Journal of Experimental Child Psychology 105 (2010) 359–375

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

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

Reading development in agglutinative languages: Evidence from beginning, intermediate, and adult Basque readers

Joana Acha [a,*], Itziar Laka [b], Manuel Perea [a]

[a] Departamento de Metodología, Facultad de Psicología, Universitat de Valencia, 46010 Valencia, Spain
[b] Departamento de Lingüística y Estudios Vascos, Universidad del País Vasco, 01006 Vitoria-Gasteiz, Spain

ARTICLE INFO

Article history:
Received 25 June 2009
Revised 27 October 2009
Available online 8 December 2009

Keywords:
Word recognition
Reading development
Orthographic representation
Inflectional morphology
Agglutination
Lexical access

ABSTRACT

Do typological properties of language, such as agglutination (i.e., the morphological process of adding affixes to the lexeme of a word), have an impact on the development of visual word recognition? To answer this question, we carried out an experiment in which beginning, intermediate, and adult Basque readers ($n = 32$ each, average age = 7, 11, and 22 years, respectively) needed to read correctly versus incorrectly inflected words embedded in sentences. Half of the targets contained high-frequency stems, and the other half contained low-frequency stems. To each stem, four inflections of different lengths were attached (*-a*, *-ari*, *-aren*, and *-arentzat*, i.e., inflectional sequences). To test whether the process of word recognition was modulated by the knowledge of word structure in the language, half of the participants' native language was Basque and the other half's native language was Spanish. Children showed robust effects of frequency and length of inflection that diminished with age. In addition, the effect of length of inflection was modulated by the frequency of the stem and by the native language. Taken together, these results suggest that word recognition develops from a decoding strategy to a direct lexical access strategy and that this process is modulated by children's knowledge of the inflectional structure of words from the beginning of their reading experience.

* Corresponding author. Fax: +34 963 864697.
E-mail address: amorjo@valencia.edu (J. Acha).

0022-0965/$ - see front matter © 2009 Elsevier Inc. All rights reserved.
doi:10.1016/j.jecp.2009.10.008

Introduction

Visual word recognition is one of the key processes involved in successful reading. Although this skill demands little effort in adult readers, it is not a natural ability and requires learning several skills (e.g., phonological awareness, letter identification) that finally lead to accurate and fluent reading. Therefore, fluent reading usually comes after a long period of extensive practice (La Berge & Samuels, 1974; Tan & Nicholson, 1997). Previous studies have shown that this period is considerably short in transparent orthographies such as German, Italian, and Greek, where learning the regularities of the orthography becomes relatively easy due to the unambiguous grapheme–phoneme correspondence (see Landerl, Wimmer, & Frith, 1997). However, to our knowledge, there are no published studies that have focused on how word recognition processes develop in orthographically transparent languages that have agglutinative morphology, such as Turkish and Basque (languages in which syntactic phrases tend to constitute words formed by stacking functional morphemes to the end of a stem). Due to the agglutinative nature of these languages (see Durgunôglu, 2006), readers need to deal with rather long words (e.g., Basque *mutil-a-ren-gana-ko-a-ri* [boy-det-gen-toward-rel-det-dat], "to the one toward the boy"). In the current experiment, we examined the development of Basque inflected word recognition in beginning, intermediate, and adult readers who were receiving school instruction in Basque language. Due to the coexistence of Basque and Spanish languages (transparent agglutinative and transparent nonagglutinative, respectively) in the Basque Country in Spain, we explored whether the way lexical access is achieved is modulated by the typological properties of the language's morphology by comparing the reading behaviors of children who differed in their proficiency on Basque morphology.

According to most theories of reading, learning to decode words is a basic step in word recognition (Perfetti & Lesgold, 1977). When children start learning to read, they map graphemes onto phonemes to read new words (phonetic–alphabetic reading stage [Ehri, 1995]). During this stage, children acquire knowledge about specific letter identities and their corresponding sounds (Frith, 1985). Thus, decoding words becomes the first reading strategy used by children in alphabetic languages, requiring them to phonologically recode from print to sound unfamiliar words that conform to regular grapheme–phoneme correspondences. However, to be fluent readers, children still need to become aware of the regularities of their own language (see Share, 1995) and recurring letter patterns need to be consolidated with reading experience. This is possible through a reciprocal interaction between orthography and phonology (Landerl, Frith, & Wimmer, 1996): Children learn to link orthographic information to the phonemes they know, but they also learn to use their phonological knowledge to extract and retrieve orthographic regularities in their writing system. This way, children develop from the recognition of small units to larger units until complete words are represented in the lexicon (Duncan, Seymour, & Hill, 2000). At this stage (consolidated alphabetic stage [Ehri, 1995; but see Beech, 2005; Frith, 1985]), children are able to read words automatically—fast and accurately—without great effort. The main sources of concern about this process involve two questions. First, at what age is automatic word recognition attained in languages with transparent orthographies? Second, to what extent does the internal structure of words influence the way automatic reading is achieved in these languages?

Recent work in the area of reading development indicates that consistent and transparent orthographies pose few constraints to reach the alphabetic stage (see Rack, Snowling, & Olson, 1992; Ziegler & Goswami, 2005). In transparent orthographies, rapid and accurate reading is achieved from 5 to 7 years of age depending on the level of consistency and teaching method (Ziegler & Goswami, 2005). The logic behind this is that in languages with transparent orthographies (e.g., German, Turkish, Greek), children may learn grapheme–phoneme rules without great difficulty (Wimmer, 1993). Thus, it seems clear that the age when automatic reading is achieved depends on the consistency with which the alphabet represents phonemes by means of graphemes (Aro & Wimmer, 2003; Wimmer & Goswami, 1994). For example, German children are able to read words and nonwords without difficulty in first grade (approximately 6 years of age), so that they reach the ceiling of competent reading relatively quickly (Wimmer, Mayringer, & Landerl, 2000). This also occurs at a very early age (approximately 6 years) in Spanish readers, although precise control of lexical information is achieved later

(approximately 9 years) when children retain regularities in their memory and make analogies to discriminate them (Sebastián-Gallés & Parreño-Vacchiano, 1995). At that age, skilled readers are able to alternate the decoding strategy with automatic access to the lexicon depending on the demands of the orthography (Acha & Perea, 2008; Arduino & Burani, 2004).

There are two consistent effects that have been used to examine the development of reading strategies during word recognition: the effects of frequency and length. The effect of frequency refers to the fact that low-frequency words are read more slowly than high-frequency words; therefore, it is a good indicator of word identification processes (Howes & Solomon, 1951). As one might expect, this effect is greater when familiar words are strongly represented in the lexicon. Previous studies have shown that the effect of word frequency is very robust when children begin reading instruction in both transparent orthographies (Alegría & Mousty, 1996) and opaque orthographies (Ellis, 2002). In other words, children become more sensitive to frequent words than to infrequent words when they start being exposed to written vocabulary, presumably because they are exposed to frequent words first. The effect of length implies that long words are read more slowly than short words, and it indicates the extent to which the decoding strategy is being used. Developmental studies have shown that this effect decreases with age, reflecting a change from a letter-by-letter reading strategy to an automatic word activation strategy (Bijeljac-Babic, Millogo, Farioli, & Grainger, 2004). In addition, this effect is particularly strong in children from a transparent orthography such as Spanish due to the extremely consistent grapheme–phoneme correspondence (Acha & Perea, 2008). Thus, the effects of frequency and length are reliable markers for the development of word identification processes and for the reliance on grapheme–phoneme correspondences during reading, respectively.

The second question concerns the way automatic reading is achieved and, more specifically, whether the internal structure of words modulates this process. There is empirical evidence showing that early awareness of how words are built in a language is related to the ability to recognize word constituents automatically (Goswami, 1993, 1995). The reason behind this is that early knowledge about word structure in a language helps to establish word-specific orthographic representations (Liberman, Shankweiler, Liberman, Fowler, & Fisher, 1977; Share & Stanovich, 1995). This might be the reason why English children are highly sensitive to rhymes (Bruck & Treiman, 1992), whereas Spanish children are more sensitive to syllables (Carreiras, Álvarez, & de Vega, 1993; Jiménez & Ortiz, 2000). The question is whether something similar to this occurs in agglutinative languages, where words are very often composed of a stem with one or several morphemes attached to it. Thus, the development of word recognition processes should be different in languages that share the same characteristics of transparency and consistency but differ in the typological properties of their morphology. This is the case with Spanish and Basque, two languages that coexist in the Basque Country. Both languages have extremely transparent and regular orthographies; the only relevant difference is that Basque is an agglutinative language, whereas Spanish is not.

One of the main differences between Basque and Spanish (concerning both syntax and word structure) is related to the position and nature of head phrases. In Basque the head appears at the end of the phrase (i.e., it is a head-final language), whereas in Spanish the head occurs at the beginning of the phrase (i.e., it is a head-initial language). What we should note here is that in (head-final) agglutinative languages, the heads of phrases are word-final morphemes. For instance, the equivalent of the Spanish prepositional phrase *a la mujer* [$_{PP}$a [$_{DP}$ la [$_{NP}$ mujer]]] (“to the woman”) is a postpositional phrase in Basque, *emakume-a-ri* [[[emakume $_{NP}$] a $_{DP}$] ri $_{PP}$], with identical structure but reverse order of heads in the phrase. In Spanish, the words *a* and *la* are free-standing words, whereas the Basque equivalents are bound morphemes (see De Rijk, 2007; Hualde & Ortiz de Urbina, 2003, and Laka, 1996, for further details on the morphology and syntax of Basque).

Consequently, in a language such as Spanish, the morphological structure of a given word hardly ever changes depending on the phrase it belongs to or its function in the sentence, so that once a word has been stored in the lexicon, little effort will be needed to retrieve it. In Basque, in contrast, most functional words are morphemes stacked at the end of the stem, and this can produce words of considerable length that constitute whole phrases. For example, the Basque equivalent of the English prepositional phrase “toward the boy” is the phonological/orthographic word *mutilarengana*, which is built by stacking after the noun *mutil* (“boy”) the following functional elements: *-a*, the genitive postposition *-ren*, and the directional postposition for animates *-gana* (“toward”). As seen, a single

word in Basque agglutinates several meaningful grammatical components that in Spanish—and other nonagglutinative languages—constitute distinct words. Hence, Basque children might learn to pay attention to the ends of words for efficient reading, and this fact could modulate the development of the strategies used by children to recognize words in this language.

Previous evidence from orthographically transparent agglutinative languages shows that already during the first years of school, children learn to be sensitive to word-final elements in their language. Finnish and Turkish children decode complex pseudowords accurately very early (Öney & Durgunôglu, 1997) and learn to pay special attention to the ends of words, becoming very sensitive to word-end phoneme–grapheme manipulations (Durgunôglu et al., 2002). This sensitiveness could mediate the progression from decoding to automatic reading. For example, Finnish 7-year-olds use the grapheme–phoneme correspondences to read Finnish words during their first school year (Holopainen, Ahonen, & Lyytinen, 2002). However, in third grade (approximately 8 years of age), they are able to read morphologically complex words better and faster than monomorphemic words, particularly when the words involve a high-frequency stem (Bertram, Laine, & Virkkala, 2000). This pattern is also observed in sixth graders (approximately 12 years of age). These findings suggest that Finnish readers learn to recognize the morphemic structure of the words in their language through the recognition of their constituent stems and morphemes (see also Freyd & Baron, 1982). In addition, Lyytinen and Lyytinen (2004) showed that Finnish children who had problems with morphemic identification during their early years of reading instruction had a greater risk of dyslexia in the future. The authors claimed that in agglutinative languages, morphological discrimination could be a better detector of reading impairments than simple vocabulary reading.

However, there are some limitations concerning the above-mentioned studies. First, these results are based on naming or writing tasks. We believe that to explore the early identification of word constituents during word recognition, another kind of procedure is necessary if we are to provide an accurate measure capable of calculating slight differences across ages. For instance, there is evidence that the lexical decision task can capture early morpheme activation during word recognition, at least for derivational morphology (Duñabeitia, Perea, & Carreiras, 2007). This suggests that a morphological detection mechanism operates very early in the word identification process of adult Basque readers. Second, most studies have focused on the development of derivational morphology only, leaving inflectional morphology aside. Possibly the greater complexity of inflectional morphology can account for this; inflectional morphology encodes grammatical structure and displays much greater cross-linguistic variation than derivational morphology. In this case, presenting words in isolation has not provided as clear evidence as derivational morphology. In some experiments conducted with English and Serbo-Croatian adults using the lexical decision task, Katz, Rexer, and Lukatela (1991) observed that a prime consisting of the stem of an inflected word did not facilitate the recognition of that word, whereas Pastizzo and Feldman (2004) found that the morphological relatedness of prime and target produced facilitation regardless of whether the prime was the stem or the morpheme (see Feldman, 1991). Although evidence is scarce and inconclusive, these results support the idea that morphological knowledge is somehow represented in the orthographic lexicon of adult readers. This evidence is in line with some recent models that account for morphemic decomposition during word identification. According to full parsing reading models (Taft, 1994; Taft & Forster, 1975), there is a differential recognition of word stems and morphemes during word identification. This procedure implies the fast recognition of the stem and the morpheme, and it entails a stem + morpheme representation in the lexicon. Hence, word recognition implies two different processing levels that occur automatically: first recognition of the word's constituents and then assembly of these constituents in the lexicon (see Taft, 2004).

In sum, the empirical evidence suggests that adult readers can automatically recognize word stems and word inflections during word identification. However, more research is needed to clarify how this stage is reached. The current experiment focused on the role of inflectional morphology in reading development. More specifically, we examined whether children who learn to read in an agglutinative language such as Basque develop from decoding words to automatically identify word constituents in terms of their morphological complexity. Given that in inflectional morphology the morphemes determine the type of syntactic constituent the stem belongs to and its role in the sentence, we presented inflected words inside a sentence rather than in isolation (see McKoon & Ratcliff, 2007). To examine

the development of stem identification, the frequency of the word stem was manipulated. To examine which reading strategy is used (letter by letter or automatic), four inflected forms of different lengths were added to the same word stem and reading times were compared across ages. To test the level of inflection discrimination, inflections were incorrectly written in half of the cases (by letter substitution at a boundary). The logic behind this is that if children can discriminate real inflections, reading times of correctly inflected words will be much shorter than those of incorrectly inflected words. On the contrary, if words are decoded using the mapping strategy, the reading time difference between correctly and incorrectly inflected words will be very small.

Finally, to test whether early knowledge of the word structure in the language modulates this process, we compared the reading behavior of children receiving Basque school instruction whose native language is Basque with that of children receiving Basque school instruction whose native language is Spanish. If the process of learning to read in agglutinative languages is modulated by the sensitivity to the morphological structure of words in Basque, beginning readers who are also native Basque speakers should show a different developmental pattern (inflection discrimination and sensitivity to frequency) from that of native Spanish speakers.

Method

Participants

The participants were 32 third graders (beginning readers, 18 girls and 14 boys, mean age = 7 years), 32 sixth graders (intermediate readers, 19 girls and 13 boys, mean age = 11 years), and 32 college students from the University of the Basque Country (adult readers, 21 women and 11 men, mean age = 20 years). The children came from average socioeconomic backgrounds and from three public schools in urban areas of the Basque Country. For all individuals, the test took place at the beginning of the academic year. All participants had normal or corrected to normal vision. All children received school instruction and were taught to read in Basque language using a phonics-based approach. However, half of the participants' native language was Basque (L1–Basque group), and the remaining participants' mother language was Spanish (L1–Spanish group) (16 participants in each group). Children in both groups started school at 3 years of age. That was the first contact of children in the L1–Spanish group with Basque language. We obtained a teacher report about each child according to which (a) all children had a normal reading level in both Basque and Spanish so far as accuracy was concerned, (b) children in the L1–Basque group spoke only Basque at home, and (c) children in the L1–Spanish group spoke only Spanish at home but were proficient with Basque in class. Individuals were excluded if they had sensory, acquired neurological, or other problems traditionally used as exclusionary criteria for learning disabilities.

Materials

The targets were 56 Basque words of 4 to 6 letters (mean number of letters = 4.9). These words were divided into two groups as a function of frequency: low-frequency words (mean word frequency per 1 million words = 3.66, range = 0.82–6.58) and high-frequency words (mean word frequency per 1 million words = 183.56, range = 47.73–392.55) in the Basque database (Perea et al., 2006). The mean number of "orthographic neighbors" was highly similar in both groups (Coltheart's *N*s = 2.6 and 2.8 for low- and high-frequency words, respectively, $p > .10$), as was the mean frequency (per 1 million words) of the orthographic neighbors (35.9 and 34.1). Low- and high-frequency words were also equated in mean log bigram frequency (1.9 and 2.1, respectively, $p > .10$), length (4.9 and 4.9), and orthographic structure. To examine the influence of the inflected forms on reading, four sentence frames were created for each word as four inflectional forms were examined: *-a*, *-ari*, *-aren*, and *-arentzat* ("the," "to the," "of the," and "for the," respectively). Bear in mind that although only the detection time for the target word was to be examined, no inflected word was presented in isolation, particularly when readers needed to detect whether it was a real or wrong inflected form. All sentence frames in each inflected condition were similar in length (34, 41, 42, and 42 characters long for the *-a*, *-ari*, *-aren*,

and *-arentzat* conditions, respectively) and number of words (4–6 words, mean length = 5) but were different with respect to the type of phrase and meaning. This way, the same target word/stem appeared in four different inflected forms across the four sentence frames (e.g., *etxe**a***, *etxe**ari***, *etxe**aren***, and *etxe**arentzat*** [“the house,” “to the house,” “of the house,” and “for the house,” respectively]). With the purpose of examining the level of discrimination of the inflected forms and to ensure that children were actually reading the target words, 56 wrong (nonexisting) inflected forms were created from the target items (*etxe**n***, *etxe**ami***, *etxe**afen***, and *etxe**alentzat***) and, hence, another 56 sentence frames. The incorrectly written item was identical to the correct one save for the substitution of one letter in the boundary of the inflected form. This substitution always created a nonexisting inflected word. Correct and incorrect targets were counterbalanced across the two sentence frames and across the four inflected conditions. This way, each participant needed to read a total of 112 sentences. Four lists of materials were constructed so that each target appeared once in each list. This way, participants could see all of the correct and incorrect targets in all of the inflected forms. Readers could not predict the inflection from the already presented part of the sentence (only subjects [e.g., *mum*] or place adverbs [e.g., *here*] were presented before the target word). All target words and the sentences in which they were embedded are presented in Appendix.

Procedure

Participants were tested individually in a quiet room. The experiment was run using DMDX (Forster & Forster, 2003). The sentences were displayed on the screen of a PC computer. For the purposes of this experiment, we always divided the sentence into four phrases (see Fig. 1), and one of them always corresponded to the inflected word. We used a self-paced reading task in which reading times were measured for different phrases in the sentence (see McKoon & Ratcliff, 2007). The reason for using this task, even though it may provide longer reading times than a lexical decision task, was the direct link between inflectional morphology and head-final grammars typical of agglutinative languages. This task has proved to be practical in situations where there is a well-defined part–whole relationship (see Tanenhaus & Lucas, 1987) such as the lexical–syntactical one in this case. Bear in mind that the main issue here is testing whether any difference across ages and between groups, if found, reflects a different sensitivity toward the agglutinative nature of the language—reflected in the inflectional structure of words—more than whether these effects are pre- or postlexical.

On each trial, a fixation point (+) was presented for 500 ms on the left side of the screen. Next, the first part of the sentence appeared, followed by a row of hash marks in place of each missing letter. After reading the first part, participants needed to press a button in the center of the keyboard (V, yellow colored) to access the next part, and this procedure was repeated until the whole sentence was read. When pressing the last key button, two events appeared separated on the screen: the word “right” on the right side and the word “wrong” on the left side. Participants needed to decide whether the inflected word was right or wrong. To choose “right,” participants needed to press a key located on the right side of the keyboard (either B, N, or M, green colored). To choose “wrong,” participants

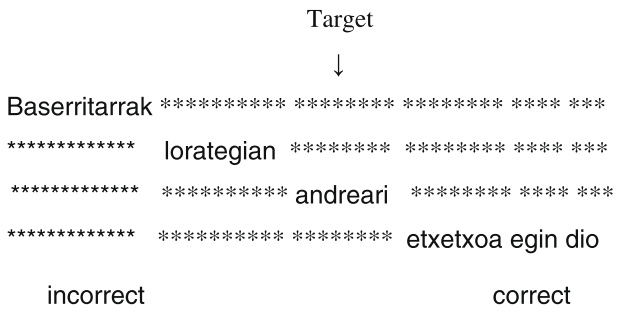

Fig. 1. Example of the sequence for stimulus presentation in the experiment.

needed to press a key located on the left side of the keyboard (either Z, X, or C, red colored). This way, not only reading times of the target words were measured, but also percentages of error made in the detection of whether the inflected form was correct or not were measured. When the key was pressed, the clock stopped measuring the response time and a new sentence appeared, repeating the entire procedure. Each stimulus remained on the screen for 4000 ms. If no key was pressed, the next stimulus appeared automatically. Participants were instructed to read each part of the sentence as fast, but also as carefully, as possible because the exercise consisted of making the decision of whether the inflected form was right or wrong as quickly, and as accurately, as possible. Hence, rapid word detection, and not comprehension, was triggered. Each participant received a different order of trials. Each participant received a total of 120 trials: 8 practice trials (with the same manipulation as in the experimental trials) and then 112 experimental trials. The whole session lasted approximately 25 min.

Results

Incorrect responses and reaction times less than 250 ms or greater than 3000 ms (<1%) were excluded from the latency analysis. Analyses of variance (ANOVAs) based on participants' mean correct response latencies and error rates were conducted based on a 2 (Detection Type: correctly or incorrectly inflected word) × 2 (Frequency: frequent or infrequent word) × 4 (Type of Inflection: *-a*, *-ari*, *-aren*, or *-arentzat*) design. List (1, 2, 3, or 4), mother language (L1–Basque or L1–Spanish), and grade (third grade, sixth grade, or college) were included as between-participant factors. List was included as a dummy variable in the ANOVAs to extract the variance due to the error associated with the lists (Pollatsek & Well, 1995). To maximize the reliability of the effects between groups, *z* scores for participants were calculated (see Faust, Balota, Spieler, & Ferraro, 1999, for a similar procedure). The mean latencies for correct responses and the percentages of error are presented in Table 1. All significant values had *p* values less than the .05 level.

The latency analysis showed a main effect of correctly inflected word detection (overall, correctly inflected words were read 259 ms faster than incorrectly inflected words), $F(1, 72) = 319.66$, $MSE = 0.46$, $\eta^2 = .81$, a main effect of word frequency (frequent words were read 283 ms faster than infrequent words), $F(1, 72) = 192.50$, $MSE = 0.30$, $\eta^2 = .72$, and a main effect of type of inflection, $F(3, 216) = 339.75$, $MSE = 0.34$, $\eta^2 = .82$, reflecting a positive linear trend across inflections. Reading times were higher when the inflection was longer (1363, 1644, 1668, and 1894 ms for the inflections *-a*, *-ari*, *-aren*, and *-arentzat*, respectively). Significant two-way interactions were found between grade and frequency (frequent words were read 156 ms faster by beginning readers, 173 ms faster by intermediate readers, and 26 ms faster by adult readers), $F(2, 72) = 15.93$, $MSE = 0.30$, $\eta^2 = .31$, and between

Table 1
Mean reading times (in milliseconds) and percentages of error for type of detection and word frequency conditions in L1–Basque and L1–Spanish beginning, intermediate, and skilled readers.

	Type of detection		Word frequency	
	Wrong	Right	Low	High
Beginning				
L1–Basque	2572 (19.6)	2010 (17.5)	2438 (20.6)	2144 (16.5)
L1–Spanish	2581 (27.2)	2271 (30.3)	2434 (30.0)	2416 (27.2)
Reading cost	24	261	−4	272
Intermediate				
L1–Basque	2194 (15.0)	1795 (17.6)	2090 (18.5)	1899 (14.1)
L1–Spanish	2205 (18.2)	2018 (22.7)	2190 (23.8)	2034 (17.1)
Reading cost	11	223	100	135
Skilled				
L1–Basque	528 (5.1)	475 (2.9)	517 (4.2)	486 (3.9)
L1–Spanish	534 (4.8)	488 (3.0)	521 (4.4)	500 (3.4)
Reading cost	13	16	14	4

Note. Percentages of error are in parentheses.

mother language and frequency (the effect of frequency was 172 ms in the L1–Basque group and 61 ms in the L1–Spanish group), $F(2, 72) = 10.58$, $MSE = 0.30$, $\eta^2 = .14$.

In addition, the three-way interaction among grade, mother language, and correctly detected word inflection was significant, $F(2, 72) = 3.57$, $MSE = 0.46$, $\eta^2 = .11$. This interaction revealed that L1–Basque third graders recognized correctly inflected words much faster than L1–Spanish third graders (562 vs. 310 ms, respectively), $F(1, 24) = 5.29$, $MSE = 141{,}872.2$, $\eta^2 = .18$, whereas this difference decreased considerably among sixth graders (399 vs. 187 ms), $p = .13$, $\eta^2 = .09$, and vanished among college students (53 vs. 46 ms), $p = .89$, $\eta^2 = .001$. But more interesting, a significant three-way interaction was found among grade, frequency, and type of inflection, $F(9, 216) = 3.85$, $MSE = 0.29$, $\eta^2 = .10$ (see Table 2). In third grade, the frequency effect for words containing the shortest inflection was much greater than for words containing the longest inflection (263 vs. 66 ms frequency effect for *-a* vs. *-arentzat* inflected words, respectively), $F(3, 72) = 172.85$, $MSE = 65{,}668.7$, $\eta^2 = .74$, whereas this difference decreased with reading experience (193 vs. 105 ms in sixth grade and 31 vs. 18 ms in college), $F(3, 72) = 169.84$, $MSE = 86{,}164.7$, $\eta^2 = .20$, and $F(3, 72) = 5.71$, $MSE = 5625.2$, $\eta^2 = .16$.

The ANOVA on the error data showed a main effect of word frequency (the error detection rate was lower for frequent words than for infrequent words, 16.9 and 13.7%, respectively), $F(1, 72) = 29.13$, $MSE = 135.5$, $\eta^2 = .29$, and a main effect of type of inflection (the error rate was greater for the longer inflections than for the shorter inflections, 13, 14, 14, and 18% for the inflections *-a*, *-ari*, *-aren*, and *-arentzat*, respectively), $F(3, 216) = 9.92$, $MSE = 175.8$, $\eta^2 = .12$. In addition, an interaction between frequency and grade was observed, $F(2, 72) = 6.50$, $MSE = 135.5$, $\eta^2 = .15$, reflecting that both beginning and intermediate readers made more errors in infrequent words than in more frequent words (25.5 vs. 21.5% and 21 vs. 15.5%, respectively), $F(1, 24) = 13.53$, $MSE = 125.6$, $\eta^2 = .22$, and $F(1, 24) = 18.23$, $MSE = 218.76$, $\eta^2 = .40$, but adults did not (4.3 vs. 3.6%), $F < 1$. Type of inflection also interacted with grade, $F(6, 216) = 2.93$, $MSE = 175.8$, $\eta^2 = .096$. Beginning readers made more errors in the words containing the longest inflection (22.1, 22.1, 23.9, and 26.6% for the inflections *-a*, *-ari*, *-aren*, and *-arentzat*, respectively), $F(3, 72) = 2.77$, $MSE = 216.35$, $\eta^2 = .13$, as did intermediate readers (14.1, 17.5, 17.9, and 23.9%), $F(3, 72) = 9.10$, $MSE = 231.60$, $\eta^2 = .36$. This difference vanished in skilled adult readers (3.7, 4.4, 3.0, and 4.5%), $F < 1$.

Table 2
Mean reading times (in milliseconds) and percentages of error for each type of inflection in L1–Basque and L1–Spanish beginning, intermediate, and skilled readers.

		Type of inflection			
		-a	*-ari*	*-aren*	*-arentzat*
Beginning					
L1–Basque	LF	2097 (23.3)	2457 (18.9)	2490 (18.2)	2743 (21.9)
	HF	1814 (15.6)	2132 (16.3)	2276 (18.2)	2415 (15.8)
		283	325	214	328
L1–Spanish	LF	2114 (28.1)	2451 (25.4)	2476 (32.8)	2725 (35.0)
	HF	1871 (21.2)	2443 (27.6)	2470 (26.3)	2921 (33.6)
		243	8	6	−196
Intermediate					
L1–Basque	LF	1644 (14.6)	2128 (18.5)	2118 (19.1)	2471 (21.7)
	HF	1476 (9.1)	1915 (13.7)	1919 (12.8)	2286 (20.8)
		168	213	199	185
L1–Spanish	LF	1806 (19.0)	2186 (23.4)	2222 (23.8)	2546 (29.0)
	HF	1588 (13.8)	1999 (14.5)	2026 (16.0)	2522 (24.0)
		218	187	196	24
Skilled					
L1–Basque	LF	499 (4.2)	507 (4.2)	530 (2.9)	529 (4.4)
	HF	469 (2.6)	484 (5.8)	490 (2.7)	502 (4.7)
		30	23	40	27
L1–Spanish	LF	507 (5.1)	522 (4.3)	520 (4.0)	539 (4.2)
	HF	474 (2.5)	500 (3.8)	496 (2.5)	531 (4.7)
		33	22	24	8

Note. Percentages of error are in parentheses. LF, low frequency; HF, high frequency.

In sum, the effects of word frequency and type of inflection were modulated by age. Interestingly, the magnitude of the effects decreased with age. First, the effect of type of inflection was modulated by word frequency across ages; young children read frequent words easier than infrequent words when these entailed short inflections, whereas this effect softened with time so long as both stem and inflection were recognized more automatically (intermediate and skilled readers). Second, the manner in which correctly inflected words were detected across ages was modulated by the native language. L1–Basque third graders recognized inflected words faster and were able to detect whether the inflected words were correct or incorrect more rapidly than their L1–Spanish counterparts, although this difference between groups tended to diminish with age. The fact that the difference between the L1–Basque and L1–Spanish groups was found only in third graders is of particular interest because it implies that as vocabulary increases, the differences between both groups—at least at the word identification level—tend to vanish.

A similar pattern was observed in the error rates; the percentage of errors for infrequent words decreased as reading proficiency increased. In addition, the longer the inflection, the greater the error rate in beginning and intermediate readers but not in adult readers. These findings are considered in more detail in the Discussion section.

Discussion

The main findings of the current experiment can be summarized as follows. First, we found robust effects of word frequency and type of inflection that decreased with reading age, nearly vanishing in adult readers. Second, the effect of type of inflection was modulated by the effect of word frequency (i.e., identification of inflection was modulated by the way word stem identification processes evolved). Third, the time needed to detect that an inflected word was correctly written also decreased with age. Fourth, this discrimination cost was high for beginning readers, particularly those who were not reading in their native language.

The current experiment confirms and extends the results obtained in recent developmental studies about the effects of frequency and length in word identification tasks (Acha & Perea, 2008; Alegría & Mousty, 1996; Bijeljac-Babic et al., 2004). As in other transparent languages, word identification is easier (a vanishing word frequency effect) and more automatic (a vanishing effect of type of inflection) for intermediate and adult readers. The robust word frequency effect found in beginning readers, which shows that young children have started storing words in their lexicon, decreased as children were exposed to more vocabulary. Nonetheless, this effect was very small in adult readers, who were already able to easily recognize both frequent and infrequent words. Along the same line, reading long inflected words implied a greater cost for young children (who read applying conversion rules) than for intermediate readers (who seemed to have already stored some basic orthographic regularities). This effect also decreased dramatically in adult readers. This finding is consistent with the view that 7-year-olds who learn to read Basque—like those who learn to read Spanish—use the decoding strategy primarily, but also with the view that the development of the ability to access words directly from the lexicon and to alternate both strategies during reading emerges during a short period of time (Duncan, Seymour, & Hill, 1997; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001). The greatest changes in the lexical system take place from 7 to 10 years of age, and after that period the reading patterns are more stable (Wimmer, 1993, 1996).

The particularity in this experiment stems from the fact that Basque is an agglutinative language and, interestingly, the current data strongly suggest that the identification of the word's inflection modulates the frequency effect; that is, the word stem identification is influenced by the "strength" with which inflections and stems are represented in the lexicon. For the interpretation of this finding, two observations are relevant. First, the evolution of the frequency and type of inflection effects offers converging evidence that third graders rely on grapheme–phoneme correspondences and that they use conversion rules as the main reading strategy (see also Acha & Perea, 2008). However, in line with Bertram and colleagues (2000), our results also show that these children are able to identify frequent word stems quickly when these are followed by easily identified inflections (the inflectional

morphemes *-a* ["the"] and *-ari* ["to the"] are among those that children learn first [see Ezeizabarrena, 1996]). Second, when the same frequent stem is followed by a long and unknown inflection, the decoding strategy is used. This finding suggests that children do not read inflected words by using the decoding strategy alone or by activating only the whole word. The implication of this finding is clear-cut. The identification of certain stems allows extracting information about inflections and vice versa. Thus, both reading strategies go hand in hand in the progression toward the identification of the word constituents in agglutinative languages that are stored progressively on a stem inflection feedback basis. This result confirms that although the decoding strategy is on the basis of reading in transparent languages, the type and size of "word chunks" that children learn to represent in their lexicon depends on the characteristics and structure of the words in their language (see Ziegler & Goswami, 2005).

Thus, children in agglutinative languages make use of the orthographic knowledge resulting from reading experience to develop a complete lexical system in which not only words but also inflectional morphemes seem to be fully represented and retrieved. The forthcoming question is whether the ability to identify the words' inflection during reading arises even earlier in 7-year-olds. The effect of correct inflection detection (i.e., the time needed to detect that the inflected word is correct compared with the time needed to detect that the inflection is incorrect) was robust in beginning, intermediate, and adult readers. In addition, this detection cost seemed to hold for children irrespective of stem frequency and length of inflection. This can be taken as evidence in favor of a tendency to identify inflections as autonomous reading units, and that is just what happens with other kinds of morphological units (Waksler, 1999). Basque readers are aware of the word constituents in their language from third grade onward, and they are able to identify both stem and inflection very quickly when given the chance (correctly written inflection). However, when one letter in the boundary of the inflection is modified, the reading strategy changes, as reflected in the reading cost (when this occurs, the inflection must be analyzed letter by letter). This result is in line with previous findings in Finnish and Turkish. Readers in agglutinative languages focus their attention on word endings when searching for "salient" cues and make fast and fine discriminations at word boundaries (Durgunôglu & Öney, 1999; Lyytinen, Leinonen, Nikula, Aro, & Leiwo, 1995).

These results can be accounted for by the multilevel interactive activation model of Taft (1991, 1994). In this model, morphemes are treated separately from their stems and activation across different units is spread hierarchically. The first level of activation is composed of graphemes and phonemes, the second level is composed of bodies and rhymes, and the third level is composed of morphemes until the word unit level is reached. Activation enters the system from the lowest level and works its way up to the highest level, but also the activation at the highest levels can feed back down to enhance the activation of lower level units that match the target stimulus (printed word). This feedback mechanism allows enhancing connections; the frequency with which a pathway to a unit is used will influence the strength of activation within that unit. A unit representing a high-frequency word will be more strongly activated than a unit representing a low-frequency word. In the same way, a unit representing a high-frequency morpheme will be more strongly activated than a unit representing a low-frequency morpheme. The time needed to recognize a word will be calculated on the amount of activation at the whole word level, but this will depend on the amount of competitive activation in the other units. The model predicts that the total weight will depend on the weight of the word components. Thus, reading times can be explained in terms of "strength" of connections at the stem and inflection level. Our results show that this logic underlies the process of inflected word recognition in beginning, intermediate, and adult readers and that whole word units are formed via a learning mechanism based on a progressive feedback process similar to the one proposed by Taft.

Importantly, one highly interesting finding in the current study is that this developmental pattern is modulated by the knowledge of the language. In other words, children who are aware of the morphological properties of Basque (an intrinsic part of their knowledge of the language) differ in the way they identify inflected words with respect to their non-native counterparts in third grade. According to our findings, the ability to decompose and identify word constituents was substantially faster in those children whose mother language was Basque. In addition, these children were more accurate in their responses; children in the L1–Basque group were able to read the correctly inflected words much

faster than children in the other group, and they were more accurate in their decisions that they were correct, showing a stable number of error detections across inflections. In contrast, children whose mother language was Spanish showed a greater ascendant pattern for high-frequency inflected words than for low-frequency inflected words in Basque and committed more errors as the number of letters in the word increased.

If we attend to the error rates across ages, data showed that in general children made more errors in words with long inflections than in words with short inflections, and this was particularly so in the L1–Spanish group. In other words, these children seem to have started storing the words but not the inflections. As a result of inflection decoding, they made more errors when there were more letters to process, and that is probably the reason why this effect vanished in adulthood after stems and inflections had been stored in the lexicon. More specifically, if we attend to the slopes of each reading age, error rates provide relevant information on the type of processing of long and short inflected words in L1–Basque and L1–Spanish third graders. The ascendant error rate slope in third grade is due to the L1–Spanish group (24.6, 26.2, 29.6, and 34.3% for *-a*, *-ari*, *-aren*, and *-arentzat*, respectively), $F(1, 12) = 10.51$, $MSE = 26{,}574.8$, but not to the L1–Basque group (19.4, 17.8, 18.2, and 18.0%), $p = .92$, revealing better knowledge of inflections in L1–Basque children. In contrast, sixth graders showed similar ascendant error rate slopes in both groups (16.4, 18.95, 19.9, and 26.5% in the L1–Spanish group and 11.85, 16.1, 15.95, and 21.25% in the L1–Basque group), both Fs < 1, and adult readers showed similar error rates across type of inflections in both groups (3.8, 4.05, 3.25, and 4.45% in the L1–Spanish group and 3.4, 5.0, 2.8, and 4.55% in the L1–Basque group), both Fs < 1. Hence, it seems that the knowledge of inflectional structures in a given language is of particular importance when reading instruction begins and children start to extract the lexical information of inflected words. It is important to mention that the average error rate per grade (23, 18, and 4% for beginning, intermediate, and adult readers, respectively) fit previous evidence using the lexical decision task (see Taft & Forster, 1975, for English adult data; Castles, Davis, Cavalot, & Forster, 2007, for English child data; and Acha & Perea, 2008, for Spanish child and adult data). However, the number of errors committed by intermediate readers was a bit higher than usual, due partly to the L1–Spanish group error rate (16.3 and 20.4% in the L1–Basque and L1–Spanish groups, respectively). This may reflect the complexity of the reading processes in bilingual children who are storing two kinds of word structure in their lexicon, in this case an agglutinative one and a nonagglutinative one (see Geva & Siegel, 2004).

Thus, we believe that the relatively lower proficiency of Basque inflectional morphology in the L1–Spanish third graders had a significant impact on the results in that it may have hindered the progressive specification of morpho-orthographic regularities in the lexicon (see McKague, Davis, Pratt, & Johnston, 2008). This fact has important implications. So long as children are making use of their cognitive resources to decode words, they will not employ them to attend to further skills that successful reading requires (Perfetti, 1977; Pinnell et al., 1995). Along the same line, Lyytinen and Lyytinen (2004) reported an interesting finding with Finnish readers. Children with low inflectional skills at 2 years of age had a higher probability of reading impairments in the future than age-matched controls. These findings support previous evidence suggesting that when children are aware of the structure of their language, they make inferences about unfamiliar written words on the basis of word constituents faster and more easily (Goswami, 1986, 1988). Our results show that this can also be applied to agglutinative languages, in particular to Basque (e.g., learning to read *ur-a-ren* [“of the water”] once children know *mutil-a-ren* [“of the boy”]).

In sum, our results provide empirical evidence that language typology affects the organization of the lexicon during word recognition and that the awareness of morphological structure in agglutinative languages modulates the development of word recognition in such languages. This process develops on a continuum that progressively goes from using a slow decoding morpho-orthographic strategy toward a fast identification of word constituents. This process is modulated by the knowledge of the word structure in the language and by the strength with which stems and inflections are stored in the lexicon through the practice of reading. The current findings shed light on how early developmental reading patterns can influence later word recognition strategies. Future research should be carried out to determine how lexical organization is developed depending on the particularities of different orthographies.

Acknowledgments

This research was supported by Grant BFI05.33 from the Basque Government (Spain) and the project Consolider Ingenio 2010 (CSD2007-00012).

Appendix. Sentence frames used in the experiment

The first word corresponds to the low-frequency stem target, and the second word corresponds to the high-frequency target.

Mendizaleak basoan garoa/lorea ikusi du	Mendiazaleak basoan garoari/loreari ongarria bota dio	Mendizaleak garoaren/ lorearen ongarria aztertu du	Mendizaleak garoarentzat/ loearentzat ongarria erosi du
Aitonak goizean urkia/ lekua erakutsi dit	Aitonak goizean urkiari/lekuari hesi bat jarri dio	Aitonak urkiaren/lekuaren hesia konpondu du	Aitonak urkiarentzat/ lekuarentzat hesi bat egin du
Aitak gosarian zukua/ esnea edan du	Aitak gosarian zukuari/ esneari azukrea bota dio	Aitak gosarian zukuaren/ esnearen ontzia bota du	Aitak gosarian zukuarentzat/esnearentzat azukrea hartu du
Txakurrak kumea/ semea laztandu du	Txakurrak kumeari/ semeari janaria eman dio	Txakurrak kumearen/ semearen ilea garbitu du	Txakurrak kumearentat/ semearentzat janaria ekarri du
Amonak labean opila/ eskua sartu du	Amonak opilari/ eskuari olioa bota dio	Amonak opilaren/ eskuaren kolorea begiratu du	Amonak opilarentzat/ eskuarentzat zapi berria ekarri du
Gazteak erbia/behia harrapatu du	Ehiztariak erbiari/ behiari belarra ekarri dio	Ehiztariak erbiaren/ behiaren hankak lotu ditu	Ehiztariak erbiarentzat/ behiarentzat belarra ekarri du
Umeak mendian zozoa/etxea ikusi du	Umeak parkean zozoari/etxeari harria bota dio	Umeak parkean zozoaren/ etxearen zarata entzun du	Umeak parkean zozoarentzat/etxearentzat lore bat utzi du
Printzesak gazteluan igela/jauna musukatu du	Printsesak gazteluan igelari/jaunari musua eman dio	Printsesak gazteluan igelaren/jaunaren begia aurkitu du	Printsesak gazteluan igelarentzat/jaunarentzat ezkutalekua aurkitu du
Gizonak kalean isuna/ dirua jaso du	Gizonak etxean isunari/diruari garrantzia eman dio	Gizonak etxean isunaren/ diruaren garrantzia neurtu du	Gizonak kajoian isunarentzat/diruarentzat lekua egin du
Txakurrak ilunpean belea/jabea haginkatu du	Txakurrak ilunpean beleari/jabeari zaunka egin dio	Txakurrak ilunpean belearen/jabearen usainari jarraitu dio	Txakurrak ilunpean belearentzat/jabearentzat zaunka egin du
Irakasleak kupela/ klasea pintatu du	Irakasleak kupelari/ klaseari bisita bat egin dio	Irakasleak kupelaren/ klasearen kokapena gogoratu du	Irakasleak kupelarentzat/ klasearentzat lan proiektu bat sortu du
Katuak bidean ezpala/ belarra ikusi du	Katuak bidean ezpalari/belarrari begirada bat bota dio	Katuak bidean ezpalaren/ belarraren dirdirari begiratu dio	Katuak bidean ezpalarentzat/ belarrarentzat zuloa egin du
Baserritarrak lorategian eltxoa/ andrea aurkitu du	Baserritarrak lorategian eltxoari/ andreari etxetxoa egin dio	Baserritarrak lorategian eltxoaren/andrearen mugimendua aztertu du	Baserritarrak lorategian eltxoarentzat/ andrearentzat etxetxoa egin du
Neskak harpea/mendia ikusi du	Neskak harpeari/ mendiari izena jarri dio	Neskak harpearen/ mendiaren izena ikasi du	Neskak harpearentzat/ mendiarentzat izen bat bilatu du
Sorginak kaiolan pozoia/mutila sartu du	Sorginak pozoiari/ mutilari hauts magikoa bota dio	Sorginak pozoiaren/ mutilaren kolorea aldatu du	Sorginak pozoiarentzat/ mutilarentzat formula magikoa erabili du

Maisuak adibidean beruna/haizea aipatu du	Maisua adibidean berunari/haizeari begira egon da	Maisuakk berunaren/ haizearen berezkotasunak aipatu ditu	Maisuak berunarentzat/ haizearentzat arriskuak aipatu dizkigu
Ahizpak artaziekin kutuna/irudia apurtu du	Ahizpak artaziekin kutunari/irudiari ebaki bat egin dio	Ahizpak artaziekin kutunaren/irudiaren forma aldatu du	Ahizpak artaziekin kutunarentzat/ irudiarentzat marko bat egin du
Atsoak errekan zarboa/ gaztea ikusi du	Atsoak kotxean zarboari/gazteari lekua egin dio	Atsoak kotxean zarboaren/gaztearen lekua okupatu du	Atsoak kotxean zarboarentzat/ gaztearentzat lekua egin du
Amak eltzea/mahaia prestatu du	Amak eltzeari/ mahaiari ornamendua egin dio	Amak eltzearen/ mahaiaren ornigarria kendu du	Amak eltzearentzat/ mahaiarentzat ornigarria egin du
Mutilak gaur tximua/ laguna aurkitu du	Mutilak gaur tximuari/ lagunari oparia erosi dio	Mutilak gaur tximuaren/ lagunaren oparia prestatu du	Mutilak gaur tximuarentzat/ lagunarentzat oparia prestatu du
Bidaiariak izurdea/ idazlea bisitatu du	Bidaiariak izurdeari/ idazleari argazkia atera dio	Bidaiariak izurdearen/ idazlearen argazkia erakutsi du	Bidaiariak izurdearentzat/ idazlearenzat dirua jaso du
Dendariak izozkia/ liburua saldu du	Dendariak izozkiari/ liburuari azala kendu dio	Dendariak izozkiaren/ liburuaren azala kendu du	Dendariak izozkiarentzat/ liburuarentzat azala hartu du
Emakumeak eskolara nerabea/ikaslea eraman du	Emakumeak nerabeari/ ikasleari ogitartekoa eman dio	Emakumeak nerabearen/ ikaslearen bokadiloa jaso du	Emakumeak nerabearentzat/ ikaslearentzat bokadiloa eraman du
Nekazariak beherea/ ingurua zaindu du	Nekazariak behereari/ inguruari begirada bat bota dio	Nekazariak beherearen/ inguruaren kalteak aztertu ditu	Nekazariak beherearentzat/ inguruarentzat laguntzak bilatu ditu
Haurrek eskolan hirukoa/kolorea landu dute	Haurrek eskolan hirukoari/koloreari ordua eskaini diote	Haurrek eskolan hirukoaren/kolorearen ezaugarriak ikasi dituzte	Haurrek eskolan hirukoarentzat/ kolorearentzat lekua egin dute
Abereak jolasteko akuilua/iturria erabili du	Abereak jolasten akuiluari/iturriari area bota dio	Abereak jolasten akuiluaren/iturriaren ondoan izkutatu da	Abereak jolasten akuiluarentzat/ iturriarentzat salto egin du
Agintariek urtegia/ eskola bisitatu dute	Agintariek urtegiari/ eskolari bisita bat egin diote	Agintariek urtegiaren/ eskolaren akatzak aztertu dituzte	Bisitariek urtegiarentzat/ eskolarentzat dirua bildu dute
Magoa ipuinean iratxo/ errege bilakatzen da	Magoak ipuinan iratxoari/erregeari mezu ba bidaltzen dio	Magoak ipuinan iratxoaren/erregearen arazoa aurkezten du	Magoak ipuinan iratxoarentzat/ erregearentzat makila majikoa egiten du
Ibiltariak bidean garoa/ lorea hartu du	Ibiltariak bidean garoari/loreari arreta jarri dio	Ibiltariak bidean garoaren/lorearen kokapena begiratu du	Ibiltariak bidean garoarentzat/lorearentzat kokapena bilatu du
Udalak aurten urkia/ lekua erosi du	Udalak aurten urkiari/ lekuari neurriak hartu dizkio	Udalak aurten urkiaren/ lekuaren neurriak hartu ditu	Udalak aurten urkiarentzat/lekuarentzat kartela egin du
Supermerkatuak zukua/esnea eskaintzen du	Supermerkatuak zukuari/esneari prezioa jarri dio	Supermerkatuak zukuaren/esnearen eskaintza prestatu du	Supermerkatuak zukuarentzat/esnearentzat eskaintza prestatu du

(*continued on next page*)

Ardiak gauean kumea/ semea babestu du	Ardiak gauean kumeari/semeari babesa eman dio	Ardiak gauean kumearen/ semearen janaria gorde du	Ardiak gauean kumearentzat/ semearentzat esnea ekarri du
Aitonak lanean opila/ eskua apurtu du	Aitona lanean opilari/ eskuari begira egon da	Aitonak lanean opilaren/ eskuaren funtzioak azaldu dizkit	Aitonak poltsikoan opilarentzat/eskuarentzat lekua aurkitu du
Artzainak erbia/behia ekarri du	Artzainak erbiari/ behiari etxea egin dio	Artzainak erbiaren/ behiaren borda garbitu du	Arzainak erbiarentzat/ behiarentzat borda bat egin du
Herriak zozoa/etxea dauka plazaren erdian	Herriak zozoari/etxeari plaza erdian oroigarria egin dio	Herriak zozoaren/ etxearen oroigarria plazatik kendu du	Herriak zozoarentzat/ etxearentzat oroigarria jarri du plazan
Lagunak klasean igela/ jauna marraztu du	Lagunak igelari/jaunari txiklea bota dio	Lagunak igelaren/ jaunaren marrazkia bota du	Lagunak igelarentzat/ jaunarentzat marrazkia egin du
Poliziak bulegoan isuna/dirua hartu du	Poliziak ofizinan isunari/diruari leku bat bilatu dio	Poliziak ofizinan isunaren/ diruaren lekua erakutsi dit	Poliziak bulegoan isunarentzat/diruarentzat kaxa bat dauka
Ugazabak belea/jabea aurkitu du	Ugazabak beleari/ jabeari atea ireki dio	Ugazabak belearen/ jabearen zarata entzun du	Ugazabak belearentzat/ jabearentzat kanpaia jo du
Argazkilariak kupela/ klasea erretratatu du	Argazkilariak kupelari/ klaseari argazkia atera dio	Argazkilariak kupelaren/ klasearen argazkia erakutsi dit	Argazki saria kupelarentzat/ klasearentzat izan da
Auzokideak ezpala/ belarra jaso du	Auzotarrak ezpalari/ belarrari ura bota dio	Auzotarrak ezpalaren/ belarraren gogortasuna neurtu du	Auzotarrak ezpalarentzat/ belarrarentzat txokoa bilatu du
Postariak kalean eltxoa/andrea zapaldu du	Postariak kalean eltxoari/andreari ostikada eman dio	Postariak kalean eltxoaren/andrearen arrastoa jarraitu du	Postariak kotxean eltxoarentzat/ andrearentzat lehiatila ireki du
Erraldoiak harpea/ mendia bereganatu du	Erraldoiak harpeari/ mendiari bizia eman dio	Erraldoiak harpearen/ mendiaren loreak zapuztu ditu	Erraldoiak harpearentzat/ mendiarentzat loreak jaso ditu
Lamiak lakuan pozoia/ mutila aurkitu du	Lamiak lakuan pozoiari/mutilari ura bota dio	Lamiak lakuan pozoiaren/ mutilaren itxura aztertu du	Lamiak pozoiarentzat/ mutilarentzat kobazuloa aurkitu du
Dokumentalak beruna/ haizea du protagonista	Dokumentalak berunari/haizeari programa bat eskaini dio	Dokumentalak berunaren/ haizearen ezaugarriak azaltzen ditu	Dokumentalak berunarentzat/ haizearentzat leku aproposa aipatu du
Maiteminduak kutuna/ irudia lekuz aldatu du	Maiteminduak kutunari/irudiari leku berria bilatu dio	Maiteminduak kutunaren/ irudiaren lekua aldatu du	Maiteminduak kutunarentzat/ irudiarentzat toki berezia bilatu du
Arrainlariak portuan zarboa/gaztea harrapatu du	Arrainlariak portuan zarboari/gazteari janaria eman dio	Arrainlariak portuan zarboaren/gaztearen janaria ostu du	Arrainlariak zarboarentzat/ gaztearentzat janaria ekarri du
Familiak eltzea/mahaia erosi du	Familiak eltzeari/ mahaiari estalkia kendu dio	Familiak eltzearen/ mahaiaren estalkia apartatu du	Familiak eltzearentzat/ mahaiarentzat estalkia erosi du
Aberezainak autoan tximua/laguna eraman du	Aberezainak autoan tximuari/lagunari oparia eraman dio	Aberezainak autoan tximuaren/lagunaren oparia ahaztu du	Aberezainak autoan tximuarentzat/ lagunarentzat oparia utzi du
Bisitariek izurdea/ idazlea ezagutu dute	Bisitariek izurdeari/ idazleari mote bat jarri diote	Bisitariek izurdearen/ idazlearen familia ezagutu dute	Bisitariek izurdearentzat/ idazlearentzat oparia ekarri dute

Mutilak gelan izozkia/ liburua lurrera bota du	Mutilak gelan izozkiari/liburuari kolpea eman dio	Mutilak gelan izozkiaren/ liburuaren gogortasuna frogatu du	Mutilak gelan izozkiarentzat/ liburuarentzat lekua dauka
Saltzaileak lan egiteko nerabea/ikaslea kontratatu du	Saltzaileak nerabeari/ ikasleari lan kontratua egin dio	Saltzaileak nerabearen/ ikaslearen kontratua apurtu du	Saltzaileak nerabearentzat/ ikaslearentzat kontratua sinatu du
Programak beherea/ ingurua zaintzeko argibideak azaldu ditu	Programak behereari/ inguruari atal bat eskaini dio	Programak beherearen/ inguruaren irudiak atera ditu	Programak beherearentzat/ inguruarentzat atal bat utziko du
Bikoteak dendan hirukoa/kolorea hautatu du	Bikoteak dendan hirukoari/koloreari eragozpenak jarri dizkio	Bikoteak dendan hirukoaren/kolorearen katalogoa ahaztu du	Bikoteak dendan hirukoarentzat/ kolorearentzat garantia eskatu du
Abeltzainak akuilua/ iturria bidean ikusi du	Abeltzainak akuiluari/ iturriari izena jarri dio	Abeltzainak akuiluaren/ iturriaren tokia ahaztu du	Abeltzainak akuiluarentzat/ iturriarentzat izena bilatu du
Alkateak urtegia/ eskola saldu du	Alkateak urtegiari/ eskolari bisita egin dio	Alkateak urtegiaren/ eskolaren urteurrena antolatu du	Alkateak urtegiarentzat/ eskolarentzat urteurrena antolatu du
Zaldunak iratxoa/ erregea harrapatu du	Zaldunak iratxoari/ erregeari eskaria egin dio	Zaldunak iratxoaren/ erregearen eskaria entzun du	Zaldunak iratxoarentzat/ erregearentzat desio bat eskatu du

References

Acha, J., & Perea, M. (2008). The effects of length and transposed-letter similarity in lexical decision: Evidence with beginning, intermediate, and adult readers. *British Journal of Psychology, 99*, 245–264.

Alegría, J., & Mousty, P. (1996). The development of spelling procedures in French-speaking, normal, and reading-disabled children: Effects of frequency and lexicality. *Journal of Experimental Child Psychology, 63*, 312–338.

Arduino, L. S., & Burani, C. (2004). Neighborhood effects on nonword visual processing in a language with shallow orthography. *Journal of Psycholinguistic Research, 33*, 75–95.

Aro, M., & Wimmer, H. (2003). Learning to read: English in comparison to six more regular orthographies. *Applied Psycholinguistics, 24*, 621–635.

Beech, J. R. (2005). Ehri's model of phases of learning to read: A brief critique. *Journal of Research in Reading, 28*, 50–58.

Bertram, R., Laine, M., & Virkkala, M. M. (2000). The role of derivational morphology in vocabulary acquisition: Get by with a little help from my morpheme friends. *Scandinavian Journal of Psychology, 41*, 287–296.

Bijeljac-Babic, R., Millogo, V., Farioli, F., & Grainger, J. (2004). A developmental investigation of word length effects in reading using a new on-line word identification paradigm. *Reading and Writing, 17*, 411–431.

Bruck, M., & Treiman, R. (1992). Learning to pronounce words: The limitations of analogies. *Reading Research Quarterly, 27*, 374–388.

Carreiras, M., Álvarez, C. J., & de Vega, M. (1993). Syllable frequency and visual word recognition in Spanish. *Journal of Memory and Language, 32*, 766–780.

Castles, A., Davis, C., Cavalot, P., & Forster, K. I. (2007). Tracking the acquisition of orthographic skills in developing readers: Masked priming effects. *Journal of Experimental Child Psychology, 97*, 165–182.

De Rijk, R. (2007). *Standard Basque: A progressive grammar*. Cambridge, MA: MIT Press.

Duñabeitia, J. A., Perea, M., & Carreiras, M. (2007). Do transposed-letter similarity effects occur at a morpheme level? Evidence for ortho-morphological decomposition. *Cognition, 105*, 691–703.

Duncan, L. G., Seymour, P. H. K., & Hill, S. (1997). How important are rhyme and analogy in beginning reading? *Cognition, 63*, 171–208.

Duncan, L. G., Seymour, P. H. K., & Hill, S. (2000). A small-to-large unit progression in metaphonological awareness and reading? *Quarterly Journal of Experimental Psychology A, 53*, 1081–1104.

Durgunôglu, A. Y. (2006). How the language's characteristics influence Turkish literacy development. In M. Joshi & P. G. Aaron (Eds.), *Handbook of orthography and literacy* (pp. 219–230). Mahwah, NJ: Lawrence Erlbaum.

Durgunôglu, A. Y., & Öney, B. (1999). A cross-linguistic comparison of phonological awareness and word recognition. *Reading and Writing, 11*, 281–299.

Durgunôglu, A. Y., Öney, B., Kuscul, H., Dagidir, F. Z., Aslan, F., Cantürk, M., et al (2002). *Functional Adult Literacy Program, Level I* (3rd ed.). Istanbul, Turkey: Mother Child Education Foundation.

Ehri, L. C. (1995). Phases of development in learning to read words by sight. *Journal of Research in Reading, 18*, 116–125.

Ellis, N. C. (2002). Frequency effect in language processing: A review with implications for theories of implicit and explicit language acquisition. *Studies in Second Language Acquisition, 24*, 143–188.

Ezeizabarrena, M. J. (1996). *Adquisición de la morfología verbal en euskera y castellano por niños bilingües*. Bilbao, Spain: Servicio de Publicaciones de la UPV/EHU.
Faust, M. E., Balota, D. A., Spieler, D. H., & Ferraro, F. R. (1999). Individual differences in information processing rate and amount: Implications for group differences in response latency. *Psychological Bulletin, 125*, 777–799.
Feldman, L. B. (1991). The contribution of morphology to word recognition. *Psychological Research, 53*, 33–41.
Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, & Computers, 35*, 16–124.
Freyd, P., & Baron, J. (1982). Individual differences in acquisition of derivational morphology. *Journal of Verbal Learning and Verbal Behavior, 21*, 282–295.
Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. Patterson, J. Marshall, & M. Coltheart (Eds.), *Surface dyslexia* (pp. 287–295). Baltimore, MD: University Park Press.
Geva, G., & Siegel, L. S. (2004). Orthographic and cognitive factors in the concurrent development of basic reading skills in two languages. *Reading and Writing, 12*, 1–30.
Goswami, U. (1986). Children's use of analogy in learning to read: A developmental study. *Journal of Experimental Child Psychology, 42*, 73–83.
Goswami, U. (1988). Orthographic analogies and reading development. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology, 40*, 239–268.
Goswami, U. (1993). Toward an interactive analogy model of reading development: Decoding vowel graphemes in beginning reading. *Journal of Experimental Child Psychology, 56*, 443–475.
Goswami, U. (1995). Phonological development and reading by analogy: What is analogy, and what is it not? *Journal of Research in Reading, 18*, 139–145.
Holopainen, L., Ahonen, T., & Lyytinen, H. (2002). The role of reading by analogy in first grade Finnish readers. *Scandinavian Journal of Educational Research, 46*, 83–98.
Howes, D. H., & Solomon, R. L. (1951). Visual duration threshold as a function of word probability. *Journal of Experimental Psychology, 41*, 401–410.
Hualde, J. I., & Ortiz de Urbina, J. (Eds.). (2003). *A grammar of Basque*. Berlin, Germany: Mouton de Gruyter.
Jiménez, J., & Ortiz, M. (2000). *Conciencia fonológica y aprendizaje de la lectura: Teoría, evaluación e intervención.* Madrid, Spain [Editorial Síntesis].
Katz, L., Rexer, K., & Lukatela, G. (1991). The processing of inflected words. *Psychological Research, 53*, 25–32.
La Berge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology, 6*, 293–323.
Laka, I. (1996). *A brief grammar of Euskara, the Basque language.* University of the Basque Country. Available from http://www.ei.ehu.es/p289-content/eu/contenidos/informacion/grammar_euskara/en_doc/index.html.
Landerl, K., Frith, U., & Wimmer, H. (1996). Intrusion of orthographic knowledge on phoneme awareness: Strong in normal readers, weak in dyslexic readers. *Applied Psycholinguistics, 17*, 1–14.
Landerl, K., Wimmer, H., & Frith, U. (1997). The impact of orthographic consistency on dyslexia: A German–English comparison. *Cognition, 63*, 315–334.
Liberman, I. Y., Shankweiler, D., Liberman, A. M., Fowler, C., & Fisher, F. W. (1977). Phonetic segmentation and recoding in the beginning reader. In A. S. Reber & D. L. Scarborough (Eds.), *Toward a psychology of reading* (pp. 207–225). New York: John Wiley.
Lyytinen, H., Leinonen, S., Nikula, M., Aro, M., & Leiwo, M. (1995). In search of the core features of dyslexia: Observations concerning dyslexia in the highly orthographically regular Finnish language. In V. W. Berninger (Ed.), *The varieties of orthographic knowledge 2: Relationship to phonology, reading, and writing* (pp. 177–204). Dordrecht, Netherlands: Kluwer.
Lyytinen, P., & Lyytinen, H. (2004). Growth and predictive relations of vocabulary and inflectional morphology in children with and without familial risk of dyslexia. *Applied Psycholinguistics, 25*, 397–411.
McKague, M., Davis, C., Pratt, C., & Johnston, M. B. (2008). The role of feedback from phonology to orthography in orthographic learning: An extension of item based account. *Journal of Research in Reading, 31*, 55–76.
McKoon, G., & Ratcliff, R. (2007). Interactions of meaning and syntax: Implications for models of sentence comprehension. *Journal of Memory and Language, 56*, 270–290.
Öney, B., & Durgunôglu, A. Y. (1997). Beginning to read in Turkish: A phonologically transparent orthography. *Applied Psycholinguistics, 18*, 1–15.
Pastizzo, M. J., & Feldman, L. B. (2004). Morphological processing: A comparison between free and bound stem facilitation. *Brain and Language, 90*, 31–39.
Perea, M., Urkia, M., Davis, C. J., Agirre, A., Laseka, E., & Carreiras, M. (2006). E-Hitz: A word-frequency list and a program for deriving psycholinguistic statistics in an agglutinative language (Basque). *Behavior Research Methods, 38*, 610–615.
Perfetti, C. A. (1977). Language comprehension and fast decoding: Some psycholinguistic prerequisites for skilled reading comprehension. In J. T. Guthrie (Ed.), *Cognition, curriculum, and comprehension* (pp. 20–41). Newark, DE: International Reading Association.
Perfetti, C. A., & Lesgold, A. M. (1977). Coding and comprehension in skilled reading and implications for reading instruction. In L. B. Resnik & P. A. Weaver (Eds.). *Theory and practice of early reading* (Vol. 1, pp. 57–84). Hillsdale, NJ: Lawrence Erlbaum.
Pinnell, G. S., Pikulski, J. J., Wixson, K. K., Campbell, J. R., Gough, P. B., & Beatty, A. S. (1995). *Listening to children read aloud: Data from NAEP's Integrated Reading Performance Record (IRPR) at Grade 4*. Washington, DC: National Center for Educational Statistics.
Pollatsek, A., & Well, A. D. (1995). On the use of counterbalanced designs in cognitive research: A suggestion for a better and more powerful analysis. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 21*, 785–794.
Rack, J. P., Snowling, M. J., & Olson, R. K. (1992). The nonword reading deficit in developmental dyslexia: A review. *Reading Research Quarterly, 27*, 29–53.
Rayner, K., Foorman, B. R., Perfetti, C. A., Pesetsky, D., & Seidenberg, M. S. (2001). How psychological science informs the teaching of reading. *Psychological Science in the Public Interest, 2*, 31–74.

Sebastián-Gallés, N., & Parreño-Vacchiano, A. (1995). The development of analogical reading in Spanish. *Reading and Writing, 7*, 23–38.
Share, D. L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition, 55*, 151–218.
Share, D. L., & Stanovich, K. E. (1995). Cognitive processes in early reading development: Accommodating individual differences into a model of acquisition. *Issues in Education, 1*, 1–57.
Taft, M. (1991). *Reading and the mental lexicon*. Hillsdale, NJ: Lawrence Erlbaum.
Taft, M. (1994). Interactive activation as a framework for understanding morphological processing. In D. Sandra & M. Taft (Eds.), *Morphological structure, lexical representation, and lexical access* (pp. 271–294). Hillsdale, NJ: Lawrence Erlbaum.
Taft, M. (2004). Morphological decomposition and the reverse base frequency effect. *Quarterly Journal of Experimental Psychology, 57*, 745–765.
Taft, M., & Forster, K. I. (1975). Lexical storage and retrieval of prefixed words. *Journal of Verbal Learning and Verbal Behavior, 14*, 638–647.
Tan, A., & Nicholson, T. (1997). Flashcards revisited: Training poor readers to read words faster improves their comprehension of text. *Journal of Educational Psychology, 89*, 276–288.
Tanenhaus, M. K., & Lucas, M. M. (1987). Context effects in lexical processing. *Cognition, 25*, 213–234.
Waksler, R. (1999). Cross-linguistic evidence for morphological representation in the mental lexicon. *Brain and Language, 68*, 68–74.
Wimmer, H. (1993). Characteristics of developmental dyslexia in a regular writing system. *Applied Psycholinguistics, 14*, 1–33.
Wimmer, H. (1996). The early manifestation of developmental dyslexia: Evidence from German children. *Reading and Writing, 8*, 1–18.
Wimmer, H., & Goswami, U. (1994). The influence of orthographic consistency on reading development: Word recognition in English and German children. *Cognition, 51*, 91–103.
Wimmer, H., Mayringer, H., & Landerl, K. (2000). The double-deficit hypothesis and difficulties in learning to read a regular orthography. *Journal of Educational Psychology, 92*, 668–680.
Ziegler, J. C., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin, 131*, 3–29.