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CAN PROSODIC CUES BE A WINDOW TO EARLY COGNITIVE DEVELOPMENT?[1]

The interactive approach to language development postulates that there are early and tight links between language perception and production in the young infant. These two aspects are also intimately related to the infant's level of cognitive development. Often, this opinion remains theoretical, and not supported by facts. In this paper we chose a narrow, but original path, consisting in the search for small and precise cues which could show the links between linguistic and cognitive development.
The paper deals with the emergent prosodic (rhythmical) structuring of a language and its relations to early cognitive development. Rhythmic structures differ across languages. Inter-regional (French vs Quebec French) and inter-language (English, French, Hungarian, Portuguese, and Spanish) comparisons showed that there seems to be an internal neural clock working at the very beginning and that very quickly the acquisition of the specific rhythmic structuring of different languages is a sign of new stages in cognitive development marked by the possibility for the child to establish relational structures between the whole and its parts. Moreover, it indicates that the child has integrated the linguistic rules of demarcation.

Early cognitive development is not an easy domain to deal with, mainly because of many possible methodological biases. As language and cognition have, of course, close links, many authors study language development from a psychological point of view, starting with the idea that cognition is a prerequisite to language, while others use language to have access to the functioning of the mind. These opposite positions were at the origin of the well-known debate between Piaget and Chomsky (Piatelli-Palmarini, 1980). This approach gave birth, in the 80s, to many general studies trying to establish a parallel between cognitive and linguistic functioning, but the results were meager. On the other hand, smaller, but more specific investigations were more fruitful. This procedure was chosen, with an even narrower, albeit original, path, which consists in searching for small prosodic cues in prelanguage and very early language. It is hypothezed that these cues might help to explain some of the remaining unclear points. Two main questions will be treated: a) what

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does the infant learn about language in general and his/her mother-tongue in particular in the so-called prelinguistic period and in the following transition period? (which we prefer to call pivotal, cf. underneath), b) how does the infant acquire this knowledge?

To achieve our aim, it was decided to study regional variations as well as cross-linguistic differences in early first language acquisition. This paper will only be devoted to one particular micro-system which includes the prosodic aspects, since prosodic structure directly expresses a speaker's knowledge of his/her language. Prosody is the result of complex interactions within and between several different levels of organization which can be summarized as, leaving aside the expressive level, the pragmatic, phonotactic, syntactic and semantic levels of information with their underlying principles and their diverse rules (Pulvermuller, 2000). These rules may sometimes be contradictory (Rossi, 1995, 1999).

Current studies on language acquisition are seldom concerned with the prosodic levels which would appear to be an error, as prosody is the first linguistic element that is perceived (Konopczynski, 1998) and produced by the infant (Konopczynski, 1986 a, 1990, 1991). Inversely, the other diverse levels of language have been well studied and one major subject which has been paramount over the past years concerns the possible links between babbling and the ambient language. Two opposite approaches are found in the literature: the inneist/independentist approach (Lenneberg, 1967; Locke, 1983; Oller, 1980, 2000) and the environmentalist or interactive approach (Boysson-Bardies et al., 1989, 1992; Konopczynski, 1990, 1991, 2000; Levitt & Aydelott Utman, 1992; Vihman, 1996).

The proponents of the first approach claim that babbling is mainly dependent on biological and mechanical constraints typical of that age. Hence, there would be no direct links between babbling and the ambient language. The baby would produce more or less universal sounds because his/her speech organs lack biological and physiological maturity. Cognition would not have much to do with these biological constraints.

The proponents of the second approach, on the other hand, claim that babbling reflects very early (already in the second half of the first year) vocal and prosodic characteristics of the ambient language. Of course, this approach postulates early and close links between language perception and production in the young baby, and hence cognitive development is directly involved.

These questions are not new. What is new is our approach and some of our answers. This study concerns the span from the babbling period at 9 months, known as prelinguistic, through the pivotal period to the very first word combinations. We call "pivotal" the period generally called "transition stage" because we think that this stage is much more than a mere transition, important things for language development happen during this time, it is a real pivot towards language. From a cognitive point of view, one must bear in mind that babbling productions do not make reference to elements of the world. "To make reference" is an important stage in cognitive development; it implies an intentional act to designate an object or an action using a symbol. At the end of the babbling period, the infant is not yet able to make reference with words. However, this does not mean a lack of intentional communication and linguistic functions. In actual fact, the baby is already able to communicate linguistic modalities, such as statements, questions, orders, exclamations, but only with prosody (Konopczynski, 1991). This is a pivotal preparation stage for the real expression of linguistic and cognitive functions which are already there, but hidden like the base of an iceberg. This is what makes this period so attractive for researchers in language development.

To have a broader look at the problem, two types of studies: were undertaken : a) a comparison of two dialectal varieties of French and b) cross linguistic studies. These studies are required in the search for characteristic traces of the ambient language in the young child's productions because they help to distinguish between what is universal and what is specific in the babbling of babies surrounded by languages which differ in their segmental and prosodic characteristics. There are two alternatives: a) is there at the onset of speech, a general prosodic pattern similar in all the languages to-be-acquired? or b) does the baby produce, from the beginning, the prosodic pattern of the dialectal variety of his/her mother tongue, whatever its complexity?

In this paper, only the prosodic aspect will be dealt with, and limited to the temporal structuring, often called rhythm, which plays the most important role in the perception and production of speech.

Quick overview of six adult models chosen for the study

Although speech is rhythmic, rhythmic structures differ across languages.

For instance, metropolitan French (that is cultivated milieus without any audible local regional accent, whose pronunciation is considered the standard variety) has a temporal rhythmicisation. It is generally described as showing a "syllable-timed tendency", because its mainly open syllables are more or less isosyllabic, i.e. equal in duration, at least at the perceptual level, albeit Wenk & Wioland (1982) rather consider French as being "trailer timed". This seems a better description because each group or sentence ends with a stress that is primarily characterized by duration. In neutral utterances, the final syllable is usually about twice as long as the internal syllables, which show a tendency towards isosyllabicity (Delattre, 1965; Fletcher, 1991). Stress does not occur on individual words, but on a whole group, called "prosodic word" (P. Martin, 1975), or rhythmic group. As its localization is imposed on right boundaries, the functions of this final stress are clear: it has a double function, a rhythmic structuring (Fraisse, 1956, 1974) and a demarcative function, indicating either the end of a syntactic or semantic group or the end of the utterance. It should be added that the location of stress is, thus, completely predictable.

The regional variety of French chosen for this study is the Quebec variety of Montreal, whose characteristics differ quite markedly from continental French both phonologically and prosodically. Montreal French has a richer vocalic system than metropolitan French mainly because it keeps the phonological contrast between short and long vowels, a contrast to which is added a difference in vowel quality (Santerre, 1974, 1992). In Montreal French, the phonological length of the vowels often leads to a diphthongization phenomenon (Dagenais, 1981). The long vowels diphthongize forming closing and decreasing diphthongs. The closed vowels are submitted in unstressed syllables to diverse modifications (laxity, devoicing, elision) which also characterize the vocalic system of Quebec French. This sometimes leads to a new syllabification and thus a restructuring of the rhythmical groups (Couturier, 1995; Santerre, 1987).

The isosyllabicity of standard French is less regular now than twenty years ago because secondary stresses, characterized mainly by pitch, occur more and more often (Dell, 1983; Vaissiere, 1991; Astesano, 1999; Di Cristo, 1999). In Quebec French this isosyllabicity does not exist (Santerre, 1991; Santerre & Roberge, 1992; Cedergren, 1992). The Montreal variety has a rhythmical pattern in which the unaccented, non final syllables tend to

increase in length towards the end of the rhythmical group (Cedergren, 1992) and the antepenultimate syllable is often the most prominent, although this pattern is strongly conditioned by the phonological contrasts in vowel duration.

Four other languages having contrasting rhythmical characteristics were also chosen: two stress-timed languages, a language in between stress-timing and syllable-timing and a more complex language.

Languages are said to have a "stress-timed tendency" (Pike, 1946; Dauer, 1983) when their basic rhythm is mainly determined by the stressed syllables. The interstress intervals tend to be more or less regular, the unstressed syllables compressed or deleted, with vowel quality alteration and/or vowel reduction, a large percentage of closed syllables and flexibility in stress placement. The acoustic parameters of stress are complex, with a mixture of pitch, intensity and duration. (Fant et al., 1991). English and Dutch are typical examples of stress-timed languages, with pitch and intensity rhythmicization. Moreover, stress location is not at all predictable. Continental Portuguese is also stress-timed (Delgado-Martins, 1982), but less than English, because the location of stress is far more predictable: although it can fall on different syllables, the penultimate is the one that is the most often stressed (75% of the cases).

Spanish was chosen as a language which is in between stress and syllable-timed, mainly because closed syllables are rare and because there is a relative tolerance for large discrepancies in the interstress intervals (Bertinetto, 1989). Its stress is predictable on the penultimate syllable in 80% of the cases (Delattre, 1965). In both these Romance languages, the phonological aspect plays an important role: stress is mainly lexical and has a grammatical distinctive function. In these three languages, words keep their stress pattern within an utterance, which can thus have more than one stressed syllable. Stressed syllables are more prominent than in French; their main physical parameters are intensity and/or pitch, rather than duration.

Finally Hungarian was added, because of its complexity (Kassai, 1991). It can be compared to French because its stress has the same demarcative function as in French, except that it affects the initial syllable. However, contrary to French, open and closed syllables are nearly equivalent in frequency and word order is free, whereas it is constrained in French, and thus the stress function is not only demarcative. Its location also depends on topic/comment organization and on given/new information; as a result, there can be more than one primary stress within a long utterance which makes things quite complex for the child. Added to these characteristics, Hungarian has phonological vowel and consonant lengthening; thus, the results have to be interpreted with caution.

These are all oversimplified descriptions of the rhythmical patterning of the different languages mentioned here. In everyday spontaneous speech, different temporal structuring can exist. However, for emergent language, these descriptions have the advantage of being simple and efficient models that are easy to apply to child language which is not yet very complex from the syntactic or semantic points of view.

Acquisition of these languages

Now the question is: Do children belonging to different linguistic backgrounds behave the same way and acquire the temporal structuring of their mother tongues at approximately the same age?

There are two opposite answers. The first is that, as all children probably go through the same stages in cognitive and linguistic development, the age of acquisition of the temporal structuring should be more or less the same, and the ambient language should have no strong effect on that performance. The second is that ambient language will have a strong influence, and that age of acquisition of rhythm will depend on the complexity of the adult model. The rule could then be: the more complex and nonpredictable the rhythmical model of a language, the more difficult its acquisition. A global result of our analyses can already be given: the answer to the above question is no. All children do not acquire the temporal structuring of their language at the same age. They show quite large and clear differences in the age of this acquisition.

First (in the following paragraph) the results of a study comparing the acquisition of the two regional varieties of French, as unpublished (oral communication by Maneva & Konopczynski, 2000a, and Maneva, submitted) will be presented. Moreover, nothing, to the best of our knowledge, was known prior to these two papers concerning the possible variations that could come from regional characteristics of a language. French, Spanish or English, for example, which are spoken worldwide are known for their dialect varieties which are sometimes quite distinct in their phonetic characteristics, whereas their morphological, lexical and syntactic structures have more in common with the standardized form. If an influence of the ambient language on early emissions could be demonstrated, this would confirm strongly the environmentalist approach. It would also help to answer questions that deal not only with language development, but also with cognitive development, such as the relationships between input and output, the selection of information by the child, his/her possibility of categorization, etc.

The next paragraph will show that differences in the babbling of babies with diverse linguistic backgrounds are well documented. The results of the cross-linguistic studies will be summarized, as they have already been published either by Konopczynski or taken from the literature. Finally, the data will be discussed in the light of the initial question.

Results of the comparison between two regional varieties of French

For a better understanding, it should first be recalled that for the acquisition of continental French, studies were carried out by Konopczynski (1986 a, 1990, 1991) on twenty babies followed from 9 to 24 months. Other children were added later, for other studies, but the results were confirmed. It was demonstrated that the babbling of French babies born and living in France reflects the basic rhythmical characteristics of standardized adult French, i.e. a clear isosyllabicity of the non-final syllables (NFS) and a significant lengthening of the final syllable (FS) of an utterance. This relatively simple rhythmical pattern appears around 10 months and concerns isosyllabicity; final lengthening (FL) is generally acquired towards the age of 14 months. Thus, very early the French baby acquires the relatively simple and predictable rhythmical pattern, called syllable-timing, of his/her mother tongue. Interestingly, this FL is also a necessary cue for French infants' productions to be judged as speech-like utterances (Bacri, 1984; Konopczynski, 1986 a ; Vinter & Konopczynski, 1994)

For Montreal babies, the corpus is presently limited to two middle class girls studied by Maneva (Maneva and Konopczynski, submitted; Maneva, submitted) presenting no known developmental handicap. Situation, age range, etc. were chosen so as to be comparable with Konopczynski's (1986 a, 1990) methodology: the girls were recorded with the au-

Table 1. Syllabic structuring in Quebec and continental French

	Quebec		French	
Months	Vowel like	CV	Vowel like	CV
10	25.9%	60.2%	51.0%	44,1%
14	14.1%	71.0%		
21	10.2%	64.4%		

N.B. The total % is not 100% because some other syllable types appear, such as CCV, CVC

thorization of their parents at the following ages: 10, 12, 14 and 21 months, because for continental French the results showed that the rhythmical pattern of standardized French is being acquired during that period. It should be recalled that this period is pre-linguistic: it precedes the first recognizable words. Recordings of approximately one hour were carried out at the home of the children, in their natural environment, during play sessions. Although this technique raises some technical problems (noise) it was chosen so as to respect the naturalistic ethnomethodological approach used by Konopczynski.

The results will be presented in the following order: Utterance structuring, syllable structuring, temporal structuring (syllabic duration) depending on three factors: syllable weight, length of the whole utterance, and position of the syllable in the utterance.

Both utterance structuring and syllable structuring of the two varieties of French were in agreement: 22.5 % monosyllabic vs. 77.5 % bi- and polysyllabic utterances for the French baby and for the Montreal babies 23.1 % vs. 76.9 %. In both dialects, two and three syllables were the most frequent, though a small percentage of utterances with more syllables were found.

For syllabic structuring both groups presented the same characteristics at the first ages, their utterances containing mainly open syllables type V and CV. However, these two syllable types evolved in opposite directions in the two groups. In the Quebec child, vowel-like syllables and utterances decreased in quantity. These results agree with those of Konopczynski (1990). The vowel-like sounds were 51% at the beginning of the tenth month, while at the end of the same month their number went down to 27.3 %, and then gradually decreased.

Inversely, the number of CV syllables increased in both groups as shown in Table 1. Nevertheless, there was a main difference: the syllabic CVC type appeared clearly in Montreal French between 14 and 21 months, increasing from 5-6% to 15-16%, which is near the adult target of 17,1%. This is not the case in French babies whose closed syllables are limited in number at all ages (4.9%) in Konopczynski's corpus as well as in a French girl studied by Levitt and Aydelott Utman (1992). CVC syllables never occurred in the final position during this age range. Of course, the preference for open syllables is not surprising: it can be explained by the articulatory limitations at this age (De Paolis et al., 1999; Oller, 2000), but it also reflects the linguistic origin of a speaker. Levitt & Aydelott

Utman (1992) found a clear difference in the syllabic preferences of the future French speaking and future English speaking children from the eleventh month on. The French girl continued to use mainly open syllables characteristic of her mother tongue, whereas the American boy produced more and more closed syllables, which are frequent in his ambient language. The Montreal babies behave the same.

Looking at the relation: syllable duration/syllable weight, Konopczynski (1990: 267-268, 277-279) found that the weight of a syllable, i.e. the number of elements composing it, did not influence their duration until the age of 21 months; it was only from then on that a slight evolution appeared: the heavier the syllable, the longer it became (despite the existence, in metropolitan French, of a slight syllabic compression which makes the duration of French adult syllables more or less equivalent, at least perceptually, independently of their weight). On the contrary, in the Quebec baby, the number of elements composing a syllable had a direct and statistically significant influence on its duration, with the following pattern: V (± 270ms) < CV (± 350ms) < CVC (± 450ms) < CCVC, etc.. The more elements in a syllable, the longer its duration. This was already apparent at 10 months and increased. This is a second major difference between French and Montreal speech.

Looking at the relation: syllable duration/length of utterance, as for the preceding point, before 21 months, the length of an utterance (number of syllables) had no influence on the syllabic duration in the French baby and there was no syllabic compression as in adult speech (Konopczynski, 1990: 279). In the Quebec baby, there seemed to be a link between utterance length and syllabic duration: the more syllables in an utterance, the shorter their duration.

These two phenomena concerning the dependency of syllabic duration on syllable weight and utterance length are two other factors which hindered the isosyllabicity of the non-final syllables in the Quebec child.

Finally, the relation between duration and position of the syllables in the utterance is where the differences are the largest in the two regional varieties. The French baby (Konopczynski, 1990) gradually acquired FL from the age of 11 months on, although there was an unstable development during 3/4 months; but towards 14-15 months, this typical cue of French rhythm was similar to that of adult speech with a ratio FS/NFS of at least 1.7, if not 2 (Konopczynski 1990: 282)

In the Quebec baby, on the contrary, FL began to appear only at 21 months; at this age, the ratio FS/NFS was still small (1.4) and not statistically significant. As FL is not acquired at 21 months, it would seem to be a late acquisition, compared to metropolitan French. More investigation is needed to know at what age it appears.

In any case, procedures of acquisition of Quebec French and metropolitan French differ. Moreover, the late acquisition of the more complex pattern of Quebec French compared to continental French confirms the Konopczynski (1993, 1995 a, b) theory of the rapidity of acquisition of the rhythmical patterns: the more complex a pattern, the later it is acquired, as already indicated..

Results from cross-linguistic studies

As these results have already been published, either by Konopczynski, or by other researchers, they will be summarized so as to provide a basis for a general discussion of their cognitive relevance.

The rhythm of languages that have a "Gestalt" with a natural FL and predictable stress location seems to be acquired early (first half of the second year). As has been shown above (§ 3) the metropolitan French pattern is one of the easiest, as it implies an isochrony of the NFS and a predictable lengthening of the FS. This has also been demonstrated for some of the most simple stress patterns of Hungarian (Kassai, 1991).

For languages which have a simple, frequent, and not very variable "Gestalt", with a syllabic structure made up of mainly open syllables, where prominence is almost stable, located near the boundaries, rhythm seems to be acquired a little later, but still early, generally towards the end of the second year. This seems to be the case of Quiche Mayan, for instance, or Mohawk, or Comanche, whose stress is on the initial syllable as in Hungarian, or of Brazilian Portuguese which is not as strongly stress-timed as continental Portuguese (Hyman, 1975). Studies of Italian seem to confirm this fact. According to Raffler-Engler (1973) her child opposes, in production, *papa* (something to eat) /*papa* (daddy) from 9 months on. Velten (1943) who made a follow-up of her daughter between 11 and 36 months, notes a substitute of a prominence. Her child seems to use different vowel types in stressed and non-stressed syllables. Ervin-Tripp (1973) found the same, but at a later age. It could probably also be the case for Quebec French. Nevertheless, the results have to be completed for the Quebec variety, and checked for all the other examples, as they come from rather old literature and were not obtained by instrumental measurements.

Japanese seems to be a bit more complex. Although this language does not show final lengthening (Hoequist, 1983), it should be noted that recent research (Vaissiere, 1997) finds that contemporary spontaneous Japanese shows more and more FL, and that the Japanese mothers probably use this characteristic in their baby talk For other researchers, Japanese children never pass through a stage of FL (Hallé & al, 1991)

When languages have a dominant, nearly predictable, stress pattern, with only a few exceptions, the child, after a phase of FL, hesitates a while, and then chooses a strategy without stress preference, called "neutral pattern" (Klein, 1984), and makes stress errors; later on, s/he follows the patterning of his/her mother tongue; this may happen in the first half of the third year. It seems to be the case of Spanish (Hochberg, 1988) and of most parts of Hungarian (Kassai, 1988, 1991). Portuguese, with its greater number of closed syllables and its numerous vowel reductions, also presents a final lengthening at the beginning of emerging proto-language. Its rhythm could be a bit more difficult to acquire, but the importance of the intensity cue may be a counterpart. And, in fact, Portuguese children seem to acquire it as quickly as do Spanish children (Konopczynski, 1995a).

For Quebec French, given its greater rhythmic complexity, it could be predicted that the child would have difficulty in producing a stable rhythmical organization in early productions between 10-14 months; the typical pattern of Quebec French would be acquired either more progressively, or in a later period of the linguistic development of the Quebec child.

In languages which do not have a dominant "Gestalt", either for syllabic structure, with a relatively high percentage of closed syllables, or for prominence which is located in variable places depending on lexical, grammatical, semantic and pragmatic factors, the child, unable to find invariability and stability in the model, seems to have more difficulty.

It is the case for German, for instance. Leopold (1947) believes that Hildegarde is not sensitive to stress and does not produce any prominence. Moskowitz (1970) hears a stressed syllable followed by an unstressed one, with falling melody, giving perceptually a trochaic rhythm. Inversely, Diestelman's data (1982), which are unfortunately hazardous, because

vocalizations and proto-language are studied in the same group, show an initial isochrony followed by FL towards 24 months.

English has been widely studied, of course (details in Konopczynski, 1993). The main results converge: generally, the child begins to acquire a part of the correct stress pattern only after two and a half years, when s/he combines two or three words, but many stress errors occur. English is a typical language with a long delay in acquisition of the correct stress pattern.

Researchers disagree on what exactly happens in English. Some have not found FL in early productions of English-speaking children. For instance, Keating & Kubaska (1978) found none at 28 months (one subject), in words of two syllables. Nevertheless, Kubaska & Keating (1981) found FL at a later age when the child begins to combine two words, but they indicate neither the mean length of the final syllables, nor the ratio SF/SNF, only the general syllabic duration (25-36cs)

Oller and collaborators (1980, Oller & Smith, 1977) found (16 subjects) that at 10 months there was no FL, but, as in French, there was isosyllabicity, at least in the reduplicated syllables whose duration varied between 19.5 and 32cs. Once final lengthening was found, it never exceeded 10% and the ratio FS/NFS was $0.93 < R < 1.24$ (too small to be heard), while adults pronouncing the same reduplicated syllables had 10 to 100% FL ($1.24 < R < 2.28$).

In a two-case study with one American male and one French female infant between 0;5 and 1;2, Levitt and Aydelott Utman (1992) reported the same kind of work as that of Konopczynski for French infants. The results were the same for French and English, except for the syllabic structure. The French infant had, by 9/10 months, more open syllables, and this percentage remained fairly stable, whereas the American infant dramatically increased his percentage of closed syllables, from 2% at 8 months to 10% at 11 months and to nearly 25% at 14 months. This discrepancy is consistent with Robb and Saxman's (1990) findings and, in general, with the greater frequency of closed syllables in English than in French. Thus, by the age of 10 months, English, Canadian and French speaking babies have begun to produce the syllabic structure typical of their linguistic environment. Recent studies by Snow (1997) and by Grabe et al. (1999), which both compare the acquisition of English and French confirm these results. Concerning the temporal organization, Levitt et al. (1991: 57) note that the French girl produced NFS that were on the average close in duration. Both her subjects showed gradual increase in FL between 11 and 14 months, but the French girl was more regular than the boy, her only lengthened syllables being the last ones. This is consistent with Konopczynski's (1986, 1991) findings. The results for the American boy were less clear. Furthermore, Levitt emphasizes that they are based on too few utterances, and that the follow-up should continue after the age of 14 months, which is probably too early to study correctly FL.

This group of findings is partly in contradiction with Bruce Smith's (1978) and Robb and Saxman's (1990) results. Smith maintains that English children have acquired FL by 2 and a half years, 80% of their final vowels, which are unstressed, being nevertheless 32% longer than the stressed non-final vowels; later on, he found no significant evolution. Children aged 4 years and adults had the same results, but meanwhile the children also had acquired a part of the English stress pattern.

Robb and Saxman (1990) studied seven babies from preword to multiwords (medium age: 10 (range: 8-14) to 22 (range: 19-26). The data, composed of 6.041 utterances, in which only 206 bi-syllables were studied, showed final lengthening consistently longer in

closed than in open syllables. The problem with their interpretation of the data is that the authors did not take into account the fact that FL, even if it exists in the raw phonetic data, has to exceed a threshold (R = FS/ NFS > 1 .30) in order to be heard. They counted as an FL every R that is >1.0. Thus, reinterpreting their results, it can be seen that, in CV structures, three subjects have no audible FL at all, and two have a slight FL which occurs after 17 months. Only two subjects have, from the beginning to the end of the data collection, a constant FL with R = 1.30 to 1.40. As the FL of most of the subjects cannot be perceived, it cannot indicate the end of a clause, contrary to the author's assumption. In CVC structures, on the other hand, FL >1.30 is present in nearly all subjects, but it is neither consistent nor stable. Robb and Saxman interpreted FL as being mostly a passive, nondeliberate process ingrained within the physiological functions of the infant and continuous throughout the preword and multiword periods of development, thus having nothing to do with cognitive development. This is contradictory to the statement that FL could indicate the end of a clause.

As a conclusion to the temporal organization at the pivotal stage, Allen and Hawkins (1978: 174) can be quoted:

> "the (English) children's polysyllabic utterances typically follow a trochaic pattern, but since the unaccented syllables ... are still heavy... the resulting rhythm typically sounds syllable-timed"

Thus, two languages like French and English, that have diametrically opposed rhythm in adult language, seem to have a quite similar rhythm in babbling and very early speech, but differ nevertheless in syllabic structure and regularity/irregularity of FL.

All these data can be summarized as follows: by the age of one and a half, the French child has acquired the typical stress-patterning of his/her mother tongue, the English child is far from such a performance, and the children from different linguistic backgrounds are in-between. The question to answer now is: when does the English child acquire the mastery of rhythm of his/her language? How does s/he acquire it? In which order are the rules of stress-placing learned? When and how does the reorganization from syllable or trailer-timing to stress-timing occur? Of course, the same questions should be raised for many other languages, but only one will be chosen, English, as the acquisition of its temporal structuring has been studied in a few papers and also because it seems to be a quite late acquisition, compared to many other languages.

A striking feature is that, after the first period where English babies sound close to French as well as to other babies, only a few investigations can be found concerning the acquisition of the stress pattern of English. B. Smith (1978) noted the appearance of some stressed syllables at 18 months which are15% longer than the unstressed ones, but it is not a perceptible lengthening. Only towards 30 months does this lengthening increase to 20-30% compared to non-stressed syllables. Generally, stress is only focused on when the child, between 2 and 3 years old, combines some words. Other scholars have regarded the language of children from three points of view: perception, repetition and spontaneous speech. Older studies showed that stress is perceptually well located from approximately 30 months on (McNeill, 1970; Slobin, 1973; Grunwell, 1975; Gathercole, 1976; Klein 1981) but more recent studies (Jusczyk et al., 1993; Swingley, 2000) found this ability already at nine months. Rather scattered remarks on repetition in 2 to 3 year olds seem to

show that stressed words are better remembered and imitated than unstressed ones because they carry the meaning (Brown & Fraser 1964, Bellugi & Brown 1964). But Scholes (1970) disagrees, saying that when form words and function words have the same stress pattern the second are forgotten. When this is tested experimentally with nonsense words (Blasdell & Jensen 1970) stress is shown to be an important cue for perception, the items which are the best remembered being the ones with a final accent. This seems to be true even in languages like Czech which carry an accent on the first syllable; nevertheless, children omit these first stressed syllables more often than the last unstressed ones (Pacesova, 1959). Thus, it seems that final stress, which helps the child segment large units inside the speech chain, is linked with cognitive functioning. It is probably not yet within the abilities of a young child to detect more complex patterns when stressed units are inside the utterance.

Concerning spontaneous speech, the remarks found are quite anecdotal, and based on purely auditory impressions, even without counting present/omitted syllables, for instance. Some tendencies typical of English are noted, like omission of some pre-tonic syllables. Although Weir (1962) states that her son at 30 months used stress in accordance with English speaking habits many think she overinterpreted her child's performance. Some other examples can be found. Braine (1963 : 10) maintains that there is a difference in stress location in the speech of a child opposing «baby chair» (small chair) to «baby#chair» (the baby is in the chair); the same was found by Miller & Ervin (1964) whose subject Christy says «Christy room» as a possessive opposed to «Christy room» as a locative = Ch. in the room. Bowerman also (1973) reported that her daughter Kendall stressed 14 times out of 17 the object in subject-object utterances, and 10 times out of 12 the possessor in utterances indicating some kind of possession. From examples like these, Slobin (1973) and Menyuk (1971) concluded that at the two-word stage stress is used to mark grammatical differences, without taking into account the following important advice by Miller & Ervin (1964: 29)

> "this may be true from a phonetic, perhaps even from a phonemic stand point, but does not necessarily entail the use of prosodic features in the grammatical system"

It can also be objected that the above-mentioned examples do not show the utilization of the normal contrastive stress, but rather an emphatic accent, because, in each example, the children's items are obtained as a response to a direct question, like "Is that the baby's chair?" .The child adds a stress because that is the only way for him/her, at this stage, to answer the question as posed. According to Maratsos (1989:113) use of emphatic stress is learned "fairly early". But how early does he mean? Nevertheless, being able to emphasize linguistically shows a new cognitive skill which did not exist earlier.

Some studies are more precise. Wieman (1976) who analyzed five children between 21 and 29 months in two-word utterances, controlling the emphasis parameter, gave support to the preceding intuitions. But the most interesting part of her study lies in the fact that she found that the child always privileged semantic over syntactic relations, and that s/he stressed in a systematic manner the new element. This gave, at that time, a confirmation to Chafe's theory (1970) stating that there is a hierarchy in accents depending on whether the information is new or given. Besides, all these authors and also Neilson Smith (1973), and Menn (1976) insist that the stress pattern which has been shown does not occur regularly

and that the child makes many accentuation errors. This pattern may simply have been focused on because it is easy to hear in spontaneous speech.

Current arguments in favor of a precocious acquisition of stress as a grammatical marker in English, and thus as a cue to cognitive functioning, are inconsistent. What is beginning to be acquired is presence/absence of a kind of prominence (Ingram 1976, Klein 1981), but neither the hierarchy of accents nor the rules of stress patterning. Harriet Klein's study concludes (1981: 388):

> "(The child's) hypotheses about stress application tend to vary... (His/her) use of stress at this stage (...) appears to be lexically based. Learning to stress may be a gradual process complicated by interactions of lexical and phonological factors (...). Words becoming more stable within the phonological repertoire soon acquire more consistent use of primary stress. Consistent primary stress placement appears to be one of the characteristics of achievement of the integration of the segmental and prosodic features of the word."

Phonological contrastive stress does not seem to appear before the end of the third year, and the relations between the different stress patterns do not seem to be mastered before 6 years, which is beyond the age group treated in this paper. At this point of the research on acquisition of stress in English, a tentative explanation could be proposed: the input baby talk, with its very strong emphatic stress, often replacing the regular stress patterning, could be one of the reasons for this late acquisition of stress in English. All these data, even scattered, contrast with theoretical affirmations (Martin, 1972 ; Kent, 1976) which predict that in stress-timed languages, where utterances are phonetically dominated by prominent elements, these stressed elements should be programmed before the others. The stressed syllables should be the first targets in the articulatory program. This may perhaps be true in adult speech; it does not seem to be the case in emergent speech.

Recently, an increasing number of studies (Jusczyk et al., 1993; Demuth, 1996; Mc Gregor & Johnson, 1997; Carter, 2000; Swingley, 2000) have dealt with either the perception or the production of two typical rhythmical patterns of English: the iambic weak + strong pattern and the trochaic strong + weak pattern which is the most frequent in English, as 78% of American-English words begin with a strong syllable (Cutler & Carter, 1987). This is especially exaggerated in baby talk. The major result is that babies tend to pull out the strong-weak pattern already by 9 months in perception (Jusczyk et al., 1993; Swingley, 2000), and by 24 months in production, with large inter-individual variation (McGregor & Johnson, 1997). According to McGregor and Johnson, towards the age of two years, the trochaic template is used by the English speaking child as a "resource-saving heuristic employed when the limited capacities of the child are exceeded" (p. 1229). The iambic pattern seems more complex for the child because it violates the quantitavely dominant trochaic pattern, and also because iambs constitute a complex timing gesture in speech just as they do in music where syncopations and offbeat rhythms are difficult to produce, and far beyond the cognitive abilities of children under five. According to Snow (1997), the boundary features are well dominated by 4 year old children, even when the children are SLI, but his own criticism of his work is that he studied an age range that was too late to know when this performance actually appears.

As a conclusion of all these results, it may be necessary to repeat that these differences in rapidity of acquisition can be explained. by two main factors: simplicity of rhythm and predictability of stress localization. From all the above data, a predictive up-down model has been presented: the more complex and nonpredictable the temporal structuring of a language, the more difficult its acquisition (Konopczynski, 1993, 1995 a, b, 2000).). Of course, more research on other languages differing in rhythm is still needed to support this model.

Discussion

What kind of cues are there for cognitive development with all these data? It was earlier thought, when only the acquisition of French had been studied, that things were clear. As already recalled, in adult French, final stressing has a double function: rhythmical structuring and linguistic demarcation, because the presence of a final accent and lengthening indicates necessarily the end of a group or a sentence. Our present data suggest that children acquiring the above mentioned languages seem nearly all to pass through a stage with open canonical syllables and an initial isochrony (neutral phase). This happens often but not always. This first stage is followed by a stage of more or less clear and stable final stressing/lengthening. This would confirm Allen's 1973 hypothesis of the existence of a very general rhythmic constraint due to an internal neural clock, with a regular rhythm, controlling the production at its base. However, unlike Allen, our studies suggest that this rhythm has a final prominence rather than a penultimate prominence (accented syllable followed by an unaccented one). This temporal structure may be governed by only biological rules. Its internal organization and its limits may correspond to the child's motor abilities. Hence, it has nothing to do with cognitive functioning. Later on, as the child matures, isochrony will be superseded by accentuo-temporal patterning constraints specific to each language. Many phonetic, phonemic, lexical, syntactic, and prosodic constraints will then prevent the internal neural clock from working correctly. These rhythmical abilities have to be learned, which is shown by the fact that FL appears progressively, and very slowly, in some languages. Rhythmical abilities are neither innate, nor physiologically constrained, contrary to a widely held belief among researchers (overview in Konopczynski, 1990). However, if this temporal structure with its final lengthening is not innate, it is useful to consider it, with Lindblom (1978), as a more or less natural phenomenon found also in dance, music, bird singing, insect stridulations, etc. Every temporally structured phenomenon seems to have FL, associated with the notion of ending. Of course, an alternative explanation may be suggested: if FL is potentially universal at a certain developmental stage, it later becomes strong in certain languages, and inhibited in others. For those languages where FL is not present in adult speech, children have to learn to inhibit the prosodic characteristics of their first productions, a cognitive skill which is probably not that easy.

Lengthening and ending seem to be a consequence of the emergence of structuring. This does not exist at the very beginning of proto-language, because the child has not yet pre-programmed the whole utterance with its FL because he does not yet have the cognitive prerequisites to do so. Once the beginning of language structuring has appeared, FL, a cue of this structuring, also appears. Hence its presence in many languages. Thus, acquisition of FL, which is after all a small phonetic detail, shows three major outcomes: 1) from

a communicative point of view, it is an indication of good acquisition of turn-taking, and from then on, proto-dialogs function properly, 2) from a cognitive point of view, which is our main purpose here, the mapping of the syllabic duration into the system shows the onset of a new stage in cognitive development marked by the appearance of a relational structure between the whole and its parts. This explanation works for metropolitan French, but not for Canadian French which shows neither isosyllabicity nor FL. In the diverse other languages, nearly all the children (with exceptions, like Japanese) also seem to have acquired this new ability which is also shown at the same age in the new strategies the child uses when playing, classifying toys, etc. Moreover, FL being in French an indicator of demarcation, also called boundary feature, gives insight into linguistic functioning, and thus, into another type of cognitive functioning. By 16 months, the French child has integrated not only the overall rhythmical system, with each syllable having its own relative duration according to its position, but also its demarcative value. This boundary feature marks the right edge of major constituent units in speech and, thus, phonetically reflects the very first expression of a syntactic structure at the level of clauses and sentences. As Mehler & Christophe (1995) as well as Pulvermuller (2000) emphasized, there is a need to develop models for the syntactic treatment of speech, based on the functoning of the brain. Looking at the very beginning of syntax may be a help.

Clearly, prosodic cues can give good insight into cognitive development. Then, what about other languages whose more complex prosodic structuring is acquired far later than in French? A new problem is raised here: are children speaking Canadian French, with a late and seemingly unstable FL, or children acquiring the stress-timed patterns, delayed in their cognitive development compared to French babies? As the answer cannot be yes, there are probably other cues, different prosodic skills, which still have to be found for these languages so as to have further insight into the cognitive development of the children speaking these languages.

Perhaps the reason is that the best acoustic cue was not chosen, or rather, that the cues are different for different languages. They were found for French, because over the years many children have been very carefully studied. The other languages studied had far smaller populations, smaller corpora, and all the prosodic parameters were not looked at. Sometimes data were secondhand, and the results were not obtained with instrumental analysis (Comanche, Mohawh, Italian, German).

Another noticeable factor is that nearly all studies have dealt with stress as a whole, without giving details about its physical parameters. Only Allen and his co-workers (1978, 1980, 1981) tried to specify which parameters are used by the child. For instance, when stress falls on the final syllable, English children use mainly a temporal parameter: they lengthen the final syllable up to double duration. But when stress falls on a non-final syllable, preference is given to rising pitch, as in adults. It should also be emphasized that, except for French, until now, only one rhythmical feature, i.e. duration, could be studied. This can bring a bias, especially for English, Portuguese, German, and probably Canadian French, which are languages where intensity and/or pitch variations are important cues of stress. Interestingly, the Portuguese and the Quebec babies babbled with the prosody of their regional variety. They did not select a general basic pattern even if it was simpler and easier to acquire. Their attention seemed to be attracted more by some salient features (which ones?) rather than by the facility of a pattern. But these results, obtained from very small populations, can be particular cases, and need to be checked. Finally, many authors insist on the great intra- and inter-subject variation.

Meanwhile, it must be noted that, even when looking only at the duration parameter, the results of these comparative studies (Konopczynski, 1993, 1995 a, b) can be summarized as follows: acquisition of rhythmical structuring is far from being simple. On the contrary, what clearly appears is that stress patterning and hence rhythm is not as easily acquired as is often said, by virtue of the principle that rhythm is inherent to all human activity, and that the child is already able to hear the rhythm of his mother tongue in utero. As the capacity of structuring the speech chain is a cognitive capacity, much more research has still to be done on various languages so as to have a maximum of warrants before concluding on the links between cognitive and linguistic functioning, and thus, cerebral maturation.

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