analysis to characterize certain aspects of the writing processes

Revisions	· Proportion of revisions in Stage I as compared to Stage II
	· Total no. of revisions in Stage II
	· Total no. of revisions in Part 2
	· Proportion of revisions above word level
	· Total no. of revisions (typing errors excluded)
	· Ratio of number of words to number of revisions
Pauses	· Duration of initial planning (in seconds)
	· Total no. of pauses
	· Average duration of pauses (in seconds)
	· Average total time spent pausing (in minutes)
	· Degree of recursion (the number of times that a formulation pause was followed by a revision pause)

Total duration of the writing process

With these twelve variables, the cluster analysis was then performed on the writing processes recorded for each of the 40 participants in each of the two modes (12 × 80). All variables for the cluster analysis were recalculated to the Z-value so that the variables all had the same weight, since the average of the Z-scores for all variables is always 0 and the standard deviation 1.

Finally, a discriminant analysis was performed on the results of the cluster analysis. This clarified the number of groups and offered insight into the discriminatory value of each variable (Wilks' step-by-step input).

Cluster analysis on the basis of the complete linkage method yielded the purest classification, which was a classification into five groups. The discriminant function assigned about 90% of cases to the correct cluster. Furthermore, discriminant analysis with step-by-step input showed that eleven of the twelve variables contributed to the classification. Only the variable 'total duration of the process' failed to be discriminatory and is therefore left out of account below.

Typology of writing profiles

As noted above, cluster and discriminant analysis of the data of the 80 writing processes yielded five different clusters. These clusters effectively form quantitative descriptions of writing profile types (or writing profiles, for short). Table 6 shows the results of the analysis, based on eleven discriminatory variables.

Table 6: Quantitative descriptions of writing profile types

Types	1	2	3	4	5	Average
Revisions						
Stage I (%)	81	76	89	34	82	77
Stage II (total)	16	28	17	88	10	26
Part 2	54	64	82	93	30	61
Above word level (%)	35	38	38	54	28	37
Total no.	87	119	151	133	55	108
No. of words / No. of revisions	10	7	7	6	15	9
Pauses						
Initial planning (total, in sec)	1310	332	235	824	319	448
Total no.	229	283	364	201	173	259
Average duration (sec)	21	12	12	20	15	14
Average time spent pausing (min)	76	57	70	67	40	59
Recursion	62	79	105	33	42	68
Number of persons°	7	24	19	9	20	

° One extreme outlier was excluded, reducing the total number of participants to 79.

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The profile types thus established cannot be located along the continuum of a single variable. Each profile consists of a well-defined combination of the variables. For convenience and clarity, each profile has been given a characteristic name: although this name is (for the most part) based on the most discriminatory variable in the profile, it should be taken to represent all values of the variables in that profile.

Profile 1: Initial Planners
Initial Planners tend to make relatively few revisions, especially during Stage II. They pause a great deal during initial planning. Their pauses tend to be relatively long and the total time spent pausing is significantly above average.

Profile 2: Average Writers
The profile of Average Writers shows a value for each variable which is closest to the average value for that variable over all the profiles. Average Writers occupy a medial position with regard to users of other profiles.

Profile 3: Fragmentary Stage I Writers
Fragmentary Stage I Writers tend to make most of their revisions during Stage I of the writing process. Although in total they make more revisions than users of other profiles, they make few revisions during Stage II. They devote little time to initial planning. They pause often during writing, but their pauses are of relatively short duration. Fragmentary Stage I Writers therefore follow a writing process which is highly fragmented and characterized by a high degree of recursion.

Profile 4: Stage II Writers
Stage II Writers make most of their revisions during Stage II of the writing process. Many of these revisions are made at a level above the word; and in relation to the total number of words in the final text, the number of revisions is high. Stage II Writers spend time on initial planning, but once they start writing, they pause relatively infrequently. However, any pauses they do make are relatively long. There is only a slight degree of recursion.

Profile 5: Non-stop Writers
Non-stop Writers show relatively low values for most of the variables. They revise less often than the other writers. In relation to the total number of words in the final text, they make relatively many revisions. In percentage terms, they make fewer revisions during Stage II and Part 2. They make relatively few revisions above the level of the word. Non-stop writers pause less often than all other writers: their total time spent pausing is clearly below average. Additional analysis showed that Non-stop Writers tend to spend little time on initial planning and tend to complete the writing task more quickly than others.

Writing Profile and Writing Mode

Writers do not always adhere to the same profile. Figure 1 shows the relationship between writing profile and writing mode. The matrix on the left shows the shifts in writing profile made by participants during the first experiment (computer vs. pen&paper); the matrix on the right shows the shifts made during the second experiment (25-line screen vs. 66-line screen). The matrices should be read as follows. Two writing profiles can be determined for each participant. For example, in the left-hand matrix, the 2 in Column 5, Row 2 shows that two participants in the first experiment adopted Profile 2 when using the 66-line screen. The same two participants adopted Profile 5 when using the 25-line screen. The digits along the diagonal of the matrix show the number of participants who did not change their writing profile when changing writing mode.

*** Figure 1 (somewhere here) ***

Two facts emerge clearly from the matrices in Figure 1: no pen&paper writer adopted Profile 3; and no computer writer adopted Profile 4.

Clearly, the preferred profile of pen&paper writers was Profile 4: it was adopted in 9 of the 19 cases in which writing was performed in pen&paper mode. The relatively large difference between Profiles 3 and 4 to a great extent corresponds to the difference between the two modes which emerged from the analysis of pausing and revision behavior. In both absolute and relative terms, the revision behavior of writers adopting Profile 4 is strongly concentrated in Stage II of the writing process; they also make more revisions above word level. On average, Profile 4 writers spend three times as much time on initial planning as Profile 3 writers. They pause much less often throughout the entire process, but the average length of pause is longer. The degree of recursion in Profile 4 is much less than that in Profile 3.

Figure 1 also shows that writers particularly tended to change their profile when they changed writing mode in the second experiment. Such shifts seemed to occur less frequently during the first experiment. In the first experiment, writers used both 25-line and 66-line computer screens. Figure 1 shows clearly that writing profiles are less affected by a change in screen mode than by a shift from computer to pen&paper mode. More than half the writers in the first experiment (11 out of 20 participants) adopted the same writing profile in each mode. Only a few shifts occurred and they were in the direction of a closely related cluster. For example, as can be seen from the Figure, three Average Writers (Profile 2) became Initial Planners (Profile 1) when they changed from the 66-line screen to the 25-line screen. Both the cluster and discriminant analyses show Profiles 1 and 2 as being the two clusters most closely related to each other.

The matrix of the second experiment shows a completely different picture. Only two writers retained the same profile when using the two different modes. This suggests that writers do not necessarily transfer their pen&paper profile to computer mode. The extent to which they adapt their way of writing varies, depending on their preferred writing behavior. Moreover, different writers adapt their way of writing in different ways.

Writers who, in pen&paper mode, used Profile 4 (Stage II Writers) shifted to Profiles 2, 3, or 5 when writing in computer mode. Each of these shifts entailed certain changes from the typical pattern

of writing behavior represented by Profile 4. In general, the impact is greatest for those variables related to Stage II revision, the level at which revision takes place, the degree of recursion, and the amount of initial planning.

Even most of the pen&paper writers who were using a profile that was transferable to computer mode (Profiles 1, 2 and 5) tended to modify their profile. Figure 1 shows that four out of six Profile 5 writers (Non-stop Writers) shifted to Profile 3 (Fragmentary Writers) when they changed to computer mode. These were mainly writers who revised and paused less often, especially during Stage II. When they shifted to computer mode, they adopted a profile which involved more pauses and revisions. The total amount of time spent pausing increased greatly and the amount of recursion doubled. The ratio of the number of words to revisions increased by 50%.

DISCUSSION AND CONCLUSION

Writing profiles seem to be clearly influenced by the writing mode. The differences between the profiles adopted by computer writers and those adopted by pen&paper writers lie mainly in the following areas:
- the level at which revisions are made;
- the way the revisions are distributed throughout the writing process;
- the degree of fragmentation of the writing process.

Level of revisions
The percentage of revisions made above word level in the profile predominantly used by writers in pen&paper mode (Profile 4: Stage II Writers) is at least one-and-half times that found in the other profiles. It was noted above that computer writers tended to revise more at the level of letters than pen&paper writers. This may be explained by the fact that, at this low level, computer writers tend not to delete the part of the word that does not need to be changed, even if it consists of only a few letters; and we observed that they often deleted a word before it had completely appeared on the screen. Such strategies are hardly ever efficient for writers using pen&paper. Pen&paper writers are more inclined to cross out a whole word, probably in order to maintain the readability of the text. To a great extent, the large number of low-level revisions made in computer mode are the result of "mechanical" considerations, and often serve the same purpose as revisions made at and above word level in pen&paper mode.

Distribution of revisions
Another notable characteristic of the profiles predominantly used by computer writers is the high percentage of revisions made during Stage I of the writing process. It was noted that pen&paper writers have a tendency to reread and revise the text systematically, working from beginning to end. The result is downward, step-by-step revision, moving relatively small distances at a time through the text. Computer writers, on the other hand, seem to revise in smaller units throughout the writing process.

The process of fragmentation
Finally, another distinctive difference that emerges between the profiles preferred in each mode is the degree of fragmentation.

The large number of short pauses within the sentence which occur in rapid succession in the writing of computer writers results in a writing process in which planning, formulation and revision are strongly focused on relatively small units of text. Computer writers were found to switch very often between formulation pauses and revision pauses, indicating a high degree of recursion. For pen&paper writers, however, the writing process took place in longer episodes and their pausing behavior seems to be less locally-oriented. The degree of recursion is also less.

One explanation for the greater degree of fragmentation and recursion in computer mode is the awareness of what we may call 'word processing comfort'. During the writing process, writers are aware of the fact that, at any moment during writing, they can alter their text without creating an illegible jumble of crossed out and inserted words. This means that writers can start typing a sentence without knowing how it will end. They ask themselves questions such as 'Does this sentence (or part of a sentence) mean what I meant it to mean?' immediately after they finished writing it, and, indeed, even before they have finished. The result is short pauses, often within the sentence.

Pen&paper writers pause longer, mostly at sentence or paragraph boundaries. This suggests that pen&paper writers tend to plan their sentences and paragraphs mentally, evaluating and revising them mentally, and only proceeding to write them down after those phases have been completed. Writing with pen&paper is usually slower, and revision on paper often results in the text having a messy appearance.

An additional explanation for the greater degree of fragmentation and recursion in computer mode is the limited initial planning typical of this mode. The average time spent on initial planning in the dominant pen&paper profile (Profile 4) was more than twice that found in the dominant computer writing profiles (Profiles 2 and 3). Computer writers apparently start writing sooner than pen&paper writers. The presence of the computer itself, with its flashing cursor, seems to be an invitation to start text production immediately (cf. the concept of 'the seductive screen': Bridwell et al., 1987; Daiute, 1985; 1986; Haas, 1989a; 1989b; 1996).

This relative lack of initial planning undoubtedly affects the rest of the writing process. In the absence of any real, explicit text structure, the writing process is naturally more fragmented and shows a higher degree of recursion. Such an ad hoc way of working leads to many more conceptual modifications during the writing process, and these may entail a fundamental change in the degree of recursion.

Less initial planning seems to affect the distribution of the longer pauses in the writing process. Analysis of the distribution of pauses in terms of time segments shows that more than half the longer pauses in pen&paper mode occur at the beginning of the writing process. There is a second concentration of longer pauses at the start of Stage II (the proofreading phase). It is precisely these pauses that are responsible for the longer average length of pauses in pen&paper mode.

In computer mode, on the other hand, longer pauses are much more evenly distributed throughout the writing process. Here, too, a similar concentration of longer pauses at the beginning of Stage II can be seen, although it is much less well-defined.

These findings suggest that writing with the computer calls for a different distribution of conceptual planning effort in the writing process: rather than being concentrated at the beginning of the writing process, it is spread more evenly over the writing process as a whole.

From the research of Haas (1989b) and Matsuhashi (1987), it may be concluded that rhetorical

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and conceptual planning and revision lead to relatively long pauses, whereas sequential planning and revision entail much shorter pauses. In our data, this can be clearly seen in the fact that the average duration of a pause varies depending on its location: pauses at paragraph boundaries, for instance, which may be assumed to be largely conceptual or rhetorical in nature, are on average 2.5 times longer than pauses within the sentence, which are sequentially-oriented. In other words, the broad spread of longer pauses throughout the writing process in computer mode may be interpreted as a strategic extension of the initial planning phase over the entire writing process.

We have presented here a typology of writing profiles, based on cluster and discriminant analyses of writing processes. A set of variables derived from the writing process itself was used as input to the analyses. Unlike earlier typologies, which often relied on vaguely formulated writing variables, our typology has the advantage that it is quantitatively defined and is susceptible to quantitative interpretation.

The writing profiles which emerged from this study show clearly that writers organize their writing in several different ways. Specifically, it appears that the writing process is strongly affected by the mode in which writing is performed: certain profiles are predominant in computer mode, while others prevail in pen&paper mode.

Our findings also show that, when writers who have been using pen&paper mode change to computer mode, they also change their writing profile. The extent to which the writing process is affected by this change of mode varies from person to person. However, it may be said that those pen&paper writers whose writing profile is similar to profiles more frequently encountered in computer mode tend to alter their writing profile less substantially when changing to computer mode. Conversely, writers who exhibit typical pen&paper characteristics (such as more elaborate initial planning and a preference for revision in the later stage of the writing process) tend to modify their writing process much more radically when changing mode.

NOTES

1   This research is described in greater detail in the first author's doctoral dissertation (Van Waes, 1991a), which was supervised by the second author.

2   Schwartz describes various approaches to writing in a teaching environment. Her writing strategies bear a close resemblance to Flower's writing heuristics described in her handbook for writers (1981) and the 'composing patterns' of Williamson & Pence (1989), who distinguish linear revisers, intermittent revisers and recursive revisers.

3   By linearity, she is not referring to the composition of text, word by word, sentence by sentence, until it is complete. Rather, she sees linearity as a continuum along which writing sessions may be located. She provides a negative definition: 'nonlinear writing means that high-level text-editing operations - insertions and substitutions of large text passages - are regularly made at a distance from the current point of insertion.' (Severinsson Eklundh, 1994, p.204).

4   Wyllie (1993) constructed a typology of writing strategies on the basis of a survey of academic writers and student writers. She found five types of writers, giving them the evocative names of Watercolorist, Architect, Bricklayer, Sketcher and Oil Painter. Other researchers have taken a quite different approach to this topic, basing themselves not on the writing process itself but on certain elements that affect the writing process, such as the personality of the writer (e.g., Jenssen & Di Tiberio, 1984) or the characteristics of the thinking process (e.g., Harris & Wachs, 1986).

5   The basis of *Keytrap* was developed by IBM, Brussels. H. Pauwels (University of Antwerp, UFSIA) updated the

program and wrote the necessary application software. For a detailed description of the program, see Van Waes (1991a), Van Waes & Van Herreweghe (1995) and Janssen, Van Waes & Van den Bergh (1996).

6   The differences in the writing processes of writers using 24 or 66-line screens will not be dealt with at length here: see Van Waes (1991a; 1991b) for a detailed analysis. Briefly, this analysis shows that, in certain respects, the 66-line computer mode occupies an intermediate position between the 24-line computer mode and pen&paper mode. This mainly applies to the level at which revisions are made. Writers working on the larger screen seem to pay more attention to revisions at the level of words, sentences and paragraphs, rather like pen&paper writers, but unlike computer writers using the traditional 24-line screen, who tend to revise at the level of the letter. This is particularly the case in the later stage of the writing process (the proofreading phase), when the size of the screen may play an important role.

    On the other hand, writing in both computer modes is characterized by relatively little initial planning and little proofreading effort. By contrast, in pen&paper mode, both planning and proofreading are given considerable attention. This suggests that the size of the screen and the amount of text visible on it are not the complete explanation of the difference observed in pausing and revising behavior between computer and pen&paper modes. We believe that, ultimately, a number of differences in the organization of the writing process have their origin in the characteristics of the computer itself.

7   This section is based on Van Waes (1992b).

8   See Aldenderfer & Blashfield (1984) for a very accessible account of the procedures used in cluster analysis.

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Experiment 1:
computer 25 lines vs. 66 lines

Experiment 2:
computer 25 lines vs. pen&paper

computer 25 lines

Profile	1	2	3	4	5
1	1				
2	3	3			2
3		3	3		
4					
5		1			4

(left label: 6 6 1)

computer 25 lines

Profile	1	2	3	4	5
1		2			
2		1	1		
3					
4		3	4		2
5		1	4		1

(left label: p & p)

Figure 1   Relationship between writing profile and writing mode. Distribution and shifts of writing profiles.