2009-04-01

Bias for consonantal information over vocalic information in 30-month-olds: cross-linguistic evidence from French and English.

Nazzi, T

http://hdl.handle.net/10026.1/9960

10.1016/j.jecp.2008.05.003
J Exp Child Psychol
Elsevier BV

Journal of Experimental Child Psychology 102 (2009) 522–537

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Bias for consonantal information over vocalic information in 30-month-olds: Cross-linguistic evidence from French and English

Thierry Nazzi [a,*], Caroline Floccia [b], Bérangère Moquet [a], Joseph Butler [b]

[a] *Laboratoire Psychologie de la Perception (CNRS UMR 8158), Université Paris Descartes, 75006 Paris, France*
[b] *School of Psychology, University of Plymouth, Plymouth PL4 8AA, UK*

A R T I C L E I N F O

Article history:
Received 30 January 2008
Revised 30 April 2008
Available online 24 June 2008

Keywords:
Language acquisition
Word learning
Object categorization
Phonetic specificity
Consonants/Vowels
Cross-linguistic comparisons
French
English

A B S T R A C T

Using a name-based categorization task, Nazzi found in 2005 that French-learning 20-month-olds can make use of one-feature consonantal contrasts between new labels but fail to do so with one-feature vocalic contrasts. This asymmetry was interpreted as developmental evidence for the proposal that consonants play a more important role than vowels at the lexical level. In the current study using the same task, we first show that by 30 months French-learning infants can make use of one-feature vocalic contrasts (e.g., /pize/–/pyze/). Second, we show that in a situation where infants must neglect either a consonantal one-feature change or a vocalic one-feature change (e.g., match a /pide/ with either a /tide/ or a /pyde/), both French- and English-learning 30-month-olds choose to neglect the vocalic change rather than the consonantal change. We argue that these results suggest that by 30 months of age, infants still give less weight to vocalic information than to consonantal information in a lexically related task even though they are able to process fine vocalic information.

Introduction

Research on early phonetic specificity has witnessed renewed interest due to the recent proposal that vowels and consonants might play different roles in language processing and language acquisition (Nespor, Peña, & Mehler, 2003). More specifically, the proposal is that consonants are more

* Corresponding author. Fax: +33 1 42 86 33 22.
E-mail address: thierry.nazzi@univ-paris5.fr (T. Nazzi).

0022-0965/$ - see front matter
doi:10.1016/j.jecp.2008.05.003

important at the lexical level, whereas vowels are more important at the prosodic and syntactic levels (this does not mean that vowels are not specified in the lexicon and do not constrain lexical access). In the current article, we restrict our discussion to the first part of this proposal, namely, the claim of a privileged implication of consonants at the lexical level (but see Toro, Nespor, Mehler, & Bonatti, 2008, for evidence of a privileged implication of vowels in "syntactic-like" rule learning). This claim was initially based on data coming from linguistics and adult psycholinguistics. More recently, this claim has started receiving some support from the field of language acquisition. In the current study, we present new data exploring the relative status of consonants and vowels at the lexical level in French- and English-learning 30-month-olds.

The claim regarding the privileged implication of consonants at the lexical level is based in part on several pieces of linguistic evidence, including the fact that consonants outnumber vowels in most languages (Crystal, 1997; Ladefoged & Maddieson, 1996) and the observation that distinctiveness between consonants within a word tends to be maximized, whereas distinctiveness between vowels within a word tends to be reduced (for more details, see Nespor et al., 2003).

Further evidence in favor of the importance of consonants at the lexical level comes from the psycholinguistic domain. First, a series of word reconstruction studies have explored how English, Dutch, and Spanish adults behave when asked to transform auditorily presented pseudowords (e.g., *kebra*) into words. The results showed that these adults tend to keep the consonants and change one of the vowels of the pseudowords (resulting in, e.g., *cobra*) rather than the other way around (resulting in, e.g., *zebra*). These results held for all three languages, suggesting that they are not influenced by the proportion of consonants and vowels in the target languages and, therefore, might be language general (for behavioral data, see van Ooijen, 1996; Cutler, Sebastián-Gallés, Soler-Vilageliu, & van Ooijen, 2000). Note that the greater activation for consonantal transformations revealed in an equivalent positron emission tomography (PET) scan study suggests that changing a consonant is more difficult and imposes greater processing demands, thereby confirming that consonants are more important for lexical access (Sharp, Scott, Cutler, & Wise, 2005). More recently, further evidence in support of this claim was found for French in a study showing that adults respond faster in a written lexical decision task following the masked presentation of the consonantal target frame compared with the vocalic target frame (New, Araujo, & Nazzi, 2008).

Second, an artificial language learning experiment looking at French adults' ability to segment fluent speech showed that lexical transitional probabilities can be tracked in a context of fixed consonants and variable vowels, but not the other way around (Bonatti, Peña, Nespor, & Mehler, 2005). Note that a failure in the vocalic condition was not observed with English adults (Newport & Aslin, 2004). Although this difference might reflect effects of different linguistic background (an issue that also emerges from the infant data presented below), a more parsimonious interpretation at this point lies in the presence of slight methodological differences between the two studies. In particular, Bonatti and colleagues (2005) found that learning in the vocalic condition is in fact possible for French participants if immediate repetitions of similar items (which make the task easier) are allowed, as had been done in the English study. Therefore, it remains a possibility that in the absence of immediate repetition, English adults would also present better performance with consonants than with vowels.

Third, Caramazza, Chialand, Capasso, and Micelli (2000) described two aphasic patients with distinct cortical lesions showing a double dissociation in their pattern of errors when producing words. One patient made significantly more errors on consonants than on vowels, whereas the other patient made significantly more errors on vowels than on consonants. Given evidence that these patterns could not be explained by sonority differences between consonants and vowels (as attested by the fact that performance on consonants was not predicted by sonority levels), these authors suggested that the production of consonants is independent of the production of vowels.

The last line of research above suggests a processing dissociation for consonants and vowels, whereas the other two lines suggest that consonants matter more than vowels for lexical processing in adults. But what about development? Recall the claim by Nespor and colleagues (2003) that consonants also play a more fundamental role than vowels at the lexical level during development. This makes the prediction that early recognition of known words should be more affected by the mispronunciation of a consonant than by the mispronunciation of a vowel. It also predicts that infants should pay more attention to detailed consonantal information than to detailed vocalic information while learning new words. In the following, we review the literature on early lexical specificity for evidence related to these two predictions.

The results of many studies with 11- to 24-month-olds suggest that early lexical representations are phonetically specified to at least a certain degree given that these infants react differently to the presentation of correct known words versus mispronunciations of the same words (for Dutch: Swingley, 2003; for English: Bailey & Plunkett, 2002; Fennell & Werker, 2003; Swingley & Aslin, 2000, 2002; Vihman, Nakai, DePaolis, & Hallé, 2004; for French: Hallé & de Boysson-Bardies, 1996). These studies further show that infants accept a certain degree of phonetic variation when hearing mispronunciations, as suggested by the fact that mispronunciation affects comprehension but does not block it entirely.

However, the above studies focused on consonantal specificity, and none directly compared the effects of alterations to consonants and vowels. Such a comparison was recently provided by Mani and Plunkett (2007) in a study designed to evaluate English-learning 15-, 18-, and 24-month-olds' sensitivity to vowel and consonant mispronunciations. That study showed that at both 18 and 24 months of age, infants react to vowel mispronunciations to the same degree as they reacted to consonant mispronunciations (although many contrasts involved more than one feature). However, the evidence was less clear at 15 months of age; although infants significantly increased their orientation times toward the target object after it was correctly named (+297 ms) but not after it was labeled by a consonant mispronunciation (−181 ms) or a vowel mispronunciation (+123 ms) of the target word, their performance on the correct pronunciations was significantly different from that on the consonant mispronunciation but not from that on the vowel mispronunciation. Therefore, the evidence at 15 months of age remains open to alternative conclusions and calls for more research to be conducted on this consonant/vowel asymmetry issue.

Other studies have investigated whether infants are able to process specific phonetic information while learning new words, a task potentially more demanding than that of recognizing familiar words. This issue was explored by evaluating whether infants can simultaneously learn two words that differ by only one phonetic contrast. At 14 months of age, English-learning infants failed to learn when the words differed by only their initial consonant (Pater, Stager, & Werker, 2004; Stager & Werker, 1997; Werker, Fennell, Corcoran, & Stager, 2002), suggesting that word learning might initially be too demanding for infants' limited computational resources and that, during this process, some phonetic information is disregarded or not accessed. However, studies with English- and French-learning infants, using different methods, established that these phonetic restrictions apply only during a limited developmental window given that 16- to 20-month-olds can simultaneously learn two words differing by only one consonant whether or not it is word-initial (Havy & Nazzi, submitted for publication; Nazzi, 2005; Nazzi & New, 2007; Werker et al., 2002) and whether or not it is in the onset or coda position in the syllable (Nazzi & Bertoncini, in press).

As a way of evaluating the claim of a consonant/vowel asymmetry (Nespor et al., 2003), Nazzi (2005) used a name-based categorization task, a task originally designed to explore the relationship between categorization and lexical development (cf. Nazzi & Bertoncini, 2003; Nazzi & Gopnik, 2001), to specify French-learning 20-month-olds' ability to use specific consonantal and vocalic information. Infants were presented with three new objects; two of the objects were labeled with a pseudoword (e.g., /duk/), whereas the remaining object was labeled with another pseudoword differing from the first label by one consonantal feature (e.g., /guk/), one vocalic feature (e.g., /dok/), or more than one vocalic feature (e.g., /doek/). One of the paired objects was then picked up by the experimenter, who asked the infant to give him "the one that goes with it." Infants succeeded (i.e., chose the object with the same name) for consonantal contrasts, but their performance was at chance level for vocalic contrasts (whether the contrasts involved one or more features) and significantly lower than in the consonantal conditions.

Nazzi (2005) interpreted the data from this name-based categorization task as evidence of a privileged role of consonants in early lexical acquisition (an interpretation that is discussed in more detail in the General Discussion in light of both recent criticisms of the categorization component of the task and new experimental data in favor of the original interpretation). Accordingly, they were seen as supporting the idea of a continuity of the consonantal advantage between infancy (acquisition) and adulthood as proposed by Nespor and colleagues (2003). However, there is somewhat of a gap in the demonstration of this continuity. For adults, the advantage of consonants over vowels revealed in particular by the word reconstruction studies (Cutler et al., 2000; van Ooijen, 1996) is found even though there is no doubt that both consonants and vowels are specified at the lexical level. Otherwise, adults would not be able to distinguish the nonnegligible proportion of phonological neighbors involving a vowel change found in Dutch (36.8%), English (31.3%), French (32.5%), and Spanish (32.6%) (cf. Cutler et al., 2000; Nazzi & New, 2007).

On the other hand, the advantage of consonants over vowels found at 20 months of age in the name-based categorization task is associated with a failure of infants to use vocalic contrasts (Nazzi, 2005), a result whose precise interpretation is still under question; vocalic information might not be specified in early lexical representations (strongest interpretation), or it might be represented but initially neglected while learning new words or recognizing newly learned words. The latter weaker interpretation is more in line with Mani and Plunkett's (2007) results for familiar words at 18 and 24 months of age, although there might be a difference in lexical specificity for familiar and newly learned words. The results of other recent studies, using a procedure different from the name-based categorization task, are also in line with this weaker interpretation. Using the switch task, Curtin, Fennell, and Escudero (in press) found that 15-month-olds notice a two-feature vocalic change (/dit/–/dIt/), but not another two-feature change (/dit/–/dut/) or a three-feature change (/dut/–/dIt/), in newly learned words. The different outcome between the first condition (the more acoustically different contrast involving height/the first formant [F1] dimension) and the last two conditions suggests an important role of acoustic distance in early lexical acquisition. In a similar vein, Mani and Plunkett (2008) used a semiinteractive task to show that 14-month-olds notice vocalic changes in newly learned words when three vocalic features are changed.

Therefore, it would be important to use the same task to gather data in which infants acquiring new words would be found to (a) be sensitive to one-feature vocalic contrasts and yet (b) pay more attention to consonantal information than to vocalic information. To do so, Nazzi's (2005) Experiment 3a, in which 20-month-olds failed to use one-feature vocalic contrasts in the name-based categorization task, was replicated with French-learning 30-month-olds. Our goal was to find evidence that by that age infants are successful at using one-feature vocalic contrasts in this name-based categorization task, providing evidence for a developmental change in infants' use of vocalic information. Note that we chose to keep using the name-based categorization in the current study (in spite of the recent criticisms of its categorization component) for several reasons. First, we wanted to be able to compare the data with those from the original Nazzi (2005) study, hence the need to use exactly the same task. Second, all of the new experiments we have been conducting in response to this criticism (Havy & Nazzi, submitted for publication; Nazzi & Pilardeau, 2007) contribute to reinforcing the original lexical-based interpretation, as will become apparent in the General Discussion. Third, the original task appeared to be more adapted to the direct study of the relative weight of consonantal and vocalic information in a "conflict" situation, which we planned to undertake in Experiments 2 and 3.

Experiment 1

Method

Participants

A total of 16 30-month-olds (mean age = 30 months 15 days, range = 29 months 27 days to 31 months 4 days) from monolingual French-speaking families participated in this experiment. There was an equal number of boys and girls. Most infants came from White middle-class backgrounds, although infants from other ethnic backgrounds were also represented. An additional 2 infants were tested but failed to complete the session.

Stimuli

Six triads of small objects were used during the testing session (with an additional triad being used during a pretest). All objects were selected so that the infants would be unfamiliar with them and would not already have a name for them. All sets were made up of three very distinct objects, with all differing in shape, color, and texture in an effort to equalize their perceptual distance (see example in Fig. 1). The rationale for using triads of very different objects, rather than very similar objects, was to help infants learn and remember the different object–label pairings (see also Nazzi, 2005; Nazzi & Gopnik, 2001; Nazzi & New, 2007; Nazzi & Pilardeau, 2007).

One pair of pseudowords was used for the training trial: /dim/–/dɛm/. Three other pairs of pseudowords were used for the six test trials: /duk/–/dɔk/, /pize/–/pyze/, and /kepɔd/–/køpɔd/. Pseudowords in all pairs differed by a one-feature vocalic contrast. All three pairs of pseudowords were used once, in counterbalanced order, for the first three test trials, and then were reused in the same order for the last three test trials (the word of the pair being used as target was switched between its two occurrences).

Procedure

Infants were tested individually for approximately 10 min in a quiet room, in the presence of a caregiver, using a procedure identical to that used in Nazzi (2005). The infant was seated on a chair across a table from the experimenter. There was first an informal warm-up period during which the infant and the experimenter played together with plastic rings. The aim of this warm-up was to "train" the infant to take objects from the experimenter and to give them back to the experimenter easily. This warm-up was crucial to elicit the infant's responses during the test phase and allowed us to be able to elicit the infant's responses on all test trials in all experiments. Once this was achieved, the testing session started. It was composed of a training trial and six test trials.

The training trial was identical to the test trials (see below) except that the presentation of the objects and the categorization question were repeated if the infant's initial response was incorrect (although the infant was not told that the answer was incorrect). The testing phase started independently of the response provided the second time.

Each of the six test trials was composed of a presentation phase followed by a categorization question. Each trial started with the presentation of the three objects one at a time. The infant was encouraged to manipulate each object for a few seconds before placing it on the table. Within each trial, the objects were arranged on the table in a left-to-right sequence (from the child's perspective) to minimize memory load. The experimenter spoke while presenting each object, saying something like the following: "Look! A /duk/. This is a /duk/. Do you want to play with the /duk/? Yes, play with the /duk/. See this /duk/? All right, let's put the /duk/ on the table. Here." Each object was named exactly six times. Within each trial, two of the objects were labeled with the same pseudoword (e.g., /duk/), whereas the other object was labeled with the phonologically contrasted pseudoword (e.g., /dɔk/).

After the presentation phase, the experimenter tested categorization by putting one object of the named pair in his own hand, placed at an equal distance from the remaining two objects, and asking the infant to give him "the one that goes with this one". While waiting for the response, the experimenter looked at either the infant's face or the object in his hand to avoid influencing the infant's response. As soon as the infant had picked up an object, the other object was discreetly removed from the infant's reach and positive feedback was provided regardless of the choice made. Successful performance corresponded to the selection of the similarly labeled object.

Fig. 1. One of the triads of objects used in the different experiments of this study. Which two objects were given which names was counterbalanced across participants.

Table 1
Distribution of infants according to their performance: Experiment 1 (chance level = 3)

Performance level	0	1	2	3	4	5	6
Number of infants	0	0	2	3	7	4	0

The order of presentation of the trials for the first three trials (that order was then repeated for the last three trials) and the pairs defined by the names (Objects 1 and 2 vs. Objects 2 and 3 vs. Objects 3 and 1) were counterbalanced between participants. Moreover, the position of the paired objects on the table (left and center vs. center and right vs. left and right) and the side of the object picked up by the experimenter within a pair (left-most vs. right-most) was counterbalanced within participants.

Before the testing session, the parent filled out the vocabulary part of the French equivalent (Kern, 2003) of the MacArthur Communicative Development Inventory–Toddlers (CDI) (Fenson et al., 1993) to determine the size of the infant's productive vocabulary.

Results and discussion

For each trial, infants were given a score of 1 when the chosen object was the second of the named pair and were given a score of 0 otherwise. Total scores, which could range from 0 to 6, were transformed into percentages. Chance in this experiment is 50% given that infants needed to choose between two objects (whose pairing was counterbalanced). The infants chose the second object with the same name 63.5% of the time, which is significantly more than chance, $t(15) = 3.32$, $p = .005$ (two-tailed).[1] As can be seen from Table 1, a majority of infants chose the correct object on more than half of the test trials.

The infants produced a mean of 342 words ($SD = 176$, range = 115–621, median = 322). There was no correlation between productive vocabulary size and categorization performance, $r = .21$, $p = .44$.

The current results show that French-learning 30-month-olds, contrary to 20-month-olds, are able to use one-feature vocalic contrasts to perform above chance level in the name-based categorization task. However, in spite of an increase in performance between the two ages, 30-month-olds still make a lot of mistakes. They are in fact performing at the level at which 20-month-olds performed when the contrasts involved consonants rather than vowels (Nazzi, 2005). This raises the possibility that even though 30-month-olds are able to use vocalic information, they might still pay less attention to vocalic information than to consonantal information.

To directly evaluate whether consonants are still more important than vowels at 30 months, we ran a new name-based categorization experiment in which we used three different pseudowords instead of two in each trial in a design inspired by the word reconstruction studies that revealed a consonantal advantage in adults (Cutler et al., 2000; van Ooijen, 1996). In these adult experiments, adults were presented with pseudowords (e.g., *kebra*) that had two phonetic neighbors (consonantal change: *zebra;* vocalic change: *cobra*) and needed to provide a word similar to the pseudowords in the presence of conflicting possibilities (consonantal or vocalic change). In our next experiment (Experiment 2), French-learning 30-month-olds were placed in an analogous conflict situation where consonantal and vocalic information led to different choices, a situation that should reveal which information they rely on more.

To do so, infants were presented with triads of unfamiliar objects, all of which were given different names. The three names were chosen so that the name of the target object that would be picked up by the experimenter (e.g., /pide/) differed from one of the other names by a consonant (e.g., /tide/) and from the last name by a vowel (e.g., /pyde/). Therefore, infants were asked to match the target object with an object with a name that differed from it by either a consonant or a vowel. Note that because both of the objects that infants needed to choose between had names that differed from the name held by the experimenter, the use of the name-based categorization task (in which infants are asked to

[1] Performance for the training trial was at the same level (62.5% correct) as for the test trials. Of the 6 infants who initially failed the training trial, only 1 chose the correct object when the trial was repeated. For both reasons (same level of performance and no effect of repetition), the training trial was removed in subsequent experiments.

"give the one that goes with this one") appeared to be a better option than more simple tasks that remove the categorization component (where infants would be asked to "give the other /pide/," as was done in Havy & Nazzi, submitted for publication; Nazzi & Pilardeau, 2007). Indeed, given that all of the labels are different, both object choices are pragmatically correct in the name-based categorization task, whereas both would be pragmatically incorrect (there is no other /pide/) in the more direct word-learning task. On the basis of Nespor and colleagues' (2003) proposal, we predict that infants should have a bias in favor of the object whose name preserves the identity of the consonants (e.g., /pyde/).

Experiment 2

Method

Participants

A total of 16 30-month-olds (mean age = 30 months 17 days, range = 29 months 21 days to 31 months 13 days) from monolingual French-speaking families participated in this experiment. There was an equal number of boys and girls. Most infants came from White middle-class backgrounds, although infants from other ethnic backgrounds were also represented. An additional 2 infants were tested but failed to complete the session.

Stimuli

Eight triads of small objects were used during the testing session. Objects were selected using the same criteria as those used in Experiment 1.

Eight triads of pseudowords were used, one for each of the test trials: /guk/–/duk/–/dɔk/, /tɛk/–/pɛk/–/pœk/, /tide/–/pide/–/pyde/, /depa/–/bepa/–/bøpa/, /pug/–/pud/–/pɔd/, /dɛt/–/dɛp/–/dœp/, /gito/–/gipo/–/gupo/, and /kedi/–/kebi/–/købi/. For each triad, there was one target pseudoword (e.g., /duk/) that differed from one of the other pseudowords by a one-feature consonantal contrast (e.g., /guk/) and from the last pseudoword by a one-feature vocalic contrast (e.g., /dɔk/). All consonantal contrasts involved a single place of articulation change; six vocalic contrasts involved a single roundedness change, whereas the last two contrasts (/duk/–/dɔk/ and /pud/–/pɔd/) involved a single height change.

The pseudowords were monosyllabic for half of the triads and bisyllabic for the other half. Moreover, the consonantal change happened earlier in the word than did the vocalic change for half of the triads, whereas it happened later in the word for the other half. Note that in terms of syllabic positions, consonantal changes were always in syllable-initial positions, whereas vocalic changes were never in syllable-initial positions. The decision not to place vocalic contrasts in syllable-initial positions, which would have required using vowel-initial words, was first motivated by evidence that such words are more difficult to segment from fluent speech (Mattys & Jusczyk, 2001; Nazzi, Dilley, Jusczyk, Shattuck-Hufnagel, & Jusczyk, 2005). Thus, it seems likely that infants' use of vocalic contrasts would be even more difficult in word-initial positions. In addition, the results by Nazzi and Bertoncini (in press) show that 20-month-olds detect consonantal contrasts in both onset and coda positions similarly well, thereby discarding the possibility of an explanation of the consonant/vowel asymmetry in terms of a simple syllabic/word position effect.

Procedure

Infants were tested individually for approximately 10 min in a quiet room, in the presence of a caregiver using the same procedure as in Experiment 1, with the few following differences. Minor differences had to do with changes in the number of trials; the training trial was removed, and there were eight test trials rather than six as in Experiment 1.

The main difference was that all three objects were given different names and that the object taken by the experimenter was always the one with the target name, so that infants needed to choose between an object whose name had a consonantal change and an object whose name had a vocalic change. The object receiving the target name was always given to the object placed in the middle, whereas the side of the object receiving the name with the consonantal change was counterbalanced across trials. Thus, the same-consonants object was on the infant's right for half of the trials and on his or her left for the other half. The order of the eight test trials was counterbalanced across infants.

Again, infants' productive vocabulary was assessed using the vocabulary part of the French equivalent of the CDI–Toddlers (Kern, 2003).

Results and discussion

For each trial, infants were given a score of 1 when they chose the object that was named with the pseudoword differing from the target by a vocalic change and were given a score of 0 if they chose the object corresponding to the consonantal change. Total scores, which could range from 0 to 8, were transformed into percentages. Chance in this experiment was again 50% given that infants needed to choose between two objects (whose pairing was again counterbalanced). Infants chose the second object with the same consonants (and thus the vocalic change) 60.2% of the time, which is significantly more than chance, $t(15) = 2.78$, $p = .007$ (two-tailed). As can be seen from Table 2, a majority of infants chose the object corresponding to the vocalic change on more than half of the test trials.

An analysis of variance (ANOVA) on the categorization scores was conducted to determine whether performance varied according to whether the stimuli were mono- or bisyllabic and whether the consonantal change appeared earlier or later than the vocalic change in the stimuli. There was no significant main effect or interaction (structure: $F(1, 15) = 1.64$, $p = .22$; position: $F(1, 15) = .70$, $p = .42$; Structure × Position: $F(1, 15) = 1.09$, $p = .31$), failing to reveal any significant difference in the performance for the four conditions.

In spite of the lack of a significant interaction, we analyzed the four different conditions separately. Infants' performance was found to be above chance level for three of the four conditions: monosyllabic words with consonantal contrast first (65.63%, > 50% chance level), $t(15) = 2.61$, $p = .010$ (one-tailed), monosyllabic words with vocalic contrast first (62.50%, > 50% chance level), $t(15) = 1.46$, $p = .082$ (marginal, one-tailed), and bisyllabic words with consonantal contrast first (65.63%, > 50% chance level), $t(15) = 1.78$, $p = .048$ (one-tailed). However, performance was at chance level for the bisyllabic words with vocalic contrast first (46.88%), $t(15) < 1$, *ns*.

Although the experiment was not designed to directly compare the different conditions, the fact that infants failed to show a consonantal advantage (there was in fact no advantage at all) in the bisyllabic words condition with vocalic contrast first suggests an interaction between infants' performance and syllabic constituents. Indeed, this is the only condition in which the consonantal change happens in the second syllable of the pseudowords; all other changes happen in the first syllables of the pseudowords. If such an effect were to be confirmed in future research, it would be consistent with data showing the importance of the syllabic constituent in speech perception and word recognition that was found for French in both adults (e.g., Mehler, Dommergues, Frauenfelder, & Segui, 1981) and infants (e.g., Nazzi, Iakimova, Bertoncini, Frédonie, & Alcantara, 2006). However, because Fig. 2 shows that there is a lot of variability across trials even within the same condition, future research using more trials than two trials per condition will need to verify whether this effect can really generalize beyond the current stimuli. This underlines how important it is to test several/many contrasts in these word-learning tasks so as to be able to generalize beyond the potential idiosyncrasies of the chosen stimuli, something that appears to be one of the strengths of the current task. Fig. 2 nevertheless shows that in spite of the variability, in only one of eight trials is there a tendency toward more preservation of vocalic information.

Infants produced a mean of 390 words ($SD = 131$, range = 132–598, median = 402). There was no correlation between productive vocabulary size and categorization performance, $r = .16$, $p = .56$.

The current results show that when French-learning 30-month-olds must match a target object with either a different-looking object whose name differs from the target by a consonant or a differ-

Table 2
Distribution of infants according to their performance: Experiment 2 (chance level = 4)

Performance level	0	1	2	3	4	5	6	7	8
Number of infants	0	0	0	3	1	8	4	0	0

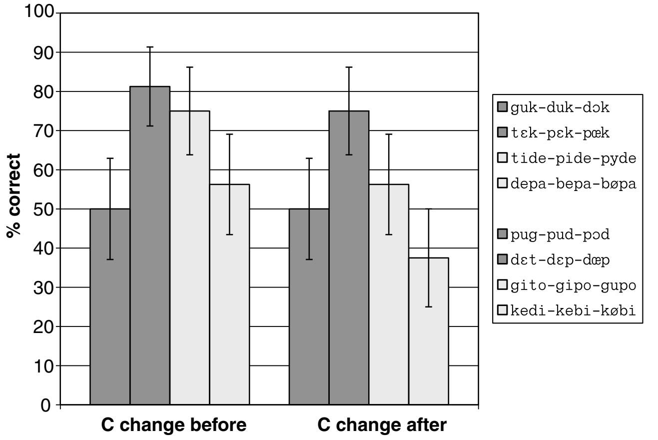

Fig. 2. Mean correct responses in percentages (and standard errors) for the eight stimulus pairs in Experiment 2, broken down according to relative position of the consonantal change versus vocalic change (left bars: four consonantal change before trials; right bars: four consonantal change after trials) and number of syllables of the pseudowords used (dark gray: monosyllabic words; light gray: bisyllabic words).

ent-looking object whose name differs from the target by a vowel, they choose the object corresponding to the vocalic change significantly more often. This behavior suggests that in a conflict task, where they must choose between preservation of either the consonantal information or the vocalic information, French-learning 30-month-olds have a bias toward identity of consonants rather than identity of vowels. This indicates that even though these infants can use one-feature vocalic contrast in this name-based categorization task (Experiment 1), they still rely more on consonantal information than on vocalic information.

At this point, we raise the question of how these results generalize to languages other than French. In particular, we have seen data for English showing that vowels constrain recognition of known words by 18 months of age, with less clear evidence at 15 months of age (Mani & Plunkett, 2007). We have also discussed data showing that by 14 months of age, English-learning infants are sensitive to some vocalic changes involving two or more features and large acoustic differences (Curtin et al., in press; Mani & Plunkett, 2008). Although there is no evidence that these young infants would be sensitive to one-feature contrasts, could it be that English-learning infants process vocalic contrasts differently from French-learning infants and, accordingly, would behave differently from French-learning infants in the name-based categorization task at 30 months of age?

Experiment 3 was designed to address this possibility. It provides a direct cross-linguistic comparison of English and French by replicating Experiment 2 with English-learning infants. The task and objects used were the same as those used in Experiment 2. The pseudoword triads were constructed as in Experiment 2 except that, to avoid problems due to syllabic stress in English, we only used consonant–vowel–consonant (CVC) pseudowords.

Experiment 3

Method

Participants

A total of 16 30-month-olds (mean age = 29 months 21 days, range = 29 months 2 days to 30 months 18 days) from monolingual English-speaking families participated in this experiment (10 boys and 6 girls). All infants came from White middle-class backgrounds. An additional 6 infants were tested but failed to complete the session. Of the 16 remaining children, 4 completed the first seven trials and refused to continue afterward. We attribute the higher attrition rate between Experiments

2 and 3 to the fact that, contrary to the French experiments that took place in a neutral room, the English infants were tested in the playroom of the Child Development Laboratory, which contained potential distractions for infants.

Stimuli

The objects were the same as those used in Experiment 2 (making up eight triads of small objects).

Eight triads of pseudowords were used, one for each of the test trials: /bɔp/–/dɔp/–/dap/, /tɒk/–/pɒk/–/pΛk/, /gIb/–/dIb/–/dɛb/, /tæg/–/kæg/–/kIg/, /bɒt/–/bɒp/–/bΛp/, /gɔk/–/gɔt/–/gat/, /tIg/–/tId/–/tæd/, and /pIb/–/pId/–/pɛd/ (due to lexical constraints, one item that is an actual word, /tæg/, was chosen for its rarity in infants' vocabulary). As for Experiment 2 on French, there was one target pseudoword (e.g., /dIb/) for each triad that differed from one of the other pseudowords by a one-feature consonantal contrast (e.g., /gIb/) and from the last pseudoword by a one-feature vocalic contrast (e.g., /dɛb/). All consonantal contrasts involved a single place of articulation change; four vocalic contrasts involved a rounding change (/Λ/ vs. /ɒ/, /a/ vs. /ɔ/), whereas four vocalic contrasts involved a height change (/æ vs. /I/, /ɛ/ vs. /I/). And as for Experiment 2, the consonantal change happened earlier in the word than did the vocalic change for half of the triads, whereas it happened later in the word for the other half. Again, we did not use vowel-initial words. Moreover, to avoid possible interferences between stress placement and phonetic realizations (De Jong, Beckman, & Edwards, 1993; Magen, 1997), and given that French-learning infants performed similarly on mono- and bisyllabic pseudowords, all of the pseudowords in the current experiment on English were monosyllabic.

Procedure

Infants were tested individually for approximately 10 min in a quiet room, in the presence of a caregiver, using the same procedure as in Experiment 2. As before, the object receiving the target name was always given to the object placed in the middle, whereas the side of the object receiving the name with the consonantal change was counterbalanced across trials (50% on the left side, 50% on the right side). The order of the eight test trials was counterbalanced across infants.

Infants' productive vocabulary was assessed using the vocabulary part of the British equivalent of the CDI–Toddlers, namely, the Oxford Communicative Development Inventory (Hamilton, Plunkett, & Schafer, 2000).

Results and discussion

As in Experiment 2, for each trial infants were given a score of 1 when they chose the object that was named with the pseudoword differing from the target by a vocalic change and were given a score of 0 if they chose the object corresponding to the consonantal change. Total scores could range from 0 to 8 (or from 0 to 7 for the 4 children who completed only seven trials) and were again transformed into percentages. Chance in this experiment was again 50% given that infants needed to choose between two objects (whose pairing was again counterbalanced). The infants chose the object with the same consonants (and thus the vocalic change) 56.5% of the time, which is significantly more than chance, $t(15) = 2.17$, $p = .046$ (two-tailed). As can be seen from Table 3, a majority of infants chose the object corresponding to the vocalic change on more than half of the test trials. A t test on the categorization scores showed that performance did not vary significantly according to whether the consonantal change appeared earlier or later than the vocalic change in the stimuli, $t(15) = 1.14$, $p = .27$.

Again, in spite of the lack of a significant difference between the two conditions, we analyzed the two conditions separately. Infants' performance was found to be above chance level for the monosyl-

Table 3
Distribution of infants according to their performance: Experiment 3 (chance level = 4 if eight trials, chance level = 3–4 if seven trials)

Performance level	0	1	2	3	4	5	6	7	8
Number of infants	0	0	0	2	4	4	2	0	0
Performance level	0	1	2	3	4	5	6	7	
Number of infants	0	0	0	1	2	1	0	0	

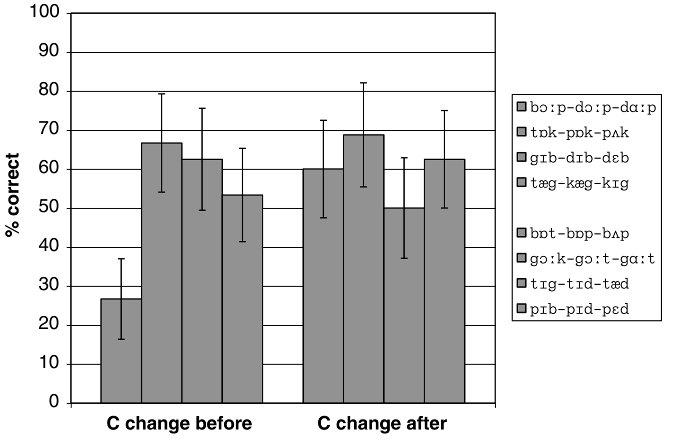

Fig. 3. Mean correct responses in percentages (and standard errors) for the eight stimulus pairs in Experiment 3, broken down according to the relative position of the consonantal change versus vocalic change (left bars: four consonantal change before trials; right: four consonantal change after trials). All stimuli were monosyllabic pseudowords.

labic words with vocalic contrast first (60.40%, > 50% chance level), $t(15) = 3.37$, $p = .002$ (one-tailed), but at chance level for the monosyllabic words with consonantal contrast first (52.60%), $t(15) < 1$, *ns.* This asymmetry is rather surprising given that one would have thought that infants would, if anything, have been more attentive to onset consonants. However, an inspection of Fig. 3 shows that this asymmetry is actually due entirely to the particularly low performance in one trial (/bɔp/–/dɔp/–/dap/) for reasons totally unpredicted. Again, this underlines the importance of testing several contrasts in these word-learning tasks so as to be able to generalize beyond the potential idiosyncrasies of the chosen stimuli.

Infants produced a mean of 354 words (*SD* = 62, range = 204–416, median = 368). As for French, there was no correlation between productive vocabulary size and categorization performance, $r = .18$, $p = .50$. Note that productive vocabulary level was similar for both French and British English infants (and, as noted previously, was lower than the numbers reported for American English infants [Fenson et al., 1993]).

To compare performance across both populations, we performed an ANOVA with the main between-participants factor of language (French [Experiment 2] or English [Experiment 3]) using mean percentage on all trials. This analysis revealed no significant difference between French-learning infants (60.2%) and English-learning infants (56.5%), $F(1, 30) < 1$. A second ANOVA was then performed by restricting the analysis to monosyllabic words, hence using data of only four of eight trials for Experiment 2 on French. Again, there was no significant difference between French-learning infants (65.6%) and English-learning infants (56.5%), $F(1, 30) = 2.12$, $p = .16$. Therefore, the observed trend of better performance in French-learning infants does not appear to be significant (for more on this point, see the General Discussion).

General discussion

First, the current study establishes that by 30 months of age, French-learning infants can correctly categorize together two unfamiliar objects on the basis of their newly learned shared name and in the presence of a third unfamiliar object having received a name that contrasted with the shared name by only one vocalic feature (Experiment 1). This was possible after just six repetitions of each object–label association. This pattern was supported both by an overall performance that was above chance level and by an infant distribution across performance levels that was different from that expected by chance. Compared with the failure found previously at 20 months of age in the exact same task (Nazzi, 2005, Experiment 3a), the current results provide evidence of a developmental change in infants' use of vocalic contrasts.

Second, the current study sheds new light regarding the consonantal bias initially found by Nazzi (2005) for French-learning 20-month-olds. Although evidence from the 20-month-olds came from a failure in the vocalic conditions (with a performance level that was also significantly below the level found in the consonantal conditions), the current evidence shows that French-learning 30-month-olds (a) can use one-feature vocalic contrasts and, nevertheless, (b) have a consonantal bias. This bias is attested by the results in Experiment 2 showing that when needing to make a choice in a conflict situation, they prefer to neglect vocalic information rather than consonantal information. And again, this was further attested by infant distribution across performance levels different from the level expected by chance.

Third, the results from Experiment 3 provide evidence (again through both mean performance and infant distribution across performance) that a bias for consonantal information is also present in English-learning 30-month-olds when these infants are also placed in a conflict situation where they must disregard a consonantal or vocalic change. Thus, Experiments 2 and 3 constitute the first direct developmental assessment, using the exact same task and age group, of the generalizability across different languages of the consonant/vowel asymmetry first revealed by Nazzi (2005). The fact that this consonantal bias in development is found cross-linguistically is in line with Nespor and colleagues' (2003) proposal.

Thus, the current data bring new evidence for a consonantal bias in this name-based categorization task. Can we go beyond this conclusion, infer that infants have learned the name–object associations, and conclude that the locus of the consonantal bias is at the lexical level? On the basis of similar results, Nazzi (2005) argued that, given that the names are the only reliable cues to categorization in the task, the fact that infants are performing above chance level in the current task implies that (a) they have learned the associations between the names and the objects during the presentation phase and that (b) they are able to use these associations to group objects together during the test phase. This ability to associate objects and names was interpreted as (a necessary step to) word learning, in line with other studies on early word learning (Hollich, Golinkoff, & Hirsh-Pasek, 2007; Houston-Price, Plunkett, & Duffy, 2006; Nazzi, 2005; Nazzi & New, 2007; Stager & Werker, 1997; Swingley & Aslin, 2007; Werker et al., 2002), all of which show that infants retain object–name associations for the duration of the experimental task/trial but do not evaluate whether these associations are retained in long-term memory (for evidence suggesting that retention is limited even by 24 months of age, see Horst & Samuelson, 2008). Accordingly, Nazzi (2005) concluded that the bias found with this name-based categorization task had to do with lexical acquisition.

However, although infants could not perform above chance level if the first implication (a) in the preceding paragraph was not correct (given all of the perceptual counterbalances made in the name-based categorization experiments), some authors have suggested that the second implication (b) might not be correct. They suggested that infants actually associate the objects during the familiarization phase (as soon as they hear the shared label used for the second object) and then forget the labels. Thus, the consonantal bias would have to do more with the categorization component of the name-based categorization task than with the lexical level. Although this is a legitimate concern, the results of two recent studies appear to contradict that possibility.

The first of these studies found evidence that even by 16 months of age, when infants fail to use the labels to categorize the objects, they have learned the labels of the objects during the familiarization phase and still remember them during the test phase (Nazzi & Pilardeau, 2007). This is shown by the fact that 16-month-olds respond above chance level when asked to "give the other [object name]" following the same familiarization as used in the name-based categorization studies. In the second of these studies, Havy and Nazzi (submitted for publication) simplified the original Nazzi (2005) procedure by first presenting infants with only two new object–label associations and then asking them to "give the [object name]," thereby removing the categorization component of the original task. This easier task was used with 16-month-olds and revealed the same consonantal bias as found by Nazzi (2005), namely that infants succeeded when the labels differed by one consonantal feature (whether place or voicing) but failed when they differed by one vocalic feature (whether place or height). Thus, both studies support the original lexical-level interpretation of the consonantal bias. Both support the conclusion that in the current study infants were learning the words and that the consonantal bias involved the lexical level. As noted earlier, the reason why we decided to keep using the name-based categorization task in the current study, rather than using a simplified "purely word learning" task, was motivated by pragmatic considerations given that such a task would have placed infants in the conflict experiments (Experiments 2 and 3) in a situation of choosing a /pide/ among two objects that had not been called a /pide/.

The above discussion, based on developmental data, supports the claim that the locus of the consonantal bias observed in the current study is the lexical level. But the current results from the conflict task (Experiments 2 and 3) are also in line with the results obtained with the word reconstruction task (Cutler et al., 2000; van Ooijen, 1996) in which adults with varied linguistic backgrounds (Dutch, English, and Spanish) found it easier to change a pseudoword into a real word by changing one of its vowels rather than by changing one of its consonants. This similarity in results suggests continuity in the consonantal bias observed during infancy and adulthood, and it further supports a lexical interpretation of our infant data. Therefore, the current study brings further confirmation of Nespor and colleagues' (2003) proposal of a consonantal bias at the lexical level (as argued above) throughout the lifespan (at least from 16 or 20 months of age [cf. Havy & Nazzi, submitted for publication; Nazzi, 2005]). As emphasized earlier, the claim is not that vowels are not specified at the lexical level but rather that consonants are given more weight than vowels during lexical access (with the exact locus of this effect, lexical or sublexical, remaining unclear).

How do our results fit with those of previous studies on the interaction between phonetic processing and early lexical acquisition? In light of the above discussion, the following developmental pattern emerges. First, infants around 14 months of age do not seem to be able to simultaneously learn phonetically similar words (Pater et al., 2004; Stager & Werker, 1997; Werker et al., 2002). Second, by 17 or 20 months of age, infants become able to learn words that differ by a one-feature consonantal contrast (Havy & Nazzi, submitted for publication; Nazzi, 2005; Nazzi & New, 2007; Werker et al., 2002) but not words that differ by a one-feature vocalic contrast (Nazzi, 2005). Data for contrasts involving more than one vocalic feature are less clear (Curtin et al., in press; Mani & Plunkett, 2008; Nazzi, 2005), with some evidence that both acoustic distance and task specificities might play a crucial role at that age for these marked contrasts (Curtin et al., in press). Third, by 30 months of age at the latest, infants can learn words that differ by a one-feature vocalic contrast (as shown here). At the same time, for known words there is evidence of sensitivity to one-feature vocalic and consonantal changes by 18 months of age at the latest, with some weak evidence of a consonantal bias at 15 months of age.

The above developmental pattern reveals a complex interaction between phonetic processing and word learning in young infants, suggesting that many factors might determine whether or not specificity and a consonantal bias are observed in a given study. In the following, we discuss what factors may or may not be important and raise some questions that will need to be further examined in future cross-linguistic research using the same tasks with infants of the same ages (as was done in the current study for name-based categorization in French- and English-learning 30-month-olds). To begin with, some factors appear not to be relevant. First, differences in age independently of task differences (see below) do not seem to explain whether or not a consonant/vowel asymmetry is found: Mani and Plunkett (2007) found no asymmetry at 18 and 24 months of age, whereas an asymmetry was found at both 20 and 30 months of age in Nazzi (2005) and the current study. Second, although initial findings suggested a possible cross-linguistic difference during infancy between French and English (in spite of a consonantal advantage in English adults [Cutler et al., 2000]), our results from Experiment 3 rule out this explanation; when the same task is used, similar effects are found in both languages. Third, studies reporting consonant/vowel symmetry had used words with simple CVC structures (Curtin et al., in press; Mani & Plunkett, 2007), whereas studies reporting asymmetries had used words with more varied CVC, CVCV, and CVCVC structures (Nazzi, 2005). However in the current study, asymmetries were found in French and English even when using CVC words.

In fact, differences in the results obtained in the various studies do not seem to be explainable without recourse to the nature and difficulty of the task used and without reference to the cognitive level tapped by the task (representation vs. processing). One likely explanation of the overall pattern of results obtained is that very early on, infants are able to represent specific consonantal and vocalic information. This explains the results on early recognition of known words, with infants reacting to consonant mispronunciations by at least 14 months of age (Bailey & Plunkett, 2002; Fennell & Werker, 2003; Mani & Plunkett, 2007; Swingley & Aslin, 2000, 2002) and to vowel mispronunciations by at least 18 months of age (Mani & Plunkett, 2007).

However, when infants are facing a situation requiring more cognitive resources, such as learning phonetically similar new words and needing to use specific phonetic information to accomplish a recognition task (measured through eye gaze or object manipulation), access to specific phonetic information might not be possible, as was first found for consonants by Stager and Werker (1997) at 14 months of age. Under such circumstances, the ability to access specific phonetic information appears to be influenced by both age and the type of contrast considered. Indeed, age effects, first reported between 14 and 17 to 20 months of age for consonants (Werker et al., 2002), were also found for vowels; although Nazzi (2005) reported failure at 20 months of age, the current study demonstrates use of vocalic information at 30 months of age. Thus, younger infants appear to be more flexible (i.e., to accept a larger range of close mispronunciations) than older ones in recognizing words they have just learned.

Moreover, this phonetic flexibility during lexical recognition in spite of specific representations of both consonantal and vocalic information appears to vary for different contrasts, on the one hand, and for different types of phonemes (i.e., consonants vs. vowels), on the other. First, Curtin and colleagues (in press) demonstrated for vowels that some contrasts are easier than others. The vocalic contrasts tested involved changes in at least two phonetic features, but infants succeeded only with the contrast that involved a larger acoustic distance, which in this case involved F1, a formant that signals height information. This initial importance of acoustic distance for use of phonetic specificity in early word learning is in line with the PRIMIR (Processing Rich Information from Multidimensional Interactive Representations) framework proposed by Werker and Curtin (2005). Note that in this context, effects of phonetic feature distance were not observed in Nazzi (2005), where infants were presented with vocalic contrasts that involved either one-feature (Experiment 3a) or three-feature (Experiments 3b and 3c) vocalic changes. However, it is unclear how phonetic feature and acoustic distances related in that study. Moreover, the fact that infants heard dozens of repetitions of the target words in Curtin and colleagues' (in press) switch task experiment, but only six repetitions in Nazzi's (2005) name-based categorization experiment, might have made the use of multiple feature contrasts more difficult in the latter study. Similarly, the failure of 16-month-olds to use one-feature vocalic contrasts in Havy and Nazzi (submitted for publication) might result in part from the fact that they heard only six repetitions of the same contrasts, and different results might be found if another task (e.g., the switch task) were used. Future research will need to address these issues and, more generally, investigate the role of the complex relation among acoustic, phonetic, and phonological properties on the use of specificity in word learning.

Second, differences between consonants and vowels have been found when using one-feature contrasts, but in line with our proposal that this asymmetry reveals processing differences rather than representational differences, so far they have been found only in situations characterized by increased processing load. They have been found when infants are faced with a difficult enough task such as the name-based categorization task at 20 months of age (Nazzi, 2005) or possibly the word recognition task at 15 months of age (Mani & Plunkett, 2007). They have also been found when an overt "choice" must be made between the reliance on consonantal information versus vocalic information—choice between two objects, as for 30-month-olds in the current study, or choice between two words for adults in word reconstruction tasks (Cutler et al., 2000; van Ooijen, 1996).

The current study provides new data showing a consonantal advantage at the lexical level that is not due to a lack of representation of vocalic information and is present for both French and English infants. Thus, it supports Nespor and colleagues' (2003) claim of a different role for consonants and vowels in language use, with increased weight given to consonantal information at the lexical level. The cross-linguistic generalization provided here is important and should be further explored in future research. In particular, it remains unclear whether the asymmetry is language general or develops due to the properties of the language in acquisition.

As stated by Bonatti and colleagues (2005), the advantage of consonants over vowels in lexical processing could be due to the fact that in most languages consonants outnumber vowels. Simply because this should result in more possible permutations between consonants than between vowels to generate words, consonants should naturally provide more informational content than should vowels. The asymmetry shown in the current article and in Nazzi (2005) for the processing of consonants and vowels in the course of language development could be due to an emerging property involving the computation of these different statistics. If that were the case, one would expect English infants to display the vowel/consonant asymmetry earlier, or in a more robust way, than do French infants simply because French has nearly as many consonants as vowels (standard Parisian French: 17 vs. 16), whereas English has nearly twice as many consonants as vowels (standard British English: 23 vs. 12). Our data do not suggest that this is the case; the bias toward consonants over vowels as evidenced by 30-month-olds appears to be statistically similar in both French and English children (if anything, there was a nonsignificant trend of slightly better performance in French-learning infants). It could be that a simple comparison between the number of vowels and consonants within a given language is not enough to provide an estimation of how the statistics of the two types of phonemes compare to build up words. Despite differences in consonant and vowel inventories, French and English have a similar proportion of one-feature pairs that differ only by one consonant versus one vowel (Cutler et al., 2000; Nazzi & New, 2007), suggesting that other factors could influence the statistics of consonants and vowels in word generation, including the syllable complexity of the language or the inflectional system. If this hypothesis were to be investigated further, it is clear that data from the study of languages that have more vowels than consonants, such as Danish, would provide crucial data, especially if coupled with more thorough analyses of the interactions between consonant/vowel statistics and resulting word formation in these languages.

Acknowledgments

This research was supported by a grant from the European Science Foundation EUROCORES program ("The Origin of Man, Language, and Languages") and an ACI ("Origine de l'Homme, du langage et des langues") grant to the first author as well as by a Franco-British Research Alliance grant to T. Nazzi and C. Floccia. We thank the participants and their families for their time and cooperation.

References

Bailey, T. M., & Plunkett, K. (2002). Phonological specificity in early words. *Cognitive Development, 17*, 1265–1282.
Bonatti, L. L., Peña, M., Nespor, M., & Mehler, J. (2005). Linguistic constraints on statistical computations: The role of consonants and vowels in continuous speech processing. *Psychological Science, 16*, 451–459.
Caramazza, A., Chialand, D., Capasso, R., & Micelli, G. (2000). Separable processing of consonants and vowels. *Nature, 403*, 430.
Christophe, A., Guasti, M. T., Nespor, M., & van Ooyen, B. (2003). Prosodic structure and syntactic acquisition: The case of the head-direction parameter. *Developmental Science, 6*, 211–220.
Crystal, D. (1997). *Cambridge encyclopedia of language*. Cambridge, UK: Cambridge University Press.
Curtin, S., Fennell, C., & Escudero, P. (in press). Weighting of vowel cues explains patterns of word–object associative learning. Developmental Science.
Cutler, A., Sebastián-Gallés, N., Soler-Vilageliu, O., & van Ooijen, B. (2000). Constraints of vowels and consonants on lexical selection: Cross-linguistic comparisons. *Memory & Cognition, 28*, 746–755.
De Jong, K., Beckman, M. E., & Edwards, J. (1993). The interplay between prosodic structure and coarticulation. *Language and Speech, 36*, 197–212.
Fennell, C. T., & Werker, J. F. (2003). Early word learners' ability to access phonetic detail in well-known words. *Language and Speech, 46*, 245–264.
Fenson, L., Dale, P. S., Reznick, J. S., Thal, D., Bates, E., Hartung, J. P., et al (1993). *Technical manual for the MacArthur Communicative Development Inventory*. San Diego: Singular Press.
Hallé, P. A., & de Boysson-Bardies, B. (1996). The format of representation of recognized words in infants' early receptive vocabulary. *Infant Behavior and Development, 19*, 463–481.
Hamilton, A., Plunkett, K., & Schafer, G. (2000). Infant vocabulary development assessed with a British Communicative Development Inventory: Lower scores in the UK than the USA. *Journal of Child Language, 27*, 689–705.
Havy, M., & Nazzi, T. (submitted for publication). Better processing of consonantal over vocalic information in word learning at 16 months of ago.
Hollich, G., Golinkoff, R. M., & Hirsh-Pasek, K. (2007). Young children associate novel words with complex objects rather than salient parts. *Developmental Psychology, 43*, 1051–1061.
Horst, J. S., & Samuelson, L. K. (2008). Fast mapping but poor retention by 24-month-old infants. *Infancy, 13*, 128–157.
Houston-Price, C., Plunkett, K., & Duffy, H. (2006). The use of social and salience cues in early word learning. *Journal of Experimental Child Psychology, 95*, 27–55.
Kern, S. (2003). Le compte–rendu parental au service de l'évaluation de la production lexicale des enfants français entre 16 et 30 mois. *Glossa, 85*, 48–62.
Ladefoged, P., & Maddieson, I. (1996). *The sounds of the world's languages*. Oxford, UK: Blackwell.
Magen, H. S. (1997). The extent of vowel-to-vowel coarticulation in English. *Journal of Phonetics, 25*, 187–205.
Mani, N., & Plunkett, K. (2007). Phonological specificity of vowels and consonants in early lexical representations. *Journal of Memory and Language, 57*, 252–272.

Mani, N., & Plunkett, K. (2008). Fourteen-month-olds pay attention to vowels in novel words. *Developmental Science, 11*, 53–59.
Mattys, S., & Jusczyk, P. W. (2001). Do infants segment words or recurring contiguous patterns? *Journal of Experimental Psychology: Human Perception and Performance, 27*, 644–655.
Mehler, J., Dommergues, J. Y., Frauenfelder, U., & Segui, J. (1981). The syllable's role in speech segmentation. *Journal of Verbal Learning and Verbal Behavior, 20*, 298–305.
Nazzi, T. (2005). Use of phonetic specificity during the acquisition of new words: Differences between consonants and vowels. *Cognition, 98*, 13–30.
Nazzi, T., & Bertoncini, J. (2003). Before and after the vocabulary spurt: Two modes of word acquisition? *Developmental Science, 6*, 136–142.
Nazzi, T., & Bertoncini, J. (in press). A comparison of consonant specificity in onset and coda positions in early lexical acquisition. *Language and Speech*.
Nazzi, T., Dilley, L. C., Jusczyk, A. M., Shattuck-Hufnagel, S., & Jusczyk, P. W. (2005). English-learning infants' segmentation of verbs from fluent speech. *Language and Speech, 48*, 279–298.
Nazzi, T., & Gopnik, A. (2001). Linguistic and cognitive abilities in infancy: When does language become a tool for categorization? *Cognition, 80*, B11–B20.
Nazzi, T., Iakimova, I., Bertoncini, J., Frédonie, S., & Alcantara, C. (2006). Early segmentation of fluent speech by infants acquiring French: Emerging evidence for cross-linguistic differences. *Journal of Memory and Language, 54*, 283–299.
Nazzi, T., & New, B. (2007). Beyond stop consonants: Consonantal specificity in early lexical acquisition. *Cognitive Development, 22*, 271–279.
Nazzi, T., & Pilardeau, M. (2007). Learning the names of objects is not enough to support name-based categorization at 16 months. *European Journal of Developmental Psychology, 4*, 435–450.
Nespor, M., Peña, M., & Mehler, J. (2003). On the different roles of vowels and consonants in speech processing and language acquisition. *Lingue e Linguaggio, 2*, 221–247.
New, B., Araujo, V., & Nazzi, T. (2008). Differential processing of consonants and vowels in lexical access through reading. *Psychological Science, 19*, 1223–1227.
Newport, E. L., & Aslin, R. N. (2004). Learning at a distance: I. Statistical learning of non-adjacent dependencies. *Cognitive Psychology, 49*, 85–117.
Pater, J., Stager, C., & Werker, J. F. (2004). The perceptual acquisition of phonological contrasts. *Language, 80*, 361–379.
Sharp, D. J., Scott, S. K., Cutler, A., & Wise, R. J. S. (2005). Lexical retrieval constrained by sound structure: The role of the left inferior frontal gyrus. *Brain and Language, 92*, 309–319.
Stager, C. L., & Werker, J. F. (1997). Infants listen for more phonetic detail in speech perception than in word-learning tasks. *Nature, 388*, 381–382.
Swingley, D. (2003). Phonetic detail in the developing lexicon. *Language and Speech, 46*, 265–294.
Swingley, D., & Aslin, R. N. (2000). Spoken word recognition and lexical representation in very young children. *Cognition, 76*, 147–166.
Swingley, D., & Aslin, R. N. (2002). Lexical neighborhoods and the word-form representations of 14-month-olds. *Psychological Science, 13*, 480–484.
Swingley, D., & Aslin, R. N. (2007). Lexical competition in young children's word learning. *Cognitive Psychology, 54*, 99–132.
Toro, J. M., Nespor, M., Mehler, J., & Bonatti, L. L. (2008). Finding words and rules in a speech stream. *Psychological Science, 19*, 137–144.
van Ooijen, B. (1996). Vowel mutability and lexical selection in English: Evidence from a word reconstruction task. *Memory & Cognition, 24*, 573–583.
Vihman, M. M., Nakai, S., DePaolis, R. A., & Hallé, P. (2004). The role of accentual pattern in early lexical representation. *Journal of Memory and Language, 50*, 336–353.
Werker, J. F., & Curtin, S. (2005). PRIMIR: A developmental framework on infant speech processing. *Language Learning and Development, 1*, 197–234.
Werker, J. F., Fennell, C. T., Corcoran, K. M., & Stager, C. L. (2002). Infants' ability to learn phonetically similar words: Effects of age and vocabulary size. *Infancy, 3*, 1–30.