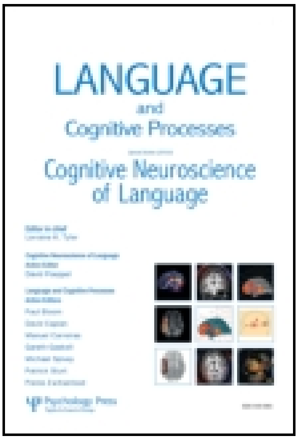

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Learning words in a third language: Effects of vowel inventory and language proficiency

Paola Escudero [a] , Mirjam Broersma [b] & Ellen Simon [c]
[a] MARCS Institute , University of Western Sydney , Penrith , NSW , 2751 , Australia
[b] Language Comprehension Department , Max Planck Institute for Psycholinguistics , 6500 AH , Nijmegen , The Netherlands
[c] Linguistics Department , Ghent University , 9000 , Ghent , Belgium
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Learning words in a third language: Effects of vowel inventory and language proficiency

Paola Escudero[1], Mirjam Broersma[2], and Ellen Simon[3]

[1]MARCS Institute, University of Western Sydney, Penrith, NSW 2751, Australia
[2]Language Comprehension Department, Max Planck Institute for Psycholinguistics, 6500 AH Nijmegen, The Netherlands
[3]Linguistics Department, Ghent University, 9000, Ghent, Belgium

This study examines the effect of L2 and L3 proficiency on L3 word learning. Native speakers of Spanish with different proficiencies in L2 English and L3 Dutch and a control group of Dutch native speakers participated in a Dutch word-learning task involving minimal and nonminimal word pairs. The minimal word pairs were divided into "minimal-easy" and "minimal-difficult" pairs on the basis of whether or not they are known to pose perceptual problems for L1 Spanish learners. Spanish speakers' proficiency in Dutch and English was independently established by their scores on general language comprehension tests. All participants were trained and subsequently tested on the mapping between pseudo-words and nonobjects. The results revealed that, first, both native and non-native speakers produced more errors and longer reaction times (RTs) for minimal than for nonminimal word pairs, and secondly, Spanish learners had more errors and longer RTs for minimal-difficult than for minimal-easy pairs. The latter finding suggests that there is a strong continuity between sound perception and L3 word recognition. With respect to proficiency, only the learner's proficiency in their L2, namely English, predicted their accuracy on L3 minimal pairs. This shows that learning an L2 with a larger vowel inventory than the L1 is also beneficial for word learning in an L3 with a similarly large vowel inventory.

Keywords: L3 word learning; Language proficiency; Minimal pairs, Vowel inventories.

It has repeatedly been claimed in the literature that the majority of people in the world are bilingual or multilingual speakers (Cook, 1992, p. 578; De Bot, 1992, p. 2). As Hammarberg (2001, p. 21) points out, this claim is hard to document with precision, though various factors, such as people's increasing mobility, make it highly likely that today monolingual speakers are indeed in the minority. This implies that most people need to learn a second or third language besides their native language. While in the

Correspondence should be addressed to Paola Escudero, MARCS Institute, University of Western Sydney, Locked Bag 1797, Penrith, NSW 2751, Australia. E-mail: paola.escudero@uws.edu.au

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past pedagogical and linguistic research focused almost exclusively on second language (henceforth L2) learning, there has been a fairly recent, but rapidly increasing interest in third (L3) or multilingual language learning, as evidenced by the publication of volumes such as those by Cenoz, Hufeisen, and Jessner (2001, 2003) and overview articles such as the one by Sanz and Lado (2008) on this topic. We define the term L3 here as the language acquired by the learners after the L2 and the L1, but which is not necessarily the L3 in the literal sense of being the third language acquired by the learners (i.e., it might be the fourth or fifth; see Hammarberg, 2001, p. 22).

The study reported on in this article sets out to examine native and non-native speakers' learning of minimally different words and is centred around two main issues: (1) the learning of L3 minimal versus nonminimal word pairs by native and non-native speakers, and the distinction between learning L3 minimal pairs which do or do not pose problems in non-native perception, and (2) the effect of L2 and L3 proficiency on L3 word learning.

MINIMAL VERSUS NONMINIMAL WORD PAIRS

Minimal pairs are defined as pairs of words which differ in just one phoneme. Examples of minimal pairs in English are *hit*-*fit* (onset), *hit*-*hot* (nucleus), and *hit*-*hill* (coda). Words which can form minimal pairs with a large number of words are said to have a high neighbourhood density, defined as the number of neighbours of a word (Storkel & Morrisette, 2002). Neighbourhood density is known to have an important effect on word recognition. Previous research has, for instance, shown that adults are slower at recognising words in dense lexical neighbourhoods than in sparse ones (Luce & Pisoni, 1998; Pisoni, Nusbaum, Luce, & Slowiacek, 1985; Vitevich & Luce, 1999). It is therefore assumed that words in dense neighbourhoods compete with one another during word recognition.

The effect of neighbourhood density on L1 word recognition and word learning has also been examined for infants (see Escudero, 2011, for an overview). A well known study by Stager and Werker (1997) has shown that 14-month-old infants who were able to discriminate between two similar sounds in their native language (*bih* and *dih*) may nevertheless fail to use this information in a word-learning task, when the sounds are presented as minimal pairs. This suggested that the infants required more phonological information to be able to match the prelexical representations to lexical representations. Hollich, Jusczyck, and Luce (2002) investigated the extent to which neighbourhood density influences infants' abilities to learn new words by familiarising infants with words in either a high-density or a sparse-density neighbourhood. They found that prolonged exposure to words in a high-density neighbourhood had a negative effect on new word learning, which was hindered by lexical competition between the words in the neighbourhood.

With respect to L2 acquisition, the recognition of minimal pairs is more difficult when the members differ in sounds that are difficult to distinguish for L2 listeners. In those cases the recognition of minimal pairs is also likely to be hindered by learners' difficulty to perceive the contrast between the members of that pair at the pre-lexical level. The recognition of L2 sounds which are not contrastive in the L1 is notoriously difficult and has been amply illustrated in previous literature (see the collected papers in Strange (1995), and Bohn and Munro (2007) for an overview). The most widely known example of problematic L2 recognition is that of English /r/ and /l/ by listeners of Asian languages, such as Chinese and Japanese (e.g., Aoyama, Flege, Guion, Akahane-Yamade, & Yamada, 2004; Goto, 1971). Inaccurate recognition of speech sounds necessarily affects the recognition of words containing those sounds. Hence, L2 listeners have difficulty recognising minimal pairs containing sounds which they find difficult to distinguish. Japanese learners of English, for example, confuse words like "write"—"light" (Cutler & Otake, 2004). Hayes-Harb and Masuda (2008) examined the acquisition of Japanese minimal pairs, differing only in consonant length, which is not a contrastive feature in English. The results of listening and production tasks revealed that the L1 English speakers did not initially encode consonant length in their lexical representations. However, after one year of experience with Japanese, learners had significantly changed the phonological structure of their lexicon in Japanese in the direction of the target language. Another example comes from L1 Dutch learners of English, who have been reported to experience difficulty with minimal pairs like "flash"—"flesh" (Broersma, in press; Cutler & Broersma, 2005), since the vowels /æ/ and /ɛ/ are difficult for them to distinguish (Broersma, 2005; Schouten, 1975).

Even early bilinguals who are fluent in both L1s have been reported to have difficulties with minimal pairs differing in phoneme contrasts which occur in only one of the two languages. Pallier, Colomé, and Sebastián-Gallés (2001) conducted a word-recognition task with Spanish-Catalan bilinguals and found that Spanish-dominant, but not Catalan-dominant bilinguals showed repetition priming for minimal pairs in which the contrasting sound was not contrastive in Spanish. In other words, the Spanish-dominant bilinguals treated the members of the minimal pairs as homophones, which implies that they stored them as the same abstract form in the mental lexicon. The problem also extends to partially overlapping word pairs (like "rocket"—"locker") (Broersma, in press; Cutler, Weber, & Otake, 2006; Weber & Cutler, 2004). L2 listeners are even more likely to confuse near-words embedded in a longer context for real words, such that Dutch but not English listeners activate the word "lamp" when they hear "eviL EMPire" (Broersma & Cutler, 2008, 2011).

In the present study, we assess the learning of minimal versus nonminimal pairs by native and non-native speakers. The minimal pairs differ in the extent to which L3 learners find it difficult to distinguish between them, including minimal pairs in which the contrastive phonemes are relatively easy vs. difficult to distinguish by non-native listeners (see Method for details). It will be investigated whether native speakers' learning of minimal pairs is similar to or different from their learning of nonminimal pairs in terms of speed and accuracy, and whether or not native speakers perform better or worse on the same minimal pairs than non-native speakers.

L2 AND L3 PROFICIENCY

Apart from the difficulties that the perception of L2 speech sounds creates for word recognition, research on L2 word recognition has also shown that sequential bilingual speakers, who learn their second language after their first, cannot separate their two language systems during speech perception. This means that when non-native listeners listen to their L2, words from their L1 are also activated in the mental lexicon (Schulpen, Dijkstra, Schriefers, & Hasper, 2003; Marian, Spivey, & Hirsch, 2003; Weber & Cutler, 2004). The situation is even more complex for trilinguals, since it has been shown that word recognition in the L3 can be affected by the listeners' L1 as well as their L2. Dijkstra and Van Hell (2003) conducted a word recognition experiment with trilingual Dutch-English-French speakers who were asked to associate a number of L1 Dutch words which did or did not have a (nonidentical) cognate status to L2

English or L3 French words. The authors found that the participants were faster in associating L1 words that were cognates with their L2 English translation as well as with their L3 French translation. This finding led the authors to conclude that the L3 can influence the learners' L1. However, it is yet unclear what the relative influence of the two languages is and under which circumstances it is the L1 or the L2 which leads to most cross-linguistic influence on the L3.

A number of earlier studies have investigated the effect of L2 proficiency on L2 acquisition, but provide contradictory answers to the question as to whether or not experience with the L2 facilitates productive and/or perceptual learning of that same L2. Whereas some studies show that experienced learners are better able to perceive and produce L2 vowels and consonants accurately (Flege, 1991, Flege, Bohn, & Jang, 1997), others did not find a positive effect of experience (Cebrian, 2003, 2006; Flege, Munro, & Fox, 1994). Cebrian (2006, p. 383) points out that the lack of significant difference between inexperienced and experienced L2 learners may be the result of the effect of formal instruction: in his study, the inexperienced but not the experienced learners had received formal instruction in English linguistics resulting in a greater meta-linguistic awareness in the former group.

While the effects of experience and proficiency in one L2 are already highly variable for the learning of that same language, the situation is even more complicated for L3 learning. As Cenoz (2001, p. 9) points out, in the case of L3 acquisition, proficiency in the target language as well as in the other two languages (the L1 and the L2) should be taken into account. Few studies have examined the effect of L2 proficiency on the learning of an L3. Smith (2009) examined the acquisition of new L3 words by speakers who differed in the age at which they had started learning their L2. She conducted an experiment in which participants learnt the meaning of L3 words which differed in the extent to which reliance on their L1 would help them learn the words. Smith found that participants with late L2 learning experience relied more on their L1 when learning L3 vocabulary than participants who had learnt their L2 earlier in life, suggesting that language learning history has an important influence on the learning of words in a foreign language.

In the realm of sound perception, Gallardo del Puerto (2007) tested the English consonant and vowel perception of Spanish-Basque bilinguals with different levels of bilingual proficiency. The participants in his study were divided into a "more bilingually balanced" group (MB) and a "less bilingually balanced group" (LB) on the basis of self-reported use of Basque and Spanish. The results of minimal pair identification tasks revealed no advantage for the MB group over the LB group on the perception of English sounds, especially of vowels. The author surmises that the lack of difference between the two groups results from the fact that the two languages of the bilinguals, i.e., Spanish and Basque, have similar vowel inventories, which are both much smaller and hence very different from the English vowel inventory.

The present study considers a case of L3 learning where some of the learners (L1 Spanish) have already acquired sounds which are similar to those of their target language (Dutch) through learning their L2 (English). We hypothesise that this situation may lead to different results from those reported in Gallardo del Puerto (2007). Specifically, the vowel inventory in Spanish (learners' L1) is considerably smaller than the inventory in English (learners' L2). As a result, L1 Spanish learners of L3 Dutch with a high proficiency in English already needed to expand their vowel inventory for the acquisition of the English vowels and are therefore predicted to outperform L1 Spanish listeners with a low proficiency in English on a word-learning task involving Dutch vowel contrasts.

THE PRESENT STUDY

The present study examines the learning of minimal and nonminimal words in a third language and the specific influence of L2 and L3 proficiency on L3 word learning. We tested how native speakers of Dutch (L1) and native speakers of Spanish (L1) with differing proficiencies in English (L2) and Dutch (L3) learned novel Dutch words which formed minimal and nonminimal pairs. Following Escudero, Hayes-Harb, and Mitterer's (2008) word learning paradigm, listeners were taught to associate novel words to their picture meanings, which were also novel objects. Escudero et al. showed that L1 Dutch speakers, who are highly advanced learners of English had problems learning words such as *tenzer* and *tandik* whose first syllables differ in English vowels that they find difficult to distinguish, namely /æ/ and /ɛ/.

In the present study, we further test whether difficulties in sound perception also impact word learning in Spanish learners of Dutch. To this end, we compare learners' ability to learn novel words which either differed only in their vowels, i.e., minimal pairs, or in more than one sound and their number of syllables, i.e., nonminimal pairs. It has been shown that Spanish learners have difficulties with a number of Dutch vowel contrasts (Escudero, Benders, & Lipski, 2009; Escudero & Wanrooij, 2010). Here it was tested whether these perceptual problems transfer to the learning of words that minimally differ in the same vowel contrasts. Given the previous literature on the recognition of minimally different words reviewed above, we predicted that minimal pairs will be more difficult to learn than nonminimal pairs for both learners and natives. In addition, if perceptual problems indeed transfer to word recognition, we expected that learners will have more difficulty than Dutch listeners with words that contain vowel contrasts that do not exist in Spanish.

An important component of the present study is its focus on learners for which the target language is their L3 rather than their L2. We expected that proficiency in English (L2) would have a positive effect on the learners' performance. That is, we predicted that having learned a second language with new vowel contrasts that are similar to those encountered in Dutch (L3) will prove to be advantageous for the learning of Dutch words that differ only in those vowel contrasts.

METHOD

Participants

One hundred and twelve listeners participated in the study. There were 92 Spanish learners of Dutch with different levels of proficiency in L2 English and L3 Dutch, as well as 20 native speakers of Dutch who came from various parts of the Netherlands. The learners were originally from Spain and a variety of Latin American countries, residing in the Netherlands at the time of testing. All participants had normal hearing and normal or corrected vision. They received either course credit or a small fee for participation.

Prior to the experiment, learners completed the comprehension ("listening") component of the Dialang diagnostic language assessment test for Dutch and English (www.dialang.org, Alderson & Huhta, 2005). After completion of this test, a listener is given one of six scores (expressed in letter-number combinations, as A1, A2, B1, B2, C1, C2), ranging from basic (A1) to highly advanced (C2). These scores correspond to those established by the Common European Framework for language learning.[1] We computed the learners' average proficiency for the two languages by using the numbers 1–6 for each of the ascending Dialang scores. Their average Dutch proficiency was 4.3 (*SD*: 2.1), while their average English proficiency was 3.0 (*SD*: 1.5); for both proficiencies the scores ranged from 1 to 6. A paired t-test comparing learners' Dialang scores (from 1 to 6) in the two languages showed that learners' general comprehension proficiency was higher in Dutch than in English, $t(91) = 5.311$, $p < .001$. Importantly, there was no correlation between English and Dutch proficiency scores ($r = .287$).

Materials and design

Listeners performed a word-learning task in which they learned to associate 12 Dutch pseudo-words to their picture meanings. The Dutch pseudo-words were randomly paired with 12 line drawings of nonsense objects from Shatzman and McQueen (2006) for native Dutch listeners, and which were also used in Escudero et al. (2008) with L2 learners. Figure 1 shows an example of a pseudo-word together with its corresponding line drawing. All words were recorded in two Dutch sentences, meaning "*This is an X*", and "*Click on the X*". A female native speaker of Dutch read the words and sentences one by one, separated by a pause, in a clear citation style. The recording was made in a soundproof booth at the Institute of Phonetic Sciences of the University of Amsterdam, and stored at a sample rate of 41.1 kHz. One token of each sentence was used as training material. Another token of the "*Click on the X*" sentences was used for constructing the test materials: the item names were cut out of the sentences and cross-spliced onto another token of the same sentence from which the item name (/ˈfo:mpəl/) had been removed, such that the carrier sentence context during the test was kept constant.

The task consisted of identifying the picture that corresponded to a pseudo-word when paired side-by-side with a picture of another pseudo-word. During training, each pseudo-word was first presented auditorily ("*This is an X*") together with its corresponding picture. Immediately after, listeners were asked to identify the correct picture for this word when paired with the picture of another pseudo-word ("*Click on the X*"). During testing, participants were presented with trials similar to the second part of the training phase, i.e., "*Click on the X*".

Six of the pseudo-words were monosyllables produced in the /p/-vowel-/χ/ context and contained one of the six Dutch vowels /ɪ, i, ɑ, a, ʏ, y/. The remaining six had two syllables, contained different consonants and vowels from the previous six, and had

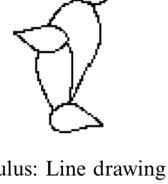

Figure 1. Example stimulus: Line drawing of the pseudo-word /pyχ/.

[1] See http://www.coe.int/t/dg4/linguistic/Source/Framework_EN.pdf for a full description of the European Framework of Language Learning.

equal numbers of long and short vowels and diphthongs in the stressed syllable (/ˈbeːptuː/, /ˈfoːmpəl/, /ˈjɔmtoː/, /ˈkɛstə/, /ˈsurkɛt/, /ˈtœykfɔm/). The six disyllabic words were either taken or adapted from Shatzman and McQueen (2006). All pseudo-words were phonotactically legal in Dutch.

Listeners were presented with all 15 pair combinations of the six monosyllabic words, which were the pseudo-words that only differed in one vowel, i.e., the 15 minimal pairs. These pairs were divided in two groups according to their expected level of difficulty for Spanish learners of Dutch:

(1) Difficult: /ɪ-i/, /ɪ-ʏ/, /ɪ-y/, /i-ʏ/, /i-y/, /ɑ-a/, /ʏ-y/
(2) Easy: /ɪ-ɑ/, /ɪ-a/, /i-ɑ/, /i-a/, /ɑ-ʏ/, /ɑ-y/, /a-ʏ/, /a-y/

Spanish listeners were expected to have difficulties identifying the correct picture when presented with the seven minimal pairs in (1), which will be referred to as "minimal-difficult". This is because the Dutch pseudo-words that correspond to the two displayed pictures contain either two high or two low vowels that are not differentiated in Spanish, a language that, among the vowels used here, only has /i/ and /a/ in its vowel inventory. Additionally, Escudero and Wanrooij (2010) have shown that Spanish learners of Dutch with advanced proficiency in Dutch have difficulty classifying the vowels involved in some of these contrasts in a sound categorisation task. In contrast, the eight minimal pairs in (2), which will be referred to as "minimal-easy", were expected to be learned with ease because Spanish also has such pairs, as is the case of /i-a/, or they involve a vowel contrast between a (mid-)high and a low vowel, which should be easy to discriminate for Spanish listeners, as Spanish also distinguishes between (mid-)high and low vowels (e.g., /e/ and /o/ versus /a/). Hence, the vowels in these pairs are likely to be classified as two different vowels by Spanish listeners, a situation that according to the Second Language Linguistic Perception Model (Escudero, 2005, 2009) and the Perceptual Assimilation Model (Best, 1995; Best & Tyler, 2007) should cause little trouble to L2 learners.

Importantly, whereas all pseudo-words are phonotactically legal, the phonotactic patterns of Dutch favour the distinction between the minimal-difficult items (in some respects) more than those of the minimal-easy items.[2] Therefore, if Spanish learners have more difficulty recognising the minimal-difficult than the minimal-easy items, it cannot be attributed to Dutch phonotactics.

Listeners were also presented with 51 pairs of pictures which referred to two pseudo-words that did not form minimal pairs, i.e., they differed in their number of syllables and/or in their consonants and vowels. Fifteen of them were formed by combining the six disyllabic words with each other and 36 by combining the six minimally different words with the six disyllabic words. These pairs will be referred to

[2] For each pseudo-word, the mean logarithmic frequency per million words of the full pseudo-word, the /p/-vowel sequence, and the vowel-/χ/ sequence was determined with the CELEX lexical database (Baayen, Piepenbrock, & Gulikers, 1995). For each pair of pseudo-words, and for each of those three frequencies, the sum of the two items in the pair and their difference was calculated. Univariate analyses of variance showed that the minimal-easy and minimal-difficult items did not differ with respect to the sum and difference for the full pseudo-word and the vowel-/χ/ sequence [$F(1, 14) < 1$ for all comparisons]. For the /p/-vowel sequence, both the sum of the frequencies, $F(1, 14) = 4.7$, $p < .05$, and the difference between them, $F(1, 14) = 6.3$, $p < .05$, was higher for the minimal-difficult than for the minimal-easy pairs, which might facilitate the distinction between the minimal-difficult compared to the minimal-easy pairs.

as "nonminimal" pairs. The number of nonminimal pairs was relatively large to divert the participants' attention from the minimal pairs. Figure 2 shows examples of minimal-easy and nonminimal pairs.

During the training phase, each item was presented as target (i.e., as "X" in the sentence "*Click on the X*") six times. The total number of trials in the training phase was 72 (12 items * 6 trials as target).

During the test phase, each of the twelve pseudo-words was presented as target 22 times, namely twice with each of the other 11 pseudo-words as distracter. Thus, all combinations of items occurred four times, with each item being the target twice. The total number of trials was 264 (12 items * 22 trials as target). Of those trials, 28 concerned minimal-difficult pairs (7 pairs * 4 presentations), 32 minimal-easy pairs (8 pairs * 4 presentations), and 204 nonminimal pairs (51 pairs * 4 presentations).

Both in the training and the test phase, all pseudo-words were used equally often, and were equally often target and distracter. The position of targets and distracters on the screen (left vs. right) was counterbalanced. To avoid clustering of target items and target positions, items were presented in a semi-random order, such that the same target could appear maximally twice in succession, and targets could appear on the same place on the screen maximally five times in succession.

Procedure

Participants were tested in a single session, one at a time in a quiet room. During training and testing, sound files were played binaurally over closed headphones at a comfortable listening level, and line drawings were presented on a computer screen in front of the participants. All listeners were given oral instructions for each part of the experiment. Instructions for both the training and testing phase were followed by 6 and 12 practice trials respectively, after which questions could be asked. The experiment was controlled with Nijmegen Experiment Set-Up (NESU) software, and lasted approximately 20 min in total.

For the training phase, participants were informed that they would be taught new Dutch words. On each trial, they would first hear the sentence "*This is an X*", and see the corresponding picture on the computer screen, and next they would hear "*Click on the X*" (with the same item name again) while two pictures were shown on the screen. Participants were asked to indicate whether "X" was the picture on the left or on the right side of the screen by pressing the left or right button on a button box in front of them.

Presentation of the first sound file ("*This is an X*") and the line drawing started simultaneously. The line drawings stayed in the middle of the screen for 2,000 ms. At 1,500 ms after the offset of the sound file (always after the line drawing had

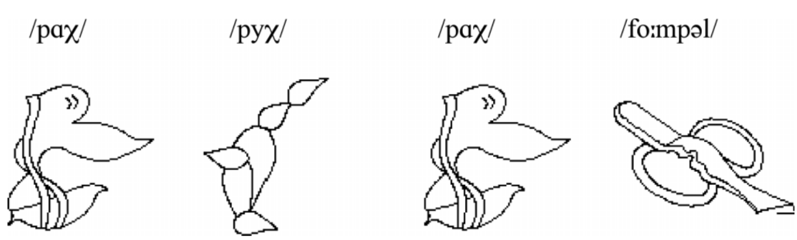

Figure 2. Left: Minimal-easy pair trial, right: Nonminimal pair trial.

disappeared), presentation of the second sound file (*"Click on the X"*) started. At the offset of that sound file, two line drawings were shown next to one another, one of which corresponded to the item "X". They stayed on the screen until one of the two response buttons was pressed. The next trial started at 1,000 ms after each button press, with a time-out of 10,000 ms.

The test phase started immediately after the training phase, with no break in between. Participants were informed that they would be tested on their recognition of the newly learned words. They would hear the sentence "*Click on the X*" while two pictures were shown on the screen. They were asked to indicate whether "X" was the picture on the left or on the right by pressing the left or right response button, like in the training phase.

Each trial started with the presentation of the sound file. At offset of the sound file, two line drawings were shown next to one another, one of which corresponded to the item "X", and stayed on the screen until one of the two response buttons was pressed. Reaction times were measured from the onset of the presentation of the two line drawings until button press. The next trial started at 500 ms after each button press, with a time-out of 10,000 ms.

RESULTS

Nonminimal, minimal-easy, and minimal-difficult pairs

All results were included in the statistical analyses. The average percentage correct for each listener was higher than 70% (range 71–100%) and the average RT of the correct responses was 1,280 ms (range 1,005 ms–1,459 ms). Figure 3 shows the percentage correct responses and RTs of the correct responses (RT) for nonminimal, minimal-difficult, and minimal-easy pairs. For convenience, the "difficult" and "easy" pairs mentioned in the Method section are repeated in (3) and (4) respectively:

(3) /ɪ-i/, /ɪ-ʏ/, /ɪ-y/, /i-ʏ/, /i-y/, /ɑ-a/, /ʏ-y/ (minimal-difficult)
(4) /ɪ-ɑ/, /ɪ-a/, /i-ɑ/, /i-a/, /ɑ-ʏ/, /ɑ-y/, /a-ʏ/, /a-y/ (minimal-easy)

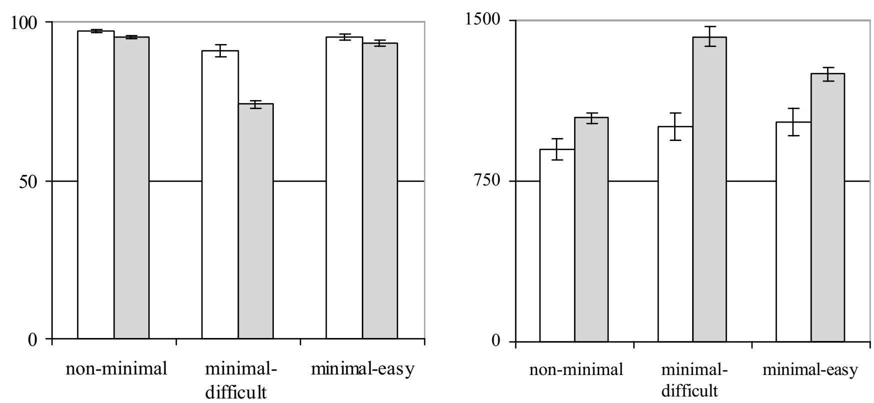

Figure 3. Recognition of nonminimal, minimal-difficult and minimal-easy novel word pairs by Dutch natives (white bars) and Spanish learners of Dutch (grey bars). Left: Percentage correct. Right: Reaction times (RTs) of the correct responses (in ms).

First, we compared performance on nonminimal pairs, minimal pairs differing in vowels that were expected to be easy for Spanish listeners (minimal-easy), and minimal pairs differing in vowels that were expected to be difficult for Spanish listeners (minimal-difficult). Repeated measures analyses of variance (ANOVAs) were performed for percentage correct and RT separately, with Pair Type (minimal-easy, minimal-difficult, and nonminimal pairs) as within-subjects and between-items variable and Group (native Dutch versus Spanish learners of Dutch) as between-subjects and within-items variable. These analyses yielded main effects of Pair Type [percentage correct: $F(1, 110) = 76{,}695$, $p < .001$; RT: $F(1, 110) = 26{,}183$, $p < .001$] and Group [percentage correct: $F(1, 110) = 20{,}498$, $p < .001$; RT: $F(1, 110) = 14{,}820$, $p < .01$], as well as an interaction Pair Type * Group [percentage correct: $F(1, 110) = 27{,}055$, $p < .001$; RT: $F(1, 110) = 8{,}415$, $p < .001$].

Crucially, as predicted, paired *t*-tests show that the Spanish learners had a higher percentage correct for minimal-easy than for minimal-difficult pairs, $t(91) = 16{,}413$, $p < .001$. Further, they had higher accuracy on nonminimal than minimal pairs [nonminimal – minimal-easy: $t(91) = 2{,}358$, $p < .05$, nonminimal – minimal-difficult: $t(91) = 18{,}653$, $p < .01$]. Their RTs were longest for minimal-difficult, intermediate for minimal-easy and shortest for nonminimal pairs (for all comparisons: $p < .001$).

Dutch natives were also less accurate on minimal than on nonminimal pairs [nonminimal – minimal-easy: $t(19) = 2{,}372$, $p < .05$, nonminimal – minimal-difficult: $t(19) = 3.219$, $p < .001$]. However, importantly, unlike for Spanish learners, their accuracy on minimal-difficult versus minimal-easy pairs was not significantly different, $t(19) = 2{,}059$, $p > .05$. Their RTs were shorter for nonminimal than minimal-difficult, $t(19) = 2{,}747$, $p < .05$, and minimal-easy pairs, $t(19) = 4{,}271$, $p < .001$, but, crucially and unlike the Spanish learners, they had very similar RTs for minimal-difficult versus minimal-easy pairs, $t(19) = .623$, $p > .5$.

Finally, independent sample *t*-tests corrected for inequality of variance when appropriate show that the Dutch natives were more accurate than the Spanish learners in the nonminimal, $t(77{,}527) = 2{,}424$, $p < .05$, and minimal-difficult pairs, $t(110) = 6{,}389$, $p < .001$, while the group difference in the minimal-easy pairs did not reach significance, $t(52{,}214) = 1{,}238$, $p > .2$. In addition, the Dutch natives were faster than the Spanish learners in all three pair types [nonminimal: $t(28{,}330) = 2{,}655$, $p < .05$, minimal-difficult: $t(110) = 4{,}171$, $p < .001$, minimal-easy: $t(110) = 3.029$, $p < .01$].

In sum, while both the Spanish learners of Dutch and the Dutch natives found nonminimal pairs easier than minimal pairs, as seen from the percentages correct as well as the RTs, only the Spanish learners showed a difference between minimal-easy and minimal-difficult pairs. Thus, vowel pairs that were expected to be difficult because of non-native speech perception difficulty for Spanish learners of Dutch indeed turned out to also be difficult in non-native word learning.

Dutch and English proficiency as predictors of word learning accuracy

To examine whether proficiency in Dutch and English can predict Spanish learners' performance in the word-learning task, we used their language comprehension scores to fit linear regression models (Method Stepwise).[3] Comprehension proficiency scores

[3] With this method, the predictor with the highest influence on the dependent variable (i.e., with the highest *F*-value) was entered into the regression model first. In the next step, the next best predictor was entered into the model. Variables were, however, only entered into the model if their significance level was below .05. If no predictor fulfilled this requirement, no regression model was formed.

TABLE 1
Regression models for percentage correct for minimal-easy and minimal-difficult pairs, Beta weight and *p* value. "*Variables included in the final regression model*": The variables Dutch and English proficiency were entered into the regression model only if they significantly contributed to the regression model, with $p < .05$

	Variables included in the final regression model:	*Beta*	*p <*
Minimal-easy pairs			
$F(1, 91) = 5{,}879$, $p < .05$; *adjusted* R^2: .051			
Dutch proficiency:	No		
English proficiency:	Yes	0.248	.02
Minimal-difficult pairs			
$F(1, 91) = 4.040$, $p < .05$; *adjusted* R^2: .032			
Dutch proficiency:	No		
English proficiency:	Yes	0.207	.05

for the 92 Spanish learners of Dutch in both languages, which were measured with English and Dutch Dialang tests (with scores ranging from 1 to 6, as described in the Method section), were entered as possible predictors of word recognition accuracy and speed (percentage correct and RT, respectively) for minimal-easy, minimal-difficult, and nonminimal pairs. Table 1 shows the results of the models for percentage correct of minimal-easy and minimal-difficult pairs.

Crucially, for both minimal-easy and minimal-difficult pairs, English proficiency significantly predicted learners' accuracy, while Dutch proficiency did not significantly contribute as a predictor and therefore was not included in either of the regression models.

For the nonminimal pairs, neither Dutch nor English proficiency significantly predicted the learners' accuracy; thus, no regression model could be formed. Similarly, neither Dutch nor English proficiency significantly predicted the learners' RTs, so that no regression models could be formed for RTs, for any of the pair types.

DISCUSSION

This study sought to investigate the learning of nonminimal, minimal-easy, and minimal-difficult word pairs by native speakers and non-native, L3 speakers. The aim was to examine to what extent native speakers are similar to or different from non-native speakers in the learning of novel words and to what extent learners' listening proficiencies in their L2 and L3 are correlated with their ability to learn novel words in the L3. To this end, an experiment was carried out in which L1 Spanish speakers with differing proficiencies in L2 English and L3 Dutch were trained and subsequently tested on their recognition of novel picture-word pairings in Dutch.

The results revealed a significant difference between nonminimal pairs on the one hand and minimal-easy and minimal-difficult pairs on the other, i.e., responses to both types of minimal pairs were found to be less accurate and slower than to nonminimal pairs, in non-natives as well as natives. This result was expected, as it is in line with the common finding that words in dense phonological neighbourhoods are recognised more slowly and less accurately than words in sparse neighbourhoods (Luce, Pisoni, & Goldinger, 1990; Newman, Sawusch, & Luce, 1997; Vitevitch & Luce, 1999). It was found that the difference between native speakers and non-native speakers was more prominent for minimal pairs than for nonminimal pairs, which suggests that non-natives experience more difficulty learning minimal pairs than native speakers do.

Most importantly, although minimal-easy and minimal-difficult pairs yielded similar accuracy and speed for the native listeners, the Spanish learners produced a higher percentage correct responses to minimal-easy than to minimal-difficult pairs and were also faster to respond to the former than to the latter. This learner result suggests continuity between pre-lexical non-native perception and L3 word recognition. Many previous studies (Broersma 2005; Broersma & Cutler, 2008; Cutler and Broersma, 2005; Cutler & Otake, 2004; Cutler et al., 2006; Escudero et al., 2008; Hayes-Harb & Masuda 2008; Pallier et al., 2001; Weber & Cutler, 2004) have already shown that L2 words containing contrasts which are difficult for learners to perceive pose problems in word recognition. The present study shows that this continuity can also be found in L3 word recognition. That is, the type of vowel contrast contained in a minimal word pair affects learners' performance only when it represents a contrast that does not exist in the learner's native language or that is likely to be perceived as a single native sound. This finding is compatible with the proposal that non-native sounds that undergo *single category assimilation*, according to Best's (1995) Perceptual Assimilation Model (Best, 1995) or that constitute a *new* contrast, in terms of Escudero's (2005) Second Language Linguistic Perception (L2LP) model, will cost the most difficulty for either non-native or L2 sound perception. Importantly, the L2LP model explicitly proposes a direct link between L2 sound perception and L2 word recognition, i.e., L2 sound perception difficulty will lead to word learning and recognition difficulty, a link that is confirmed with the L3 results of the present paper.

Secondly, with respect to learners' proficiency, an important finding of the study is that target language proficiency (L3 Dutch) did not significantly contribute to predicting learners' accuracy in the learning of minimal or nonminimal word pairs. This means that an increase in general language proficiency does not necessarily affect all domains of language acquisition, such as word learning. This result seems counter to the common thought that an increase in language proficiency applies across the board. However, many previous studies on L2 acquisition have in fact found that there is no correlation between the learners' target language proficiency, calculated independently by a variety of proficiency tests and measures, and learners' performance on sound perception tasks (Cebrian, 2006; Escudero et al., 2009[4]; Kondaurova & Francis, 2008; Morrison, 2008, 2009). While these earlier studies all tested less than 40 L2 learners per group, a recent study by Escudero and Wanrooij (2010) tested a large group of L1-Spanish L2-Dutch listeners ($N = 204$) and also found no correlation between either general comprehension scores or self-estimations and Dutch vowel categorisation. The results of the present study reveal that this lack of correlation is not confined to (pre-lexical) perception, but extends to novel word learning.

Interestingly, in contrast to L3 Dutch proficiency, L2 English proficiency significantly predicted the Dutch word learning accuracy on both minimal-easy and minimal-difficult pairs, while Dutch proficiency did not significantly contribute as a predictor. This finding cannot be the result of a higher proficiency in English than in Dutch, as it was shown that the opposite was true: learners were significantly more proficient in Dutch than in English (see Method). Even though, on average, learners had a higher proficiency in Dutch than in English, it was the learners' proficiency in

[4] It should be noted that Escudero et al. (2009) tested Spanish learners of Dutch on one of the vowel contrasts considered in the present study, namely /a-ɑ/.

English, but not their proficiency in Dutch, which predicted their performance on the Dutch word-learning task. Moreover, the range of scores was the same in Dutch and English (1 to 6 for both languages) and variability was greater in the Dutch proficiency scores (*SD*: 2.1) than in the English ones (*SD*: 1.5) (see Method). As a result, the chance of capturing a potential relationship between proficiency and performance was in fact higher for Dutch than for English, yet a relationship was observed for English and not for Dutch. The observation that learners with a higher L2 English proficiency outperformed learners with a lower proficiency confirmed the hypothesis formulated in the introduction that the vowel inventory sizes of the languages involved would have an influence on learners' performance. More specifically, we argue that this finding can be explained by the fact that English and Dutch have comparable vowel inventory sizes, in both cases at least double the number of Spanish vowels. To attain a high English proficiency, L1 Spanish learners already needed to learn new vowel contrasts. Despite the fact that the vowel contrasts in the Dutch and English languages are not the same, they involve similar acoustic dimensions such as vowel duration and tenseness which are absent in Spanish, and learners who have acquired these cues when learning L2 English can reuse them when learning L3 Dutch. Thus, the learning of new vowel contrasts that have similar counterparts in both languages, such as /a-ɑ/ or /i-ɪ/, may enhance performance in at least one of the languages, in this case the learners' L3 (Dutch). This is in line with the finding by Mattock, Polka, Rvachew, and Krehm (2010) that bilingual French-English infants learned minimally different novel words such as "bowce" and "gowce" faster than monolingual English and French children because these words differed in a phoneme contrast, i.e., /b/-/g/, that is present in both of the bilinguals' languages.

On a final note, the hypothesis that vowel inventory expansion affects L3 learning also implies that L2 learners whose first two languages have a small vowel inventory would not have the same advantage when learning an L3 with a large vowel inventory as the one we found in this study for Spanish learners of Dutch with L2 English. Although Gallardo del Puerto's (2007) study does not test word learning but vowel perception, it shows that more balanced Spanish-Basque bilinguals who have a small number of vowels in both of their first languages did not show an advantage over less balanced bilinguals who were dominant in Spanish when learning English vowels. Further research should show the degree to which comparable sound inventories between trilinguals' three languages facilitate the learning of minimally different words in either of the three languages.

In sum, the present study has contributed to the growing body of research on L3 acquisition by showing, first, that L3 vowel contrasts which do not occur in the learners' L1 pose problems in L3 word recognition. While it is well known that non-native contrasts lead to problems in the realm of sound perception, the observation that these contrasts also cause problems in L3 word recognition suggests that there is strong continuity between pre-lexical non-native perception and non-native word recognition. Secondly, the results showed that L2 proficiency may play an important role in L3 word recognition when the sound inventories of the L2 and L3 are similar: when learners have acquired additional cues to distinguish between non-native contrasts in the L2, they can apparently reuse these cues for L3 word learning.

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