Kansas Working Papers in Linguistics

edited by

Giulia R. M. Oliverio
Mary Sarah Linn

Partial funding for this journal is provided by the Graduate Student Council through the Student Activity Fee.

Volume 18
1993

Kansas Working Papers in Linguistics
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1993

Part I: General Linguistics

THE PHONOLOGICAL RHYTHM OF EMERGENT LANGUAGE : A COMPARISON BETWEEN FRENCH AND ENGLISH BABBLING

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Abstract : The phonological rhythm of French is characterized by a tendency to syllabic isochrony within an utterance and a clear final lengthening, whereas the rhythm of English is stress-timed. A study of babbling at a turning period of the child's development has shown that the French child acquires adult phonological rhythm quite early in interactive situations. There is a strict initial isochrony followed progressively towards 13 months by a final lengthening which, from 16 months on, is the same as in adult speech. This kind of rhythm is not found in solitary play. A review of the literature on English babbling indicates that things are not so clear in the acquisition of phonological rhythm in this language, as its main characteristic, which is stress, seems to be acquired quite late.

This paper is concerned with the acquisition of the phonological rhythm of French and English by babies aged 9 to 24 months. The transition from babbling to early language has been the focus of a wide range of recent research which has an equally wide range of implications. On the one hand, there is substantial evidence of universal development, which seems to reflect a maturational process independent of the language environment. On the other hand, there is equally compelling evidence for early language-specific influences on babbling. As current research has produced much evidence in support of continuity between prelinguistic utterances and the speech which is going to follow, both kinds of processes could easily have been predicted. However, there are somewhat mixed outcomes perhaps in part because of differences in the types of language-specific influences that were investigated. Finally, most of the cross-linguistic research was restricted to segmental cues; prosodic cues have only very recently been looked at, and we have very few results. Therefore, in the present investigation on continuity and language specificity, I shall focus only on one prosodic parameter, rhythm.

Kansas Working Papers in Linguistics, Volume 18, 1993, pp. 1-30

The data for French babies is drawn from experiments in my laboratory; for English babies, it is taken from the literature, which includes some experimental. evidence. To begin, I will define what I call "phonological rhythm" and, next, fix the limits of what I call "emergent language", and "turning point, or pivotal period".

The concept of phonological rhythm is not always clear. Allen (1980 : 227) devoted a long article to that subject, showing that

> rhythm is the structure of a sequence , i.e. the relationship or set of relationships among the units making up that structure..this definition leaves open what those units are; they can be features,segments syllables, words, phrases, etc . (...) Time is only one of several possible components of that structure.

Rhythm is called 'phonological' because it explicitly deals with the temporal-sequential constraints of a specific language, and it can be best understood within the framework of this linguistic level. As a matter of fact, some phoneticians think that rhythm is an individual speech act, even if each language has its own rhythmical characteristics which oppose it to other languages. But other phoneticians, quite as numerous, think that rhythm is a language fact, which has a precise linguistic function. For most languages, the basic rhythm, which is the rhythm of neutral utterances, is mainly determined by the accentual and temporal organization of an utterance. That is to say its rhythm is determined by the organization of pauses and accentuation. From this point of view, the French language is generally said to have a "syllable-timed tendency ", because its syllables are more or less equal in duration. I prefer the terminology proposed by Wenk & Wioland (1982) who describe French as being " trailor timed " because each group or sentence ends with an accent whose main physical parameter is duration (Delattre 1965, Llorca 1987) The final syllable is more or less twice as long as the internal syllables, which still are characterized by a tendency towards isosyllabicity. As its localization is imposed on boudaries, the function of this final accent is clear : it has a demarcative function, indicating either the end of a syntactic or semantic group or the end of the utterance.

Concerning the English language, it is said to have a " stress-timed tendency", because its basic rhythm is mainly determined by the stressed syllables, which appear at more or less equal intervals, the syllables in-between being compressed or extended in duration so that the intervals between stressed syllables remain nearly constant (Pike 1946). The main point in English is that the stressed syllable is noticeably longer, and higher in pitch, and the unstressed ones are shortened to the extent that they can disappear completely. Stress in English, mainly lexical, has strong grammatical functions, and even a contrastive one when opposing verbs to nouns (import/ import). This is but a very oversimplified description of the accentuation system of the two languages. In everyday spontaneous speech, a neutral utterance appears very seldom; on the other hand , the physical parameters of stress are numerous (pitch and intensity play an important role, especially in English, and also some segmental parameters); finally, diverse temporal structuration can exist in both languages. Concerning the French rhythm, for instance, variability and mobility have become its main characteristics in the recent years, and it should now rather be described in terms of "rhythmic possibilities/impossibilities" (Fonagy & Léon 1980, Dauer 1983). But for emergent language, the description as "trailor-timed" has the advantage that it is simple, efficient and easy to apply to child language which is not yet very complex at the syntactic or semantic level. The same is true for English emergent language: stress-timing is an efficient concept, although we know that in adult language, English rhythm is in fact less dependent on interstress intervals than on the whole syllabic organization, with many closed syllables, with syllabic reduction, and more than one stressed syllable located towards the middle of the utterances (Fletcher 1991).

For the French language, I shall describe the babbling of the child at the turning point of his/her cognitive and linguistic development, between 9-24 months, between prelanguage and the beginnings of articulated and referential language, when the child passes from pure vocal play to the very first utterance of linguistically interpretable sounds. It is the important time during which the child must restrict his/her large vocal possibilities to some social and linguistic constraints. At this turning or "pivotal" period, the utterances of a hearing child look on the whole like the utterances of the target language, although they do not yet contain articulated and recognizable words. My study ends at 24 months when a basic syntax, with combinations of 2 or 3 lexical units, begins to appear.

Finally, one last point has to be specified before I turn to the topic of the child's rhythm. In previous studies (Konopczynski 1986a,b,1990), I demonstrated that during the pivotal period a very striking thing is that the child already knows how to use differentiated utterances appropriate to the context. When an auditory analysis was made using a large population and compared with an analysis of the situational context, there was a positive correlation between the utterance context, type of utterance and auditive characteristics of the utterances. Thus, it appeared that babbling is neither egocentric nor monolithic. On the contrary, it contains various types of utterances. For example, when the baby was alone, he emitted irregular blurred sounds to which the listener could not attribute a meaning. These utterances were called GIBBERISH. However, in an interactive situation with an adult, the sound production was more stable and a majority of listeners were able to attribute precise functions to an utterance, i.e., classifying the utterances into categories such as questions, callings, orders, etc. These were called Proto- or Pseudo-Language (abbreviated PL). Finally, when the baby was playing with a doll or an animal toy, his/her utterances were categorized either as PL or classified in an intermediate series (I shall not deal with this intermediate category here). My findings are consistent with Kadar's (1983) results. In his study, social interaction was distinguished from situations in which infants were playing alone. The duration and form of the air wave curve of vocalizations were analyzed for their occurrence in the different situations; they appeared to exhibit 'a situational sensitivity' in 5/6 month olds. So one should predict that it would be the same later on, which, as a matter of fact, I found to be true. Rome-Flanders et al (1992) arrive at the same conclusion after a study of a sample of 25 babies followed from the age of 6 to 24 months. On the other hand, D'odorico who studied the non-segmental features of five Italian infants between 4 to 11 months found that 'vocalizations were selectively uttered in relationship to their production until 9 months only' (1991:475), but the selectivity disappeared after 0;9. My findings to some extent contradict this conclusion. It should however be said that D'odorico is less interested in the environmental context than Kadar and I are, and instead focuses on the emotional state of the children. In my earlier studies several experimental situations were established (adult remote from the child, adult pretending not to see/hear the child) such that the children were likely to use their full linguistic competencies. The results of these experiments confirmed those I obtained in natural situations.

French Subjects

Method

Subjects and Data Collection. My population was composed of 12 babies who could hear well and had no birth problem, monitored from the age 9 months to 24 months. Two were studied in a familial environment , the others in a day-care unit. Recordings were collected each week during the critical period between 9 and 11 months, and once a month from 11 to 24 months, for the two babies followed at home, and two others. The remainding children were not followed as closely: they were studied half longitudinally, half transversally, depending on the periods they were at the day-care unit. The investigator, helped by an assistant, did the recordings with a Uher 4200 Report Magnetophone and for some sessions with a Nagra 4000S.

Utterance Sampling and Procedures. Everything except cries, emotive sounds like squeals, growls, laughing, and vegetative sounds was included in the sample. Utterances were divided into separate strings defined on the basis of sequences separated by a silent interval of 400 ms or more [1]. To give an idea of the amount of my data, I obtained from the two children recorded in their homes, during the pivotal stage 8-12 months, a large sample of 27 minutes of speech, once the longer pauses and noises were deleted. This sample was made of 2000 utterances, out of which 1830 were analyzed for this study. For the whole period of 8-12 months, 12 subjects followed longitudinally gave 16 hours of recordings, out of which 160 minutes have been analyzed instrumentally. It is the equivalent of the total amount of speech of a 2-year-old child in a 12 hour day (Wagner 1985). For the period 12-24 months, I have selected 800 utterances for each of the four babies followed longitudinally, and at least 40 utterances for two more day-care children;10 to 20 utterances were chosen from the other children to verify some particular points.

A three level analysis was undertaken.1) an auditory analysis made by 11 native listeners without any knowledge of the situation of the child while babbling/speaking. 2) an acoustic analysis was undertaken in order to measure the following parameters : vocal and melodic (Fo) characteristics, and rhythmic characteristics, especially duration and location of prominence. The duration measurements were made on oscillographic traces, with a wave sound line, a pitch

line and an intensity line in order to improve segmentation. 3) a linguistic analysis followed in which I attempted to find out if intonation and rhythmic patterns had a linguistic function in the child's early productions.

As a reference unit, I chose the syllable, which, at least for the child, seems to be both a perception and a production unit (Bertoncini & Mehler 1981, Lindblom 1983, Ladefoged 1983, Seguy 1984). The duration figures are given for the total syllable. It would have been interesting to make the measures on the vowels, simply to eliminate the differences in duration for consonants, and to permit me to compare my results with those of other investigators who measured only vowel length, but it seems sensible to note that the articulation of the youngest children is very unstable.So it is better to work on the level of the syllable which is less sensitive to variations in flow. (Kozhevnikov & Chistovitch1965, Nooteboom & Slis 1969). [2]

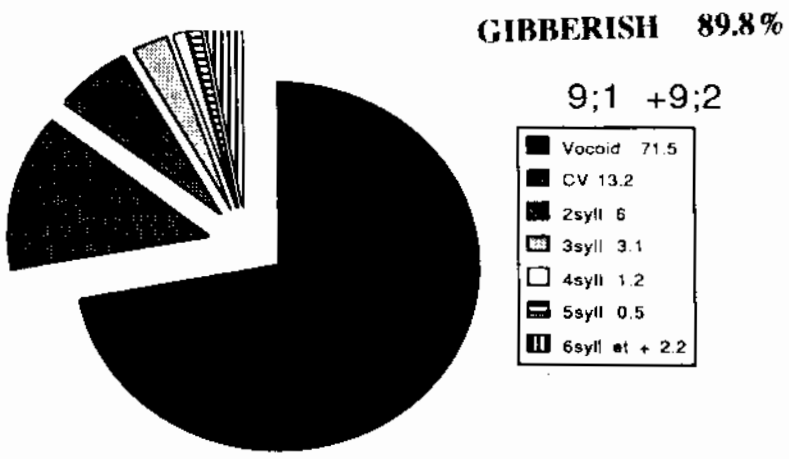
Results.

Syllabic Organization. The syllabic organization is completely different when the child is alone uttering GIBBERISH or when s/he is interacting with adults and emitting Proto-Language.

During months 9 and 10 Gibberish (fig.1) is mainly (71%) made up of vocoids. PL , on the contrary (fig.2), is mainly made up of CV structures which can be reduplicated, but this is not compulsory. Variegated babbling, whose beginning is predicted by Stark & Oller (1980) between 0;10/0;11, appears a little bit earlier. Structures with 2 or 3 syllables each represent 28% of the whole. Longer multisyllabic utterances represent 29% of the whole.

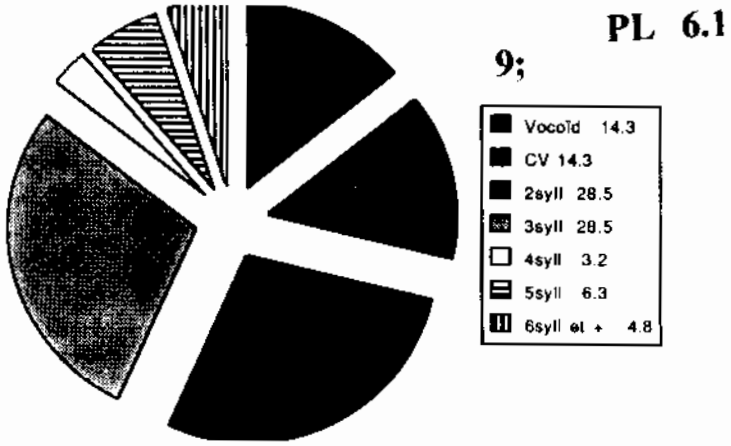
It should not be thought, however, that Gibberish and PL are only made up of the structures I just spoke about. Each category contains some of the structures typical of the other one. For instance, it can be seen from Fig.1 and 2 that Gibberish has 15% of multisyllabic utterances, and inversely PL has 14% vocoids. These findings are consistent with Levitt's (1991) findings.

More interesting is the fact that the vocoids of Gibberish do not evolve when the baby gets older. Of course, the total quantity of Gibberish diminishes, but in what is called "late babbling" which appears, for instance, in monologues, the 24 month old child, who is already able to produce articulated speech in other circumstances, still has Gibberish mainly made up of the same kind of vocoids as at 9 months.



Total # utterances : 467
Total # syllables : 545
Total # measured syllables : 418

FIG.1 : SYLLABIC STRUCTURE (%) OF UTTERANCES AT 9 MONTHS IN **GIBBERISH**



Total # utterances : 52
Total # syllables :126
Total # measured syllables : 63

FIG.2 : SYLLABIC STRUCTURE (%) OF UTTERANCES AT 9 MONTHS IN **PROTO - LANGUAGE**

Temporal organization.Temporal organization also contributes to contrasting completely the two categories. As can be seen from fig.3A, in Gibberish, the vocoids have extremely variable durations, going from very short elements to very long ones. The syllabic mean (M) is very high and the dispersion $(ET)^3$ enormous. The temporal repartition is totally random. Gibberish is a-rhythmical, no temporal organization can be found in these odd durations. This means that the child is exploring his/her respiratory and vocal capacities. As for the syllabic organization, these figures do not evolve with age and the same means are found in late babbling.

On the contrary, the PL's CV structures have a duration which has nothing in common with the duration of the vocoids in Gibberish. As can be seen from fig. 3B, the syllabic duration is quite short, and near (nevertheless +30%) the syllabic duration of adult speech, generally estimated at about 200ms. The dispersion is very low, and the temporal distribution is no longer random, but gaussian.

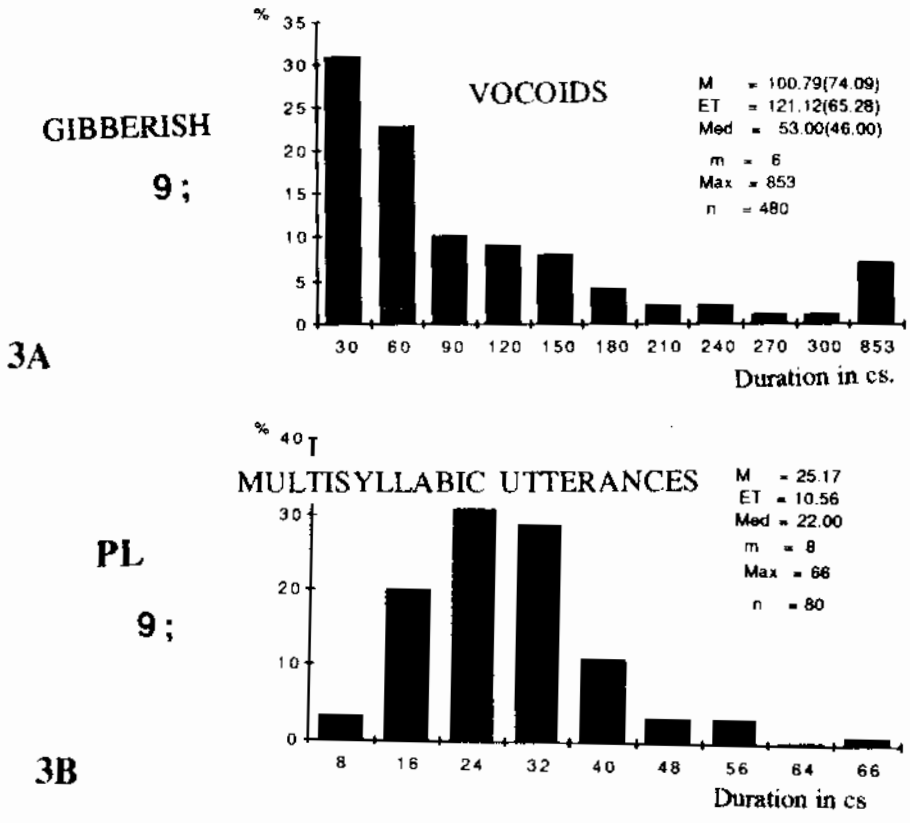


FIG.3 (A, B) : COMPARATIVE DURATION OF VOCOIDS in GIBBERISH (A) and in CV STRUCTURES OF PROTO - LANGUAGE (B) (9 Months)

One noticeable thing, compared to Gibberish, is the evolution of the temporal organization. First, at 9/10 months the syllables are all nearly equal. A clear isosyllabicity exists at the beginning of the PL. After that, the duration of the syllables depends on their position in the utterance. The non-final syllables (SNF) become gradually, nevertheless noticeably, shorter, as can be seen from fig. 4. The correlation coefficient or linear regression curve r = age/syllabic duration SNF = -0.763 (minimum significative value = m.s.v. for r = ± 0.63) becomes relevant from 10 months on. [4] (fig.5). Concerning final syllables (SF), they have an unstable duration for quite a long time, but as the non final syllables get shorter, the final ones seem to be longer, which is not true in fact if one looks at the duration figures. But there is a significant correlation (r = +0.663, m.s.v. = ± 0.59, slope = 0.46) between the duration of SF and SNF between 8-24 months.(Fig.6). Even clearer is the ratio SF/SNF which gets higher than 1.30, [5] which gives, from a perceptual point of view, the impression of final lengthening. Later on, towards 16 months the SF get even longer and finally they are twice as long as the SNF. So the typically trailor-timed rhythm of the French language, with its "point d'orgue" at the end of the utterance is acquired in the middle of the second year.

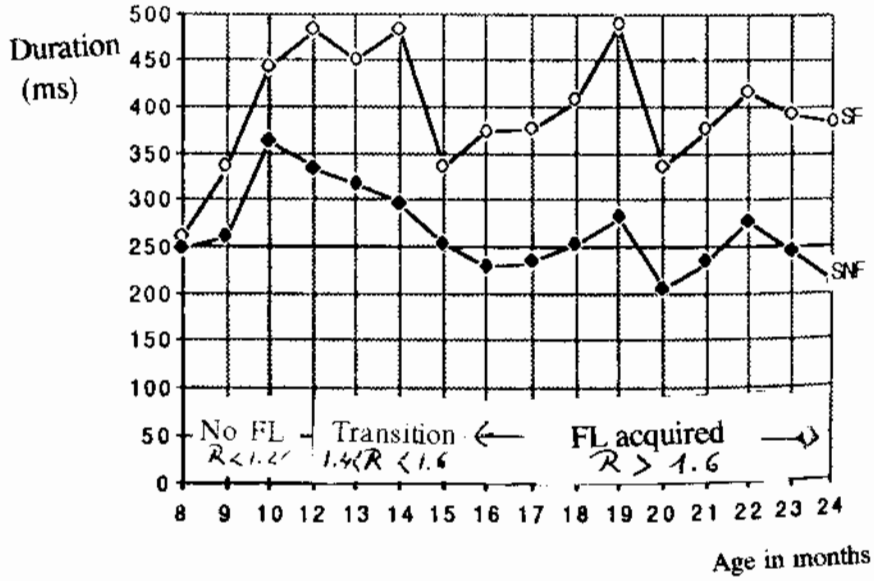


FIG.4 : EVOLUTION OF FINAL (SF) and NON-FINAL (SNF) SYLLABLES in PROTO-LANGUAGE Between 8-24 months.

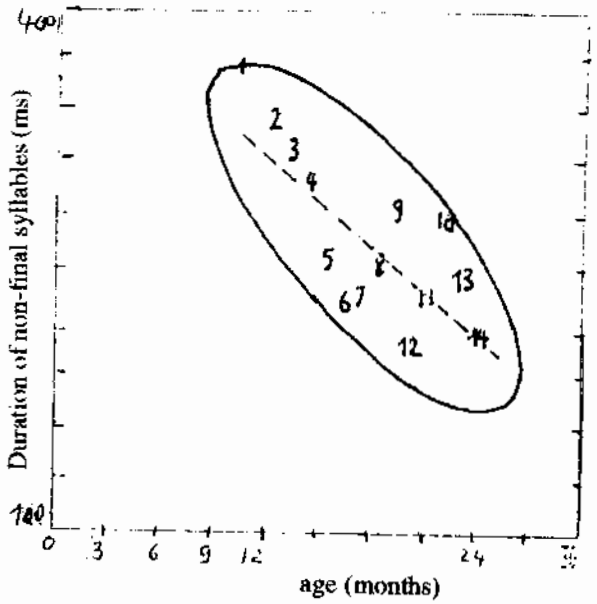


FIG.5 : LINEAR REGRESSION CURVE BETWEEN AGE (8-24;) and DURATION OF NON-FINAL SYLLABLES (14 subjects)

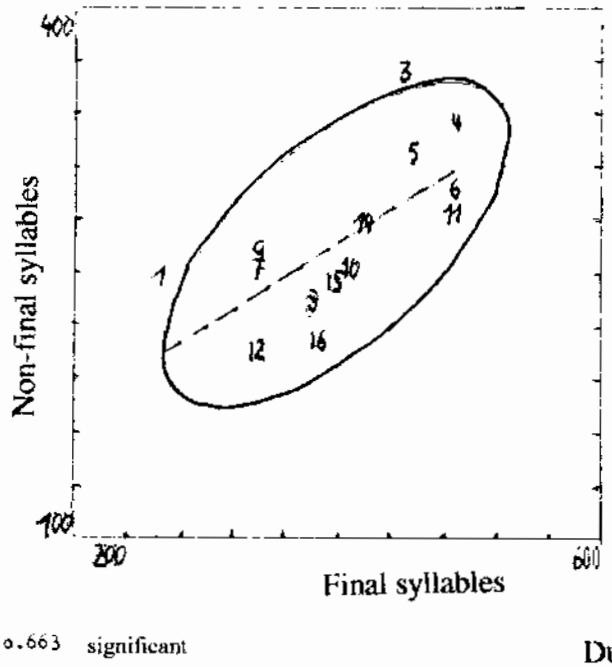
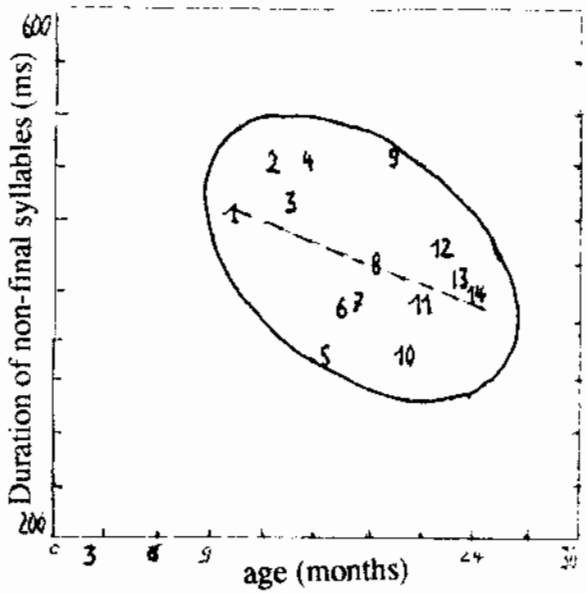


FIG.6 : LINEAR REGRESSION CURVE BETWEEN DURATION OF FINAL (SF) AND NON-FINAL SYLLABLES (SNF) SYLLABLES. (14 subjects)

Of course, if one considers the details, the evolution can sometimes be more complex, and it even presents some apparent regressions. Many studies of children's speech have observed tendencies towards decreasing duration and also decreasing inter- and intrasubject variability with increasing age. But these studies generally involve children who are no longer at the stage of emergent language. For instance, Kent & Forner (1980) observed that four- and six- year-old children showed longer and more variable productions than 12-year-olds and adults. Bruce Smith (1992) also worked on children older than the ones I studied. He compared two groups, one being 2;10, the other 4;4 years old. The same phenomenon of duration decrease was found. But all these children already had mastered their mother tongue, at least to a better extent than the babies I studied. So the discussion about a possible relation between decrease in duration and decrease in variability with increase in age cannot be made on the same bases. In my data, variability in duration and regression phenomenon appear especially in the final syllables. Contrary to the non-final syllables, there is no significant correlation between age/SF (r= -0,433, m.s.v = ± 0.63, Fig.7), because the duration of SF is very unstable through the different ages; only the ration SF/SNF reaches significance.



r = -0.433
non significant

FIG.7 : LINEAR REGRESSION BETWEEN AGE AND DURATION OF FINAL SYLLABLES BETWEEN 10-24 MONTHS.
(14 subjects)

Is this duration variability a problem of neuromotor maturation? It cannot be determined at present from the studies I am aware of, but if it were, the same thing should happen to non-final syllables. Variability is often associated with imprecise, unsystematic or erroneous movements (Kent & Forner 1980, Sharkey & Folkins 1985), which is the case in emergent language, but here too, it should affect both final and non-final syllables. It could also be an indication of greater flexibility or less habitual performances by younger subjects. Another alternative mentioned by Sharkey & Folkins (1985) is that the greater variability could indicate that the speaker is exploring the capabilities or limitations of production, which is the explanation I gave for the very great variability of duration in the vocoids of Gibber. I suggest that variability in final syllables could be explained with this same kind of argument. The child tries to reach his/her target, which is a quite precise lengthening of the final vowel; sometimes s/he goes too far, sometimes s/he does not go far enough, which creates variability in duration. I think that this is a major sign of the fact that final lengthening is being acquired, and has to be acquired. It is not a passive process; as in every acquisition strategy, there are errors and successes before the child gets to the right target. Some other reasons, such as the fact that the segmental target becomes more precise, that new words are learned, that there may exist difficulties for combining elements, that some words are more frequent than others, and therefore more quickly learned, that the total length of utterance varies, and so on, can interfere and make the whole picture seem less clear than the evolution which has just been described. We studied these different factors in detail previously (Konopczynski 1986 a, b, 1990). Let's simply say that these regressions are only apparent, on the surface level, and that they reflect in fact a new organization at a deeper level.

At this point it seems worth quoting a contrastive study made by Allen (1980, 1981) on French, German and Swedish preschool children. It appears that even the French subjects, both in perception and in production at the youngest ages, are sensitive to place of stress, wherever it may be. This reflects general prelinguistic abilities that are not yet restrained by the properties of their specific language environment. But when they get older, by age five, the French children only imitate the items corresponding to the structure of their mother-tongue, and they transform the odd (to them) items so that they match with the temporal organization of French.

As a first conclusion, I can say that my study has shown that the typical syllable structure and the phonological rhythm of French are already acquired before one year and a half, and that my results are consistent with some others (Allen 1980, 81, Levitt et al 1991.)

Comparison With The Acquisition of Rhythm For English

Information about English-speaking children's acquisition of rhythm is rather limited. Only very recently have a few investigators (Allen 1981, a few researchers of Haskins Laboratories 1991,Wahlen et al 1991, Konopczynski 1991) tried to make a comparative study of the acquisition of prosody by English and French children. The majority of these studies are more interested in intonation curves than in rhythm (Robb et al 1989, Whalen et al 1991, Best et al 1991).

For the pivotal period, the main research studies on the rhythm of English speaking infants have been conducted by Delack (1974,75), J.A.M. Martin (1981), Oller (1980), Robb & Saxman (1990), and Levitt et al (1991). But Delack (1974,75) for instance, like many other investigators for other languages, does not seem to be aware of the fact that, at least from 8/9 months on, one should not indiscriminately combine Gibberish and PL utterances in the same corpus. As a result, his analysis remains very superficial: working on 19 children from 1 to 12 months, he says that duration, which lengthened slowly between 1 and 7 months shows the same progression until 9 months where there is a maximum (80cs.for males, 90cs for females), and then diminishes fairly quickly ending with 62.5cs at 12; (M: 60.5cs, F: 64.5cs). He concludes 'duration is the feature which tends to show developmental trends most saliently' (Delack 1975:97). It seems to me that the values given by Delack are erroneous and far too rough, because he put in the same basket all types of utterances and syllables. As a result, these values can only describe a very global evolution.

From the histograms published without comments by Kent & Murray (1982) for age 9 months some other information can be noted. The most occupied duration classes seem to be under 40cs, but the dispersion seems to be large, going up until 200cs.

J.A.M. Martin (1981) insists on the apparition, towards 8/9 months of 'adult-like structures', with some recognizable contoids, with CV, CVCV, VCVCV

structures (syllabic Mean with vocoids and CV syllables in the same bundle = 87cs.). He is the only one, other than me, - as far as I am aware of- to put the accent on the coexistence of both these older structures with vocoids and the newer ones with CV.

> There is an interesting mixture of vocal behavior...boisterous prolonged vocalization strongly reminiscent of those at 4/5 months, and some compact, very controlled vocal utterances... (their) structure and (their) quality is that of a single spoken word. (Martin 1981:80)

Oller 's position (1980) is nearer to mine. He insists that there is a big difference between the utterances before 7/8 months and those produced towards 9/10 months when canonical syllables, containing CV, CVC, VCV, CVCV appear; then, a 'relative rigid timing' is introduced. He calculates the duration ratio between syllables at different ages, and, as Konopczynski (1976), concludes that the temporal structuration, quite variable between 2 and 7 months, gets more stable towards 10 months and comes nearer the adult structuration, but he is not really interested in the evolution of duration. His preoccupation is final lengthening (FL). He finds out, from his 16 subjects, that at 10 months there is no FL in the English speaking child's production, but, as in French, there is isosyllabicity, at least in the reduplicated syllables he is studying. Their duration varies between 19.5 and 32cs. When final lengthening is found, it never exceeds 10%, which is not a perceptible increase in duration [5] ($0.93 < R < 1.24$). Adults pronouncing the same reduplicate syllables have 10 to 100% FL ($1.24 < R < 2.28$).

Robb & Saxman (1990) studied seven English-speaking babies from preword to multiwords, using a combination of chronological and lexical age points. At the beginning of the study the children ranged from 8 to 14 months (M = 10;) and all demonstrated reduplicated and variegated babbling. At the end of the data collection, they ranged in age from 19 to 26 months (M = 22;), and were all producing a bit over 50 words, as well as word combinations. It should be noticed that there are not the same children who are followed throughout the study.The data was composed of 6 041 utterances, in which 206 bi-syllables were found. Mean bi-syllables duration ranged from 532ms. to 1260ms, average 842ms. and no systematic change was found as a function of age. This is consistent neither with

Boysson de Bardies et al (1981) findings, nor with Konopczynski's (1986 a,b, 1990) which showed a punctual increase in duration in bi- and tri-syllables between preword and meaningful speech. Konopczynski explained this phenomenon, by arguing that,when a child is learning new words, containing no longer reduplicate syllables but syllables of the type C1V1C2V2, his/her neuro-muscular program has to slow down. Once he has acquired them, the speech of his/her speech increases again, and thus syllabic duration decreases. Would that not happen in English? Then, our explanation may be wrong, as it is a physiological one, and the English speaking children should have, for this particular point, the same kind of phenomena as the French speaking children. As for final lengthening, which is the main goal of Robb & Saxman's paper, they say (1990:591) that

> ... it was observed across nearly all recordings sessions for all children, whether recorded during preword, single-word or multiword periods, either in open or closed syllables ... (but) FL in closed syllables (is) consistently longer than in open ones, presumably because there is an additional time requirement for articulation of a final consonant .

The problem with their interpretation of the data is that the authors don't take into account the fact that FL, even if it exists in the raw phonetic data, has to exceed a precise threshold (R = final syllable/ non final syllable > 1 .30) [5] in order to be heard. They count as a FL every R that is > 1.0. So, reinterpreting their results we can see that, in CV structures, three subjects have no FL at all, and two have a slight FL which occurs after 17 months for one of them, and after 22 months for the other. For both it is in the period of more than 50 words. Finally, 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 authors's thinking.On the other hand, in CVC structures, FL is present in all subjects, except one who has very unclear results; sometimes this child's FL is increasing for a few recording sessions, and sometimes it is decreasing. On the whole, it is not very consistent. Of course, I disagree with Robb & Saxman's conclusion (1990:592)

> We suggest that all children display FL in their pre-word vocalizations, and it is only after acquiring language and concomitant experience, that significant increases or decreases in lengthening occur. Thus the process of FL appears to be mostly a passive, non deliberate process ingrained within the physiological functions of the infant and is continuous throughout preword and multiword periods of development .

Added to that, Robb & Saxman say a few lines later that 'final lengthening is a deliberate prolongation of the final syllable to signify the completion of a purposeful vocalization' . There appears to be a contradiction in their conclusions : either F.L. is acquired, and non deliberate, or it is deliberate and then indicates the end of a clause (if it reaches perceptibility),but it can not be both at a same time.

These results, at least for open syllables, are consistent neither with Oller's findings, nor with Levitt's conclusions, nor with Smith's ones. They neither are consistent with my results on French, but this may be due to a difference of language, of course.

In a recent two-case study with one American male and one French female infant between 0;5 to 1;2, Levitt et al (1991) reported the same kind of work as I did for French infants from 1975 on. The authors don't study the typical vocoids of Gibber, and restrict their measures to two syllables or longer utterances. They confirm our results for the syllabic structure of PL, and add that, although multisyllabic babbling was significantly higher in their French subject than in the American one, the pattern of reduplicated and of variegated babbling was essentially the same for the two children. But the syllabic structure showed a difference, such that the French infant had, by 9/10 months, more open syllables, and this percentage remained fairly stable, whereas the American infant increased dramatically 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 & Saxman's (1990) findings and in general with the greater frequency of closed syllables in English than in French (Delattre 1965, confirmed by all the following studies on French and English phonetics). So, by the age of 10 months, English and French speaking babies have begun to produce the syllabic structure which is typical of their linguistic environment. The same has been shown for some very

broad segmental characteristics which are already language-specific in babbling, although no recognizable sounds of the language are produced (Boysson-Bardies et al. 1984).

Concerning the temporal organization of both infants studied by Levitt et al, the authors note (1991:57) that the French girl produced 'non final syllables that were on the average closer in duration to one another than did the American infant'. As for final lengthening in reduplicative babbling, both infants showed FL with gradual increase at 11 and 14 months but the French child was more regular, her only lengthened syllables being the last one. This is consistent with our own findings. The results for the American boy are 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, because 14 months is probably too early to study correctly the problem of final lengthening.

Keating & Kubaska (1978) find, at 28 months, for just one child, in words of two syllables, the same results as Oller (1980), that is, no final lengthening by that age. This is partly in contradiction with Bruce Smith (1978), who was also interested in final lengthening. He says that the English children have acquired FL by 2 years and a half, 80% of their final vowels, which are unstressed, being nevertheless 32% longer than the stressed non final vowels; later on there is no significant evolution. Children 4 years old and adults have the same results, but meanwhile they also have acquired a part of the stressing patterns.

Kubaska & Keating (1981) find FL later on (they don't tell us precisely at which age), when the child begins to combine two words. Then, the general syllabic duration is 25 to 36 cs. But they indicate neither the mean length of final syllables, nor the ratio SF/SNF. As a conclusion to the temporal organization at the pivotal stage, I shall quote Allen-Hawkins (1978 : 174)

> 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

So, two languages like French and English, which are diametrically opposed by their rhythm in adult language, seem to have a quite close rhythm in babbling and very early speech, but differ nevertheless by their syllabic structure

and by the regularity/irregularity of final lengthening. By the age of one year and a half, the French child has already acquired the typical trailor-timed rhythm of his/her mother-tongue.

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 trailor-timing to stress-timing occur? A last question would be : which kind of timing is easiest to acquire?

A striking thing is that almost no investigator of early English child language has studied the acquisition of stress, which is so important in English compared to French. Smith (1978) is an exception. He noted the appearance of some stressed syllables at 18 months. At first they are15% longer than the unstressed ones. But this 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. Scholars have regarded the langauge of children from three points of view : perception, repetition and spontaneous speech. Stress is said to be perceptually well located from 30 months on, more or less (Mc Neill 1970, Slobin 1973, Grunwell 1975, Gathercole 1976, Klein 1981). In repetitions, the location of stress is also well imitated at the same age.

Other rather scattered remarks on repetition in 2 to 3 year olds seem to show that stressed words are better remembered and reproduced than unstressed ones because they carry the meaning (Brown & Fraser 1963, Bellugi & Brown 1964). But Scholes (1970) disagrees, saying that when form words and function words have the same stress pattern, nevertheless the second ones 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). Concerning spontaneous speech, the remarks are quite anecdotal, and based on purely auditory impression, even without any counting of present/omitted syllables, for instance. Some tendencies typical to English are noted, like omission of some pre-tonic syllables. For example, Weir (1962) says

that her son at 30 months uses stress in accordance with English speaking habits, but many think she overinterpreted her child's performance. Some other examples can be found. Braine (1963:10) quotes that there is a difference of stress location in the speech of a child opposing 'baby chair' (small chair) to 'baby#chair' (the baby is in the chair); the same is found by Miller & Erwin (1964) whose subject Christy says 'Christy room' as a possessive opposed to 'Christy room' as a locative = Ch. in the room. This happens in four of their subjects. Bowerman also (1973) reports that her daughter Kendall stresses 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 a few examples like these, Slobin (1968:70) and Menyuk (1971) conclude that at the two-word stage stress is used to mark grammatical differences, without taking into account the following important advice by Erwin & Miller (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

We could also object that the above-mentioned examples don't show the utilization of the contrastive accent, 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?

Some studies are more precise. Wieman (1976) who analyzes five children between 21 and 29 months in two-word utterances, controlling the emphasis parameter, gives support to the preceding intuitions. But the most interesting part of her study lies in the fact that she finds out that the child always gives privilege to semantic relations over syntactic ones, and that s/he stresses in a systematic manner the new element. This gave, at that time, a confirmation to Chafe's theory (1970) saying that there is a hierarchy in accents depending on whether the information is new or given. Wieman gives many examples. However, let me say that emphasis and focus on new information are two very close notions. Besides, all the authors I cited, and also Nelson Smith (1973), and Menn (1976) insist that the stress pattern

which has been shown does not occur regularly and that the child makes a lot of accentuation errors. This pattern simply may have been focused on because it is easy to notice it auditively in speech. So Brown asks (1973:115)

> Are the phonetic features, independent of word order, which create response types reliably associated with particular relational meanings? The answer is negative. Eve did not reliably signal her presumed semantic intentions with suprasegmental features .

Presently, arguments in favor of a precocious acquisition of stress as a grammatical marker in English are inconsistent. Nevertheless, the various examples show that between 2 and 3 years children perceive in the acoustical signal something which is called stress, and that they can reproduce it at the right place in a lexical item (Ingram 1976, Klein 1984). However, they don't seem to use it as a grammatical marker. What is beginning to be acquired is presence/ absence of a kind of prominence, but neither the hierarchy of accents nor the rules of stress patterning. Harriet Klein's study concludes (1984 : 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 .

So, phonological contrastive stress does not 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 'tranche d'age' I am involved with in this paper.At this point of the research on acquisition of stress in English, I would propose a tentative explanation : may be the input baby talk, with its very strong emphatic stress, often replacing the regular stress patterning, could be one of the reasons of this late acquisition of stress in English. All these data, even

scattered, contrast with theoretical affirmations (J.G. Martin 1972, R. Kent 1976) which predict that in stress-timed languages, where sentences are phonetically dominated by accented elements, these stressed elements are programmed before the others. So, 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.

It is also noticeable that all the studies I cited deal 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. Moreover, Allen emphasizes the large intra- and intersubject variability that he noted.

General discussion.

Instrumental and linguistic analyses of the rhythm of babbling of a dozen of French babies and comparison with the data coming from the literature for English speaking babies showed clear evidence of similar developmental patterns, presumably due to universal processes of maturation, as well as of the prelinguistic influence of the adult language environment.

Evidence of general developmental effects is apparent in the syllabic structure, which is the same in the two languages before 10 months. It provides some evidence in support of the developmental stages of babbling as described by both Stark (1980) and Oller (1980), although the presence of variegated babbling prior to their predicted onset is consistent with our findings, as well as the findings of B.L.Smith et al (1989), Mitchell & Kent (1990), Robb & Saxman (1990), and Levitt et al (1991) Evidence of general development is even more clear in the temporal organization which shows not only comparable mean values in duration of the syllables in the two languages, but above all a tendency towards isosyllabicity not only in French, where it could have been predicted from the adult language, but also in English where predictions would be some prominence in the child's language imitating more or less the stress pattern of English. These results tend to show that final lengthening does not seem to be innate, as many phoneticians think

(Oller 1973, Cooper-Sorensen 1977, Lyberg 1979, Robb & Saxman 1990). Final lengthening would rather be an acquired behavior, as it appears progressively, shows some regressions, and corresponds to a precise stage of entrance in referential language (at least in French, and, from Robb & Saxman's data, also partly in English,). So I do agree with Nooteboom (1972), Klatt & Cooper (1975), Lehiste (1983), Allen & Hawkins (1978) and many others who consider, sometimes not very explicitly, that final lengthening, although being a "natural" phenomenon found also in music, in birds singing..., is not innate but has to be acquired. [6]

The evidence of language-specific effects is also clear, and appeared from the syllabic structure in longitudinal analyses from 11 months on, when the English-speaking child has more and more closed syllables. The temporal organization of babbling revealed evidence of the characteristic isosyllabicity of French from 9 months on. The typical trailor-timing was found from 13 months on, whereas the English children who have been described seemed to show only subtle differences from the French ones, in the sense that they also had isosyllabicity and final lengthening, like the French babies, but it was not as consistent as in the French early speech.

In general, our findings agree with recent findings of language-specific influences on both the prosodic (Levitt et al 1991,Wahlen et al 1991) and the segmental (Vihman et al 1986, Boysson-Bardies et al 1984, 1989) level of babbling before the end of the first year. However, some of the timing differences that emerged from both Levitt's (1991) and our study, suggest that the language environment may affect the rhythm of babbling even earlier than its segmental characteristics. Moreover, the rhythm of French babbling from 13 months on is not only language specific in its phonetic properties, but it already has a linguistic function, the demarcative function of final lengthening in French. For this acquisition, three tentative conclusions can be put forward :

- from a linguistic point of view, the child must have integrated the overall organization of the utterance which appears as an overall system with each syllable having its own relative duration according to its position.

- from a cognitive point of view, the integration of the syllabic duration into the system can show the onset of a new stage in cognitive development marked by the appearance of a relational structure between the whole and its parts.

- from a communicative point of view, the final lengthening could be an indication of good acquisition of the turn-taking rules in dialog, which of course have begun to be learned earlier, but with many errors. We noticed that from the moment the child has acquired final lengthening, there is very little overlapping in the 'dialogs' between mother and baby.

There does not yet seem to be any clear linguistic function of rhythm for the English speaking babies at the same age. Nevertheless, the studies of English speaking babies' rhythm are so rare, made on such few subjects, and on so few utterances, that

> clearly the prosody (rhythm and intonation) of infant's babbling warrants further cross-linguistic research (Levitt et al 1991 : 61).

Presently, it seems that, even in languages which drastically differ from one another from a rhythmical point of view, there is an initial isosyllabicity, towards 9 months, when babbling has become canonical. This isochrony could be due to an internal neural clock, as Allen (1973) hypothesized. This first, more or less universal stage, could be followed some months later (towards 13;) by a more or less strong final lengthening. Still later does the typical rhythmical patterning of a language appear, at a speed depending on the complexity of stress patterning and on the language-specific constraints which give to each language a specific rhythm with specific linguistic functions. Before answering these questions, we need more studies on rhythm and its function in the emergent language of many different language communities. We already put forward a tentative answer to these last questions in a beginning cross-linguistic (English, Portuguese, German, Hungarian) study of prominence (Konopczynski 1991b). We think that in languages were prominence has a stable location, as in French, the accentuation pattern can be acquired easily and quickly, because the model offered to the child does not have too much variability, even if there exists, of course, quite a large intra- and intersubject variability in spontaneous speech. But in languages were prominence is at variable locations within an utterance, as in English, the child, who has no stable model, has much more difficulty finding out the rules of stress patterning.

NOTES

1. We suggested 400ms. in 1975 at the VIII Int. Congress of Phonetic Sciences, Leeds. It is based on the fact that the mean duration of pause in adult speech is 250ms. (Grosjean & Deschamps 1972) and that the general tempo of child's speech is half as quick as the tempo in adult speech. Almost all researchers in babies' language took that duration, with a few exceptions.

2. For more details, cf. Konopczynski 1986 a,1990.

3. ET stands for Δt = standard deviation. Med = Median. m = minimum. M = Maximum. n = number of syllables in the sample. Duration is given in cs. instead of the classical duration unit which is the ms. because of the scale of the figures.

4. The correlation coefficent r is always between ± 1; the more r is close to 1, the better the correlation between the variables. A positive correlation indicates that the two variables evolve in the same direction; with a negative correlation, the variables evolve in opposite directions.

5. The ration R= SF/SNF is significant when R>1.20, which corresponds to a increase of duration of 20%, minimum increase necessary for a phonetic lengthening to be heard (Rossi 1972, Klatt 1976).

6. For an argumented discussion on this subject, cf. Konopczynski 1986b, 1991.

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