INFLUENCE OF SCRIPT STRUCTURE ON PUNCTUATION

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Abstract

The influence of script structure on punctuation was studied. The general hypothesis was that punctuation is used to indicate the degree of separation between adjacent elements in the surface structure. The hypothesis was tested with a three-step experiment. First, the hierarchical structure of two texts was determined by asking subjects to sort out the propositions in the texts, then by representing the results by an additive tree. The goodness of fit found between the additive-tree metric and the sorting matrix suggests that subjects basically agreed on the script structure. Second, the subjective degree of separation induced by the punctuation marks was estimated by asking subjects to rate each mark on a seven-point scale. Results were analyzed using optimal scaling (also known as correspondence analysis, dual scaling, or reciprocal averaging), which gives an optimal estimation (in a least squares sense) of the degree of separation of an interval scale derived from the rating scale used by the subjects. Third, a new group of subjects was asked to write out the texts, adding punctuation marks. A regression analysis with interproposition distance as the independent variable and scaled punctuation as the dependent variable indicated a very high correlation (.903 and .801, p<.0001). Thus, script structure is an important determinant of punctuation.

The aim of this paper is to show the effect of the structure of a particular kind of schema — namely a script — on the use of punctuation marks. Punctuation marks are interpreted as the "surface traces" of deeper cognitive operations such as chunking of or discriminating between pieces of information.

The notion of *schema* originated in Bartlett's (1932) classical work, and is used currently to refer to a Long Term Memory structure dealing with concepts and their organization (Rumelhart, 1980; Schallert, 1982). Schemata are created by induction, and possess constants and variables. They are automatically activated in familiar situations, and then guide comprehension and action (Rumelhart, 1981; see Fayol, 1985, pp. 45-62 for a review).

A script is generally defined as a particular kind of schema (or frame; cf. Friedman, 1979, for a discussion of these notions) which acts as a general knowledge framework that leads to expectations of different events. A script is a cognitive structure that refers to a relatively fixed series of events (Abelson, 1981; Schank & Abelson, 1977).

The psychological validity of scripts has been investigated in several experiments (e.g., Mandler & Goodman, 1982). Specifically, Bower, Black, and Turner (1979) showed in their classic study that subjects agree on the basic elements of a script as well as on the "chunking" of script elements. Several experiments have shown that typical elements in a script are processed faster than atypical ones, and that scripts are processed faster when the order of the events in the script is followed (Uyl & Oostendorp, 1980; Belleza & Bower, 1981, 1982). Moreover, the "on-line" processing of scripts is facilitated when the exposition order is the chronological order (Haberlandt & Bingham, 1984).

Scripts influence information processing not only at the encoding level but also during storage: input information combines with that made avail-able by the script to give a "composite trace" in episodic memory (Yekovich & Walker, 1986). As a consequence, highly typical items of a script are recalled or recognized even when they are absent from the story (Bower et al., 1979; Pompi & Lachman, 1967; Dooling & Lachman, 1971). Intrusions do not occur with atypical items since they are easily identified — at least in the short term — due to their high saliency (Graesser, 1978, 1981; Graesser, Woll, Kowalski, & Smith, 1980; Nakamura & Graesser, 1985; Nakamura, Graesser, Zimmerman, & Riha, 1985; Smith & Graesser, 1981).

The interpretation of these results in recognition or recall tasks can be made within concurrent theoretical frameworks. For example, Graesser et al. (1980) propose a model (Schema-Pointer-Plus-Tag), whose aim is *only* to give an account of data related to scripts. However, other authors (cf. Yekovich & Walker, 1986) integrate these results pertaining to the scripts into a broader conception of human memory. In fact, the interpretation of these phenomena depends strongly upon the knowledge we have about the structure of scripts. Several studies have suggested that scripts are likely to have a "double struc-

ture". That is, scripts show the properties of both linear orders (Galambos & Rips, 1982; Nottenburg & Shoben, 1980) and hierarchies (Abbott, Black, & Smith, 1985; Barsalou & Sewell, 1985). Thus, when the task given to the subjects deals with the order of the items of the script, three effects typically associated with linear order are observed (Nottenburg & Shoben, 1980):
- symbolic distance effect,
- semantic congruence,
- serial position effect.

On the other hand, when subjects are asked to make judgments of attribution, typicality effects "*à la Rosch*" (cf. Rosch & Mervis, 1975) are observed, with typical items leading to a faster decision than atypical ones (Galambos & Rips, 1982). Consequently, as stated by Barsalou and Sewell (1985), in some general sense scripts and categories seem to share several features (i.e., superordinate relations, representation of dimensional properties). Nevertheless, some differences are likely to appear when scripts and categories are compared at a more specific level. All in all, it nevertheless seems that scripts have the potential to show either a hierarchical or a linear structure depending upon task demand (Fayol & Monteil, in press).

Abbott et al. (1985) proposed a synthetic approach to scripts in order to give an account of the empirical data reviewed previously. According to their formulation, a script is organized into three levels. The upper level (*script header*) activates all the elements of the script. The intermediate level (the *scene headers*) corresponds more or less to the Rosch's "basic level" (1973). It involves main conceptualizations or episodes subsuming the *elementary actions* which constitute the third level (more or less equivalent to Rosch's subordinate level). The Abbott et al. (1985) model remains untested for production tasks. Indeed, the effect of scripts on production seems to have been largely ignored except for the determination of the elements of the scripts (Bower et al., 1979) and the verification of the canonical script-order facilitation (Barsalou & Sewell, 1985). Nonetheless, script structure probably influences other psycholinguistic activities.

One main problem with the script structure is its actualization on the surface of texts. Indeed, due to the linear structure of language, two propositions that are close to each other are — in general — expected to be closely related (Ochs, 1979). However, that relation does not always hold. As a consequence, it is necessary to have a system of signs capable of indicating the extent to which spatially close propositions are related meaningwise. Besides the syntactic and pragmatico-semantic characteristics of the sentences, a diacritic system like punctuation seems to be a good candidate for that role.

The aim of this paper is to show that the hierarchical organization of scripts influences the use of punctuation marks. Specifically, the hypothesis to be tested states that punctuation marks are used to indicate the extent of the separation between spatially adjacent elements on the surface of the text (Fayol, 1981, 1985, 1987; Fayol & Lété, 1987).

Contrary to some other linguistic subsystems, punctuation has not been investigated frequently by psychologists and psycholinguists. However, punc-

tuation presents the interesting property of being a micro-system with a limited number of discrete marks that intuitively seems to be hierarchically organized (Catach, 1980). For example, in French, the following linear order seems to hold for the separating power of punctuation marks: paragraph > period (plus capital letter) > semicolon > comma. Consequently, it should be easy to study its development and function. Unfortunately, the study of the punctuation mark function is almost exclusively restricted to a phrastic context (Baldwyn & Coady, 1978). In contrast, developmental studies have consistently shown that at least in the beginning of learning to write, the use of punctuation does not seem to depend upon syntactic criteria. Despite different experimental approaches, Fayol (1981, 1985), Schneuwly (1984), Shaughnessy (1977), and Simon (1973) have all found that subjects between the ages of six and nine use punctuation marks to group actions that depend upon the "same kind of activity" (defined somewhat loosely). Thus, punctuation marks seem both to separate and to group propositions on the basis of their meaning.

   One main advantage of studying punctuation with a developmental approach is its clarity. Indeed, young subjects on the whole use only one punctuation mark, the period. Consequently, they use punctuation to separate or group things according to the opposition "punctuated" *vs* "non-punctuated". With older subjects the general picture becomes more complex because their texts are more complicated, and the number of punctuation marks increases. However, it seems reasonable to assume that even with adult subjects, the system of punctuation marks depends upon the chunking of the semantic elements of the text. Consequently, we propose that the distribution and nature of punctuation marks used in the production of texts depend upon the structure of the script. More precisely, we hypothesize that punctuation marks are used on the surface of a text to indicate the structure of the activities being described. If that hypothesis is supported, it would help explain to classes of phenomena, namely, the variability of reading time as a function of "text blocking" (i.e., the manner in which the text is chunked), and the impact of the punctuation and connectors on subjective parsing of texts (Mandler & Murphy, 1983).

Materials

   Two stories were written: "Jean goes to a restaurant" and "Annie visits the dentist" (although the stories were written in French, this article will ignore that fact and present the English translation in the main text; the original French version can be found in the Appendix). These stories were constructed using the data available in the literature (e.g., Bower et al., 1979) so as to contain three different script levels as defined by Abbott et al. (1985). For example, in the script "Annie visits the dentist", some scenes are just represented by their title (e.g., arrives at the dentist's, comes back home), whereas other scenes are broken down into a series of actions. Both scripts are made up of 26 propositions that describe an elementary action or state (see Table 1).

TABLE 1. List of the propositions given for the sorting task and for the text production task.

ANNIE VISITS THE DENTIST	JEAN GOES TO A RESTAURANT*
1 Annie has a toothache	1 Jean arrives in front of the restaurant
2 Annie thinks about it	2 Jean reads the menu
3 Annie calls the dentist	3 Jean looks at the wine list
4 Annie is happy	4 Jean decides to go in
5 Annie can go to the dentist now	5 Jean goes in
6 Annie arrives at the dentist's	6 Jean puts his coat in the cloakroom
7 Annie goes into the waiting room	7 Jean sits at a table
8 Annie sits down	8 Jean opens the menu
9 Annie takes a magazine	9 Jean reads attentively
10 Annie tries to read	10 Jean chooses three dishes
11 Annie is in too much pain to read	11 Jean decides to drink water
12 Annie looks at the other patients	12 Jean calls the waiter
13 Annie goes into the dentist's room	13 Jean orders
14 Annie sits on the dentist's chair	14 Jean eats the appetizers
15 Annie closes her eyes	15 Then Jean enjoys the veal with carrots
16 Annie opens her mouth	16 Jean reads the newspaper
17 Annie feels the vibrations	17 Jean savours the dessert
18 Annie hears the noise of the instruments	18 Jean waits for the coffee
19 Annie is not in pain anymore	19 Jean looks at the other customers
20 Annie gets up	20 Jean drinks his coffee
21 Annie listens to the advice of the dentist	21 Jean has finished
22 Annie pays	22 Jean pays the check
23 Annie goes out relieved	23 Jean stands up
24 Annie goes back home	24 Jean gets his coat back
25 Annie feels better	25 Jean leaves the restaurant
26 Annie will be able to go to work	26 Jean goes back to work

* In French, Jean is a man's name.

TABLEAU 1. Liste des productions fournies pour la tâche de tri et pour la production de texte.

EVALUATION OF THE SCRIPT STRUCTURE

In order to assess the validity of the script structures, it was necessary to verify that subjects indeed perceived them. This is the aim of the first part of the experiment.

Subjects

Twenty volunteer psychology graduate students from the "Université de Bourgogne" (at Dijon) participated in this part of the experiment. All were native French speakers. Subjects were unaware of the aims of the experiment.

Procedure

The propositions composing each script were written on a single sheet of paper. Booklets were made containing the two scripts, presented in random order. The propositions were listed in the order given in Table 1. The subjects were given the following instructions:
"You are going to read two series of 26 propositions written from top to bottom. These sentences describe successive actions or states. Intuitively, you

may feel that some of these actions or states 'go together' and that some 'do not go together'. If you feel that a set of successive propositions goes together, indicate this by circling that set. Be careful: a) each proposition must be put in one and only one set; b) there is no limit to the number of sets that can be made; and c) the order of the propositions must be preserved."

Results

Subject groupings were used to build a distance matrix in which the distance between any given pair of propositions was the number of subjects that did not group the two propositions together. This distance matrix was then analyzed with an additive-tree representation. The aim of this analysis was to reveal the potential hierarchical structure of the script rather than to predetermine it (i.e., if the structure were linear instead of hierarchical, then the program would reveal a linear structure, cf. Abdi, Barthélémy, & Luong, 1984). Results are given in Figures 1 and 2. In this kind of analysis, the matrix distance is represented graphically by a tree. The leaves of the tree represent the propositions, and the path length between vertices (or leaves) on the tree expresses the distance between them. The algorithm used here is a variant of Abdi et al.'s algorithm (1984; cf. also Abdi, Guénoche, & Luong, in press; Abdi, to be published). The proportion of explained variance is an indication of how well the tree fits the data. The high values obtained (92 and 84) suggest that subjects agree on the hierarchical organization of the scripts and disagree only on the similarity threshold used to group propositions together.

Figure 1. Additive-tree representation of the sorting task results for the Annie script. Percentage of explained variance: 92 (correlation = .96).
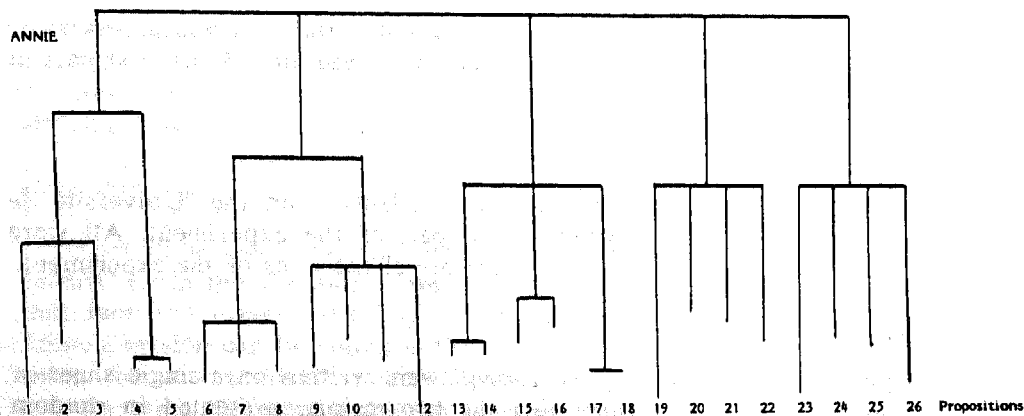

Figure 1. Représentation arborée des regroupements de propositions effectués par les sujets relativement au script "Annie". Plus les propositions sont réunies bas dans le graphe, plus forte est leur liaison dans les réponses des sujets.

Figure 2. Additive-tree representation of the sorting task results for the Jean script. Percentage of explained variance: 84 (correlation = .92).
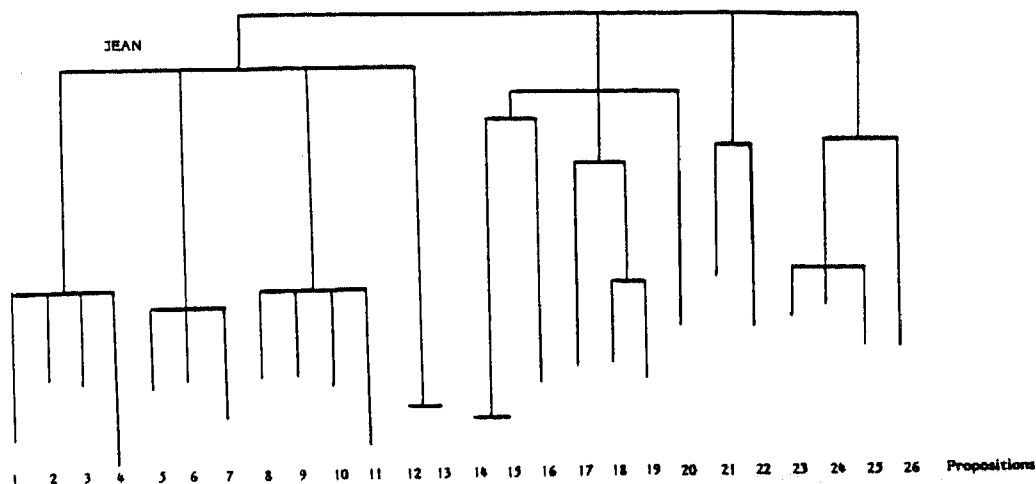

Figure 2. Représentation arborée des regroupements de propositions effectués par les sujets relativement au script "Jean". Plus les propositions sont réunies bas dans le graphe, plus forte est leur liaison dans les réponses des sujets.

EVALUATION OF THE SEPARATING POWER
OF PUNCTUATION MARKS

As noted, the linguistic subsystem of punctuation marks seems (in French at least) to indicate the degree of separation between propositions. Actually, punctuation marks seem (at first sight, at least) to have the properties of an *ordinal scale* in that it is possible, given any pair of punctuation marks, to decide which one indicates the strongest separation between propositions. However, for the purposes of the present study, an estimation of the strength of punctuation marks should be measured on an interval scale. The aim of this part of the experiment was to evaluate the "subjective strength" of the punctuation marks. The general procedure was first to ask subjects to evaluate the separating power of each mark, then to derive the separating power of each mark from their answers by using a technique known as *correspondence analysis* (or *dual scaling*, or *optimal scaling*, or *reciprocal averaging*, depending upon the authors; cf. Benzécri, 1973; Nishisato, 1979; Greenacre, 1984). We will use the term *correspondence analysis* here.

Subjects

Thirty-six volunteer psychology undergraduate students from the "Université de Bourgogne" (at Dijon) were tested in one group session. All subjects were native French speakers.

Procedure

The following instructions were read to the subjects:

"We want you to rate several punctuation marks as to the degree of separation they induce. To do so, please use a scale from 0 to 7, where 0 represents the lack of separation between words (which is equivalent, for example, to a space) and 7 represents the strongest possible separation, corresponding for example to the separation between chapters. We want you to evaluate the following punctuation marks on that scale".

The punctuation marks were written on a blackboard one on each line in the following order:

, ; . paragraph : ... - () ! ? ""

Results

When subjects rate the degree of separation induced by punctuation marks, it is likely that the rating scale used has at most ordinal properties. Consequently, the use of the mean to represent the group value is not meaningful (the computation of a mean implies that the data are on an interval scale). To obtain an interval scale from the ordinal data, the appropriate procedure to apply is correspondence analysis (Greenacre, 1984). Basically, correspondence analysis transforms the ordinal scale into an interval scale so that the values of the interval scale optimally fit (in a least squares sense) the order defined by the subjects with the rating scale. The results of the analysis of subject data are given in Table 2. Due to the instructions given to the subjects, the "absence of punctuation" is not explicitly present in the analysis (the lack of punctuation was used to "anchor" the zero value of the scale). Consequently, the value of the weakest punctuation mark (the parentheses) is attributed to the absence of punctuation in the statistical analysis in the next section. This procedure restricts the range of the variable, and consequently makes a *conservative* estimation of the correlation when used in a regression analysis. It is worth noting that the hierarchy of the marks we obtained is very similar to that obtained on English and German productions by O'Connel and Kowal (1986) and Van de Water and O'Connel (1985, 1986) with a very different methodology. The similarity of the results clearly increases the validity of the present study.

TABLE 2. Separating power obtained by "correspondence analysis" (or optimal scaling). The mean rank values are also given.

Punctuation marks	,	;	para-graph	:	...	—	()	!	?
Mean values	2	3.14	5.03	5.81	2.58	4.53	2.97	2.09	4.47	4.47
Optimal weights	-995	-336	817	964	-631	514	-465	-1001	520	545

TABLEAU 2. Intensité de séparation associée à chaque marque de ponctuation. Ligne 2 : moyennes ; ligne 3 : valeurs obtenues par l'analyse factorielle.

PRODUCTION AND PUNCTUATION OF SCRIPT-BASED TEXTS

The general aim of this study was to ask subjects to punctuate script-based texts, and to analyze the punctuation of the texts in terms of the separating power of the punctuation marks.

Method

The stories were presented separately on a sheet. The propositions were written on the first quarter of the sheet in the order given in Table 1. Lines were drawn on the remaining three quarters of the sheet to facilitate writing by the subjects.

Subjects

Thirty-six volunteer psychology graduate students from the "Université de Bourgogne" were tested in one group session. All subjects were native French speakers. Each subject was tested with only one text. The assignment of texts to subjects was random.

Procedure

Subjects were given the following instructions:
"You are going to read a series of propositions written from top to bottom on a sheet of paper. These propositions describe the actions of one person. That series of action is not 'written down' completely (see below). It describes only the successive actions of a person. Please, read it. After having read it, you will write down in 'correct French' the text describing the same series of actions. In order to do so, you should not change or add propositions (i.e., actions), or make any modifications in order. You may: 1) put several propositions in a same sentence; 2) add 'connectors' (e.g., and, but, because, etc.); 3) conjugate verbs; 4) punctuate."
All subjects completed the task within 15 minutes.

Results

The hypothesis states that interpropositional subjective distance (expressing the script structure) predicts the use of punctuation marks. The statistical test appropriate for this kind of hypothesis is either regression analysis when the independent variable and dependent variable are interval scale, or ANOVA when the independent variable is measured on a nominal scale and the dependent variable is measured on an interval scale (cf. Abdi, 1987). The independent variable (interpropositional distance) is obviously an interval scale, but the punctuation marks are a nominal variable. Each punctuation mark is associated with a separating power derived from the optimal scaling analysis. Consequently, for each interproposition, it is possible to compute a

"separating power score" (i.e., each mark is assigned its separating value, and the sum is calculated for all the subjects). The separating power score is the dependent variable of the regression analysis. For each script, Figures 3 and 4 give the tree describing the hierarchical structure of the script, and the separating power score for each interproposition. These figures show that interpropositional distance and separating power are inversely proportional. The regression analysis confirms this interpretation for both scripts [Jean, $r(24) = .903$, $p<.0001$; Annie, $r(23) = .801$, $p<.0001$].

Figure 3. Annie script: Degree of separation of the punctuation given for each interproposition. Results are plotted on the tree describing the script. Y-values are to be multiplied by 1000.
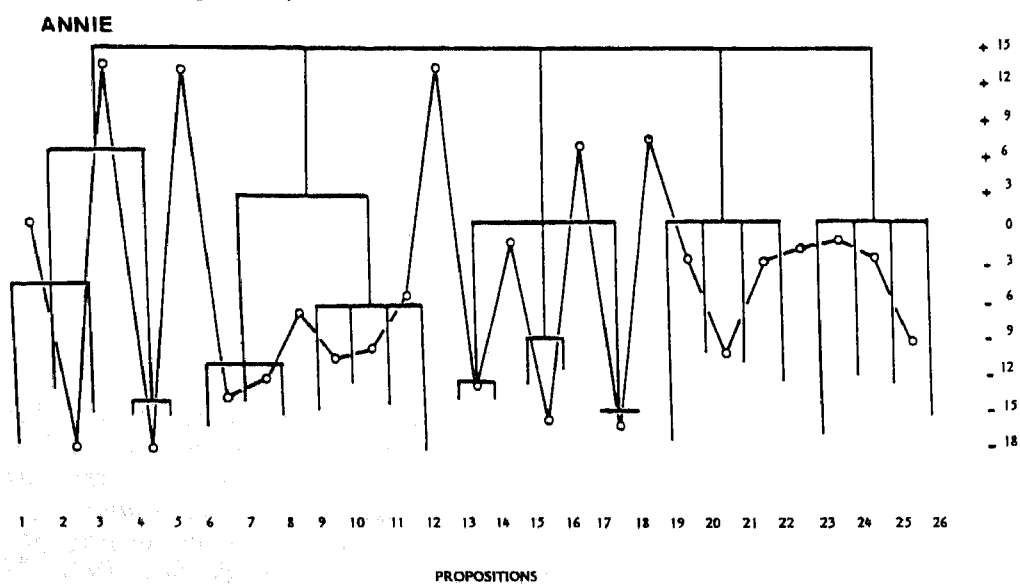

Figure 3. Valeur pondérée de la ponctuation interpropositionnelle (les valeurs en ordonnée sont à multiplier par 10^3) en relation avec la structure hiérarchique arborescente du script "Annie".

DISCUSSION

Our hypothesis that punctuation obtained here on the surface of a text expresses the hidden script structure is supported by the data. Specifically, subjective interproposition distance is a powerful predictor of the punctuation used, and therefore of the extent of the separation required. These results are robust, especially since the statistical procedures used are conservative ones. The function of the punctuation marks thus seems to provide the reader with a guide for the reconstruction of the hierarchical structure of the script.

Figure 4. Jean script: Degree of separation of the punctuation given for each interproposition. Results are plotted on the tree describing the script. Y-values are to be multiplied by 1000.
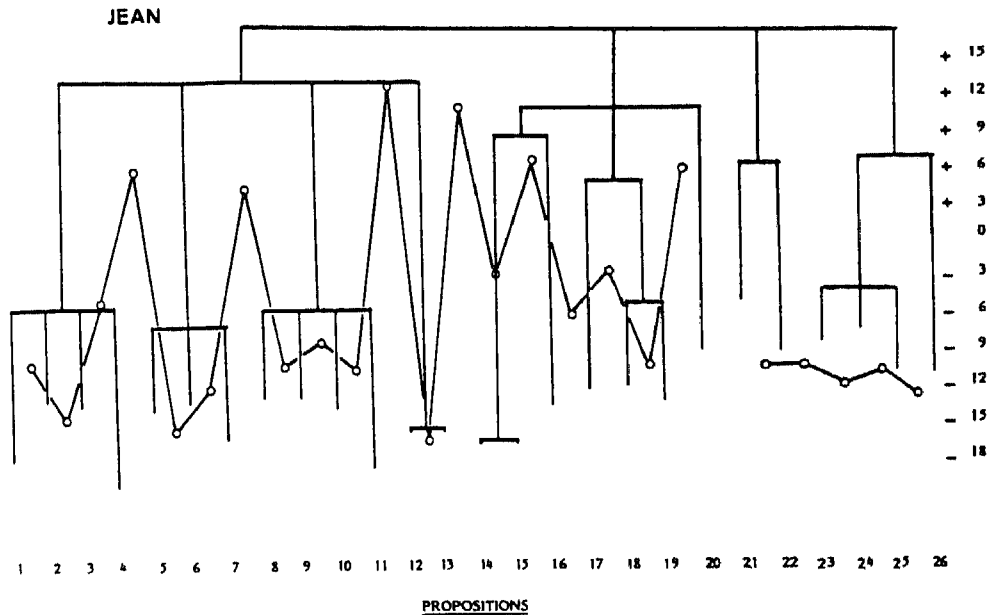

Figure 4. Valeur pondérée de la ponctuation interpropositionnelle (les valeurs en ordonnée sont à multiplier par 10^3) en relation avec la structure hiérarchique arborescente du script "Jean". La ponctuation de l'interproposition 20-21 n'a pas été reportée du fait de la très faible occurrence de la proposition 21.

Moreover, the hypothesis provides an explanation of some of the conflicting results in the literature. Thus, Mandler and Murphy (1983), contrary to Bower et al. (1979), observed substantial interindividual variability in the delimitation of the parts of the script. Having given variably punctuated texts to their subjects, these authors probably induced conflict, or at least some uncertainty in the delineation of the script parts. Thus, some subjects may have used punctuation to infer the script structure, and others to infer the inter-event organization.

The results of our analysis need to be qualified, however. The clear consensus of the subjects, both for the script structure and for the use of punctuation, may be attributed to the stereotyped aspect of the scripts, and to the complete knowledge the subjects had of them. The results would probably have been less impressive had we used texts that deal with less predictable series of events. In such cases, subjects may vary greatly in their construction of the script structure, and thus in their use of punctuation. Within individual subjects, however, the script structure can be expected to determine the choice of punctuation.

APPENDIX: French original version of the texts Annie and Jean.

ANNIE VA CHEZ LE DENTISTE

1   Annie a mal aux dents
2   Annie réfléchit
3   Annie téléphone chez le dentiste
4   Annie est contente
5   Annie peut y aller tout de suite
6   Annie arrive chez le dentiste
7   Annie entre dans la salle d'attente
8   Annie s'assoit
9   Annie prend une revue
10 Annie essaie de lire
11 Annie a trop mal pour lire
12 Annie regarde les autres clients
13 Annie entre dans le cabinet du dentiste
14 Annie s'allonge sur le fauteuil incliné
15 Annie ferme les yeux
16 Annie ouvre la bouche
17 Annie sent les vibrations
18 Annie entend le bruit des instruments
19 Annie n'a plus mal
20 Annie se relève
21 Annie écoute les conseils du médecin
22 Annie paie
23 Annie sort soulagée
24 Annie retourne chez elle
25 Annie se sent mieux
26 Annie va pouvoir aller travailler

JEAN VA AU RESTAURANT

1   Jean arrive devant le restaurant
2   Jean lit le menu
3   Jean regarde la carte des vins
4   Jean décide d'entrer
5   Jean entre dans le restaurant
6   Jean laisse son manteau au vestiaire
7   Jean s'assoit à une table
8   Jean ouvre le menu
9   Jean lit attentivement
10 Jean choisit trois plats
11 Jean décide de boire de l'eau
12 Jean appelle le garçon
13 Jean dicte sa commande
14 Jean mange l'entrée
15 Jean se régale ensuite avec l'entrée
16 Jean parcourt le journal
17 Jean déguste le dessert
18 Jean attend le café
19 Jean regarde les autres clients
20 Jean boit son café
21 Jean a terminé
22 Jean règle la note
23 Jean se lève
24 Jean récupère son manteau
25 Jean sort du restaurant
26 Jean retourne au travail

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RESUME

Cette recherche a pour objectif d'étudier l'impact de l'organisation sous-jacente des textes de type script sur la nature et la distribution des marques de ponctuation. On fait l'hypothèse que la ponctuation est principalement utilisée pour indiquer, dans les textes, le degré de "coupure" entre éléments adjacents en surface. On a élaboré deux trames de scripts comportant des actions de différents niveaux et on a déterminé expérimentalement leur organisation hiérarchique en demandant à des sujets adultes de regrouper les propositions de la trame des scripts. A partir des résultats, on a obtenu une matrice de distance inter-propositionnelle. Cette matrice a été utilisée pour obtenir une représentation sous forme d'organisation arborescente hiérarchique. On a ensuite demandé à un autre groupe de sujets adultes de rédiger un texte à partir des trames de scripts fournies. On a analysé la nature et la fréquence des marques de ponc-

tuation inter-propositionnelles. On a enfin conduit une analyse de régression avec, pour variable indépendante, les distances entre propositions successives et, pour variable dépendante, la valeur pondérée de la ponctuation. Les corrélations obtenues, très élevées, permettent de penser que l'organisation hiérarchique sous-jacente aux textes constitue le principal déterminant de la nature et de la fréquence de la ponctuation.

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