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TITLE:

Is there an orthographic boost for ambiguous words during their processing?

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RUNNING HEAD:

Orthographic processing of ambiguous words

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The present study explores the issue of why ambiguous words are recognized faster than unambiguous ones during word recognition. To this end we contrasted two different hypotheses: the *semantic feedback* hypothesis (Hino & Lupker, 1996), and the hypothesis proposed by Borowsky and Masson (1996). Although both hypotheses agree that ambiguous words benefit during recognition in that they engage more semantic activation, they disagree as to whether or not this greater semantic activation feeds back to the orthographic level, hence speeding up the orthographic coding of ambiguous words. Participants were presented with ambiguous and unambiguous words in two tasks, a lexical decision task (LDT) and a two-alternative forced-choice task (2AFC). We found differences between ambiguous and unambiguous words in both the LDT and the 2AFC tasks. These results suggest that the orthographic coding of ambiguous words is boosted during word processing. This finding lends support to the semantic feedback hypothesis.

Keywords**:** semantic ambiguity; ambiguity advantage; word recognition; orthographic processing; two-alternative forced-choice task

Introduction

Many studies have shown that ambiguous words (that is, words having more than one meaning, such as *bank*) are recognized faster than unambiguous words (words having only one meaning, like *tennis*) in a lexical decision task (hereafter, LDT; e.g., Borowsky & Masson, 1996; Fraga, Padrón, Perea, & Comesaña, 2017; Haro, Demestre, Boada, & Ferré, 2017; Haro & Ferré, 2018; Hino, Kusunose, & Lupker, 2010; Hino, Lupker, & Pexman, 2002; Hino & Lupker, 1996; Hino, Pexman, & Lupker, 2006; Jastrzembski & Stanners, 1975; Jastrzembski, 1981; Kellas, Ferraro, & Simpson, 1988; Lin & Ahrens, 2010; Millis & Button, 1989; Pexman, Hino, & Lupker, 2004; Rubenstein, Garfield, & Millikan, 1970). Despite such a large body of evidence, the source of the so-called *ambiguity advantage* has not been fully clarified. Some early accounts claimed that the cause of the facilitation for ambiguous words in LDT was that these words are represented by multiple lexical entries, one for each of their meanings. As such, the likelihood of finding a match for an ambiguous word during the scanning of lexical entries is higher than for an unambiguous word (e.g., Forster & Bednall, 1976). More recent accounts, by contrast, have suggested that ambiguous words do not have multiple lexical entries, but rather multiple semantic representations (i.e., Borowsky & Masson, 1996; Hino & Lupker, 1996). Thus, the cause of the facilitation for ambiguous words in LDT would be that these words engage a large amount of semantic activation during processing.

Although an interesting proposition, it is not clear how such enhanced semantic activation might boost ambiguous word recognition. Indeed, two different hypotheses have been suggested. On the one hand, Hino and Lupker's (1996) *semantic feedback* hypothesis relies on principles of interactive activation (e.g., Balota, Ferraro & Connor, 1991; McClelland & Rumelhart, 1981). Within this framework, the visual word processing system consists of at least two linked, bidirectional levels of processing, one devoted to the orthography and the other to the meaning of the word. When the system is presented with a word, activation spreads forward (from the orthographic to the semantic level) and backwards (from the semantic to the orthographic level), and the word is recognized when the activation at the orthographic level reaches a given threshold. Accordingly, the activation at the semantic level modulates the activation at the orthographic level during word processing, so that the more semantic information a word has (e.g., number of meanings), the higher is the impact on its orthographic processing. The ambiguity advantage, then, is the result of multiple semantic representations of ambiguous words providing a large amount of semantic feedback for their orthographic representation, leading to ambiguous words reaching the threshold for word recognition faster than unambiguous words.

The alternative hypothesis for the ambiguity advantage was provided by Borowsky and Masson (1996). They developed and tested a Parallel Distributed Processing (i.e., PDP) model consisting of three levels of processing units, each representing the orthography, phonology and semantics of a word. The model differs in two significant aspects with respect to that of Hino and Lupker. First, Borowsky and Masson assigned a unidirectional link between orthographic and semantic levels, so that activation can only flow forward (i.e., from the orthographic to the semantic level). Second, they postulated that word recognition not only depends on the amount of activation reached at the orthographic level, as Hino and Lupker suggested, but also at the semantic level. Thus, a word is recognized when the summed activation of both orthographic and semantic levels reaches a given value. Despite these restrictions, simulation data from Borowsky and Masson’s model clearly replicated the ambiguity advantage, as ambiguous words reached the criterion for word recognition faster than unambiguous words. This was the case because all the different meanings of ambiguous words were partially activated during word processing, eliciting more semantic activation than unambiguous words. However, it is important to note that since the link between orthographic and semantic levels was not bidirectional, this increased semantic activation for ambiguous words had no effect on orthographic processing. Therefore, when ambiguous words reached the criteria for word recognition during the simulations, no differences in the amount of orthographic activation were found between these words and unambiguous words.

In light of the above considerations, it seems clear that the main discrepancy between the two accounts is related to whether or not orthographic processing is boosted during the recognition of ambiguous words. To test this hypothesis, in the present study we compared ambiguous and unambiguous words in a task designed to tap perceptual aspects of word processing. We employed a two-alternative forced-choice task (hereafter, 2AFC), in which a word was presented briefly (i.e., flashed word), and immediately afterwards the participant was asked to decide which of two strings of letters was the flashed word. It should be noted that similar 2AFC tasks have been employed in previous studies that investigated perceptual aspects of word processing. For instance, they have been used to examine (a) perceptual encoding of emotional words (Zeelenberg, Wagenwakers, & Rotteveel, 2006); (b) recognition of words (e.g., *lied*) after the study of orthographically similar (e.g., *died*) and dissimilar words (e.g., *sofa*) (Bowers, 1999; Ratcliff & McKoon, 1997); (c) letter position coding effects (Gomez, Ratcliff, & Perea, 2008), and (d) word frequency and repetition priming effects (Wagenmakers, Zeelenberg, & Raaijmakers, 2000), among others.

In the 2AFC task used in the present study[1], the flashed word, which could be either an ambiguous or an unambiguous word, was displayed for 50 ms. After that, participants were presented with two response alternatives: the word that had been presented before (i.e., the

[1]Note that the following description and predictions correspond to the 2AFC task used in Experiment 2. Since there is some evidence showing that semantic processing may affect 2AFC responses (see discussion of Experiment 2), we conducted a third experiment in which the response alternatives were a lexical neighbor of the flashed word and a control word of that neighbor, in order to be sure that the observed effects are produced by orthographic activation.

flashed word) and a lexical neighbor of it (see figure 1 for a schematic representation of the task). Thus, since participants were asked to discriminate between two words that were almost identical in their orthography, we expected that those flashed words triggering more orthographic activation would be discriminated more easily. According to the semantic feedback account (Hino & Lupker, 1996), since the orthographic representation of ambiguous words benefits from a great amount of semantic-to-orthographic feedback, ambiguous words should be discriminated easier in the 2AFC task. By contrast, based on Borowsky and Masson (1996)'s model, because the enhanced semantic activation for ambiguous words does not have any influence on orthographic processing, we should not observe an advantage for ambiguous words in the 2AFC task. Finally, before conducting the main experiment we verified that our experimental stimuli showed the typical ambiguity advantage in LDT. Thus, the experimental stimuli to be presented in the 2AFC task (Experiment 2) were first tested in a LDT (Experiment 1).

Experiment 1

Method

Participants

Twenty-two Spanish speakers (18 women and 4 men, mean age = 22 years) participated in the experiment. These were undergraduate students who received academic credits for their participation. All had either normal or corrected-to-normal vision.

Design and materials

Experimental stimuli consisted of 50 Spanish words: 25 ambiguous words and 25 unambiguous words. The ambiguous/unambiguous categorization was based on Number-Of-Meanings (NOM) ratings (c.f., Kellas, et al., 1988; Pexman et al., 2004). The NOM ratings were obtained from the normative study of Haro, Ferré, Boada, and Demestre (2017). To obtain NOM, participants were required to indicate how many meanings a string of letters has, on a 3-point scale: (0) *the word has no meaning*, (1) *the word has one meaning*, or (2) *the word has more than one meaning*. Words with NOM ratings below 1.3 were classified as unambiguous, and words with NOM ratings above 1.4 were classified as ambiguous. This criterion was similar to that used in previous studies (e.g., Hino et al., 2006). The average NOM rating was 1.11 (SD = 0.08) for unambiguous words and 1.71 (SD = 0.16) for ambiguous words, $t(48) = 17.20$, $p < .001$. In addition, stimuli were matched on several lexical and semantic variables that influence word recognition (see Table 1). Specifically, they were matched in terms of number of letters, number of syllables, logarithm of word frequency (log word frequency), mean Levenshtein distance of the 20 closest words (OLD20), number of neighbors, number of higher frequency neighbors, bigram frequency, trigram frequency, and logarithm of contextual diversity (log contextual diversity) (all *p*s > .13). These values were taken from EsPal (Duchon, Perea, Sebastián-Gallés, Martí, & Carreiras, 2013). Ambiguous and unambiguous words were also matched in terms of familiarity, concreteness, valence, and subjective age of acquisition (all *p*s > .48). The values for these variables were taken from Haro et al. (2017). Finally, 50 pseudohomophones matched in length to words were included as nonwords in the LDT. All the materials are presented in the Appendix.

[Table 1 near here]

Procedure

Participants completed a LDT consisting of 100 experimental trials. Each trial started with a fixation point (i.e., “+”) appearing in the middle of the screen for 500 ms. Next, a string of letters (a word or a pseudoword) replaced the fixation point, and then participants had to decide whether the string was or was not a Spanish word. They were instructed to press the "yes" button of a keypad with the preferred hand if the string of letters was a word, and to press the "no" button of the keypad with the non-preferred hand if it was not a word. The string of letters remained on the screen until participant's response or timeout (2000 ms). After responding, a feedback message (i.e., "ERROR" or "CORRECT") was displayed for 750 ms. The interval time between trials was 500 ms. We used DMDX software (Forster & Forster, 2003) to present the stimuli and to record the responses. The order of the experimental trials was randomized for each participant. Prior to the beginning of the experiment, a practice block consisting of 10 trials (5 words and 5 nonwords) was presented.

Results and Discussion

RTs that exceeded 2 SD of each participant's mean were rejected (4.9%). The mean of reaction times (RT) for correct responses and the mean of error rates (%E) across experimental conditions (averaged across participants) are shown in Table 2.

[Table 2 near here]

The results showed that ambiguous words were faster and more accurately recognized than unambiguous words, $t_1(21) = 5.81$, $p < .001$, $t_2(48) = 2.41$, $p = .02$, $t_1(21) = 2.37$, $p = .028$, $t_2(48) = 1.88$, $p = .067$, for latency and error data respectively. Therefore, the selected stimuli produced a robust ambiguity advantage, resembling that observed in previous studies (e.g., Haro et al., 2017; Haro & Ferré, 2018; Hino et al., 2002; Hino & Lupker, 1996; Jastrzembski & Stanners, 1975; Jastrzembski, 1981; Kellas et al., 1988; Lin & Ahrens, 2010; Millis & Button, 1989; Pexman et al., 2004; Rubenstein et al., 1970). The stimuli were thus suitable to be tested in the 2AFC task, which was the task used in the Experiment 2 to assess the two theoretical accounts of the ambiguity advantage mentioned above.

Experiment 2

Method

Participants

Thirty-one Spanish speakers (22 women and 9 men, mean age = 22 years) from the same population as those in the first experiment carried out the task. They were undergraduate students who received academic credits for their participation, and all of them had either normal or corrected-to-normal vision.

Design and materials

Experimental stimuli comprised 50 pairs of words, each pair consisting of a word from Experiment 1 and a lexical neighbor differing in one or two letters. For example, the unambiguous word *techo* ("roof") was paired with its neighbor *pecho* ("chest"), and the ambiguous word *fuente* ("fountain" or "source") was paired with its neighbor *puente* ("bridge"). Thus, there were two conditions: one formed by 25 pairs of words containing an unambiguous word, and the other formed by 25 pairs of words containing an ambiguous word. Experimental conditions were matched for a large number of variables (all *p*s > .28; see Table 3). First, conditions were matched for the Levensthein distance, and number of different letters between the target and its neighbor. Levensthein distance and orthographic similarity were computed using NIM (Guasch, Boada, Ferré, & Sánchez-Casas, 2013). Furthermore, since deviant letter position (i.e., the position occupied by the letter that varies between the target and the neighbor) can influence word recognition (see Comesaña, Coelho, Oliveira, & Soares, 2017, for more detail), this variable was matched between conditions. There was a similar number of pairs between conditions having a deviant letter in the first, middle, last and other positions. Finally, the lexical neighbor of each pair was matched between conditions in log word frequency, number of letters and syllables, number of neighbors, number of higher frequency neighbors, OLD20, and trigram and bigram frequency. All these variables were obtained from EsPal (Duchon et al., 2013).

[Table 3 near here]

Procedure

The stimuli were presented using a 2AFC paradigm. The sequence of each trial was as follows. First, a fixation point ("+") was displayed for 500 ms in the center of the screen. Then, a word (i.e., an ambiguous or unambiguous word) was presented for 50 ms, and was then immediately masked with segments of letters. When the mask appeared, two lowercase words were displayed below it, one on each side. These words were the flashed ambiguous or unambiguous word and its lexical neighbor (e.g., *cerveza-certeza*). Then, participants were asked to decide which of the two words was the flashed one. Participants had to press the right button of a keypad if the flashed word was the one located on the right, and left button if it was the one located on the left. The next trial started automatically after response or timeout (3000 ms). There were two different versions of the experiment to counterbalance the position of the target (i.e., left or right) across participants. Participants were presented with 10 practice trials and 50 experimental trials. The order of the experimental trials was randomized for each participant.

Results and Discussion

Following the usual procedure for analyzing the 2AFC data (e.g., Ratcliff & McKoon, 1996), we calculated the mean %E across experimental conditions (see Figure 2).

[Figure 2 near here]

The results showed that ambiguous words (mean %E = 12.52%, SD = 9.84%) were identified more accurately than unambiguous words (mean %E = 16.39%, SD = 11.88%),

$t_1(30) = 2.27$, $p = .031$, although the effect was marginal in the analysis by items, $t_2(98) = 1.67$, $p = .097$.

The advantage for ambiguous words in the 2AFC task suggests that orthographic processing is boosted during ambiguous word processing, in accordance with the semantic feedback account (Hino & Lupker, 1996). However, there is the possibility that the ambiguity advantage observed in the 2AFC task was not caused exclusively by an orthographic boost for ambiguous words. Indeed, there is evidence showing that 2AFC responses may be somewhat influenced by semantic processing (e.g., Bell, Forster, & Drake, 2015; Marcel, 1983). For example, in the study of Marcel (1983), participants conducted a 2AFC task in which the flashed word and one of the two targets were related semantically (e.g., *dog* - wallet/animal). Participants had to indicate which of them was semantically related to the preceding flashed word. The results showed that although participants did not consciously perceive the flashed word, they were able to select the correct option above chance.

Taking this into account, one could argue that the results of Experiment 2 do not strongly suggest that ambiguous words benefit from an orthographic boost. For this reason, we designed a new 2AFC experiment in which targets and flashed words were only orthographically related. In this experiment, the targets were a lexical neighbor of the flashed word and a control of that neighbor. Participants were asked to decide which of the two targets was orthographically related with the previously flashed word.

Experiment 3

Method

Participants

Forty-one Spanish speakers (35 women and 6 men, mean age = 21 years) from the same population as those of the previous experiments participated in this experiment. They were undergraduate students who received academic credits for their participation, and all of them had either normal or corrected-to-normal vision.

Design and materials

The experimental stimuli were the same as those employed in Experiment 2. In addition, we selected 50 control words for the lexical neighbors. They were pairwise matched with the lexical neighbors in log frequency, number of letters, number of neighbors, number of higher frequency neighbors, and OLD20 (all *p*s > .32). The values for these variables were obtained from EsPal (Duchon et al., 2013).

Procedure

The procedure of the 2AFC was similar to that employed in Experiment 2, but with some changes that are detailed as follows. Unlike Experiment 2, the words presented after the unambiguous or ambiguous flashed word (e.g. *faro*) were its lexical neighbor (e.g., *foro*) and a control for that neighbor (e.g., *lona*). In addition, participants were asked to decide which of the two words was orthographically related with the flashed word. Finally, all 50 trials were presented three times (in three different randomized blocks) to each participant.

Results and Discussion

As in Experiment 2, we calculated the mean %E across experimental conditions (see Figure 2). The results showed that lexical neighbors preceded by ambiguous words (mean %E = 8.62%, SD = 7.98%) were identified less accurately than those preceded by unambiguous words (mean %E = 6.57%, SD = 7.80%) in the analysis by participants, $F_1(1,40) = 14.88$, $p < .001$, although the effect did not reach significance in the analysis by items, $F_2(1,48) = 1.97$, $p = .17$.

Hence, ambiguous words caused an inhibitory effect in this experiment. At a first glance, this result might seem to contradict the facilitation effect found for ambiguous words in Experiments 1 and 2. However, this is not the case: The inhibition effect found here is similar to that observed in other studies that employ a masked form priming procedure, where participants are required to respond to a target word preceded by an orthographically related subliminal word. Using this procedure, some studies reported that target words are recognized slower and less accurately when they are preceded by a lexical neighbor in the LDT (e.g., De Moor & Brysbaert, 2000; Segui & Grainger, 1990). The explanation for this effect, according to the interactive activation model (McClelland & Rumelhart, 1981), is that the orthographic representation of the neighbor, that was presented as a prime, is strongly activated while participants try to recognize the target. Consequently, the activation of the neighbor interferes with the recognition of the target word, resulting in slower reaction times and more errors for these words in the LDT. Taking this into account, the inhibition found in the 2AFC can be explained in a similar way. Assuming that semantic-to-orthographic feedback is larger for ambiguous words than for unambiguous words, the orthographic representation of an ambiguous word would be more active after its presentation than that of an unambiguous word. As such, when participants were required to decide which of the two displayed words (i.e., a lexical neighbor of the flashed word or a control of that neighbor) was orthographically related to the one presented before, more interference would be expected when the flashed word was an ambiguous word than when it was an unambiguous word. Thus, the results of this experiment provide further support to the hypothesis that ambiguous words benefit from an orthographic boost (Hino & Lupker, 1996).

General Discussion

The aim of the present study was to investigate the source of the ambiguity advantage, that is, the reason why ambiguous words are recognized faster than unambiguous words during word recognition. We contrasted two hypotheses here: i) the semantic feedback hypothesis (Hino & Lupker, 1996), and ii) the hypothesis developed by Borowsky and Masson (1996). Although both agree that the facilitation for ambiguous words is because these words elicit more semantic activation than unambiguous ones, they differ in whether such enhanced semantic activation boosts orthographic coding (Hino & Lupker, 1996) or not (Borowsky & Masson, 1996). To examine this question, we analyzed the processing of ambiguous and unambiguous words using a task that taps perceptual aspects of word processing (i.e., the 2AFC task). A LDT was also used to verify that the typical ambiguity advantage reported in previous LDT studies (e.g., Hino et al., 2002; Lin & Ahrens, 2010; Rubenstein et al., 1970) was also observed here.

The results showed a facilitation of ambiguous words in the LDT as well as differences between ambiguous and unambiguous words in the 2AFC tasks. Therefore, the results of the 2AFC tasks are incompatible with the PDP model of Borowsky and Masson (1996). This model assumes that the link between the orthographic and the semantic level is unidirectional, so that semantic-to-orthographic feedback is not allowed, and thus no differences should be expected between ambiguous and unambiguous words in tasks that tap perceptual aspects of word processing. In contrast, the evidence obtained in the 2AFC tasks suggests that orthographic processing is boosted during ambiguous word processing, thus giving support to the semantic feedback account (Hino & Lupker, 1996). This account is based on interaction activation principles, in which activation flows bidirectionally between orthographic and semantic levels after presenting the input word (e.g., Balota et al., 1991; McClelland & Rumelhart, 1981). Hence, because ambiguous words have multiple semantic representations, their orthographic representation would receive a large amount of semantic feedback during word processing. This would eventually speed up the orthographic coding of these words, allowing them to reach the orthographic activation criteria for word recognition faster. In sum, the present study suggests that ambiguous words benefit from a boost in their orthographic coding during word processing, and this would explain why such words are usually recognized faster than unambiguous words in LDT.

On the other hand, the findings of the present study may have more implications beyond ambiguous word processing. These results support the existence of bidirectional links between orthographic and semantic levels of word representation, so that feedback from semantics to orthography is allowed during word processing. This semantics-to-orthography feedback mechanism may account for several effects found in word recognition research. For instance, it could explain why words with many synonyms are recognized more slowly in LDT than those with few synonyms (Hino et al., 2002). Namely, such a synonymy effect would be due to a single semantic representation spreading its activation to multiple orthographic representations (i.e., one for each synonym), thus increasing competition at the orthographic level and delaying the recognition of the target word. Similarly, semantics-to-orthography feedback could also account for semantic richness effects in word recognition. There is evidence showing that words having more or richer semantic information exhibit an advantage in different experimental tasks, such as LDT, naming, and semantic categorization (e.g., Yap, Pexman, Wellsby, Hargreaves, Huff, 2012). This effect has been observed with variables such as the number of semantic features (Pexman, Hargreaves, Siakaluk, Bodner, & Pope, 2008), the number of semantic neighbors or the density of semantic neighborhood (Yap et al., 2012), and the strength of the visual associations of a word (e.g., Hargreaves & Pexman, 2012). The explanation for semantic richness effects in word recognition would be the same as that given for semantic ambiguity effects: words with more or richer semantic information would give rise to a greater amount of semantic-orthographic feedback, boosting the orthographic processing of these words and, therefore, their recognition in the lexical decision task.

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Table 1. *Characteristics of the stimulus used in both experiments (standard deviations are shown in parentheses).*

	NOM	FRE	CTD	FAM	AoA	LNG	SYL	CON	VAL	OLD20	NEI	NHF	BFQ	TFQ
Unambiguous	1.11	1.18	0.75	5.51	6.83	6.16	2.60	5.43	4.78	1.87	4.76	0.80	6,100	718.39
	(0.08)	(0.60)	(0.43)	(0.95)	(2.63)	(1.7)	(0.82)	(0.86)	(1.38)	(0.51)	(5.19)	(1.12)	(4,017)	(756.48)
Ambiguous	1.71	1.03	0.71	5.55	6.37	6.36	2.52	5.35	5.01	1.68	5.60	0.88	5,117	793.37
	(0.16)	(0.47)	(0.37)	(0.80)	(1.89)	(1.35)	(0.59)	(0.68)	(1.09)	(0.35)	(6.80)	(1.23)	(3,840)	(756.85)

Note. NOM = subjective Number-Of-Meanings ratings; FRE = log word frequency; CTD = log contextual diversity; FAM = familiarity; AoA = subjective age-of-acquisition; LNG = word length; SYL = number of syllables; CON = concreteness; VAL = emotional valence; NEI = number of substitution neighbors; NHF = number of higher frequency substitution neighbors; BFQ = mean bigram frequency; TFQ = mean trigram frequency.

Table 2. *Mean RT (in ms), and percentage of error rates (%E) in Experiment 1 per experimental condition (standard deviations in parentheses)*

Ambiguity	Mean RT	%E
Unambiguous	628 (113)	5.19 (4.29)
Ambiguous	591 (102)	2.48 (3.62)
Pseudowords	672 (119)	8.46 (6.77)

Table 3. *Characteristics of the pairs of stimulus used in the 2AFC task (standard deviations are shown in parentheses).*

	LD	OS	DIFF	FRE	LNG	SYL	OLD20	NEI	NHF	BFQ	TFQ
Unambiguous	0.75	0.70	1.52	1.01	6.16	2.52	1.71	5.52	1.04	7,368	1,117
	(0.08)	(0.11)	(0.51)	(0.55)	(1.70)	(0.77)	(0.43)	(5.92)	(1.43)	(5,878)	(2,373)
Ambiguous	0.75	0.71	1.52	1.11	6.36	2.56	1.62	5.52	1.16	5,805	1,190
	(0.08)	(0.11)	(0.51)	(0.67)	(1.35)	(0.58)	(0.28)	(5.99)	(2.10)	(4,002)	(1,140)

Note. LD = Levensthein distance between the target and its neighbor; OS = orthographic similarity between the target and its neighbor; DIFF = number of different letters between the target and its neighbor; FRE = log word frequency of the neighbor; LNG = word length of the neighbor; SYL = number of syllables of the neighbor; NEI = number of substitution neighbors of the neighbor; NHF = number of higher frequency substitution neighbors of the neighbor; BFQ = mean bigram frequency of the neighbor; TFQ = mean trigram frequency of the neighbor.

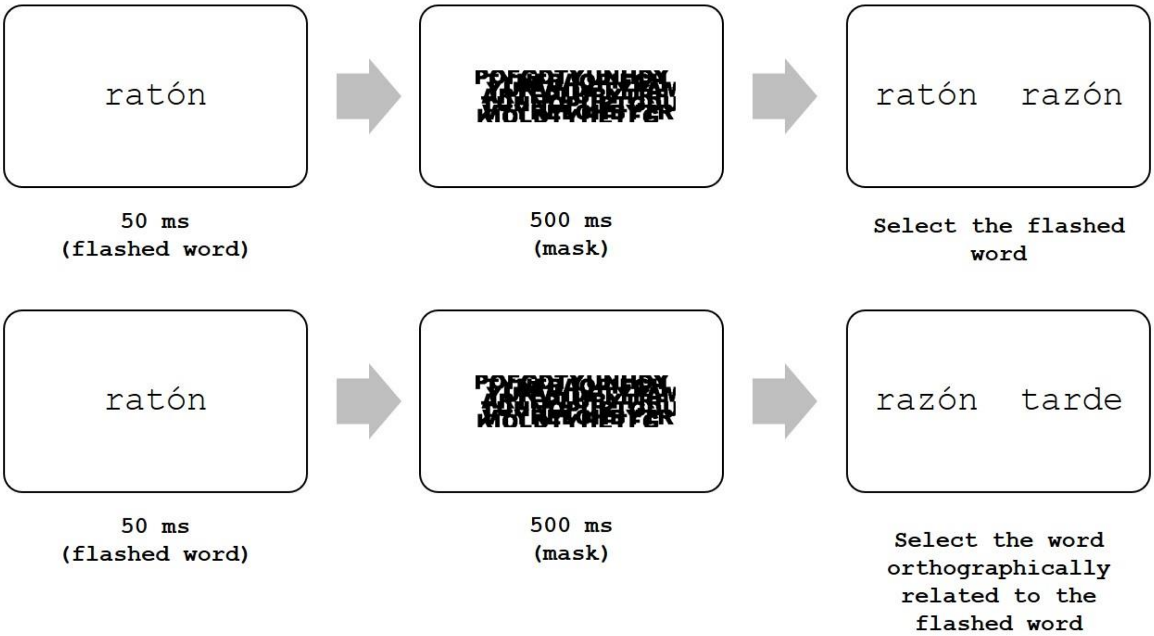

Figure 1. Schematic illustration of the 2AFC tasks employed in Experiment 2 and Experiment 3, respectively.

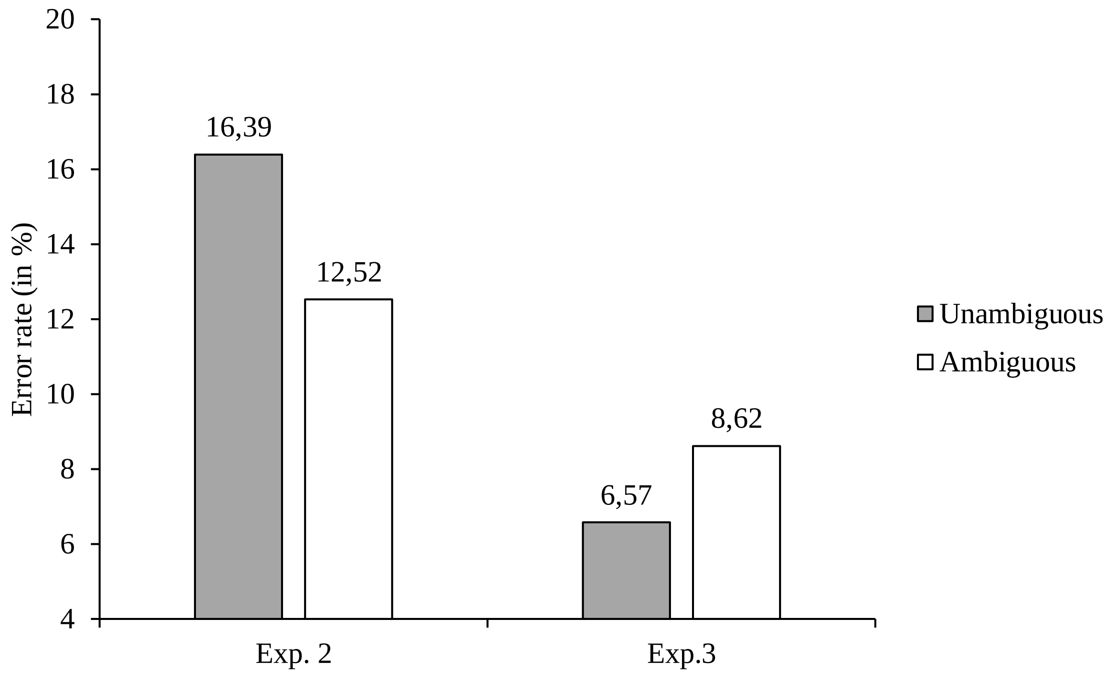

Figure 2. Mean error rate for unambiguous and ambiguous words in experiments 2 and 3.

APPENDIX

Experimental stimuli

Condition	Target	Target trans.	Neighbor	Neighbor trans.	Pseudohomophone	Pseudohomophone original word
unambiguous	abeja	bee	queja	complaint	arina	harina
unambiguous	aceite	oil	agente	agent / officer	bajina	vagina
unambiguous	alcalde	mayor	alcance	range /significance	tunva	tumbas
unambiguous	almirante	admiral	aspirante	candidate	bervo	verbo
unambiguous	cal	lime (calcium oxide)	col	cabbage	ardiya	ardilla
unambiguous	calor	hot	color	colour	gayo	gallo
unambiguous	camión	truck	cartón	cardboard	fayo	fallos
unambiguous	cerveza	beer	certeza	certainty	monio	moño
unambiguous	cirugía	surgery	ciruela	plum	omosexual	homosexual
unambiguous	contusión	bruise	confesión	confession	rodiya	rodilla
unambiguous	cueva	cave	curva	curve	llate	yate
unambiguous	demencia	dementia	decencia	decency	raia	raya
unambiguous	ecuación	equation	erupción	eruption	berso	verso
unambiguous	electrón	electron	elección	choice	jobentut	joventut
unambiguous	enzima	enzyme	encina	holm oak	beneno	veneno
unambiguous	hijo	son	hilo	thread	hoso	oso
unambiguous	humo	smoke	zumo	juice	urvano	urbano
unambiguous	jabón	soap	jamón	ham	vaía	bahía
unambiguous	lealtad	loyalty	fealdad	ugliness	poyo	pollo
unambiguous	lencería	lingerie	mercería	haberdashery	anvición	ambición
unambiguous	miel	honey	piel	skin	havuso	abuso

unambiguous	modestia	modesty	molestia	bother	amariya	amarilla
unambiguous	techo	ceiling	pecho	chest	idrójeno	hidrógeno
unambiguous	tenis	tennis	tesis	thesis	rovo	robo
unambiguous	vejez	old age	veloz	quick	orario	horario
ambiguous	activo	active / assets	altivo	arrogant	bisual	visual
ambiguous	acuario	Aquarius / aquarium	armario	cupboard	elado	helado
ambiguous	asistir	help / assist / attend	existir	to exist	varvilla	barbilla
ambiguous	botones	buttons / bellboy	balones	balls	viología	biología
ambiguous	canario	canary / Canarian (demonym of Canary Islands)	catarro	cold (illness)	abenida	avenida
ambiguous	churro	fritter / mess	charco	puddle	bela	vela
ambiguous	cómoda	comfortable / chest of drawers	comida	food	vurguesía	burguesía
ambiguous	complejo	complex	completo	full	enbra	hembras
ambiguous	faro	lighthouse / headlamp	foro	forum	vevé	bebé
ambiguous	ficha	piece / ticket	fecha	date (time)	corvata	corbata
ambiguous	fracción	part / fraction	tracción	traction	alva	alba
ambiguous	fuente	source / fountain	puente	bridge	envra	hembra
ambiguous	golpe	hit / robbery	gripe	flu	imbasión	invasión
ambiguous	herencia	legacy / heredity	carencia	lack	novle	noble
ambiguous	lima	lime (tool) / rasp	liga	league / garter	erida	herida
ambiguous	navaja	knife / razor shell	baraja	deck of cards	yabe	llave
ambiguous	pasador	bolt (security) / hairclip	paladar	palate / taste	ierva	hierba
ambiguous	pensión	pension / hostel	presión	pressure	bibienda	vivienda
ambiguous	plato	plate	plazo	period / deadline	onbro	hombro
ambiguous	postal	postal / postcard	portal	hallway / website	beículo	vehículo

ambiguous	ratón	mouse	razón	reason / reasoning	biernes	viernes
ambiguous	resolución	resolution / decision	revolución	revolution	notavle	notable
ambiguous	segundo	second	seguido	followed	voteya	botella
ambiguous	tanque	tank	parque	park	dever	deber
ambiguous	tronco	trunk / mate	trofeo	trophy	jenética	genética