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ABSTRACT

The current study examined whether 11-month-old and 12-month-old French infants were able to recognize familiar words in a situation yielding no extra-linguistic cues, before they made identified attempts at producing such words. A head-turn preference paradigm was used to compare infants' interest for familiar words against rare words. Lists of familiar words were auditorily presented to each child from one side, lists of rare words from the other side. A preference for familiar words was found to be very consistent in 12-month-olds, just emerging in 11-month-olds. These results reveal the existence of a developing receptive lexicon by 11 months, which seems to be closely related to the first production lexicon. (One figure and two tables of data are included.) (Author)

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INTRODUCTION

It sounds like a commonplace to state that children understand a great deal more than they say. Psycholinguists have reported that comprehension of complex utterance types outstrips production in children aged 2-3 years and more [1, 2]. But can we assume that this is also true for vocabulary?

Goldin-Meadow *and coll.* [3] found that in two-year-olds, single word comprehension precedes single word production. They also suggest that "early production vocabulary is not merely a deficient comprehension vocabulary, but is to some extent a different vocabulary". A more comprehensive account based on 9 to 18 month-old children is given by Benedict [4], who found that comprehension development (supposedly of words) is ahead of production development by several months: She located the onset of comprehension of words at 9 months, that of production of words at 12 months. She believed that first words produced are "by extrapolation understood by the child". This line of research, however, has been largely based on diary records and on scoring appropriateness of infants' responses to commands or questions in naturalistic settings [3, 4, 5]. More recently, Thomas *and coll.* [6] used a semi-structured setting in an attempt to set aside unwanted circumstances that may bias infant's responses (maternal cuing, object preference, focal intonation...). They took as measure of comprehension by the infant the duration of looking to referent-objects, named by the mother and the observer. Controls included the use of nonsense words, and of words and corresponding referent-objects judged by the mother to be unknown to the infant. Their results pointed to a developmental shift between 11 and 13 months: In response to *verbal commands to find objects*, 13-month-olds, but not 11-month-olds, were credited with "lexical understanding". Yet, we may suspect that the comprehension displayed by infants was triggered by their familiarity with the task (a verbal demand in the form of "Where is the __?" or "Show me the __") and by the presence of the matching referent-object. In short, past experience may be part of their representations of individual words. Yet, according to Oviatt's results [7], short and recent experience may be sufficient: She showed that infants could be trained to recognize previously unknown words. She ran infants from 9 to 17 months, using controls similar to Thomas et al.'s. Again, a dramatic developmental shift was located at around 10-11 months. Older infants exhibited "recognitory comprehension" after a short training (they were taught the name of one referent-object or of one action) followed by a short or long distraction phase. In summary, different sources suggest that comprehension develops early and increases rapidly circa 11 months. At this age, the child appears to recognize sound patterns within sentences, *in conjunction with specific events*. He may have stored words as sound sequences *plus situation* [8]. What we do not know is whether infants of this age have coded words in a receptive lexicon as sound sequences only, that is, whether they can recognize words not only in a situation or a variety of situations, but even when presented in isolation. We do not know either if this lexicon is a precursor of the early production lexicon, which is first observed circa 12 months. There are indications, however, that the construction of such a lexicon is feasible from an early age.

First, acquiring a lexicon requires the ability to perceive sound contrasts and to learn about the patterns of sound co-occurrences that are permissible *in the native language*. The work of Werker [9], Best [10], and Kuhl [11] has demonstrated that the perception of speech sounds becomes attuned to the language being learned by 10-12 months or earlier (8 months for vowel typicality in [11]). The recent work of Jusczyk *and coll.* (in preparation) indicates that infants aged 9 months are sensitive to the phonotactic and stress patterns of their native language: They exhibit a preference for words that respect native phonotactic constraints [12], and for frequently occurring phonotactic patterns as opposed to infrequently occurring ones; also at 9 months, American infants prefer Strong/Weak stress patterns (predominant in English words) over Weak/Strong patterns.

Second, in order to acquire a lexicon, the child must be able to segment individual lexical items from fluent speech. Some indication of this ability comes from the work of Woodward [13], extending the line of research of Hirsh-Pasek, Jusczyk, *and coll.* who demonstrated infants' ability to segment fluent speech into prosodic units: at clause boundaries [14] and at major phrase boundaries [15]. According to [13], 11-month-old infants are also able to segment speech into word units, in the sense that they perceive words as bounded units.

So it seems plausible that 11-month-olds are sufficiently equipped to recognize words from fluent speech. What do production studies contribute to this view? On the one hand, there is a growing body of evidence that babbling forms are language-specific in many respects at least from 10 months on [16, 17, 18, 19]. Combined with the evidence for language-specific attunements of speech perception at roughly the same age, this strongly suggests that infants have developed active representations of the sounds and arrangements of sounds in their language, if not of words in the sense of sound-meaning associations. On the other hand, babbling forms (i.e. forms not identified as words) have been found to be *more* similar in phonetic composition to the adult glosses of early production vocabulary than to the learned language as a whole [17]. Thus, babbling forms already foreshadow sound representations of some words: the early first words produced a little later. We may infer from this that *before they are produced*, words of the early production lexicon (the early 'preferred' words) are already coded in some way for production, hence for perception ("by extrapolation" as Benedict put it).

The present study was designed to check this hypothesis. We used for that purpose a head-turn preference paradigm aiming at measuring the preference, as indexed by attention span, for words belonging to the early production lexicon over unfamiliar words. Words were presented in lists of words and no referent-objects were used. Accordingly, the experiment directly tested for word recognition in the absence of situation and context cuing, that is, it tested for the existence of a receptive lexicon devoid of non-linguistic representations.

METHOD

Subjects

Subjects were two groups of 12 infants: one 11-month group (mean age 0;10.30, range [0;10.20, 0;11.9]), one 12-month group (mean age 0;11.30, range [0;11.17, 1;0.14]). There were seven boys and five girls in either group. Parents were questioned about familial sinistrality, but their report did not seem fully reliable. In order to obtain data for 12 x 2 = 24 subjects, 15 subjects in the 11-month group and 14 in the 12-month group had to be run. One subject was eliminated due to errors in the experimental procedure, one because he fell asleep during the test, three because they cried, could not be soothed, and could not complete the session.

Stimuli

We used 12 familiar and 12 rare words, all two-syllable words. Familiar words were the adult glosses of the most frequent attempts at words encountered in a previous longitudinal study of 5 French infants from 12 to 18 months. Rare words were infrequent words of varied phonetic forms. Care was taken to avoid closeness of each rare word to any familiar word, so that they were unlikely to be recognized in place of familiar words similar in shape. All these words were recorded by a female speaker with an even tempo, intonation, and intensity, then digitized and stored. Six pseudo-random lists were constructed with the 12 familiar words: These were "familiar lists". Likewise, 6 "rare lists" were constructed. Different lists had to begin with different words. All lists were about 21 seconds in duration, words about 1 second.

Apparatus

The subject sat on his/her mother's lap in the center of a three-sided booth, which stood in a small room. A small lamp and a loudspeaker were fixed on each side panel, at eye level and about 75 degrees from the center direction. The observer stood behind the center panel and could see the infant's eyes through a hole, without being seen. The observer used a doll which he swayed gently above the center panel to call the infant's gaze to the center direction; he used two Morse keys to signal right/left gaze to a computer in the next room, and any key of the computer keyboard to start stimuli playback. Stimuli playback was performed using a two-channel 16 bit D/A convertor (10 kHz sampling rate).

Procedure

Experimental sessions consisted of two phases: a training phase (more properly, a familiarization phase), then a test phase. For each subject, familiar words always came from the speaker on one side, rare words from the speaker on the other side. In the 'training' phase, three different lists of one 'type' (rare or familiar) were presented *in extenso*, then three lists of the other type. In the 'test' phase, the type of the list presented first was the same as in the training phase. In the next lists presented, the type was randomly changed, with two constraints: no sequence consisting of more than three lists of the same type; total number of 6 rare lists and 6 familiar lists. In both phases, the presentation was interrupted after every list until the subject looked back to the doll in the center direction. Once this was obtained, the lamp on the side of the list to be presented next was turned on, and that next list started (immediately in the training, as soon as the subject looked at the lamp in the test). In the test phase, presentation of a list was terminated before its last item if the subject stopped orienting to the speech for more than two seconds (the termination always occurred during a pause between words). The total gaze duration for each presented list was measured by the total time the observer had pressed the Morse key of the corresponding side.

RESULTS

The total looking times to each type of list are shown in Tables 1 and 2 as follows: total gaze duration to familiar words, D(F) and to rare words, D(R), total gaze duration, and proportion of gaze duration to familiar words, P(F)=D(F)/(D(F)+D(R)). Results are grouped by condition. Two independent factors were counterbalanced: the side of presentation of familiar words, S(F) (which could be Right or Left), and the type of the first list presented, T(L1) (Familiar or Rare). Instead of S(F) x T(L1), an alternative choice for the two independent factors is S(F) x S(L1), where S(L1) is the side of presentation of the first list presented (Right or Left). Note that, for example, S(F) x T(L1) = Right x Familiar is equivalent to S(F) x S(L1) = Right x Right. Paired *t*-tests showed that the difference between D(F) and D(R) is significant in the 11-month group ($t(11)=2.67$, $p<.03$), highly significant in the 12-month group ($t(11)=3.74$, $p<.004$). However, this raw measurements incorporate the variance due to individual differences in total attention span. To factor out this source of variability, we retained the single dependent variable P(F), in place of D(F) and D(R). The difference between P(F) and the chance level proportion 0.5 is found to be highly significant in the 12-month group ($t(11)=4.02, p<.003$), marginally significant in the 11-month group ($t(11)=2.17, p<.06$). Twelve-month-olds clearly prefer listening to familiar words as opposed to rare words. The same tendency is weaker in the 11-month group.

We further examined how P(F) interacted with the S(F), T(L1), and S(L1) factors: None of them had an effect on P(F) reaching significance in both groups. In the 12-month group, however, the preference for familiar words is somewhat more marked when familiar words are presented on the right side (P(F)=0.70) than on the left side (P(F)=0.60). But this difference does not reach significance ($t(10)=1.43$, $p=0.18$). T(L1) has no significant effect in either group. S(L1) has no significant effect in the 12-month group, but seems to have a marginal effect in the 11-month group ($t(10)=1.62$, $p=0.13$): Preference for familiar words is found only when the first list is presented on the right side (P(F)=0.61), not on the left side (P(F)=0.52). Figure 1 summarizes these results.

Table 1. Looking times to presented lists (11-month-olds)

Condition		Times (seconds)			
S(F)	T(L1)	D(F)	D(R)	total	P(F) (%)
Right	Familiar	22.0	13.4	35.4	62.1%
"	"	26.0	17.1	43.1	60.3%
"	"	34.5	15.1	49.6	69.6%
"	Rare	14.9	21.0	35.9	41.5%
"	"	39.2	28.6	67.8	57.8%
"	"	45.8	42.8	88.6	51.7%
Left	Familiar	31.4	11.5	42.9	73.2%
"	"	30.7	32.4	63.1	48.7%
"	"	14.8	23.4	38.2	38.7%
"	Rare	45.2	33.7	88.9	57.3%
"	"	34.3	25.7	60.0	57.2%
"	"	29.4	21.2	50.6	58.1%
Means		**30.7**	**23.8**	**54.5**	**56.3%**

Table 2. Looking times to presented lists (12-month-olds)

Condition		Times (seconds)			
S(F)	T(L1)	D(F)	D(R)	total	P(F) (%)
Right	Familiar	55.6	8.9	64.5	86.2%
"	"	22.4	8.6	31.0	72.3%
"	"	39.4	30.5	69.9	56.4%
"	Rare	27.8	28.0	55.8	50.0%
"	"	69.0	12.1	81.1	85.1%
"	"	57.8	27.8	85.6	65.5%
Left	Familiar	48.0	20.0	68.0	70.6%
"	"	38.3	27.8	66.1	57.9%
"	"	65.8	42.0	107.8	61.0%
"	Rare	38.9	39.8	78.7	49.4%
"	"	29.6	28.1	57.7	51.3%
"	"	35.1	16.7	51.8	67.8%
Means		**44.0**	**24.2**	**68.2**	**64.5%**

Finally, further t-tests indicate no significant effect of sex on P(F) in either group (11-month: P(F)=0.562 for girls, 0.565 for boys; 12-month: P(F)=0.600 for girls, 0.680 for boys). No interaction between familial sinistrality and side of presentation of familiar words is found. But the extent to which this information is reliable was somewhat doubtful.

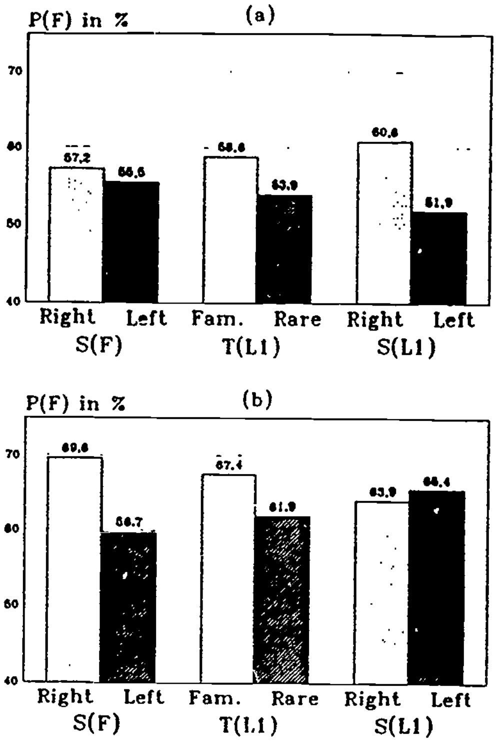

Figure 1. P(F) (in %) according to experimental condition in: (a) 11-month and (b) 12-month olds.

DISCUSSION

A reliable preference for familiar words was found in 12-month-olds. It is just emerging in 11-month-olds. In 12-month-olds, preference is somewhat more marked when familiar words are presented from the right side. This slight effect of S(F) on P(F) probably reflects a motoric right bias, not hemispheric specialization, since the presentation was essentially binaural. (No effect of presentation side was found in 11-month-olds.) We suggest that preference was due to recognition, but another kind of explanation deserves examination: Infants may prefer our familiar words because their detailed phonetic structure is simpler, or more frequently occurring, than that of the 'rare' words we used. Indeed, there is a natural tendency in languages for phonetically more complex words to be less frequent. French is no exception and our rare words, although constrained to be disyllabic, reflected this trend: For example, rare words contained more phonemes than familiar words (average number of phonemes 5.7 against 4.5). If infants' preference was due to the complexity (or to the frequency of occurrence) of sound patterns in words, the much weaker preference exhibited by 11-month-olds would indicate a much lesser sensitivity to that aspect of words. The recent findings of Jusczyk's group, however, indicate that preference for frequent phonotactic patterns over infrequent ones emerges as early as 9 months. This does not fit well with an explanation of our results in terms of preference for familiar sound patterns. Nonetheless, we are currently running a new experiment where phonetic complexity has been more strictly controlled: Rare words now have from 5 to 4 phonemes (average 4.75 phonemes), just like the familiar words, left unchanged. Preliminary results obtained from 16 infants aged 11 months (± 13 days) indicate a significant preference for familiar words (57.3% of gaze duration, $t(15)=2.45$, $p<0.03$). These new results seem to rule out an interpretation in terms of phonetic complexity and support the notion that preference reflects recognition. At the same time, they strengthen our statement that recognition of familiar words emerges by 11 months. At this age, infants have already built representations of words independently of situation, at least for those words that are widely represented in early production lexicons. That the early production lexicon is probably part of the early receptive lexicon can hardly be thought of as a mere coincidence. Rather, it seems likely that infants select words they like or understand, and try to produce them without delay. Their attempts at words are detected later, after having been left unnoticed: This is suggested by the production data on babbling forms [17]. But how are the representations underlying recognition and production of words related? Words may first be coded in production as whole word shapes, unanalyzed into phonological subunits, as proposed by Ferguson [20] and others [21]. This form of coding impedes a rapid growth of the first lexicon, as is observed. However plausible this may seem, we still do not know how whole-word coding is implemented, neither do we know whether or not it also holds for the receptive lexicon. We believe that the preference paradigm could be used to trace which transformations of familiar words suffice to cancel out the preference effect, indicating thereby which cues are necessary to recognition. To give an example, we may reverse the ordering of syllables: If preference is not maintained, syllable ordering, hence syllables themselves, are mandatory to the representation of words in the early receptive lexicon. Of course, this should be taken as sheer speculation for the present.

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