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The Role of Intonation in Processing Left and Right Dislocations in French¹

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This study attempts to determine the effects of intonation morphemes in French on the processing of simple reversible sentences containing a dislocated element. Synthetic speech stimuli were used. Subjects (80 children aged 5.0 and 6.0 and 48 adults, all monolingual, native French speakers) generally processed the sentences better when they retained the standard subject-verb-object order characteristic of most French utterances. When that order was not maintained, appropriate intonation promoted the correct attribution of roles in sentences with a dislocated object. The on-line analysis of adult response timing suggested that intonation morphemes serve as processing instructions for these subjects, guiding them in deciding whether to express their answer immediately or to delay responding.

INTRODUCTION

As a syntactically independent and semantically complete unit of a discourse, a sentence is produced through the interference of two structural levels: the utterance (the enunciation unit made up of a series of elements performing syntactically interrelated functions) and the message (the communication unit that organizes the information to be conveyed) (Perrot, 1978).

Message formulation is based on the use of four linguistic devices: lexical items, word order, morphological marks, and prosody (accent, tone, rhythm, and intonation). The result of the interplay of these four devices is that a given linguistic form can fulfill several functions (specify the reference and semantic relationships, convey pragmatic information), and a given function can be expressed in different forms. Accordingly, a correspondence is established in each language between coalitions of forms and coalitions of functions (Bates & MacWhinney, 1979, 1982; Bates, New, MacWhinney, Devescovi & Smith, 1982; MacWhinney 1987, 1989).

In the present article, I shall defend the idea that considering these two levels of sentence structuring allows us to better account for the way in which utterances are processed. Indeed, among the four linguistic means available in French for sentence interpretation, two of them (order and intonation) involve both syntactic and enunciative features.

Cues for Processing Simple Sentences

The roles of lexical items, word order, and morphological marks as cues for sentence comprehension have been relatively well documented since Bever's work in 1970 (for a

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summary, see Bronckart, Kail, & Noizet, 1983). It is worth noting, however, that research on sentence processing has been limited to only one structural level.

Thus, word order has only been considered from one angle: the order of the constituents of the utterance (SVO). In other words, it has only been viewed as a syntactic cue, even though various authors have recognized its dependency on the pragmatic constraints of discourse in different languages (Bates & MacWhinney, 1982; Bates et al., 1982; Bronckart, Gennari, & De Weck, 1981; Kail, 1986; Sinclair & Bronckart, 1972; Siobin & Bever, 1982). As a general rule, pragmatics refers to the relationships held between a language and its users. It pertains both to language acts and "the relation between the utterance and the speaker who chooses a strategy defining a hierarchy between what the utterance says (rheme) and what it says it about (theme, considered to be less informative)" (Hagège, 1982, p. 81). Only this "utterance-hierarchy" viewpoint is of interest here.

For French, word order is not solely governed by syntactic constraints, but also performs communicative functions. Linguistic analysis of dislocations provides us with an example of this. The phrase "sa carte d'étudiant" (his student card), which functions as the object in (a) below, loses that status in (b) where it simply serves a communicative purpose. The element shifted to the left is used to indicate the referent that will be brought up later in the utterance via a clitic object pronoun:

(a) "Il a enfin reçu sa carte d'étudiant" (He finally received his student card).

(b) "Sa carte d'étudiant. il l'a enfin reçue" (His student card, he finally received it).

Current phonetic studies on French intonation have provided evidence of its extremely complex functions. In addition to modal and attitudinal functions, intonation plays a role in both the syntactic structuring of the utterance and in organizing the theme and rheme information in the message (Di Cristo, 1981, in press; Rossi, 1981). To my knowledge, the latter two functions of intonation (both of which are involved in French dislocations, as we shall see) have not been studied in psycholinguistics.

Based on the competition model, the validity of a cue is defined by two properties: applicability (or availability) and reliability (or nonambiguity). The most valid cues are the ones with both a high degree of applicability and a high degree of reliability. Cross-linguistic research has shown that for native French-speaking adults and children, cues indicating the animate quality of lexical items are more valid than word order (Kail, 1986).

My goal is to experimentally study how word order (less valid in French than in English for semantic role attribution) and intonation morphemes (whose relevance remains to be determined) contribute to the accuracy of comprehension when animate versus inanimate lexical cues are lacking. It is hypothesized that intonative packaging contributes to the reliability of the positional and lexical cues in the utterance. This study attempts to show this for the processing of dislocated sentences, which, while being composed of basically the same elements as canonical sentences, allow for organizing the message differently.

Linguistic Characteristics of Dislocation in French

It is customary to state that the grammatical construction favored by the French for encoding a transitive event consists of a noun subject, a verb, and a noun object (for a typology of languages based on the canonic organization of elements, see for example Greenberg, 1963). The SVO order corresponds to the NVN lexical structure and the agent-actionpatient semantic structure, as in (c) below.

(c) "Le garçon mange la pomme" (The boy eats the apple).

But as mentioned above, it is possible to dislocate an element and link it to the main predicate via a clitic pronoun. The dislocated element can be placed at the beginning of the sentence (left dislocation) or at the end (right dislocation), as shown in Table 1.

In everyday conversation, pronouns, nouns, phrases, and clauses can be dislocated. The dislocation may bear on one of various syntactic functions (subject, direct object, etc.).

Pronouns are detached more often than other sentence constituents. The syntactic function most frequently involved is the subject, then the direct object, although much less frequently (Ashby, 1988).

In practice, dislocation can serve stylistic or communicative purposes. Moreover, different detachment structures have different pragmatic functions. Larsson (1978), Barnes (1985), and Ashby (1988) agree that left dislocations are used for topicalization and the highlighting of

TABLE 1
PHRASE PERMUTATIONS MADE POSSIBLE BY AN NP DISLOCATION IN FRENCH

Dislocation	Subject (the boy)	Object (the apple)
Left	"Le garçon, il mange la pomme" (LDS) (The boy, he eats the apple)	"La pomme, le garçon la mange" (LDO) (The apple, the boy eats it)
Right	"Il mange la pomme, le garçon" (RDS) (He eats the apple, the boy)	"Le garçon la mange, la pomme" (RDO) (The boy eats it, the apple)

referents. This type of dislocation is commonly found in conversations where speaker and listener take turns (at turn opening). Ashby's analysis showed that right dislocations have a wider range of pragmatic functions (to give additional information, fill discourse space, close discourse at turn closing). Example (d) below, taken from Ashby, is a concise illustration of some of the different functions of right dislocations.

(d) "Vos grands parents, ils vous en ont parlé de fois de l'escalier? Ils l'ont connu, vos grands parents?" (Your grandparents, they have talked to you sometimes about the stairway? They knew of it, your grand parents?)

Through the recent analysis of a corpus of child speakers, we were able to show that 5 year olds and especially 6 year olds are more inclined than 4, 9, and 11 year olds to produce utterances that refer back to a noun via a clitic pronoun (generally in the noun-pronoun order, Vion & Colas, 1987). Not all of the utterances contained genuine dislocations. Approximately three times out of four, the prosodic features of the utterances were such that they could be considered rather as stylistic redundancy phenomena. (We shall see below that a specific intonation pattern is applied to dislocated utterances.) In the remaining quarter of the utterances, more than 88% were subject dislocations, 55% of which were left dislocations. The tendencies observed here for children were thus the same as those described by Ashby (1988) for adults. Note finally that in the above corpus, only 6 year olds used all of the construction types shown in Table 1, that is:

"Le petit garçon, il mange une pomme." (The little boy, he eats an apple.)

"Un cadeau, elle le donne à la fille." (A gift, she gives it to the girl.) "Elle prend son chien, la fille." (She takes her dog, the girl.)

C'est le garçon qui le porte, le chien." (It's the boy who carries it, the dog.)

It sometimes happens in dislocated sentences that the message structure is induced solely by the choice of an intonation pattern. According to Perrot (1978), a given sequence of elements can convey two fundamentally different messages, depending on the intonation contour assigned to each of the information-bearing elements in the utterance. Thus, (b) above can convey message (b') or message (b''), depending on the intonation morpheme applied:

(b') Speaking of his student card, he finally received it. In this message, "his student card" is the theme.

(b'') His student card, he finally received, but not the other objects he was waiting for. Here, "his student card" is a rheme.

Three intonation morphemes (or intonemes) suffice in French to mark the theme: continuation, appellative continuation, and parenthesis (Rossi, 1985; see Delattre, 1966, and Léon & Léon, 1964, for a pitch level analysis of French).

The continuation intoneme is characterized by "a melodic contour in the infrahigh pitch register and an increase in duration of about 50% over and above the mean duration of unstressed vowels" (Rossi, 1985, p. 141).

The appellative continuation intoneme consists of "a perceptible glide in the upper part of the infrahigh pitch register and a lengthening in duration analogous to that characterizing" simple continuation (Rossi, 1985, pp. 141-142).

The parenthetical intoneme "is manifested . . . by a flat pitch contour in the infrahigh register" (Rossi, 1985, p. 142). This intonation contour characterizes a postposed theme.

Rhemes are always indicated by the presence of a conclusive intoneme, which is "a melodic fall or a static tone in the low or infra-low pitch register: this is accompanied by an intensity glide of about - 10 dB and an increase in duration of about 100% over and above the mean duration of unstressed vowels" (Rossi, 1985, p. 141).

The main characteristic of continuative intonemes and conclusive intonemes is that they are not only used to mark the organization of the message, but also the syntactic structure of the utterance. Thus in different speech situations, (b) can be produced as (b'):

"Sa carte d'étudiant/CA/il l'a enfin reçue/CC/"
(His student card/CA/ he finally received it /CC/)

or as (b''):

"Sa carte d'étudiant/CC/ il l'a enfin reçue/PAR/" (His student card/CC! he finally received it /PAR/).

OVERVIEW OF EXPERIMENTS

In the following experiments, subjects (adults and children) were asked to process reversible sentences expressing prototypical transitive situations. The situations involved an animate agent whose action (direct contact) produced a change in the state or location of a patient (Hopper & Thomson, 1980).

The choice of age 5-6 for the child population was based on the fact that children at that age are known to be familiar with dislocated constructions (they produce such constructions very frequently, Vion & Colas, 1987).

In the experimental tasks chosen, isolated sentences were presented without the usual conversational context. Due to this fact, the subjects did not have all of the information that forms the contextual environment by means of which utterances are interpreted in everyday

living. In addition, synthetic speech stimuli were used to construct the test sentences. One might object initially that synthesized speech does not capture all of the perceptual characteristics of natural speech intonation, in which case any findings could not be generalized beyond the processing of the material actually used. But, it is precisely because speech synthesis allows for removing all features of expression (or emphasis) while retaining the minimal features required to perform enunciative and syntactic functions that it is a good tool for exploration. The "Porte parole" software package (Ediciel Matra et Hachette, CNET license) was used for synthesis by diphones. This program reconstructs an inexpressive male voice that abides by the accentuation rules of both isolated words and phrases in French (the stressed syllable is always the last one pronounced) and incorporates all of the minimal perceptual features of the main intonation patterns that can be generated through stress. In this framework, the intonemes associated with each type of dislocation were chosen for the predominant pragmatic functions (as determined through linguistic analysis). Thus the left dislocations, which put the referred-to element in the foreground, were produced with intonation morphemes that endow the message with a theme-rheme organization, while the right dislocations were produced with intonemes that structured the message in rhemetheme order.

Verbal Material and Experimental Design

Lists

The experiments were designed to compare left and right dislocations of a noun phrase (the subject or the object).

Two lists of sentences were set up. List A contained only left and right dislocations of a subject NP. List B consisted of left and right dislocations of an object NP.

Type of Sentence

Canonical sentences were also set up, e.g., "The Schtroumpf pompier bouscule le gendarme" (The fireman Smurf shoved the policeman): NP(agent)-V-NP(patient). The term "Smurf" refers to the imaginary characters created by the cartoonist Peyo (Editions Dupuis). This term was used in the canonical sentences so that there would be the same number of words per sentence.

Each list contained three types of sentences (see lists A and B in the Appendix).

The dislocated sentences were categorized according to type of lexeme ordering (lexeme order factor, with two modalities: lexemes were in symmetrical (NVN) or asymmetrical (VNN, NNV) order).

Thus, canonical sentences and sentences with a left dislocation of the subject or a right dislocation of the object were symmetrical, with the name of the agent mentioned first, whereas sentences with a right dislocation of the subject or a left dislocation of the object were asymmetrical, with the agent mentioned last (see Table 1). In sentences with right subject dislocations, the agent's name was at the end of the sentence, whereas it was not in sentences with left object dislocations.

Type of Utterance

The list of stimuli for each type of sentence included the same number of items with nouns of the same gender (masculine/feminine) as items with nouns of different genders (Gender factor with two modalities: homogeneous gender and heterogeneous gender).

Each list thus contained six types of utterances.

Items

Four exemplars of each type of utterance were constructed, making a total of 24 items per list.

Intonation

The different sentences were presented in one of the two modalities of the Intonation factor: either the intonation was appropriate to the structure of the sentence, or it was inappropriate (the sentence was produced as a series of isolated words).

For each intonation condition, 24 synthetic speech sentences were generated, as described in Table 2. (The speech synthesis was done on an Apple II computer equipped with a "Porte Parole" board and accompanying software.)

Lexical Choices for the Lists

The names of the actors were chosen because of their familiarity to children. The verbs were chosen on the basis of two criteria specific to collecting data from children: first, the verb had to be a verb of action, and second, it had to be possible to act out the verbs (see "Procedure" in Experiment 1).

TABLE 2
INTONATION PATTERNS

Appropriate intonation	
Canonical	le schtroumpf pompier/CT/bouscule le gendarme/CC
Left dislocation	
Subject	le pompier/CA/il bouscule le gendarme/CC
Object	le gendarme/CA/le pompier le bouscule/CC/
Right dislocation	
Subject	il bouscule le gendarme/CC/le pompier /PAR/
Object	le pompier le bouscule/CC/ le gendarme /PAR/
Word by word intonation	
Canonical	le schtroumpf/CC/pompier!CC/bouscule/CC/le gendarme/CC/
Left dislocation	
Subject	le pompier/CC/il/CC/bouscule/CC/le gendarme/CC
Object	le gendarme/CC/le pompier/CC/le/CC/bouscule/CC/
Right dislocation	
Subject	il/CC/bouscule/CC/le gendarme/CC/le pompier/CC/
Object	le pompier/CC/le/CC/bouscule/CC/le gendarme/CC

Note. CT, continuation intoneme; CA, appellative continuation intoneme; PAR, parenthetical intoneme; CC, conclusive intoneme.

In order to balance the distribution of agent and patient roles, each actor was the agent at least once, and the patient at least once, with different verbs. The same actor was either the agent twice and the patient once, or the patient twice and the agent once in each modality of the Gender factor.

Recording

The list of 24 sentences for each intonation condition was recorded on magnetic tape. The stimuli were presented to subjects in four different random orders so as to counteract any presentation order effects that might occur within a group of subjects.

Predicted Effects

The expected effects pertained either to the cues available to the subjects in the verbal material, or to the processing system the subjects used to deal with that material.

Lexeme Order

Slobin and Bever (1982) compared the interpretation of utterances for three word orders: NVN, NNV, and VNN in four languages with different canonical orders (English, Italian, Turkish, and Serbo-Croatian). They showed that the canonical schema extracted by the children on the basis of their linguistic experience serves as a guide for processing different orders. This schema is thought by the authors to be acquired at approximately age 3;6.

As Moreau (1987) recently confirmed, despite the existence of various mechanisms such as clefting, dislocation, and relativization, which can be associated with other phrase arrangements, the SVO order remains the most frequent in French. It was found in nearly 70% of the sentences in the corpus studied by that author. SVO was predominant over all other orders, regardless of the age and type of speaker producing the utterance, or of the listener to whom they are directed.

It is thus legitimate to assert that constructions in which the first noun is the agent are in keeping with the canonical sentence schema used by speakers of French. The symmetrical orders proposed in our experiments should thus be processed more effectively than the asymmetrical ones.

Pronoun Gender

In dislocated sentences, the gender of the clitic pronoun (which necessarily agrees in gender and in number with the dislocated element) may or may not give any indication of the identity of the actor to which it refers, depending on the gender of the nouns in the sentence. The utterances with nouns of heterogeneous gender should thus be processed better than those with nouns of homogeneous gender.

Pronoun Form

In addition to gender, the very form of pronouns in French indicates grammatical category, although sometimes ambiguously. The object pronouns "le" (him) and "la" (her) do not differ in form from the definite articles "le" (masculine "the") and "la" (feminine "the"), both of which were present in our sentences. The subject pronouns "il" (he) and "elle" (she), however, are different. Thus, object pronouns are less reliable cues than subject pronouns.

Dislocation of the object should therefore be more difficult to process than dislocation of the subject.

Intonation

In the condition with appropriate intonation (Table 2), the conclusive and continuation intonemes simultaneously fulfill both their enunciative function and their syntactic unit identification function. They establish the boundaries between the constituents of the utterance (demarcation function). In addition, the integration function of the conclusive intoneme groups together the clitic pronoun, the verb, and a noun.

The above identification function whereby intonation is used to identify syntactic units is beginning to be recognized in language acquisition theory. Intonation is one of the linguistic cue systems thought to induce a hierarchally structured syntax (Morgan & Newport, 1981; Pinker, 1984). It can be hypothesized that appropriate intonation contributes indirectly to determining semantic roles by grouping elements together to form the constituents of the utterance. Given the lack of empirical research in this area, it is difficult to further elaborate upon this hypothesis. In the inappropriate intonation condition here, the sentences were produced as isolated words (Table 2). French word stress, which always falls on the last syllable, was thus used. In this case, although the applied intonemes performed the demarcation function, they did not give any clues as to utterance organization.

Type of Processing

Kail and Charvillat (1984) suggested introducing the notion of cue cost into the competition model. This notion is based on the distinction between two kinds of processing: local versus topological. A linguistic element that is processed without reference to its environment is said to undergo local processing. According to these authors, the animate property of nouns, marks of gender and number, cases, and inflections are processed locally. The term "local" was introduced by Ammon and Slobin (1979) in regards to the development of language comprehension. These authors state that the early acquisition of inflections in Turkish is due to the fact that nothing else is involved in processing them. They call them local cues. In Kail's proposal, the terms "local" and "topological" are used to refer to cue processing modes rather than to cue properties. In our experiments, the form and gender of the pronouns could be processed locally. An element processed while taking its insertion in the context of the sentence into account is said to undergo topological processing. In our experiments, word order and intonation contours can be assumed to be processed in this second manner.

A developmental study on the comprehension of clefting and the passive voice in French has allowed us to suggest, however, that a given cue can in fact be processed in both ways (Amy & Vion, 1986; Vion & Amy, 1985). Lexeme order appears first to be processed by children in algorithmic fashion: the first noun in a sentence is chosen as the agent (local processing). This kind of processing is at its peak at age 6. Then, the position of the nouns with respect to the verb is gradually taken into account, and continues increasing until adulthood.

If it is true that local processing occurs earlier than topological processing, sentences uttered one word at a time should be less costly to process for children than for adults. This word-by-word presentation mode indeed provides the ideal conditions for allowing processing based on the absolute position of the first noun, or on the intrinsic characteristics of a given mark. On the other hand, topological cue processing is more consistent with sentences that have the proper intonation. They should therefore be less costly to process for adult subjects.

Here again, it is difficult to formulate a precise hypothesis. It can only be said that differences in performances linked to changes in the comprehension mode of the proposed

verbal material should distinguish the two subject populations. These differences should show up in the comparison of performance across intonation conditions.

EXPERIMENT 1

Method

Subjects

Four groups of 20 kindergartners (boys and girls between the ages of 5 and 6) participated in the first experiment. All were monolingual, native French speakers. For each list, subjects were randomly assigned to one of the intonation conditions.

Procedure

Comprehension was assessed via an acting-out task. The subjects were asked to use toy characters to act out the meaning of the sentences heard.

The child and experimenter were seated at a table. On the table, there were toy characters (6 cm tall) taken from a fictitious universe, the "Smurfs." The characters were wearing the appropriate clothing and had the necessary accessories and properties to suit the social function of the names used to designate them.

At the beginning of the experiment, the subjects were allowed to arrange the toys as they wished in the play space. They were also free to pick up the characters at any time during the experiment.

First, the experimenter noted the names spontaneously used by the children to refer to the characters. Whenever those names did not correspond to the ones planned in the experiment, the experimenter told the child the new name and asked him or her to learn it for later use. Then the experimenter pronounced the trial sentences (see list in the Appendix). These sentences were used to introduce the various verbs used in the experiment, and to make sure the child could act them out without ambiguity. To facilitate the scoring of performance, actions that could be acted out in a reciprocal manner, for example, were avoided.

Second, the experimenter made sure that the child properly recognized the names and the actions when they were spoken with the synthetic voice. The experimenter explained that a robot had been recorded, and that from then on the robot would talk about what the Smurfs were doing. Then the experiment proper began. Each subject heard 24 sentences in succession (list A or list B). After each sentence was played, the experimenter stopped the tape recorder and allowed the child as much time as he or she needed to respond. If the child requested, the sentence could be heard a second time.

The experimenter noted what the child did with the toy characters.

Results

Response Coding and Analysis

Responses in which the child chose the expected agent and patient based on the semantic roles in the sentence were considered as correct interpretations and were scored "1." Whenever the child chose an incorrect toy character for one of the actors in the sentence, the choice was considered acceptable, and the incorrect character was taken as the substitute for the correct character. For example, for a sentence involving the logger and the cabinet maker, if the child chose the cook and the cabinet maker, then the logger was replaced by the cook in

assessing performance. For a given type of utterance, a subject's total score ranged from 0 to 4 (number of correct answers).

The data for lists A and B were collected at two different times. The results from each list were analyzed separately using the Lexeme order factor to describe dislocated sentences. An analysis of variance pooling the results from both lists was then carried out in order to determine how sentence processing was affected by the syntactic function involved in the dislocation (Dislocation factor, with two modalities: subject dislocation vs object dislocation).

Main Tendencies

The analysis of variance bearing on the data from both lists showed that the main effects of all factors were significant. Six significant interactions were also found for factors taken two at a time (Dislocation-Intonation, Dislocation-Gender, Dislocation-Lexeme order, Intonation-Gender, Intonation-Lexeme order, and Gender-Lexeme order). There was one significant three-factor interaction (Intonation-Lexeme order-Gender).

The main tendencies extracted from the overall analysis are shown in Table 3.

The three-factor interaction [$F(1, 76) = 13.403, p < 4.6 \times 10^{-4}$] reflects the following facts.

Sentences with the appropriate intonation gave rise to more correct responses than those with word-stress intonation [effect of Intonation: [$F(1, 76) = 22.928, p < 1 \times 10^{-5}$]]. This already allows us to assert that intonation plays a part in how children process such sentences.

More correct responses were given for symmetrical sentences than for asymmetrical ones [effect of Lexeme order: [$F(1, 76) = 101.543, p < 1 \times 10^{-5}$]]. This indicates the importance of the canonical sentence schema as a guide for processing. This difference in performance was even greater when the sentences were heard word by word [Lexeme order-Intonation interaction: [$F(1, 76) = 25.385, p < 1 \times 10^{-5}$]]. Although the responses to symmetrical sentences did not vary by intonation condition, performance was poorer for asymmetrical sentences with word-stress intonation. Intonation thus mainly affected asymmetrical sentence processing. Appropriate intonation promoted the correct processing of these sentences.

TABLE 3
CORRECT ROLE ASSIGNMENT (MEANS)

			Dislocation				
			Subject			Object	
			Ho	He		Ho	He
Iw	S	(LDS)	3.95	4	Children (RDO)	3.75	3.65
	nS	(RDS)	2.15	3.45	(LDO)	1.4	1.75
Ia	S	(LDS)	3.7	3.8	(RDO)	3.8	3.9
	nS	(RDS)	3.45	3.5	(LDO)	3.1	2.95
Iw	S	(LDS)	3.67	3.58	Adults (RDO)	3.67	4
	nS	(RDS)	2.92	2.75	(LDO)	2.33	2.58
Ia	S	(LDS)	3.92	4	(RDO)	4	3.83
	nS	(RDS)	3.08	2.92	(LDO)	3.08	3.75

Note. Ia, appropriate intonation; Iw, word by word intonation; Ho, Gender homogeneous; He, gender heterogeneous; S, Word order symmetrical; nS, word order asymmetrical.

Sentences with nouns of heterogeneous gender obtained higher performance [effect of Gender: $F(1, 76) = 9.823, p < 2.45 \times 10^{-5}$]. This effect only occurred when inappropriate intonation was used [Gender-Intonation interaction: $F(1, 76) = 7.647, p < 7.13 \times 10^{-5}$]. and for asymmetrical sentences (Lexeme order-Gender interaction: $F(1, 76) = 6.568, p < .01$). These results suggest that local processing of clitic pronoun gender is facilitated by word-stress intonation in asymmetrical sentences.

Two findings showed that object pronouns are less reliable: (1) sentences with a dislocated subject were processed better on the average than sentences with a dislocated object [effect of Dislocation: $F(1, 76) = 18.673, p < 5 \times 10^{-5}$]. and (2) the gender effect mentioned above was the strongest for subject dislocations [Dislocation-Gender interaction: $F(1, 76) = 5.744, p < .01$]; the overall effect of Gender was not significant for object dislocations (list B), while it was for subject dislocations (list A).

The effect of intonation was more marked for object dislocations: the overall effect of Intonation was not significant for subject dislocations (list A), while it was for object dislocations (list B).

The last three effects suggested that performance be examined by comparing subject-dislocation processing to object-dislocation processing.

Processing of Sentences with a Dislocated Subject

The tendencies noted in the processing of the sentences in list A are summarized in the left-hand portion of Table 3 which shows the threefactor interaction $F(1, 38) = 9.628, p < 3.61 \times 10^{-3}$].

We have already seen that the effect of gender was greater for sentences with a dislocated subject. The impact of homogeneous and heterogeneous noun genders was thus examined in these sentences as a function of intonation and type of sentence, even if the factor in question caused better overall performance.

With appropriate intonation, lexeme order and gender had a cumulative effect. Performance was essentially the same in both gender modalities. On the other hand when the sentences were heard word by word, the Lexeme order and Gender factors interacted. Performance on asymmetrical sentences, which do not provide any information about the gender of the actors, dropped to chance level (the correct answer being given approximately half of the time).

Inappropriate intonation did not lead to an overall decline in performance on symmetrical sentences. Scores remained high for both gender modalities in this case.

At the same time as word-stress intonation made it impossible to process unreliable pronouns in asymmetrical sentences with nouns of homogeneous gender, it fully allowed for the local processing of lexeme order. Symmetrical sentences were processed slightly better here than in the appropriate intonation condition [Lexeme order-Intonation interaction: $F(1, 38) = 15.89, p < 2.9 \times 10^{-4}$].

For sentences with dislocated subjects, the observed uniformity of performance when the intonation was appropriate can be interpreted as follows. By indicating the relations held between the sentence constituents, correct intonation can lead subjects who may be inclined to use local processing to process all of the proposed constructions topologically.

Processing of Sentences with a Dislocated Object

The tendencies noted in the processing of sentences in list B are summarized in the right-hand portion of Table 3, which shows the three-factor interaction $F(1, 38) = 3.987, p < .053$. The result patterns resemble those obtained for subject dislocations. As in list A, when intonation was appropriate, the effects of lexeme order and gender were cumulative (performance being very similar in both Gender modalities). When sentences were presented with word-stress intonation, the Lexeme order and Gender factors interacted.

The results obtained for object versus subject dislocations differed mainly by the fact that there was a greater difference for dislocated objects between symmetrical sentence processing (approximately the same scores were found for both lists) and asymmetrical sentence processing (scores were lower here than for list A).

When the intonation was inappropriate, performance on asymmetrical sentences was below chance level for both Gender factor modalities (which was not the case for asymmetrical sentences in list A). This finding confirms the fact that incorrect local processing of word order was done here (the first word was taken as the agent). Scores approached chance level when noun gender was heterogeneous. Subjects thus appear to be sensitive to the presence of a pronoun, yet unable to process it correctly.

The lack of appropriate intonation [effect of Intonation: $F(1, 38) = 24.83, p < 1 \times 10^{-5}$] did not lead to an overall drop in performance on symmetrical sentences here either. The local processing of word order may be one explanation of these results. As in list A, appropriate intonation thus does seem to promote topological processing of the material. The lower reliability of object pronouns accounts for the observed difference in the processing of symmetrical and asymmetrical sentences, a difference which did not occur for subject dislocations.

EXPERIMENT 2

Method

Subjects

Four groups of 12 native French-speaking adults (psychology students) participated in the second experiment. They were randomly assigned to one of the two intonation conditions.

Subjects were told beforehand that they would be the control group in an experiment using stimuli designed for children.

Device and Procedure

The experiment was run on an Apple 11e computer. The program was designed for self-pacing by the subject. The computer was connected to a tape recorder and controlled the starting and stopping of the magnetic tape in compliance with the commands issued by the subjects.

To start, the following instructions were displayed on the screen: "You are going to hear sentences containing two nouns and a verb. Listen carefully. You must understand them. Press the "1" key if the first noun you hear is the agent of the action. Press the "2" key if the second noun is the agent. To begin, press the space bar, then the return key."

The tape stopped turning every time the "1" or "2" key was pressed and once the stimulus item was complete. It started up again each time the return key was pressed. The locations of the "1" and "2" keys were reversed for half of the subjects.

After the instructions had been displayed, the practice phase began. The same sentences were used for the adults as had been used for the children in Experiment 1. For the adults, the practice sentences were spoken only in synthesized speech to familiarize them with the synthetic voice. The test phase immediately followed the practice session.

The goal of this experiment was the same as in the preceding experiment, namely, to study role attribution. However, rather than involving "acting out," the tasks chosen explicitly required making a decision about the agent. Two reasons backed this choice. First, while acting-out tasks have proven over the past 20 years to be well suited for studying role attribution in children, adult subjects may consider them childish. Second and above all, due to their on-line response tracking capability, computerdriven tasks provide a richer set of basic observations than those obtainable through acting-out tasks. For each sentence presented, the program recorded which key was pressed to respond, and the time lapse between when the subject began to hear the sentence and when the response key was pressed. The point in the sentence at which responding occurred was deduced by the program from the latter piece of information.

Results

Two dependent variables were defined to describe the recorded responses. As with the children, the first variable was the number of correct responses. The second variable was designed to permit the on-line assessment of performance, and represented the point in the stimulus at which the response was made (as the sentence was being heard, or after it was heard). For these two variables, analyses of variance were computed for both lists taken together and for each list separately.

Response Accuracy

The expected ceiling effect on the correct response variable did not occur. The performance of adult subjects was not void of error. The significance levels of the observed effects were nevertheless lower than for the children.

For the two lists pooled, the Lexeme order and intonation factors had significant effects. A significant interaction was also found between the Gender and Dislocation factors (Table 3).

As with the children, symmetrical sentences were processed more accurately than asymmetrical ones [effect of Lexeme order: $F(1, 44) = 25.69, p < 1^{-05}$]. This effect was found for both subject dislocation processing in list A [effect of Lexeme order: $F(1, 22) = 9.41, p < 5.6^{-05}$], where it was the only significant effect, and object dislocation processing in list B [effect of Lexeme order: $F(1, 22) = 18.89, p < 2.61^{-05}$]. The hypothesis that the canonical schema acts as a guide in sentence processing appears to be valid for adults also.

The finding that the processing of sentences with correct intonation was more accurate [effect of Intonation: $F(1, 44) = 4.49, p < .039$] is essentially due to the results obtained for object dislocations, as previously found for the children [effect of Intonation in list B: $F(1, 22) = 5.76, p < .025$]. It should be noted that the effect of intonation on object dislocation processing was particularly strong for asymmetrical sentences, which were processed better with appropriate intonation [effect of the Lexeme order-Intonation interaction for list B: $F(1, 22) = 4.11, p < .051$].

Gender only had an effect here on object dislocations [Gender-Dislocation interaction: $F(1, 44) = 5.63, p < .02$]. Sentences with pronouns of unlike gender triggered more accurate responses than those with like gender [effect of Gender for list B: $F(1, 22) = 7.07, p < .04$]. For both children and adults, then, the gender factor had the predicted effect: sentences with nouns of heterogeneous gender were processed better. However, children exhibited this tendency for subject dislocations only, while adults did so for object dislocations only. Remember that this finding is backed by a marked effect of gender for children processing sentences with inappropriate intonation, whereas for adults this effect was found on sentences with appropriate intonation. This can be assumed to indicate topological processing of pronoun gender by adults. We should be able to confirm this finding by analyzing the corresponding on-line data.

Response Location

The distribution of responses by the location in the sentence where responding occurred is given in Figs. 1 and 2 (by intonation condition and type of sentence).

In the appropriate intonation condition, the response could occur on the first part of the stimulus, on the second part, between the two (see Table 2 to refresh your memory), or after the second part. Remember that the intonation pattern of a left-dislocated sentence (subject and object) isolates the name of the thematic actor in the first segment, whereas the first segment of a right-dislocated sentence puts the rhematic part of the message up front. In this case, the rheme is a sentence in itself (with a pronoun subject or a pronoun object). In addition, the rheme of a sentence with right object dislocation explicitly mentions the object.

Although rarely, some responses were found on the first segment, except for left dislocations of the object where they occurred only on the second segment. The responses made early turned out to be correct for left subject dislocations and right object dislocations, but were of chance level accuracy for right subject dislocations.

In the inappropriate intonation condition, the response could be given at seven different points within the sentence (on any one of the four segments, or in the intervals separating

them: see Table 2) or after the sentence was completed. Except for sentences with right object dislocations, responses were in fact given before the third segment was heard.

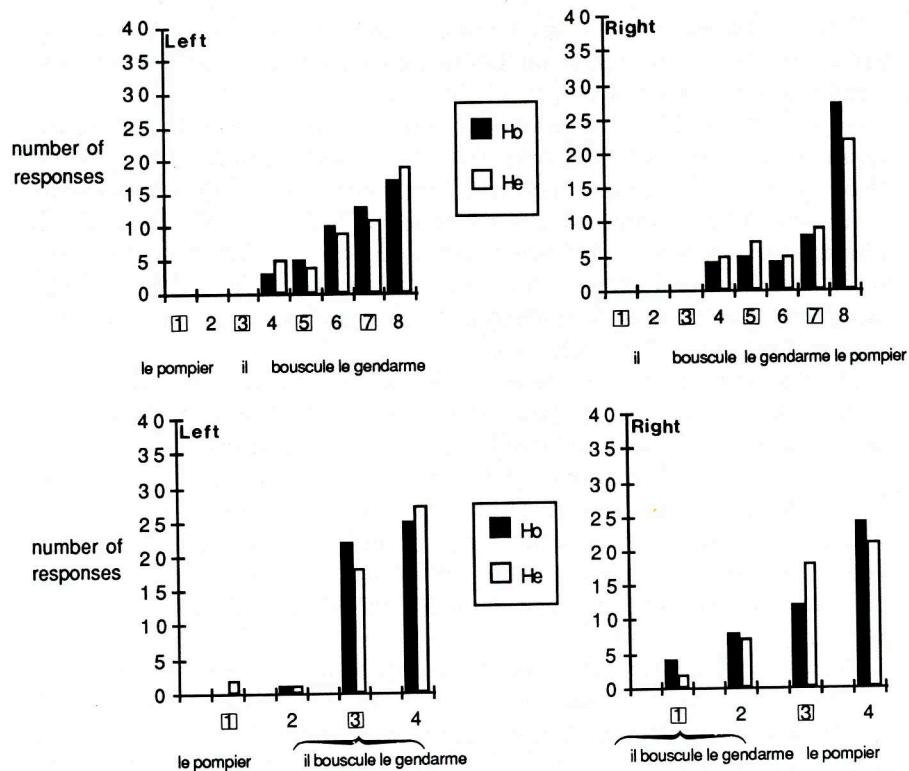


FIG. 1. Left and right dislocations of the subject—(top) word by word intonation; (bottom) appropriate intonation.

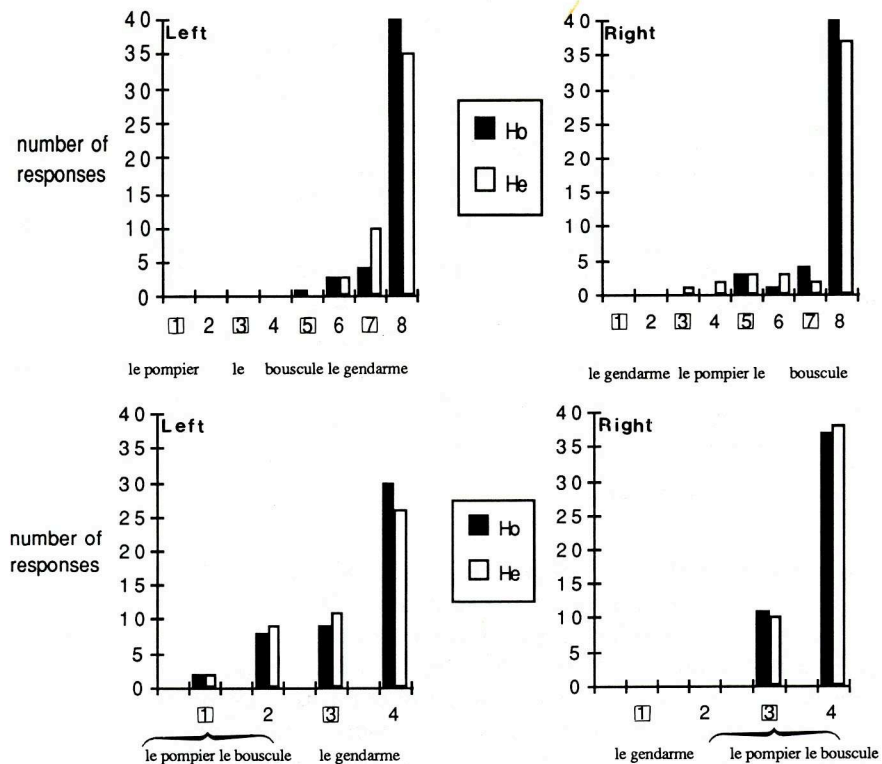


FIG. 2. Left and right dislocations of the object—(top) word by word intonation; (bottom) appropriate intonation.

For each sentence, a subject's response was coded "O" if it was made as the sentence was being heard, and "1" if it was made afterwards. For each type of utterance, this gave us the total number of responses made after the stimulus. The higher the overall value obtained for this index the more subjects waited until the end of the stimulus to respond. Analyses of variance were computed on this index (which ranged from 0 to 4). More post-stimulus responding was in fact done for object dislocations [effect of Dislocation: $F(1, 44) = 7.39, p < 9.32 \times 10^{-3}$] and asymmetrical lexeme orders [effect of Lexeme order: $F(1, 44) = 6.08, p < .01$]. These results complete the findings obtained for the response accuracy variable. In these cases, subjects made more errors, while taking more time to respond. The effect of the Dislocation and Lexeme order factors can be more closely examined by looking at the Dislocation-Lexeme order-Intonation interaction [$F(1, 44) = 12.41, p < 1.011 \times 10^{-3}$] and the Dislocation-Lexeme order-Gender interaction [$F(1, 44) = 5.20, p < .02$].

Table 4 presents the latter interaction.

For object dislocations, an interaction between the Lexeme order and Gender factors was found [interaction for list B: $F(1, 22) = 3.01, p < .09$]. The point at which responding was done did not vary by gender modality on asymmetrical sentences. Responding was generally done after the sentence had been completely heard (Fig. 2, bottom). In the left object dislocations, the pronoun came late in the sentence, being located in the second to the last position in the sequence. Therefore, the information it provided could only be used later on. In the symmetrical sentences, the pronoun occupied the second position in the sequence. A difference in gender could thus be processed as the sentence was being heard, in which case the subjects could answer earlier than above. Responding was indeed done more often on the last segment heard for these stimuli (Fig. 2, top).

TABLE 4
ADULTS: RESPONSE LOCATION (MEANS)

		Dislocation				
		Subject		Gender	Object	
		Ho	He		Ho	He
S	(LDS)	1.71	1.92	(RDO)	2.88	2.54
nS	(RDS)	2.13	1.79	(LDO)	3.17	3.13
		Word Order				
		Iw	Ia		Iw	Ia
S	(LDS)	1.46	2.17	(RDO)	3.13	2.28
nS	(RDS)	2.04	1.88	(LDO)	3.17	3.12

Note. See footnote to Table 3.

A Lexeme order-Gender interaction was also found for sentences with subject dislocations [interaction for list A: $F(1, 22) = 2.78, p < .10$]. This time, the Lexeme order factor had the opposite effect for the two gender modalities: with heterogeneous genders, responding was done sooner on asymmetrical sentences with a subject dislocation, where the pronoun occupied the first position in the sequence, than on symmetrical sentences, where it was in second position (Fig. 1).

We can thus see that the rapidity with which subjects responded depended upon how soon it was possible to process the information provided by the pronoun.

Table 4 presents the Dislocation-Lexeme order-Intonation interaction.

For object dislocations, an interaction between the Lexeme order and Intonation factors was found [interaction for list B: $F(1, 22) = 6.41, p < .01$]. The point at which the response was given did not vary by intonation condition for asymmetrical sentences. The reasons why a decision could only be made later for sentence of this type are explained above. On the other hand, the answers to symmetrical sentences, which on the average were given at the same point as in the preceding case whenever they were heard word by word, were given sooner when the appropriate intonation was applied. Responding sometimes occurred by the end of the first segment of symmetrical sentences with proper intonation [Fig. 2, top right), although it never did on asymmetrical sentences in the same condition (Fig. 2, bottom right). With appropriate intonation, as soon as the first segment was heard (the rheme of a sentence with a right object dislocation), subjects had all the necessary information for determining the agent, even though they did not know its identity, which would be given in the second part of the utterance.

For subject dislocations, the Lexeme order effect was reversed for the two intonation conditions [Lexeme order-Intonation interaction with list A: $F(1, 22) = 6.07, p < .02$]. For symmetrical sentences, responding occurred more often after sentence completion for sentences with the appropriate intonation than for those with word stress only. It looks as though the presence of a continuation intoneme encouraged subjects to delay making a decision until the required information was available. Responding was not done (except in a few rare cases) until after the last segment of sentences with a left subject dislocation (Fig. 1, top right), whereas it occurred as early as the end of the first segment in sentences with a right subject dislocation (Fig. 1, bottom right). In the latter case, all of the information needed to determine the agent was available once the first segment had been heard, even if the identity of that agent was not yet known.

The Dislocation-Lexeme order-Intonation interaction thus clearly indicates that intonation was taken into account by adult subjects. When the sentences had the appropriate intonation, processing was either immediate or delayed, depending on the constituent delimited by the intonemes.

DISCUSSION

Intonation was not found to be a determining factor in the most general phenomenon observed in these experiments. In both of the populations studied, and regardless of what intonation morphemes were used to generate the stimulus sentences, positional cues were the main guide to correct interpretation. Slobin and Bever (1982) previously showed that children acquire a canonical schema that is both specific to their language and highly important to the interpretation of utterances involving diverse word orders. This importance was confirmed here for French, with both child and adult subjects. As hypothesized, when cues indicating the animate versus inanimate property of lexical items are lacking, stimuli that retain the SVO order that characterizes most French utterances are the ones for which subjects most accurately attribute roles. The second phenomenon common to both of the populations concerns the importance of appropriate intonation in determining the agent in sentences with a dislocated object. Remember that in French sentences of this type, the pronoun takes on the same form as the definite article. Because of this, an object pronoun that is coreferent with a dislocated noun is not as valid a cue as a subject pronoun ("il"/"elle") in the same circumstances. The presence of the appropriate intonation morphemes in object-dislocated sentences was shown to improve the accuracy of role attribution. Sentences with a noncanonical structure, in which positional cues are not as reliable, benefit the most from having the proper intonemes. As expected, the syntactic segmentation of the utterance provided by intonation leads listeners to take the resultant grouping of elements into account.

The "le"/la" forms of the pronoun then provide a reliable referential cue. The initial hypothesis set forth here concerning the role of intonation may now be restated more precisely. When the cues are of lesser validity (either because they are not as available, or because they are not as reliable), the appropriate intonation morphemes contribute to the accuracy of role attribution, even though alone they are not capable of directly indicating the identity of the agent.

Prior studies on passive and cleft constructions have suggested that children process positional cues locally, while adults process them topologically (Vion & Amy, 1985). The manipulation of the intonative features of the verbal material in the present experiments confirmed the prevalence in each of these populations of a specific mode for processing the cues available in each utterance.

The speech rate of the sentences produced with word stress only, which as a result were void of appropriate intonation contours, was slower than normal. These sentences must therefore have had a very "school-like" tone. The children's approach to them was such that the first noun heard was systematically taken to be the agent (local processing of positional cues). This behavior was especially prevalent during the processing of asymmetrical sentences with left dislocated objects. The local processing of the gender of subject pronouns, when reliable, was also found to occur for sentences presented without the appropriate intonation.

However, the children did not process cues locally in all circumstances. Sentences with the appropriate intonation seem to have induced comprehension of the sequence as a whole, which restricted the systematic choice of the first name as the agent. But this induction of a global comprehension did not yet have an impact on the children's efficiency for processing other cues. Indeed, it did not enable them to perform better in cases where the gender of the pronoun in a given sentence was not a reliable cue.

The adults exhibited a more relational apprehension of the utterance constituents. Unlike the children, they were capable of correctly processing object pronoun gender when it was a reliable cue, provided the appropriate intonation was present. The recording of the point in the sentence at which responding was done by the adults provided us with some additional information about how the various cues were taken into account during utterance interpretation, depending on their validity, and about the role played by intonation morphemes. According to the competition model, cues captured during utterance processing can reinforce or weaken the candidacy of a given element (a noun phrase, for example) for a given role. The strength of this candidacy is thought to be updated at each step in the processing as new cues are encountered (marks of agreement, for instance) (MacWhinney, 1989). To my knowledge, the studies conducted in the framework of this model have not yet relied on on-line analysis to empirically validate the latter proposal. Two of the findings of the present experiments are consistent with this idea of gradual updating. First of all, more than for the other types of utterances, subjects waited until they had heard the entire stimulus before responding to asymmetrical sentences or to dislocated-object sentences. In both cases, positional and lexical cues, which are a determining factor in interpretation, were less valid than in the other types of sentences in the experimental material. It follows that more complete exploration of the material would be done in an attempt to find confirmation. Second, subjects responded more quickly when the information provided by the pronoun itself came earlier in the stimulus sequence.

Comparison of the point at which responding was done for a given sequence with and without the appropriate intonemes provided additional information about the role of intonation in utterance processing. The effect of intonation can be examined in cases where other cues are being processed. For a given sentence, the comparison of when responding was done if the sentence was produced as a series of isolated words to when it was endowed with

the appropriate intonation showed that response timing appears to depend on what intonation morphemes are present. Continuation intonemes seem to lead subjects to delay their decision to respond, whereas conclusive intonemes seem to permit immediate responding.

As regards the pragmatic dimension where message information is organized, the dislocated sentences chosen for the present experiments perform both thematic and rhematic functions in the conversational situations of daily living. Via left dislocation, the speaker opens by stating the theme of the utterance. An utterance onset marked by a continuation intoneme serves as a starting point for communicating the most informative part of the message. Via right dislocation, the speaker focuses attention on the most informative element (closed by a conclusive intoneme) and places the rest in second place. In both cases, the continuation and conclusive intonemes constitute instructions indicating how that information should be processed by the listener in order to integrate it with the information already available in memory.

In the experimental situation chosen, marks indicating the organization of information need not be processed at the pragmatic level, but the intonemes retain their role as processing instructions. They guide the construction of a semantic-referential representation. This last finding is a good illustration of how the processing done by adult subjects integrates the two levels of sentence structuring (utterance vs message).

To gain further knowledge of the tendencies outlined here with synthetic verbal material, further studies must of course be conducted, particularly bearing on natural intonation. Another area that might be more thoroughly explored is the on-line processing of prosodic, positional, and lexical cues by adult subjects. If it is true that intonation is the leading universal mark of the theme-rheme opposition (Hagège, 1982), then studies that take the diverse structures of different languages into account would certainly be worthwhile.

However, it already appears legitimate in the light of the findings of this study to assert that intonation plays a dual role in dislocated sentence constructions in French. Not only does it provide nonredundant information to reinforce the candidacy of a given element for a given role when the usual role attribution cues are not sufficiently valid, but it also regulates the reassessment of the strength of this candidacy at various points in the processing.

APPENDIX

Practice Sentences

l'indien assomme le cosmonaute
le cosmonaute secoue l'indien l
'indien chatouille le cosmonaute
le cosmonaute attrape l'indien

Left Dislocations

List A: Test Sentences

le schtroumpf jardinier assomme le bûcheron
le schtroumpf pirate secoue le cow-boy
la schtroumpf cuisinière chatouille la maîtresse
la schtroumpf sportive attrape la coiffeuse

le schtroumpf maman assomme le pirate
le schtroumpf cuisinier secoue la sirène
la schtroumpf coiffeuse chatouille le bûcheron

le schtroumpf menuisier attrape la danseuse

la sirène, elle assomme la patineuse
la maman, elle secoue la cuisinière
le cow-boy, il chatouille le jardinier
le cuisinier, il attrape le boulanger

le cow-boy, il assomme la sportive
la maîtresse, elle secoue le boulanger
le pirate, il chatouille la patineuse
la sirène, elle attrape le musicien

il assomme le musicien, le boulanger
il secoue le menuisier, le bûcheron
elle chatouille la maman, la danseuse
elle attrape la maîtresse, la patineuse

elle assomme le cuisinier, la danseuse
il secoue la coiffeuse, le musicien
elle chatouille le menuisier, la sportive
il attrape la cuisinière, le jardinier

Right Dislocations

List B: Test Sentences

le schtroumpf pompier caresse le gendarme
le schtroumpf pirate chatouille la cuisinière
la schtroumpf maman bouscule la princesse
la schtroumpf sirène renverse la patineuse

la schtroumpf maman caresse le pirate
le schtroumpf cosmonaute chatouille la patineuse
la schtroumpf patineuse bouscule le musicien
le schtroumpf cowboy renverse la princesse

la maîtresse, la princesse la caresse
la maman, la danseuse la chatouille
le cosmonaute, le gendarme le bouscule
le pompier, le musicien le renverse

le cowboy, la cuisinière le caresse
la musicienne, le pompier la chatouille
le cuisinier, la musicienne le bouscule
la danseuse, le pirate la renverse

le cosmonaute le caresse, le musicien
le cowboy le chatouille, le soldat
la maîtresse la bouscule, la danseuse
la cuisinière la renverse, la musicienne

le cuisinier la caresse, ta sirène
la sirène le chatouille, te gendarme
le soldat ta bouscule, la cuisinière
la maîtresse le renverse, le soldat

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