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# REPORT

# Is Dutch native English? Linguistic analysis by 2-month-olds

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### Abstract

*A variant of the non-nutritive habituation/dishabituation sucking method was used to test 2-month-old English infants' perception of languages. This method tests for the spontaneous interest of the baby to a change in the stimulus. English and Japanese were clearly discriminated. The difference between French and Japanese was equally clearly not of interest to babies using this procedure, the babies behaving as though both languages were classified simply as 'foreign'. In order to further specify babies' representation of native and foreign language, we used Dutch, which shares a number of suprasegmental features with English. The results from our last 2 experiments indicate that a portion of our 6 – 12 week-old babies consider Dutch as native, suggesting that we tapped in a transition period where the babies are still refining the suprasegmental specification of their native language.*

One of the most important tasks for a new-born infant is to learn its native language. The majority of babies grow up in a multi-lingual environment and must learn some characteristics of their mother tongue as early as possible so as to distinguish it from other languages. This is a particularly crucial ability, since infants could not possibly learn the syntax of a language (that is, discover the regularities shared by a number of sentences) if they worked on a database containing sentences from several different languages (Mehler *et al.*, 1994).

It has been shown that newborns can discriminate between their mother tongue and a foreign language. Mehler, Jusczyk, Lambertz *et al.* (1988) found that 4-day-old French infants discriminate between French (their mother tongue) and Russian stimuli, showing a preference for their native language (see also Moon *et al.* 1993, for equivalent results with English and Spanish). In addition, newborns are able to discriminate between utterances in two foreign and unfamiliar languages (Mehler and Christophe, 1995; Nazzi, Bertoncini, and Mehler, 1998). Most of these studies have been replicated successfully using speech which has been low-pass filtered at 400 Hz. Under these conditions, prosodic features such as intonation and rhythm are preserved, whereas most phonemic information is missing. It is therefore probable that babies' ability to discriminate between languages is based on a representation of speech prosody. It is very likely that the infant's preference for their native language comes from their having learned its prosody in utero. However, we still do not know the precise nature of the prosodic representation that babies use to classify languages.

Babies of 2 months of age behave slightly differently from newborns. They still discriminate between their native language and other languages but they fail to show any recovery of interest when switched from one foreign language to another. Thus, Mehler *et al.* (1988) showed that while 2-month-old American babies were able to discriminate between English (their mother tongue) and Italian, they did not discriminate between French and Russian. A possible interpretation of this counter-intuitive result is that, while newborns still attempt to analyse in detail any speech sample they are exposed to, 2-month-old infants have sufficient knowledge of their mother tongue to be able to filter out any foreign language as being not relevant.

Hesketh, Christophe and Dehaene-Lambertz (1997) developed a variant of the contingent sucking response method which has the advantage that it can be used both with new-borns and with 2-month-old infants and can be used with extended segments of speech. With this technique, 2-month-old English babies distinguished clearly between English and Japanese. It is this technique which we used to explore the infants' abilities further.

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## Method

The method for the Hesketh *et al.* experiment will first be briefly described (see Hesketh *et al.*, 1997, for details). The other experiments to be reported used the same technique apart from changes in language. The stimuli consisted of 80 sentences, half in English, half in Japanese, between 15 and 21 syllables long. These were recorded by four female native English speakers and four female native Japanese speakers respectively. Speakers were naïve as to the aim of the experiment and were instructed to read as naturally as possible. Ten sentences from each speaker were selected and matched for syllabic length (17.8 syllables) and duration (3.1 seconds). Each infant underwent two changes in stimulation, one experimental (language) change, the other control (or speaker) change. The key measure was the difference between these two changes.

Half the babies received the experimental change first and the control change second. In addition, the order of presentation of languages and of speakers was counterbalanced across subjects. This yielded eight conditions. In each of the three phases the baby heard sentences from two speakers with the idea of making speaker change mundane.

Subjects were seated in a car seat placed in a soundproofed chamber and offered a standard (steam sterilised) pacifier. One experimenter, out of view of the baby and deaf to the stimuli, checked that the pacifier stayed in the baby's mouth throughout the experiment. A second experimenter monitored the experiment on the computer outside the chamber. The computer recorded the pressure of the infant's sucks via an analogue-digital card (NIDAQ), detected the sucking responses and delivered the sentences through a ProAudio 16 sound board according to the reinforcement schedule (see below). The computer also saved both the moment and amplitude of each suck as well as the stimuli triggered by the sucks. Hesketh *et al.* (1997) reported that the number of sentences triggered was a cleaner measure than the number of sucking responses. Only this measure will be reported here.

The experiment started with a short period without stimulation (about 30 secs) to settle the infants. The first phase of the experiment then began, during which infants heard sentences in either English or Japanese contingently upon their high-amplitude (HA) sucks. After a short 'shaping' phase, three HA sucks were required to trigger each sentence (such that there was less than one second between two consecutive sucks). There was an ISI of at least 600 ms between consecutive sentences. When reaching the end of an ISI period after presentation of one sentence, the program looked back to see if HA sucks had occurred recently: any sequence of three HA sucks such that the last one occurred within the last 600 ms was used to instantly trigger a new sentence. This procedure ensured fluent presentation of sentences in case of sustained sucking activity. Within each phase of the experiment, the order of presentation of the sentences was quasi-random for each baby.

A switch in stimulation occurred after a predefined habituation criterion had been met. For two consecutive minutes the infant's HA sucking rate had to be less than 80% of the maximum sucking rate from the beginning of the experiment. Each phase of the experiment lasted at least 5 full minutes. Sixteen babies aged between 6–12 weeks participated in the study, mean age 8 weeks 6 days. Subjects were randomly assigned to one of the eight conditions prior to testing.

To assess the effect of the experimental manipulation, two kinds of analyses were performed on the data: ANOVAs and non-parametric tests. For each baby we counted the number of sentences triggered during the two minutes before and after the experimental (language) switch. The difference between these two values gives us a measure of dishabituation to the language shift. The equivalent measure was computed for the control (speaker) switch. The difference between these two dishabituation scores represents a *discrimination index* for each baby: whenever this value is positive, the baby reacted more to the language change than to the speaker change. These values are shown in figure 1 (left hand column).

A Wilcoxon signed ranks test showed that the median of the discrimination index for the number of sentences triggered was significantly above zero ($Z = 3.4$, $p < 0.001$). In the ANOVAs, the dependent measure was the dishabituation scores for the Experimental and Control switches. There was one within-subject factor (Experimental vs Control switch) and two between-subject counterbalancing factors, Order (experimental switch first, versus control switch first), and Language (English first vs Japanese first). There was a main effect of the Experimental factor ($F(1,12) = 11.6$, $p < 0.01$), no significant effect of any of the counterbalancing factors, and no interactions between the Experimental and counterbalancing factors.

## Discrimination of two foreign languages: French vs Japanese

Previous experiments using other techniques have indicated that 2-month-old infants discriminated their native tongue from other languages, but that they failed to distinguish between pairs of unfamiliar languages.

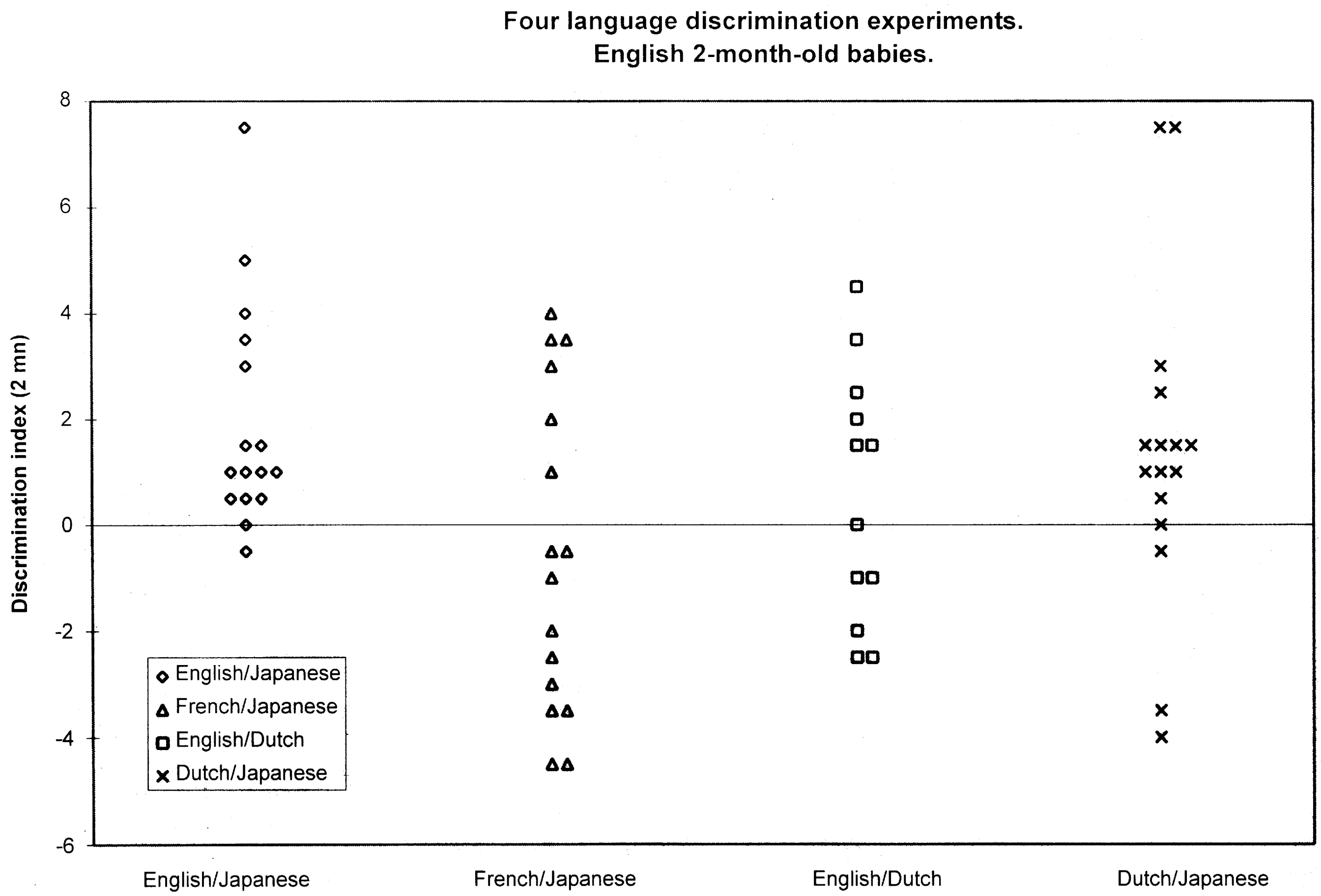


**Figure 1** *Results of four language discrimination experiments using the modified non-nutritive sucking method (Hesketh* et al.*, in press) where sentences are presented contingently upon sucking responses and each baby is submitted to two shifts of stimulation, one experimental (language change) and one control (speaker change). A discrimination index is computed for each baby: it represents the difference between the increase in the number of sentences triggered for the language change and the increase for the speaker (or control) change. Whenever this value is positive, the baby showed more interest in the language change than in the speaker change. Increases in the number of sentences triggered are computed using two minutes before and after each shift of stimulation.*

Our next experiment, then, involved testing English babies on French and Japanese. These languages are very different from each other as well as from English; for instance, French has fixed word stress, and rather simple syllabic structure through resyllabification; Japanese exhibits pitch accent, is left-recursive (while both French and English are right-recursive), and prohibits consonant clusters (Dupoux *et al.*, submitted). Sixteen babies took part in this experiment, mean age 9 weeks, 5 days.

The distribution of the discrimination index can be seen in the second column of figure 1. The infants gave no indication of being more interested in language change than in speaker change (Wilcoxon, $Z < 1$; ANOVA: $F(1,12) < 1$). This result is significantly different from the results of the experiment with English and Japanese. In an ANOVA contrasting the distribution of discrimination indices in these experiments, $F(1,28) = 8.32$, ($p < 0.01$).

The lack of interest shown by 2-month-olds in the differences between foreign languages is in line with previous work. Paired with Nazzi *et al.*'s (1998) confirmation that newborn infants can discriminate between sentences belonging to two foreign languages (with the same experimental technique as here), this result confirms the developmental trend already described. Our best interpretation is that 2-month-old infants have enough knowledge of the properties of their native language to be able to filter out foreign input as being irrelevant to their language learning. In that case, both French and Japanese would simply be classified as 'foreign' and would not be analysed to a sufficient depth to allow the differences to be detected.

The results of the first two experiments immediately pose a new question: how specified is the 2-month-olds' representation of their mother-tongue? What do they consider native, and what do they filter out as being foreign? To answer this question, we picked a language which shares with English a number of prosodic properties. Dutch, like English, has vowel reduction, complex syllabic structure, and the same sort of word stress as English. These factors lead to both English and Dutch as being heard as stress-timed (Cutler *et al.*, 1997). In fact, Dutch and English have already been shown to be rather similar to babies' ears: Nazzi *et al.* (1998) demonstrated that French newborns do not distinguish between Dutch and English filtered sentences.

## Discrimination of two stress-timed languages: English vs Dutch

There are two main possibilities for this experiment. On the one hand, it is possible that English 2-month-olds would behave exactly like the French newborns, and confuse the two languages. On the other hand, they may be able to discriminate Dutch from English, thanks to their exposure to English. Unlike Nazzi *et al.* (1998), we decided to use unfiltered sentences, as in our previous experiments. This means that, as Dutch and English differ widely in their phonemic inventories and phonotactics, being very distinct for adult listeners, these factors could give the infants additional cues for making the discrimination. Sixteen babies participated in the study, mean age 10 weeks 1 day.

The data are shown in the third column of figure 1. The group showed some interest in the shifts between Dutch and English but the relative increase in sucking rate was only marginally significant (ANOVA: $F(1,12) = 4.17$, $p = 0.064$; Wilcoxon, $Z = 1.85$, $p = 0.065$). The distribution of the discrimination index scores for English/Dutch was not significantly different from that for English/Japanese (ANOVA $F(1,28) < 1$, $p = 0.10$) and was marginally different from that for French/Japanese ($F(1,28) = 3.97$, $p < 0.06$).

## Is Dutch native English? Dutch vs Japanese

The previous experiment indicated that some babies of 2 months find it hard to discriminate between English and Dutch sentences. This cannot be attributed to a lack of interest of infants, since their mother tongue is present in the experiment. Instead, this result indicates that at least some of the infants confuse sentences from the two languages. In addition, it is possible that we tapped in a transition period where babies start paying attention to cues that distinguish Dutch from English (which might be phonemic). Taken to its limit, this result implies that our babies, or at least some of them, consider Dutch sentences as belonging to their native language. If this is truly the case, we predict that these infants should discriminate between Dutch (assimilated to native) and Japanese. This is what we tested in the next experiment. Sixteen babies, mean age 9 weeks 4 days, participated in the study.

The distribution of discrimination index scores is shown in the fourth column of figure 1. A majority of the infants were more interested by the language change than by the speaker change. Just like in the previous experiment, we observed marginally significant discrimination ($F(1,12) = 3.4$, $p = 0.09$, $Z = 1.9$, $p = 0.054$). The distribution of the discrimination index scores for this experiment was not significantly different from English/Japanese ($F(1,28) < 1$), was marginally different from French/Japanese ($F(1,28) = 3.89$, $p = 0.06$), and was not different from English/Dutch ($F < 1$). Inspection of Figure 1 shows that there is a wide distribution of data, suggesting that the group is not homogeneous. In other words, some infants have specified *native* sufficiently to exclude Dutch, whereas the rest have not.

## Discussion

Using the modified contingent sucking response we have shown that English 2-month-olds discriminate English from Japanese but not French from Japanese. Given that this habituation-dishabituation technique measures infants' interest in changes in auditory stimulation, it allows us to evaluate their spontaneous partitioning of perceptual space into categories. In the present case, the results suggest that babies form two major categories, one for English, which could be termed 'native' or 'mother tongue', and one, with French and Japanese, of 'foreign languages'.

In the last 2 experiments of this paper, we studied English infants' perception of Dutch, a language that is prosodically very similar to English. We contrasted Dutch to English and to Japanese. If English babies treat Dutch as native, they should not be able to discriminate between English and Dutch, but should readily distinguish Dutch from Japanese; in contrast, if they have already set up their *native* category such that Dutch is excluded, they should distinguish between Dutch and English but ignore the difference between Dutch and Japanese, both of which would be in the category *foreign*. Both experiments gave marginally significant results, indicating that some English babies consider

Dutch as native but others do not. The former would distinguish Dutch from Japanese but not from English; the latter group would distinguish Dutch from English but not from Japanese. If we tested babies in both conditions, we predict that whenever one condition works the other would not. What factors may account for this individual variation? The most obvious candidate is age. At one month, all infants might regard Dutch as native, whereas by four months they might all have excluded it. Further, we would expect early exposure to different languages to affect the speed of setting up a tight specification of *native* but it is unlikely to be a factor in our experiments since we selected the babies to come from monolingual English households.

Eventually we will need to distinguish between environments where second languages are addressed to the infant from those where second languages are present but not directly addressed. The second case might accelerate the definition of *native* whereas the first case, true bilingualism, might lead to confusion. Recent experiments by Bosch and Sebastian (1997) showed that by four months of age, bilingual Spanish/Catalan babies already behaved differently from monolingual babies (either Spanish or Catalan). Monolingual babies oriented faster to their mother tongue than to English. In contrast, bilinguals orient to Spanish or to Catalan significantly more slowly than to English. Is this because of confusion? Apparently not, since in more recent and still unpublished work, these authors showed that, although Spanish and Catalan are close, both monolingual and bilingual 4-month-olds can discriminate between them. Of course the gap between these 4-month-olds and our 2-month-olds is enormous and it could be that at 2 months bilingual babies are confused. At any rate, it has become clear that, from birth, infants work hard at learning what language is native.

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