Brief Report

Usage-based account of the acquisition of liaison: Evidence from sensitivity to the singular/plural orientation of nouns

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A B S T R A C T

This study investigates whether children’s production and recognition of obligatory liaison sequences in French depend on the singular/plural orientation of nouns. Certain nouns occur more frequently in the plural (e.g., arbre “tree”), whereas others are found more often in the singular (e.g., arc-en-ciel “rainbow”). In the input, children more frequently encounter these plural-oriented nouns after determiners that indicate plurality (e.g., les, des “the”, deux “two”) and that are often associated with a /z/ liaison (e.g., deux arbres [døzarbr] “two trees”). In Experiment 1, 122 children (3 years 2 months to 6 years 3 months of age) were asked to produce nominal phrases with either /z/ liaisons (i.e., in plural contexts such as deux arbres [døzarbr] “two trees”) or /n/ liaisons (i.e., in singular contexts such as un ours [oøurs] “one bear”). We found correlations between the plural orientation of the nouns and (a) the probability that they will be preceded by an incorrect /z/ liaison in the singular context and (b) the probability that they will be preceded by a correct /z/ liaison in the plural context. This result was, however, restricted to the younger children. In Experiment 2, 20 children (5 years 5 months to 6 years 3 months of age) were asked to monitor target words in auditorily presented sentences. The results showed shorter reaction times for singular-oriented nouns when preceded by a singular determiner than when preceded by a plural determiner. Conversely, plural-oriented nouns were responded to faster when preceded by a plural determiner than when preceded by a singular determiner. Results are discussed.

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within the framework of a two-stage model of liaison acquisition recently proposed by Chevrot, Chabanal, and Dugua (Journal of French Language Studies, 17 [2007] 103–128) as well as by Chevrot, Dugua, and Fayol (Journal of Child Language [in press]).

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Introduction

Liaison in French involves the production of a consonant between two words (e.g., /z/ in deux ours [dzørs] “two bears”). For the liaison to appear, the right-hand word (hereafter Word2) must begin with a vowel when spoken in isolation ([urs] “bear”). When this liaison consonant is produced, it generally forms a syllable with the initial vowel of the following word and any coda. For example, the sequence deux ours “two bears” is syllabified [dzørs]. Because lexical segmentation processes make use of the probable correspondence between syllable boundaries and word boundaries (Content, Kearns, & Frauenfelder, 2001), the resyllabification process of liaison in French creates a tricky situation for young children who hear different forms of Word2 depending on the preceding Word1. For example, they are confronted with [nurs] in un ours “one/a bear”, [zurs] in les ours “the bears”, and [turs] in petit ours “little bear”.

Liaison acquisition is not easy; it takes approximately 6 years for French children to fully master liaison. In a case study, Chevrot and Fayol (2000) and Dugua (2006) analyzed the liaison errors produced by a little girl (“Sophie”) from 2 years 1 month to 6 years 4 months of age. The largest proportion of errors was observed at around 3 years of age. Sophie’s liaison errors could be divided into two main categories: addition errors (e.g., [mam ~a nurs] maman ours “mommy bear” instead of [mam/urs]) and replacement errors (e.g., [grænekles] grand éclair “great flash of lightning” instead of [grætekles]).

Dugua (2006) evaluated developmental changes in the production of liaison in determiner + noun sequences (e.g., un ours “a/one bear”, deux ours “two bears”) of 200 children between 2 years 4 months and 6 years 1 month of age. Over time, correct productions increased from 36% at 2 to 3 years of age to 83% at 5 to 6 years of age, while replacement errors decreased from 44% to 4%. This pattern of production performance was confirmed by a longitudinal study of 20 children tested five times between 2 and 6 years of age (Dugua, 2006).

Ever since Schane (1968), modeling French liaison has served as an unavoidable test for all generative theories of adult phonology (Tranel, 2000). With regard to the acquisition of liaison, Wauquier-Gravelines and Braud (2005) proposed a model within the generative framework of autosegmental phonology. They considered liaison errors between a determiner and a noun to be one of the first indications that prosodic positions are independent of the phonetic content of the segments. In line with the principle that syllables with onsets are preferred, a prosodic position C corresponding to the liaison would then be associated with the syllable onset of the noun. In contrast, Chevrot, Dugua, and Fayol (in press) and Chevrot, Chabanal, and Dugua (2007) recently proposed an exemplar-based model of liaison acquisition between a determiner and a noun in line with Bybee’s (2001) view in adults. This view assumes that early on, children memorize concrete chunks of speech (Tomasello, 2003), some of which contain determiner + noun sequences that include a liaison. When segmenting these chunks, children would favor the presence of a consonant at the beginning of the Word2 (les ours “the bears” would be segmented as /le/ + /zurs/). They would deal with the variation in liaison in the input by memorizing multiple concrete exemplars of the same Word2 (/nurs/, /zurs/, /turs/ for ours “bear”). Because children simultaneously generalize schemata based on the determiner, this model weaves together progress in the production of liaisons, segmentation of new words, and development of item-based constructions.

During the first stage of the model (~2–4 years of age), children segment lexical exemplars of each Word2. Given that the lexical segmentation process makes use of the probable correspondence between syllabic boundaries and word boundaries (Matty & Jusczyk, 2001), children attach the different liaison consonants preceding the Word2 to this word, thereby resulting in several exemplars of each Word2: /nurs/, /zurs/, /turs/ for ours “bear”. The segmentation of the Word2 is dependent on the segmentation of the Word1, which constitutes the stable lexical item in a large number of chunks. The
determiner, therefore, could become the concrete element in schemata taking the form \textit{un} + X, \textit{les} + X, and so forth. As assumed by the usage-based theory (Tomasello, 2003), the formation of the schemata results from the connection between memorized chunks on the basis of their phonological or functional similarities. When the stock of memorized chunks increases and changes under the influence of the input, the possibilities for generalization develop.

A second stage (from 4 years of age) is characterized by a more abstract structure that generalizes the relation between a specific Word1 (e.g., \textit{les} [le]) and a class of Word2 variants (e.g., exemplars beginning with \textit{z}). From determiner + noun sequences that include a liaison (\textit{les ours} [lezurs] “the bears”, \textit{les ânes} [lezan] “the donkeys”, \textit{les amis} [lezami] “the friends”), children generalize specified schemata (\textit{les} + zX) that include information about the liaison. More precisely, these schemata specify the nature of the lexical variant that should fill the slot following a specific Word1 (in the case of \textit{les} + zX, an exemplar beginning with \textit{z} should follow the Word1 \textit{les}). These schemata enable children to produce correct liaisons that they have never heard.

Central to this exemplar-based account of liaison acquisition is the role of frequency. Children learn the correct relations between each Word1 and the Word2 exemplars through exposure to the well-formed sequence (\textit{un} + [narbr] “one tree”, \textit{deux} + [zarbr] “two trees”). Hence, if a Word1 frequently co-occurs with a Word2 (e.g., \textit{un} + \textit{âne} in the sequence \textit{un âne} [\textit{un} nan] “a donkey” with the \textit{n} liaison), it should lead to a high level of correct liaison production. Moreover, this should render the exemplar [nan] more available to the production/recognition system than other less frequent exemplars such as [zan]. Some nouns are more often encountered in the plural form (e.g., \textit{indiens} “Indians”), whereas other nouns are more often encountered in the singular form (e.g., \textit{arc-en-ciel} “rainbow”). It follows that children more frequently encounter plural-oriented nouns such as \textit{indiens} after determiners that indicate plurality (e.g., \textit{les} “the (definite)”, \textit{des} “the (indefinite)”, \textit{deux} “two”) and that are often associated with a \textit{z} liaison (Morin & Kaye, 1982). Similarly, children encounter singular-oriented nouns such as \textit{arc-en-ciel} more frequently after singular determiners (\textit{un} “one/a”) often associated with an \textit{n} liaison.

Thus, the model predicts an influence of the singular/plural orientation of nouns on the liaison production of young children but not of older children. As a matter of fact, the general schemata of the first stage (\textit{un} + X, \textit{les} + X) provide no constraint on the nature of the liaison consonant following a Word1, and they allow a frequency effect. Experiment 1 was designed to test this prediction.

**Experiment 1**

Children were asked to produce short phrases with either \textit{z} liaisons (i.e., plural phrases such as \textit{deux ours} [\textit{døzurs}] “two bears”) or with \textit{n} liaisons (i.e., singular phrases such as \textit{un ours} [\textit{un} ours] “one bear”). We evaluated (a) whether the rate of correct \textit{z} and \textit{n} productions depended on the singular/plural orientation of nouns and (b) whether replacement errors followed the singular/plural orientation of nouns.

**Method**

**Participants**

Participants were 122 native speakers of French from 3 years 2 months to 6 years 3 months of age (\textit{M} = 4 years 8 months, \textit{SD} = 8.4 months). There were 70 girls and 52 boys, all from middle-class families. Three age groups were formed: Age Group 1 with 29 children from 3 years 2 months to 4 years 1 month of age (\textit{M} = 3 years 9 months, \textit{SD} = 3.1 months), Age Group 2 with 48 children from 4 years 2 months to 5 years 0 months of age (\textit{M} = 4 years 7 months, \textit{SD} = 3.3 months), and Age Group 3 with 45 children from 5 years 1 month to 6 years 3 months of age (\textit{M} = 5 years 5 months, \textit{SD} = 3.6 months). To avoid any effect of literacy on liaison performance, all children were tested before they started to learn to read and write.

**Stimuli**

Target words that met the following constraints were selected: masculine, vowel-initial nouns that were both picturable and frequent enough to be known by 3-year-olds. Eight target nouns were selected; four were more frequent in the plural than in the singular (e.g., \textit{arbres} “trees”), and four were
more frequent in the singular than in the plural (e.g., ours “bear”). The singular/plural orientation of these targets was obtained by the means of a pretest in which adult participants (70 adult native speakers of French) needed to choose between two sequences (e.g., un ours “one/a bear”, des ours “(some) bears”), indicating the one that seemed more common. For each noun, we established a ratio that gave the tendency for the noun to be plural (see details in Appendix). There were also five masculine consonant-initial filler targets (e.g., balai “broom”) for which no liaison consonant is produced after determiners (e.g., un balai [i-balε], deux balais [dø-balais]).

Procedure

Children were tested individually at school and were asked to perform a picture naming task. Pictures were composed of items that were represented in one or two exemplars. The experimenter asked the children, “What is there in this picture?” and the children needed to give an answer of the type un + Word2 (e.g., “one bear”) or deux + Word2 (e.g., “two bears”). After each target presentation, a filler was presented. The presentation order of target words was randomized across children.

Results and discussion

Percentages of correct productions and of replacement errors for each age group are reported in Table 1. Analyses of the production data showed that both correct productions and replacement errors globally varied with age, Kruskall–Wallis $H = 16.168$, $p = .0003$, and Kruskall–Wallis $H = 15.640$, $p = .0004$, respectively. Correct productions increased significantly between Age Group 1 and Age Group 2, Mann–Whitney $U = 373.5$, $p = .0006$, but not between Age Group 2 and Age Group 3, Mann–Whitney $U = 1000.5$, $p = .5210$. Moreover, replacement errors decreased significantly between Age Group 1 and Age Group 2, Mann–Whitney $U = 501$, $p = .0137$, but also between Age Group 2 and Age Group 3, Mann–Whitney $U = 904$, $p = .0396$.

We assessed whether the singular/plural orientation of nouns affected the children’s correct productions and their error production. Thus, we established two ratios that gave the orientation of production toward the /z/ liaison, which is associated with the plural determiner. The first ratio based on the correct productions was obtained by dividing the number of correct productions with /z/ by the number of correct productions. The second ratio was based on the replacement errors and was obtained by dividing the number of replacement errors in /z/ by the number of /z/ and /n/ replacement errors. Ratios close to 1 show a bias toward /z/ liaison whether correct responses or errors.

For each age group, correlations between the singular/plural orientation of the nouns and the orientation of the responses toward /z/ liaison (both correct responses and errors) were calculated. These correlations are reported in Table 2.

Table 1
Mean percentages (and standard deviations) of correct productions and of replacement errors for each age group and for plural- and singular-oriented nouns

<table>
<thead>
<tr>
<th></th>
<th>Plural-oriented nouns</th>
<th>Singular-oriented nouns</th>
<th>All nouns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group 1</td>
<td>79.8 (20.7)</td>
<td>73.2 (28.3)</td>
<td>76.7 (22.0)</td>
</tr>
<tr>
<td>Age group 2</td>
<td>93.2 (11.1)</td>
<td>88.4 (16.9)</td>
<td>91.5 (11.7)</td>
</tr>
<tr>
<td>Age group 3</td>
<td>92.9 (13.4)</td>
<td>90.2 (17.3)</td>
<td>91.8 (14.0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Plural-oriented nouns</th>
<th>Singular-oriented nouns</th>
<th>All nouns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group 1</td>
<td>14.7 (22.3)</td>
<td>16.3 (27.0)</td>
<td>15.6 (23.0)</td>
</tr>
<tr>
<td>Age group 2</td>
<td>2.6 (6.5)</td>
<td>4.0 (10.2)</td>
<td>3.0 (7.0)</td>
</tr>
<tr>
<td>Age group 3</td>
<td>1.1 (5.2)</td>
<td>1.4 (6.6)</td>
<td>1.3 (5.2)</td>
</tr>
</tbody>
</table>

Note. Standard deviations are in parentheses.

Nouns were integrated in two types of sequences: plural and singular. The former included the determiners les “the plural” and des “some plural”, and the latter included the determiners le (le) “the” and un “a/one”. Each noun was judged in two modalities: (a) with singular versus plural definite determiners (e.g., l’âne vs. les ânes “the donkey” vs. “the plural donkeys”) and (b) with singular versus plural indefinite determiners (e.g., un ami “a friend” vs. des amis “friends/some friends”). The singular/plural presentation order was crossed with the determiner conditions. For example, if the first presentation of the noun ours “bear” was the opposition l’ours versus les ours singular– plural, definite, the second presentation order was des ours versus un ours plural– singular, indefinite.)
Analyses of the correlations showed an effect of the singular/plural orientation of nouns for children in Age Group 1. The more often a noun is encountered in the plural form (e.g., *arbre* “tree”), the more the /z/ liaison following the plural determiner *deux* (e.g., in *deux arbres* [døzarbr] “two trees”) is correctly produced. Moreover, these plural-oriented nouns more often induced /z/ liaison errors after the determiner *un*. In other words, children were more likely to make errors such as *un zarbre* ([~/C27 zarbr]) in which the plural liaison consonant incorrectly surfaces after a singular determiner (*un*). The effect of the singular/plural orientation of nouns in the children’s productions was only marginally significant in Age Group 2, and no effect was observed for the oldest age group (Age Group 3).

Results of this production experiment are in line with the predictions of Chevrot and colleagues’ (2007, in press) model of liaison acquisition. Children of 3 and 4 years are sensitive to exemplar frequency. Therefore, they produce more correct liaisons in Word1–Word2 sequences consisting of a plural-oriented noun following a plural determiner, that is, sequences they hear frequently. Moreover, because the general schemata of first stage (*un + X*) provide no constraint on the nature of the exemplars that should follow Word1, high-frequency exemplars are also favored in unexpected contexts (e.g., [zarbr] is produced after *un*), resulting in replacement errors. But the productions of 5- and 6-year-olds no longer correlate with the noun’s number orientation. This latter result is also compatible with the two-stage model and illustrates the emergence of specified schemata of the type *un + nX* in which Word2 exemplars are constrained by Word1. When such specified schemata are operative, exemplar frequency should not influence production because the schema determines the form that ought to be produced. However, we assume that lexical units that were frequently produced (i.e., high-frequency exemplars) should remain more available in the lexicon. Consequently, for older children, there should be memory traces of the exemplars that frequently occurred in earlier productions. We tested this prediction in a perception experiment where 5- and 6-year-olds needed to monitor singular-oriented nouns (e.g., *arc-en-ciel* “rainbow”) and plural-oriented nouns (e.g., *indien* “Indian”) preceded by singular (*un*) or plural (*les*) determiners.

### Experiment 2

In the second experiment, children were asked to monitor target words in auditorily presented sentences. If we assume memory traces of high-frequency exemplars in the lexicon, those exemplars should be more easily available. Thus, we predicted that nouns that are more often encountered at the plural form (e.g., *indien* “Indians”) should be better detected after the plural determiner *les* (e.g., in *les indiens* [lezijdjɛ] “the Indians”) than after the singular determiner *un* (e.g., in *un indien* [ʊnidjɛ] “an/one Indian”). Indeed, in the sequence *les indiens*, the plural-oriented noun *indien* is activated by its more frequent /z/ exemplar [zidjɛ], whereas it is activated by its less frequent /n/ exemplar [nidjɛ] in the sequence *un indien*. Conversely, singular-oriented nouns (e.g., *arc-en-ciel* “rainbow”) should be better detected after the singular determiner *un* than after the plural determiner *les*.

### Method

#### Participants

Participants were 20 kindergarten children, all of whom were native speakers of French. Their average age was 5 years 10 months (range = 5 years 5 months to 6 years 3 months).

<table>
<thead>
<tr>
<th>Age group 1</th>
<th>Correlations between the orientation of the nouns and the orientation of the correct responses</th>
<th>Correlations between the orientation of the nouns and the orientation of the replacement errors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r = .775, p = .024 (n = 8)</td>
<td>r = .713, p = .047 (n = 8)</td>
</tr>
<tr>
<td>Age group 2</td>
<td>r = .666, p = .071 (n = 8)</td>
<td>r = .715, p = .071 (n = 7)</td>
</tr>
<tr>
<td>Age group 3</td>
<td>r = -.413, p = .309 (n = 8)</td>
<td>r = .485, p = .330 (n = 6)</td>
</tr>
</tbody>
</table>
Stimuli

The stimulus set was composed of 10 masculine vowel-initial target words. Of these, 5 were more frequent in the plural than in the singular (e.g., *indien* “Indian”), and the other 5 were more frequent in the singular than in the plural (e.g., *arc-en-ciel* “rainbow”). The singular/plural orientation of these targets was obtained by means of a pretest similar to that in Experiment 1 (with 70–104 adult native speakers of French, depending on the items).

Experimental trials. Targets were presented in their plural and singular forms. Because the singular/plural distinction is silent in the auditory modality, number is signaled by the determiner preceding the target (either *un* “a/one” or *les* “the”). Two carrier sentences were created for each target in the singular form (i.e., with the determiner *un*) and in the plural form (i.e., with the determiner *les*): one with the target occurring at the beginning of the sentence and the other with the target occurring later in the sentence. Hence, there were 40 experimental trials.

Filler trials. For target-present trials, 60 carrier sentences containing the targets were created so that targets were heard with preceding adjectives instead of determiners (e.g., *joli* “nice”, *petit* “little”, *super* “super”). For target-absent trials, 100 additional sentences were created. These sentences did not contain targets but did contain the determiners of the experimental trials (*un* and *les*) and the adjectives of the target-present fillers presented above (*joli*, *petit*, and *super*). Hence, 10 blocks of 20 sentences were created: one block for each target containing as many target-present trials as target-absent trials.

Procedure

Participants were tested individually at school in a quiet room. They were asked to detect a target word in a sentence. A picture of the target was first displayed at the center of a computer screen, and the children were asked to name it. This picture remained on the screen during the entire block. The spoken sentences were then presented auditorily at a comfortable sound level through headphones. The participants were instructed to press the response button as soon as they heard the target word or to do nothing if the target was not present. Response latencies were recorded. The experiment was controlled by E-Prime software. The target word remained the same during the entire block. Within each block, the 20 sentences appeared randomly. The order of blocks presentation was also randomized for each subject. The experiment began with two practice blocks of six sentences.

Results and discussion

Mean reaction times (RTs) from word onsets\(^2\) and standard deviations (SDs) for the targets presented in the two conditions are presented in Table 3. For experimental targets, there were 1.4% omissions (no response) collapsed across all conditions and 1% false alarms (participants responding before the targets) that were removed from the analyses. Moreover, RTs shorter than 250 ms, as well as RTs above and below 2 SDs were also removed, leading to the exclusion of 1.5% of the data. Altogether, a total of 3.9% of the data was removed from the analyses. The results were evaluated using two-way repeated-measures analyses of variance (ANOVA). The main factors were determiner type (singular *un* vs. plural *les*) and number orientation (plural oriented vs. singular oriented\(^2\)), both of which were within-participant factors.

Analyses of RTs revealed no main effect of determiner type, \(F(1, 19) = 1.4, \text{ns}, \eta^2 = .07\). The effect of the number orientation was marginally significant, \(F(1, 19) = 3.25, p = .084, \eta^2 = .15\). However, the interaction between these two factors was significant, \(F(1, 19) = 9.1, p < .01, \eta^2 = .32\). Planned comparisons showed shorter RTs for singular-oriented nouns when preceded by a singular determiner (798 ms) than when preceded by a plural determiner (889 ms), \(F(1, 19) = 6.74, p < .05, \eta^2 = .26\). Conversely, plural-oriented nouns were responded to faster when preceded by a plural determiner.

\(^2\) Because response latencies were recorded from the beginning of the sentences, cues were placed at the onset of target words as identified by visual inspection of the waveforms and spectrograms using Cool Edit Pro software (cue tagging was double checked by a professional phonetician). Reaction times were then computed by subtracting durations from beginnings until target onsets to responses latencies.
than when preceded by a singular determiner (911 ms), but this effect was only marginally significant, $F(1, 19) = 3.05, p < .09, \eta^2 = .14$. These results show that for singular-oriented words (e.g., âne "donkey"), /n/ exemplars (e.g., [nan]) are more available to the recognition system than are /z/ exemplars (e.g., [zan]), and that for plural-oriented words, /z/ exemplars are more available to the recognition system than are /n/ exemplars. Thus, a frequency effect can be evidenced for 5- and 6-year-olds even though frequency does not affect production at that age.

**General discussion**

In this study, we found that production (Experiment 1) and recognition (Experiment 2) of obligatory liaison sequences depended on the singular/plural orientation of nouns. We used singular/plural orientation of nouns as an indicator of liaison-initial exemplar frequency in children’s input. Our results showed that young children tended to produce high-frequency exemplars (e.g., zarbre) more often in both expected and unexpected contexts, resulting in correct liaisons (e.g., deux arbres [dɔzɑʁbr] “two trees”) and replacement errors (e.g., un zarbre [ɔzɑʁbr] “one tree”), respectively. The first stage of the liaison acquisition model accounts for these results because any exemplar can fill the slot X in the general schemata un + X or deux + X. Thus, frequent exemplars are favored. But for 5- and 6-year-olds, specified schemata of the type n + nX or deux + zX are operational. These schemata select exemplars following Word1s on the basis of their initial consonant and do not allow replacement errors. As a consequence, singular/plural orientation of nouns no longer influences liaison production at that age. However, 5- and 6-year-olds remain sensitive to singular/plural orientation of nouns in spoken language recognition. In a word monitoring experiment, they were faster at detecting high-frequency exemplars (e.g., indien [ɛ̃dɛ̃] “Indian”) than low-frequency ones (e.g., indien [ɛ̃dɛ̃]). This suggests that frequent lexical exemplars remain more available in the lexicon than do low-frequency ones even when they are no longer produced in the wrong context. Results of these two experiments are in accordance with the usage-based model in that they account for the simultaneous presence of multiple exemplars of the nouns and more abstract schemata in the lexicon (Chevrot et al., 2007; Chevrot et al., in press).

More precisely, the results of Experiment 1 allowed us to test competing predictions of the (generative) autosegmental model and of the exemplar-based model. In the exemplar-based model, the multiple lexical representation associated with the noun ours is the combination of a number of concrete sequences (/ûrs/, /ûn/). The phonetic material corresponding to the liaison consonants specifically belongs to these exemplars. In the autosegmental conception, children assign phonetic content to an abstract initial position either on the basis of context or by default (Wauquier-Gravelines & Braud, 2005). This phonetic content is not related to the lexical representation of the noun and does not belong to it. Our data show, however, that there is a relation between the phonetic nature of a child’s production of liaison before a specific noun and the frequency of the liaisons that precede this noun in the input. If the phonetic content of the liaison depends on the following noun, it is difficult to imagine that it starts with an abstract position with no phonetic content.

Our results rather support the view that young children memorize several exemplars of the same word starting with different liaison consonants and that frequency of exposure is central to the construction and availability of these exemplars. Thus, frequency appears to be an important issue during the first stage of the acquisition of liaison. Given that one liaison context occurs every 16 words in
adult speech (Boë & Tubach, 1992), the phenomenon is sufficiently frequent for children to identify regular patterns in its use. Moreover, research on word segmentation has shown that learners can use transitional probabilities between syllables to segment speech into word-like units. For example, Saffran, Aslin, and Newport (1996) established that the segmentation of words from running speech can be accomplished by 8-month-olds based solely on the statistical relationships between neighboring speech sounds. Statistical learning should be involved in exemplar formation, leading to the availability of the more frequent sound sequences encountered in the input.

During later stages of liaison acquisition, the emergence of specified schemata from the concrete memorized exemplars allows children to produce correct liaisons without memorizing all of the Word1–liaison consonant–Word2 sequences. Our results show that when such specified schemata are operative, exemplar frequency no longer influences production. Nevertheless, children kept memory traces of the exemplars that frequently occurred in earlier productions. Thus, our results support the idea of two stages during liaison acquisition, starting with the memorization of several exemplars of the same word, from which generalization occurs, by the emergence of more abstract schemata.

Acknowledgments

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Appendix

Material used in Experiments 1 and 2

<table>
<thead>
<tr>
<th>Target</th>
<th>Frequency at the singular form</th>
<th>Frequency at the plural form</th>
<th>Ratio toward the plural</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiment 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Oeil</em> “eye” (plural oriented)</td>
<td>278.51</td>
<td>955.74</td>
<td>.791</td>
</tr>
<tr>
<td><em>Oeuf</em> “egg” (plural oriented)</td>
<td>20.34</td>
<td>29.80</td>
<td>.741</td>
</tr>
<tr>
<td><em>Arbre</em> “tree” (plural oriented)</td>
<td>67.16</td>
<td>141.49</td>
<td>.604</td>
</tr>
<tr>
<td><em>Escargot</em> “snail” (plural oriented)</td>
<td>2.84</td>
<td>4.32</td>
<td>.536</td>
</tr>
<tr>
<td><em>Ours</em> “bear” (singular oriented)</td>
<td>Not available</td>
<td>Not available</td>
<td>.307</td>
</tr>
<tr>
<td><em>Éléphant</em> “elephant” (singular oriented)</td>
<td>8.92</td>
<td>6.01</td>
<td>.293</td>
</tr>
<tr>
<td><em>Avion</em> “airplane” (singular oriented)</td>
<td>46.82</td>
<td>31.22</td>
<td>.196</td>
</tr>
<tr>
<td><em>Ordinateur</em> “computer” (singular oriented)</td>
<td>2.30</td>
<td>1.96</td>
<td>.051</td>
</tr>
<tr>
<td><strong>Experiment 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Abricot</em> “apricot” (plural oriented)</td>
<td>1.15</td>
<td>1.35</td>
<td>.613</td>
</tr>
<tr>
<td><em>Indien</em> “Indian” (plural oriented)</td>
<td>0.47</td>
<td>3.65</td>
<td>.762</td>
</tr>
<tr>
<td><em>Ongle</em> “fingernail” (plural oriented)</td>
<td>10.14</td>
<td>35.34</td>
<td>.746</td>
</tr>
<tr>
<td><em>Oiseau</em> “bird” (plural oriented)</td>
<td>47.97</td>
<td>65.14</td>
<td>.667</td>
</tr>
<tr>
<td><em>Enfant</em> “child” (plural oriented)</td>
<td>382.23</td>
<td>343.92</td>
<td>.803</td>
</tr>
<tr>
<td><em>Arrosoir</em> “watering can” (singular oriented)</td>
<td>3.04</td>
<td>0.54</td>
<td>.078</td>
</tr>
<tr>
<td><em>Ane</em> “donkey” (singular oriented)</td>
<td>14.32</td>
<td>4.32</td>
<td>.137</td>
</tr>
<tr>
<td><em>Ange</em> “angel” (singular oriented)</td>
<td>21.62</td>
<td>20.88</td>
<td>.413</td>
</tr>
<tr>
<td><em>Arc-en-ciel</em> “rainbow” (singular oriented)</td>
<td>4.39</td>
<td>0.54</td>
<td>.036</td>
</tr>
<tr>
<td><em>Avion</em> “airplane” (singular oriented)</td>
<td>46.82</td>
<td>31.22</td>
<td>.196</td>
</tr>
</tbody>
</table>

Note. Ratios toward the plural were calculated in this way: number of plural choices/(number of plural choices + number of singular choices). They are given by the pretests (a ratio close to 1 indicates that an item is judged to be plural oriented). Frequencies (occurrences per million) given by the French database Lexique (New, Pallier, Ferrand, & Matos, 2001) confirm the singular/plural orientations obtained by the ratios except for one item in Experiment 2 (enfant).
References


