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# Language in the infant's mind

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## SUMMARY

We review recent work that shows that, during the early stages of language acquisition, molar properties such as prosody are important to the infant. We argue that the specification of these structures allows the infant to learn the language processing routines that adults employ.

## 1. INTRODUCTION

Some years ago, Mehler (1981) proposed that the syllable is a molar structure that plays the most salient role during speech processing. After reviewing limited empirical observations, he concluded that these structures play a central role in language processing and are independent of any specific language.

Today, the database has grown dramatically and it is difficult to maintain the proposal. However, we remain convinced that in some form it remains correct. Let us try to state once again what we take to be a central problem in speech perception. The speaker–hearer, regardless of his or her maternal language, utilizes molar structures to represent speech and access the lexicon. These molar structures are used by the child to acquire a lexicon in early childhood. Mehler *et al.* (1990) argue that models of lexical access that attribute a major role to top-down processing have intrinsic shortcomings, regardless of their descriptive adequacy. These models do not take account of the fact that the information necessary for top-down processes to function is lacking in very young infants and toddlers even though they are capable of representing speech signals. Before one can use lexical, syntactic or semantic information, one needs to represent the speech signal, segment the relevant words, identify the prosodic phrases, and categorize the acoustic–phonetic segments. If the child solves all these tasks before relying on top-down processes then one must suppose that the signal affords the cues to bootstrap the speech-processing system. If so, there is no reason why these cues should not be used by adults as well.

At the same time, speech processing in the adult has largely been considered universal, the only difference between languages lying in the lexical representations and the phonemic inventories. Indeed, speakers of a language that lacks a particular phonemic contrast fail to perceive this contrast although it is distinctive in other languages (Goto 1971; Trehub 1976; Werker & Tees 1984, among others). However, even this failure has been attrib-

uted to some sort of late quasi-cognitive shift of attention or bias rather than to specific modular language-processing routines (Best *et al.* 1988). However, psycholinguists have recently begun to focus on how these phonemes are organized into larger structures and how these larger structures play a role in speech processing. For instance, the data indicating that syllables intervene in language processing seem quite strong (Cutler *et al.* 1983, 1986; Dupoux & Mehler 1990; Sebastian-Galles *et al.* 1992; Pallier *et al.* 1993). However, speakers of different languages use different molar structures and compile processing routines from the rhythmical regularity in their respective maternal languages. Our research, and that of a number of colleagues from England, Canada, Japan and Spain, provides an empirical stand from which to claim that, besides the contrasting phonemic inventories of natural languages, the rhythmical structures they instantiate also affect our representations and processing algorithms. Language processing itself is moulded by the native tongue of the speaker. Thus, the speakers of romance languages are sensitive to *syllables* while the speakers of Japanese are sensitive to *moras* (a rhythmical unit smaller than a syllable). The speakers of English are sensitive to the distribution of *strong and weak syllables*. Attention to the locus of the accent is critical in languages such as Italian, where pairs of words like *prìncipi* and *prìncipi* differ only in the vowel that bears the accent, but not critical in languages like French, where no similar minimal pairs can be found, since the locus of the accent is always word final. In contrast, syllabic structure in French can vary a great deal: for example, complex onsets and codas are permitted as in the words *SPLendide* and *TRaCT*, while in Japanese the most complex mora is a CV. Consequently when the Japanese experience words like *tract* they claim they hear *turakutu*.

If one accepts that speakers of different languages attend to and use different molar structures (Cutler & Mehler 1993; Otake *et al.* 1993), one must ask how the child discovers the relevant properties that are pertinent to his or her language and how he or she

acquires the right processing algorithm to become optimally efficient when listening to speech. In this paper we will present some recent results pertaining to how this is done. First, we provide a short overview of some facts about speech acquisition that are more or less accepted by all the workers in the field.

1. *The brain is specialized to process speech at birth differently from other acoustic stimuli.* Anatomical and functional studies have shown that the asymmetric organization of the brain at birth corresponds to a functional asymmetry by which speech stimuli are processed with a left-ear advantage and many other acoustic stimuli with a right-ear advantage or without any asymmetry at all (Entus 1977; Best 1988; Bertoncini *et al.* 1989).

2. *The neonate has the ability to track voices and recognize some of them within only a few days of birth.* In a series of experiments it has been shown that the infant is able to react distinctively to a given voice. The general finding is that infants have a precocious recognition of their mother's voice (Mills & Meluish 1974; Mehler *et al.* 1978; DeCasper & Fifer 1980). This shows that the infant is able to single out and attend to one speaker.

3. *The child is born with the endowment to operate all the contrasts that arise in natural languages.* Research over the past twenty years has established that the neonate has the ability to discriminate stop consonants that differ by just one distinctive feature, such as voicing (Eimas *et al.* 1971), place (Eimas 1974) or manner (Eimas 1975).

4. *During the first year of life the baby is sensitized to the sounds of the native language.* By six months the child changes so as to remain sensitive, attentive or able to process differentially the vowels of his or her maternal language (Kuhl *et al.* 1992). The same process seems to take longer for consonants that are distinctive in the parental language (Werker & Tees 1984). In short, there is no evidence that the process of phonetic to phonemic convergence starts before the baby is six months old and there is a considerable amount of evidence showing that the process is well advanced by the time the baby approaches the end of its first year of life.

## 2. TUNING TO THE MATERNAL LANGUAGE, OR THE PROBLEM OF MULTILINGUAL ENVIRONMENTS

We have already sketched some of the results that show that language processing is speech-specific. The question that ensues is: how does the infant discover the structures that are essential for learning the maternal language? Once such a question is asked there is another one that is even more puzzling: how can a child raised in a multilingual environment avoid the fatal confusion these circumstances should cause? Indeed, if the child considered utterances drawn from several languages to arise from the same underlying structure, he or she would be unable to find a lawful structure that would match the requirements of both sets of sentences at the same time. If this were true, the infant would never learn language. So, what

mechanisms protect infants from falling into confusion when raised in multilingual environments?

Bahrack & Pickens (1988) have shown that infants four months old notice a language change when tested with the habituation–dishabituation paradigm. Infants habituated to an English sentence and tested with a novel English utterance dishabituated less than experimental subjects who were tested with a Spanish sentence.

Mehler *et al.* (1988) studied the ability of French-born infants four days old and American-born infants two months old to notice a language change when presented with sets of varied sentences. They found that French newborns could discriminate Russian from French utterances. The authors also found that these newborns displayed greater sucking rates when listening to French than when listening to Russian. This result was explained as a preference for the maternal language, or, more neutrally, that French is a more familiar stimulus than Russian. Moreover, French newborns were able to discriminate English from Italian utterances (see Mehler & Christophe (1994) for a re-analysis of the original data). Comparing the neonates to the older infants, the authors reported that American infants two months old had a discrimination behaviour that contrasted with that of French newborns: they discriminated English from Italian sentences, but failed to discriminate Russian and French sentences. No reaction to familiarity as evidenced by greater sucking rates for English was found in these older infants.

In brief, at four days of age, infants are able to distinguish sentences drawn from two different languages, regardless of whether one of the two languages is familiar to them. The behaviour of the infants two months old differs interestingly from that of neonates. Indeed, at this age, the infants are only able to discriminate a language change when one of the languages is familiar to them. This suggests that the ability to sort utterances according to the language from which they are drawn changes during the first two months: while younger infants try to classify any sentence-token into a language-type, the older ones classify utterances as belonging either to their maternal language or to an undefined foreign type.

Below, we argue that infants construct language-types on the basis of prosodic structures, suggesting that, by the age of two months, they have specified some of the distinctive properties of their maternal language. When sentences from two different unknown languages (even with different prosodic types) are presented, the infant treats both of them as fitting an unfamiliar model.

Mehler *et al.* (1988) also showed that infants, neonates and those two months old, discriminate a change in language when they listen to lowpass filtered speech that permits frequencies below 400 Hz (that is, overall properties of utterances such as intonation and rhythm) while filtering out most of the higher-frequency components (those that carry phonemic information). This observation strengthens the hypothesis that infants embark on the acquisition

of language by paying attention mainly to the prosodic properties of speech. A consequence of this disposition is that it facilitates the classification of inputs according to the natural language from which they are drawn. It is much more difficult to decide from the above studies whether infants already react as if their maternal language was more familiar to them shortly after birth or whether such behaviour develops a few months later. Two recent experiments bear specifically on this issue.

Moon *et al.* (1993) assessed the preference of infants two days old, tested with Spanish and English sentences. Although all the mothers were monolinguals, half of them were Spanish-speaking and half American. Infants sucked during three periods of six minutes each. Moon *et al.* report that all infants sucked more during the third period, when they were listening to their mother's native language, than when listening to the other language. The authors interpret this behaviour as showing that infants two days old prefer the native language of their mother.

G. Dehaene-Lambertz (in preparation) has adapted a method previously used to study visual preference (Johnson *et al.* 1991) to assess preference for auditory stimuli in two-month-olds. Dehaene-Lambertz used French and English utterances of less than 3 s duration. Utterances were presented either in their original form or after having been lowpass filtered. The results show that American-born infants start moving towards the side of the English utterances significantly faster than to the French ones. The latency advantage to orient to the English sentences is comparable for both filtered and unfiltered utterances. This ability of American infants two months old to orient faster towards English utterances confirms the fact that they already consider their maternal language as familiar, as opposed to a foreign language. Moreover, the fact that this 'preference' holds both for filtered and unfiltered speech supports the view that infants rely on distinctive prosodic properties of their maternal language to categorize the utterances. Notice that the infants no longer orient faster to the 'familiar' language when they listen to lists of open-class words drawn from the previous utterances. Lists of words do not capture the prosodic structure of the language.

To recapitulate, the picture that arises from these studies is that neonates discriminate utterances that are drawn from different languages. Two months after birth, under certain testing conditions, infants show a preference for their maternal language, but they have partly lost the ability to characterize the prosodic difference in utterances from two unfamiliar languages. These results show us that infants indeed manage to avoid confusion when confronted with several languages in their surroundings. However, we still do not know how they manage to classify utterances according to the language from which they are drawn.

We have seen that infants still manage to classify languages when speech is lowpass filtered, i.e. when only the prosody is preserved and the segmental information is removed. The prosodic characteristics

of a language relate to durational, energetic and pitch parameters that induce the perception of rhythm, stress and intonation. We hypothesize that there exist classes of natural languages that differ with respect to their prosodic characteristics. Thus, we entertain the hypothesis that infants first tune to a subset of languages and only at a later stage do they converge to the precise language spoken by their parents. Up to now, we have seen that infants use prosody at the level of whole sentences to keep languages apart. We shall now turn to the second main problem that the newborn infant encounters in the very first stages of language acquisition, namely segmenting the continuous speech stream into linguistically relevant units. There, too, prosodic structure may help the infants to bootstrap language acquisition, although this time at a level that specifies smaller units.

### 3. TUNING TO THE PROSODIC UNITS OF ONE'S MATERNAL LANGUAGE

The structure of language is discrete at several levels of structure, i.e. we compute the meaning of sentences by identifying phrases and operating on individual words. There is thus no doubt that, on hearing utterances, speakers of a language have to access individual words. If we now think about the task facing the infant hearing a language, it is clear that acquiring the lexicon is a necessary stage of learning, because the sounds that languages use to refer to things are extremely idiosyncratic. However, even superficial inspection of the speech stream shows that it is continuous, and that there are no pauses between words. Some models of adult speech perception take this fact at face value and offer mechanisms via which words could be identified in sentences without any prior segmentation (see, for example, McClelland & Elman 1986). Yet such strategies rely on the knowledge of the lexicon, and are thus not available to infants, who do not yet possess a lexicon. It seems unlikely that children keep a record of whole utterances on which they perform statistical analyses in order to obtain probable word boundaries (Christophe *et al.* 1993). The alternative to this appeals to prosody. The prosodic segmentation hypothesis (Christophe 1993) states that some prosodic units, which are smaller than sentences but probably larger than individual words, are marked in the signal. Each unit may contain one or two content words (nouns, adjectives or verbs). Furthermore, because there is a lawful relationship between these prosodic units and syntactic units (Nespor & Vogel 1986), knowledge of these prosodic units would be useful not only for lexical acquisition, but also to trigger syntactic acquisition.

What evidence is there for the prosodic segmentation hypothesis? Jusczyk and his colleagues have conducted experiments to evaluate the units in the signal to which infants are sensitive. Typically, they present infants with continuous speech samples that are interrupted by short artificial pauses introduced at different places in the utterance. In one experiment (Hirsh-Pasek *et al.* 1987) they presented infants with

utterances interrupted either at a boundary between two constituents, or somewhere within a constituent. To test the infants they relied on a modified version of Fernald's preference looking paradigm (Fernald 1985). Studies with American infants 9 months old, 6 months old and even 4.5 months old show that they prefer listening to speech that has pauses between clauses rather than pauses that interrupt clauses. Moreover, American infants 4.5 months old also prefer to listen to an unfamiliar language like Polish with interruptions that preserve the integrity of clauses (P. Jusczyk, D. Kemler Nelson, K. Hirsh-Pasek & T. Schomberg, in preparation). The authors suggest that the clause's integrity is signalled both by temporal and frequency cues, and that these cues may well be universal. Indeed, in languages as different as English and Japanese, clause boundaries are marked by a fall in pitch, and a lengthening of the last segments of the clause (Fisher 1991).

Jusczyk *et al.* (1992) investigated whether infants were also sensitive to units smaller than the clause. To explore this issue they placed pauses in utterances, either at the major syntactic boundary, namely between the subject and the verb, or at a minor syntactic boundary, generally between the verb and its complement. Jusczyk *et al.* report that infants 9 months old, but not those 6 months old, prefer listening to stories with the pause at the major syntactic break. This result is difficult to interpret. Indeed, in some cases the break between subject and verb does not correspond to a major prosodic break, although it still is a major syntactic one. Gerken *et al.* (1994) pointed out that when the subject is realized as a pronoun, it tends to cliticize with the following verb (unless it bears emphatic stress); when this happens, subject and verb together form a clitic group, a very cohesive prosodic unit. Gerken *et al.* (1994) carried out an experiment designed to establish whether it is the integrity of syntactic and/or prosodic units that matter to the infant. They used identical stories with either the full noun phrase (NP) repeated for each sentence (e.g. 'the caterpillar'), or with it replaced by a pronoun ('it'). Only in the first case did the major syntactic break between subject and verb correspond to a major prosodic boundary (a phonological phrase boundary). Gerken *et al.* (1994) found that infants 9 months old were sensitive to the integrity of prosodic units, but not to syntactic units *per se*.

Thus, one is tempted to conclude that infants organize sentences into strings of clauses (which correspond almost perfectly to intonational phrases in the prosodic hierarchy) from a very early age. Moreover, they seem capable of doing this for any language, without any need for adaptation or tuning. Infants hear phonological phrases, e.g. the prosodic unit just below in the hierarchy at the age of nine months. We still do not know at what age infants display sensitivity to clitic groups (formed by the grouping of a content word and its adjacent clitics, such as articles, pronouns and auxiliaries), but a reasonable bet would be sometime after they reach the age of nine months.

The studies carried out with infants seem to be highly dependent on the method that is used to assess their competence. Indeed, there is evidence from other paradigms, i.e. using lists of words instead of long samples of continuous speech, that infants younger than nine months have some knowledge of the prosodic configuration of the words of their maternal language. We take this as indirect evidence that infants are sensitive to prosodic units smaller than the phonological phrase before nine months. We will cite here two such studies.

Jusczyk *et al.* (1993*b*) report that American infants 6 months old show a preference for lists of unfamiliar English words compared with Norwegian words uttered by a single bilingual speaker. However, these infants shown no preference for lists of English as opposed to Dutch words. Moreover, these results hold when the words are lowpass filtered, indicating that the infants rely on the prosodic properties of the words. The authors stress the fact that the prosodic properties of English and Norwegian words are radically different (for instance, in Norwegian pitch tends to rise at the end of words), while English and Dutch words have similar prosodic properties. This study indicates that infants 6 months old have a notion of what is a legal prosodic unit in their language, even though these prosodic units are only two syllables long.

Jusczyk *et al.* (1993*a*) have raised a similar question in relation to stress. As Cutler and her colleagues have argued, most content words in English start with a strong syllable (Cutler & Carter 1987), and English adult listeners make use of this regularity in their processing of continuous speech. Jusczyk *et al.* (1993*a*) showed that American infants 9 months old, but not 6 months old, show a preference for lists of unfamiliar Strong-Weak words, as opposed to lists of unfamiliar Weak-Strong words. Again, the result holds when the words are lowpass filtered. This study may be taken as evidence that, at the age of nine months, infants have an idea of what is the most frequent prosodic structure in their native language.

It appears that the age at which sensitivity to smaller-sized prosodic units is found depends on the paradigm chosen. This should not be too surprising. When presented with long samples of continuous speech, infants' attention is likely to be focused on the larger-sized prosodic units (intonational phrase, phonological phrase). This would explain why they do not react to the disruption of smaller units such as clitic groups or phonological words. In contrast, when infants are confronted with lists of words they will focus their attention on smaller units. Possibly, the infant, like the adult, processes speech automatically to the highest level of structure that it can extract from the signal. This may be why the two word-list studies reported uncovered sensitivity to smaller prosodic units before the age of nine months, while the continuous speech studies did not.

To sum up: these results allow us to conclude that infants are sensitive to prosodic cues separating clauses (alternatively, intonational phrases). These cues, moreover, are universal, and presumably the child

does not have to acquire them. In contrast, smaller prosodic units are not universal. Their form, and the way they are disjoined from one another, are all things that have to be acquired by infants. So far we do not have any notion of how they do this nor at what age the different units become available. We hypothesized that infants come prepared to segment speech into the relevant units regardless of language. Although the units may not be universal, they might fall into natural classes that the infant can characterize without too much trouble.

To investigate further the hypothesis that prosodic information is used by infants at a very early age to segment the speech stream into linguistically relevant units, Christophe *et al.* (1994) tested whether newborn infants are sensitive to the prosodic cues that might mark prosodic units. Christophe *et al.* (1994) used bisyllabic CVCV contexts that either did or did not include a phonological phrase boundary. All bisyllabic contexts were phonemically identical (e.g. *mati*), and spliced out from sentences where they were the two middle syllables of a long word (e.g. *mati* in 'mathématicien'), or the last syllable of a noun and the first of the following adjective (e.g. *mati* in 'panorama tibétain'). Measures of the prosodic parameters of the stimuli showed a significant word-final vowel lengthening, which is not surprising since French is an accent-final language. A significant word-initial consonant lengthening was also measured. French infants 4 days old were tested with the high-amplitude sucking procedure, and the results show that they were able to discriminate the CVCVs that contained a phonological phrase boundary from those that did not. This result was replicated with another bisyllabic context, *menta*, produced by another speaker.

To summarize, we have found that infants during the first year of life acquire a knowledge of the shape of the word-sized prosodic units of their maternal language (as early as six months for gross prosodic features, and nine months for finer representations). Furthermore, we reviewed studies that show that newborns are already sensitive to the prosodic cues that mark boundaries, at least in French. Taken together, these findings support the hypothesis that prosody is used to bootstrap acquisition, allowing the infant to segment the continuous speech stream into linguistically relevant units (useful for acquiring phonology, syntax, and the lexicon). In the last section of this paper, we will turn to studies on even smaller prosodic units in the hierarchy, namely, the prelexical units of representation (moras, syllables and feet). These units are crucial to infants in that they support the differing rhythms of languages, and are used to represent the speech signal and to access the lexicon.

#### 4. TUNING TO THE PRELEXICAL UNITS OF THE MATERNAL LANGUAGE

Writers such as Lehiste (1977) have argued that languages may differ in the periodic units they support. Port *et al.* (1987) argue that natural languages have rhythmic structures that are related

to 'timing-units'. According to Fant and his colleagues, for each language 'there can be a different basis by which a significant proportion of the variance in durational measures of speech can be accounted for' (Fant *et al.* 1991). Traditionally, French, English and Japanese are described as syllable-timed, stress-timed and mora-timed, respectively (Abercrombie 1967). The traditional description captures the phenomenological experience reported by speakers of those languages. However, there is a compelling need for more data to support the above statements. Recent data from on-line psycholinguistic experiments suggest that parts of the processing routines of listeners depend on their maternal tongue, and in particular on the prelexical unit that is most prominent in their maternal tongue. To understand how speakers discover the pertinent routines for their language, we have to start by investigating the initial state.

We know from work by Starkey & Cooper (1980) and Antell & Keating (1983) that infants are able to represent the numerosity of sets of small cardinality. Bijeljac-Babic *et al.* (1993) capitalized on that work to assess whether infants represented the number of syllables in simple CV sequences. They habituated infants to a list containing either varied bisyllabic or varied trisyllabic items whose composition was CVCV and CVCVCV respectively (a speech compression-extension algorithm was used to diminish the difference in duration to a negligible magnitude). In the post-shift phase, the infants who had been habituated on bisyllabic items were presented with one of the following two situations: either they continued hearing bisyllabic items (control condition) or they were shifted to the list of trisyllabic items (experimental condition). Reliable discrimination was observed; this result indicates that infants react to the number of syllables in lists of stimuli, even in the context of wide phonemic variation.

The above results suggest that infants behave as if they had represented the number of CVs per item, or some other configuration that correlates with number of syllables. It is reasonable to speculate, and we are of the opinion that it is actually the number of vowels that is important. Indeed, previous work has already highlighted how important vowels are for infants' speech perception. Bertoni *et al.* (1988) tried to assess directly the representations or traces that babies have of previously heard speech sounds. They habituated infants with a set of four syllables, presented one at a time and in random order. In one experiment infants were habituated to a set of syllables sharing the same vowel, e.g. /bi/, /si/, /li/ and /mi/. In another study infants were habituated to a set of syllables sharing the same consonant, e.g. /ba/, /bae/, /bi/ and /bo/. During the post-shift phase the infants were tested with the same four syllables used during the habituation phase with a new syllable added to each one of the experimental groups. The new syllable could share either a consonant or a vowel with the habituation syllables, or differ from them by both its consonant and its vowel. Infants 2 months old noticed the addition of the new syllable regardless of how it differed from the four initial ones. In contrast,

newborns noticed the addition of a new syllable only when it differed from the other syllables by its vowel. The salience of the vowel seems to be so critical to very young infants that under tests like the one described, the newborns even failed to notice the addition of the syllable /is/ in the context of /bi/, /si/, /li/ and /mi/. This series of experiments adds to our conviction that during the earliest stages of language acquisition vowels are central to the infants' representations.

However, it would be premature to dismiss the syllable as a good candidate for the representation that infants construct during the habituation phase of the Bijeljac-Babic *et al.* (1993) experiment. Bertoncini & Mehler (1981) demonstrated that syllables have special status in the discriminations that infants 1 month old operate. This result was recently corroborated by Mood *et al.* (1992) using a very different method. How can one tease apart the options available to describe the infants' early representations of speech?

To obtain a better understanding of this problem, J. Bertoncini, C. Floccia, T. Nazzi, K. Miyagishima, and J. Mehler (in preparation) explored whether infants are sensitive to other rhythmic units, such as the Japanese mora. The mora is a subsyllabic structure that includes all the CVs in the language, and the nasal N; geminate consonants and long vowels count as two moras. In a first experiment, the authors verified that French newborns still discriminated lists of bi- and trisyllabic words when Japanese words were used. In a second experiment, they used only bisyllabic words that differed in the number of moras: either two or three. In this experiment, no discrimination was obtained. These results show that infants born to French parents in Paris do not notice a change in the number of moras in the context of an unchanging number of syllables. The authors proposed that the trimoraic bisyllables are represented like the bimoraic bisyllables, on the basis of a periodicity that is initially given by the number of vowels they possess, i.e. two in each case. These results can be taken as supporting the view that newborns represent speech as a sequence of vowels. Of course, the infants' behaviour may be guided by a more sophisticated representation. Possibly, the whole syllable is represented and the number of syllables counted. However, we suggest that infants first represent speech inputs in term of a sequence of vowels including some information about their duration and energy.

## 5. CONCLUSION

In the above sections, we have reviewed studies that incline us to believe that the human infant is born with a specialized mechanism for processing speech. This device allows infants to segregate utterances from environmental noises and utterances drawn from different languages, for example French from Russian, English from Italian and from Spanish. These results suggest that babies are not just passive receivers of utterances which sensitize them to the linguistic

nature of inputs. Rather, the linguistic stimulation they receive is organized into files in which knowledge of different phonologies is compiled. We have also shown that the baby precociously builds a template that makes it possible to rate inputs as belonging to the familiar system or as being foreign. Next, we turned to the segmentation problem, and showed that there is good evidence that infants build prosodic templates for word-sized units of their maternal language during the first year of life. Research on neonates suggests that even at birth infants are already sensitive to cues that demarcate prosodic units. Last, we reviewed existing experiments that inform us about the early representations that infants construct. We outlined an early predominance of vowels in these representations.

At all three levels considered, we referred to *prosodic properties* as responsible for the infants' behaviour. Halle & Clements (1983, p.11) in their book on phonology state that intonation is 'the "melody" with which a word, phrase, or sentence is pronounced'. For these authors, phonemes and intonational aspects of words as tones are represented on separated autosegmental tiers. For Selkirk (1984) two hierarchically organized structures are the essential parts of the phonological representation, namely, the prosodic constituent structure and the rhythmic structure. The former is the level that represents the groups of the units in the hierarchy while the latter represents a level where temporal periodicities are states. But still, it is to Roman Jakobson that we turn to obtain the clearest notional definition. In his book with Waugh he states that:

Characteristically enough, the prosodic features are a property of phonemes when functioning as syllabics and thus are primarily a property of vowels. In contradistinction to the relatively transient consonantal phonemes, vowels have been repeatedly delineated as relatively sustained, stationary units, prone to extension in time. Therefore they prove to be suitable for a set of prosodic features which are based on the contrastive comparison of a given vocalic phoneme with the vocalic phonemes of the surrounding syllables – stressed phonemes with unstressed ones, higher pitch with lower pitch, greater length with shorter length – or on the contrastive comparison of the beginning and the end on the temporal course of the syllable through the use of level and deflected tones in the different rising or falling modulations. (Jakobson & Waugh (1979), pp. 142–145).

We feel that the baby is in a similar predicament to the linguist because they are both aware that pitch, stress, duration and in general prosodic phenomena are essential to the description of languages. However, linguists have yet to provide us with a device that captures the different melodic and rhythmical regularities that the infant so skilfully extracts. We posit that it is in the area of phonology where an interaction between psycholinguistics and linguistics will be most fruitful. Already, we are using the infant

as an informer who tells us, not only which structures are present in the language, but also in what order they have to be specified in order to converge to the parental language. In this sense, the studies we are conducting, with adults and with infants, will eventually generate much richer and more interesting frameworks than the ones that have arisen so far.

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