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Spoken word recognition in French
Reconocimiento de palabras habladas en francés

A study about the effects of phonological neighborhood density
Un estudio sobre los efectos de la densidad de vecindad fonológica

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Abstract:

Different linguistic factors can influence the recognition of spoken words in French. We are interested in the impact of the linguistic factor of phonological density, which refers to the number of phonological neighbours of words and which is related to the recognition process according to a principle of inhibition and lexical competition. By using a lexical decision task, where half of the words have a low phonological density, and the other half a high phonological density, we aim to measure the reaction times of a group of young French-speaking participants (18-35 years old). The results of the young French-speaking group did not show a phonological density effect, however, these results did show a lexicality effect, demonstrating that the word and pseudo-word recognition task worked well. Thus, from the error analyses, the involvement of another factor, word familiarity, was induced. The post-experimental survey on this new factor showed an imbalance between the high and low density groups. By removing the low familiarity items from the analysis, a significant phonological density effect was obtained at this time. It is essential to discuss the role of word familiarity on spoken word recognition; as well as the material development for spoken word recognition tasks.

Keywords:

Spoken word recognition, phonological density, lexicality, processing speed, lexical decision, French.

Resumen:

Diferentes factores lingüísticos pueden influir en el reconocimiento de palabras habladas en francés, como es el caso de la densidad fonológica, que se refiere al número de vecinos fonológicos de las palabras y que está relacionado con el proceso de reconocimiento según un principio de inhibición y competencia léxica. Mediante una tarea de decisión léxica, en la que la mitad de las palabras tienen una densidad fonológica baja y la otra mitad una densidad fonológica alta, se pretende medir los tiempos de reacción de un grupo de participantes jóvenes francófonos (18-35 años). En este estudio, el resultado obtenido del grupo de jóvenes francófonos no mostró un efecto de densidad fonológica, lo que difiere del resto de la literatura. Sin embargo, estos resultados sí mostraron un efecto de lexicalidad, indicando que la tarea de reconocimiento de palabras y pseudopalabras es funcional. En vista de esto, a partir de los análisis de errores, se indujo la implicación de otro factor, la familiaridad de las palabras. La encuesta post-experimental sobre este nuevo factor mostró un desequilibrio entre los grupos de alta y baja densidad. Al eliminar del análisis los ítems de baja familiaridad, se obtuvo esta vez un efecto significativo de densidad fonológica. En conclusión, es necesario discutir sobre el rol de la familiaridad de las palabras en el reconocimiento de las palabras habladas, así como replantear el desarrollo del material para las tareas de reconocimiento de las palabras habladas.

Palabras Clave:

Reconocimiento de palabras habladas, densidad fonológica, lexicalidad, velocidad de procesamiento, decisión léxica, francés.

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Introduction

Spoken word recognition is a natural phenomenon in the everyday communication process. On the one hand, we are able to grasp the speaker's intention, and on the other hand, we are able to carry out other cognitive functions such as attention, learning and memory. Therefore, since the beginning of cognitive science and psycholinguistics, spoken word recognition has been a popular subject of study (Dufour & Nguyen, 2017). In cognitive science, theories of spoken word recognition refer to episodic details stored in memory and to abstract representations or mental images. In psycholinguistics, which is the approach to this work, theories imply that the auditory input can activate other words that overlap with the phonemic composition. For example, the word 'cat', can lead to the activation of words like: 'cab', 'cap', 'bat'. (Dufour & Nguyen, 2017). Precisely, listeners recognise words through a process of activation and competition, in which the activation of several candidate words partially matches the speech signal (Hunter, 2016). When one of these candidates stands out, all others are eventually deactivated. For this reason, the number of phonological neighbours of a spoken word can have an effect on recognition. Thus, regarding phonological high-density words, recognition is expected to be more difficult; because there will be more lexical options available. On the contrary, regarding phonological low-density words, recognition is expected to be easier and faster; because there will be fewer lexical competitors available. Previous research on this topic has been primarily based on visual word recognition contexts, where the concept of neighbourhood density is defined in terms of spelling and not in phoneme similarity (Hunter, 2016). The small amount of research based on auditory contexts, mainly deals with the involvement of environmental noises, hence the interest of this work.

Spoken word recognition and models of speech perception

Words can be perceived through two different channels, visual and auditory. Visual word recognition concerns reading. Auditory word recognition concerns oral exchanges in everyday life. By spoken word recognition we refer to the processes matching acoustic-phonetic information to lexical patterns stored in memory (Amanda & Metsala, 1990). Due to subsequent processes which encompass how individuals access and retrieve words in the mental lexicon, different theories of speech perception and many models emerged. The two main ones are the COHORT model and the TRACE computational model, which were developed in the 1980s. Among these models, the TRACE model (1986) seems to be the most adequate for this study. If we compare it to models like the COHORT model (1987), The COHORT model follows a principle of activation and rest of candidate words, meaning that it does not consider the linguistic factors of frequency and phonological neighbourhood density; whereas the TRACE model follows a principle of lexical competition where the number of competitors is important. Moreover, the COHORT model is conditioned by a linear and continuous recognition mechanism that does not allow error. Since there is no going back, great importance is placed at the beginning of the word. Thus, when there are sound distortions at an early stage of recognition, the whole process is affected. Sound distortions or environmental noises could cloud the listener's perception and impact on the creation of the cohort; while the TRACE model has many manipulable parameters and it has the advantage of feedback. Finally, since the COHORT model takes into account semantic and syntactic cues in the integration phase (the last phase of the recognition process), it is ideal for the recognition of words in a sentence context; and not for isolated words as in the TRACE model. In the following paragraph, we explain, in more detail, how this model works.

TRACE: connectionist model of speech perception

TRACE model has three levels of processing: acoustic features, phonemes and words. We move from one level to another to determine which word we have heard. Acoustic features, phonemic information, and semantic information are taken into account in order to link what we have just heard with the words stored in memory. For example, changing a phoneme, defined as the smallest sound unit, could lead to a change in the meaning of the word. This is the case for the phonemes /u/ and /y/ for the French minimal pairs 'roue' [wheel] and 'rue' [street]. Thus, the model seeks to explain the phenomenon of spoken word recognition under a principle of interactive activation between acoustic features, phonemes and words. This is why the name of the model refers to the trace of these three levels when activated over time (McClelland & Elman, 1986). This sequential activation follows a connectionist principle represented by three types of connectivity: top-excitatory, lateral-inhibitory, and retroactive-excitatory. The first connectivity, the top-excitatory (figure 1), is in a linear direction; from auditory input into features, from features into phonemes and from phonemes into words (McClelland & Elman, 1986).

Top-excitatory connectivity

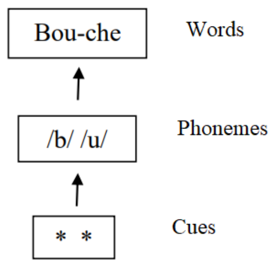


Figure 1. TRACE model first connectivity: top-excitatory. Word 'bouche' [mouth].

In the second connectivity, the lateral-inhibitory (figure 2), phonemes and words inhibit units in their specific layers (McClelland & Elman, 1986). In the phoneme stratum, inhibition is lateral, with one layer for each phoneme: /b/, /u/. In the word stratum, inhibition is also lateral, there must be a layer for each word.

Lateral-inhibitory connectivity

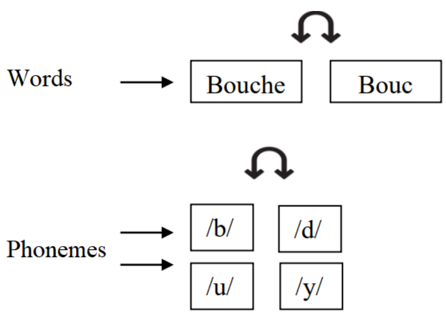


Figure 2. TRACE model second connectivity: lateral-inhibitory. Words 'bouche' [mouth] and 'bouc' [goat].

The third connectivity, the retroactive-excitatory (Figure 3), uses feedback; which is one of the special features of TRACE compared to other models of speech perception. This connectivity runs from higher to lower levels, from words to phonemes (McClelland & Elman, 1986):

Retroactive-excitatory connectivity

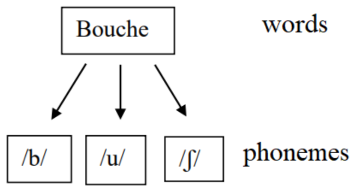


Figure 3. TRACE model third connectivity: retroactive-excitatory. Word 'bouche' [mouth] and phonemes /b/, /u/, /ʃ/.

This third type of connectivity allows improvements in categorical perception, because it reaffirms sound discrimination, provides insight into how phonemes relate within a language and analyses lexical effects on phoneme identification (Ganong, 1980). For example, according to the English data presented by Ganong (1980), if the sound heard by the speaker is ambiguous '/?/ash', the listener might perceive the phoneme /d/ instead of the phoneme /t/, because 'dash' is a word in English and 'tash' is not. Thus, lexical processing is evidenced from the linking of sensory input to the various phonological, semantic, and pragmatic information of words stored in memory, and recognition occurs as a result of competition between several potentially activated candidate words.

Lexical competition and phonological neighbours

Candidate words are similar acoustic-phonetic representations activated in memory and processed by a listener (Dufour & Nguyen, 2017). When these activated representations compete, intra-level inhibitions occur: one word manages to inhibit its competitors. Furthermore, the similarity between these auditory word forms becomes an important factor for recognition. Specifically, as already mentioned, one of the key concepts that allows us to measure the impact of this similarity between auditory word forms is the phonological neighbourhood density; which refers to the total number of words that audibly resemble a given word. In this case, the total number of similar or neighbouring words results from the addition, deletion or substitution of one of the phonological segments of the word in question (Gahl & Strand, 2016). Thus, we think that the more phonologically similar a word is, the more uncertainty it causes. High-density words will be less easily recognised than low density words as they have a greater number of lexical competitors. Words such as 'poids' /pwa/ [weight] will refer to a large number of words such as: 'bois' /bwa/, 'trois' /tʁwa/, 'mois' /mwa/, 'noix' /nwa/. [wood, three, month, nut] (examples from the Usito online dictionary, 2021).

Methodology

In order to test this hypothesis, where we seek to affirm or to dispute what is in the literature, we propose an experimental paradigm in which, based on a behavioural task of lexical decision, we measure the reaction times of participants.

Participants

Thirty-four young native French speakers between the ages of 19 and 33 participated in the experiment. However, due to technical problems where the data acquisition software did not work properly, the performance of two subjects was not taken into account. In addition, in order to avoid bias in the study, the responses of subjects three and four, who were bilingual subjects and whose exclusion criterion was discovered after the test, were also removed from the analysis. Thus, of the remaining thirty participants (mean age 21.73), there were twenty-five females and five males. With the exception of three people who worked, the rest of the participants were students at the University of Aix-Marseille. There was one doctoral student, three master's students and twenty-three undergraduate students. In terms of field of study, there was a wide variety of backgrounds, however, (56.6%) were studying psychology. With regard to other languages learned at school, with the exception of four subjects, twenty-six had knowledge of languages such as English, Spanish, Italian, German, Chinese, Vietnamese, Arabic and Comorian. Finally, with regard to the dominant hand, twenty-five participants were right-handed, three left-handed and two ambidextrous. No one had any hearing or language disorders.

Material

Regarding the creation of the experiment's material, the lexical database VOCOLEX was used (Dufour, Peereman, Pallier & Radeau, 2002). This database provides statistical indices on various linguistic characteristics of words, in particular the phonological similarity between French words according to two criteria: the first in relation to the similarity between the initial phonemes of a word, the second concerning the phonological neighbourhood density of a word. Thus, 25 high phonological density words and 25 low phonological density words were chosen. For the high density words, we considered words with 11-17 neighbours, while for the low density words, the number of neighbours was 0-4. Concerning the lexical frequency of both groups of words, in order to avoid bias in the study, this factor was controlled. For the low density words, we had an average of 114.84 (see appendix 1), while for the high density words it was 108.16 (see appendix 2).
As for the creation of the 50 pseudo-words, which were going to have a filler function, we selected again 25 high phonological density words and 25 low phonological density words. Every word had three phonemes, and only the last one was changed (see appendix 3).
All 50 words and 50 pseudo-words were monosyllabic words with a CVC (consonant-vowel-consonant) structure. In Appendix 3, the list of pseudo-words used in the experiment is shown, as well as the base words that were used for their construction.
In order for the subjects to understand the task and to adapt to the dynamics of lexical choices, another 10 items were presented in advance in a training phase: 5 words and 5 pseudo-words (see appendix 4)
a deaf room where she repeated 3 times consecutively each word from the list of 110 items. This recording was played back on the PRAAT software. This software made possible to look at the spectrogram of the speaker's oral production and, in a second step, to cut it into audio files and select the one of best quality (see figure 4). Finally, using the E-prime software, the list of 100 audio files was randomised and presented to the participants with a laptop, headphones and a two-button answer box for the lexical decision task. This software also simultaneously recorded and stored all the participants' responses: reaction times, choice errors.

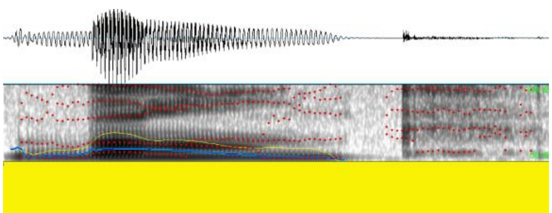


Figure 4. Spectrogram of the audio file 'banque' [bank]. Best stimulus selected on the PRAAT software.

Lexical decision task

Although pseudo-words are used as fillers for this particular task, the lexicality variable, which refers to the sound sequence heard in relation to the information stored in the listener's memory, is emphasised in order to determine whether or not it is a word of the French language. There are two types of possible sound sequences: on the one hand, there are semantic-free sequences, which are constructed from a series of random phonemes that do not correspond to the phonotactic structure of the language (non-words); and on the other hand, there are non-semantic-free sequences, which respect the phonotactic rules of the language (pseudo-words) (Whiteside & Varley, 1999), which is the case for this experiment.

Procedure

Before starting the experiment, participants were asked to fill in the 'participant form' (appendix 5), which requested personal information from the subject such as: gender, age, education level, and a test to identify the dominant hand. The participants performed the experiment one by one in an experimental room at the Labortoire Parole et Langage (LPL). In order to enhance the participant's concentration, the experiment was conducted in an experimental room where external noise was muted. Stimuli were presented through headphones at an appropriate sound level.

Participants were asked to perform the lexical decision task as quickly and accurately as possible. This involved grasping the answer box in front with both hands and putting both index fingers on the buttons to press when the experiment was started. The 'word' button had to correspond to the participant's dominant hand and the 'pseudo-word' button to the non-dominant hand. There was no time limit for responding, but a 2s delay between the subject's response and the presentation of the next trial.

Results

Statistical analysis

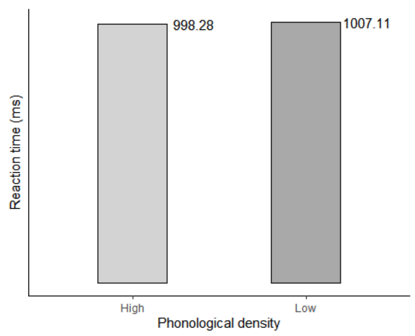
To evaluate the effect of phonological density, a linear mixed regression model was used using the statistical program R. The significance threshold value was set at $p < 0.05$.

An item-base analysis was conducted, considering the dependent variable reaction time (log), a central tendency where the values are continuously and symmetrically distributed by the normal distribution (expectation μ; standard deviation σ), as well as the independent variables: low density and high density; and lexical status: word, pseudo-word.

Phonological neighbourhood density

The calculated reaction times were 998.28 ms (+/- 239.76) for high-density words, and 1007.11 ms (+/- 242.31) for low-density words (graphic 1). This indicates that there is no significant effect between the two groups (β = 0.01, std.err 0.02, t= 0.39, p=0.69).

Phonological density effect



Graphic 1. Average reaction times for phonologically high-density words and phonologically low-density words.

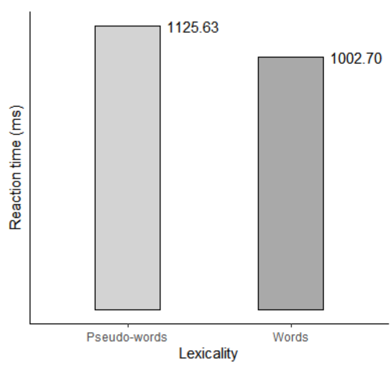
Errors

Concerning the percentage of assertiveness per group, there is an acceptable and very balanced margin of error: 94.2% for words with many neighbours and 94.1% for words with few neighbours.

Lexicality

An additional verification analysis was performed to ensure that the task was carried out correctly. The calculated reaction time for words were 1002.70 ms (+/- 288.16), and 1125.63 ms (+/- 286.14) for pseudo-words (figure 6). This shows a significant effect (β = 0.11, std.err 0.016, t= 6.56, p<0.001).

Lexicality effect



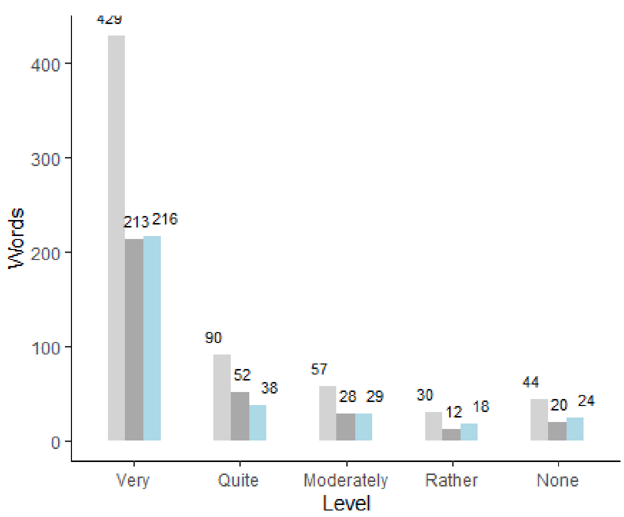
Graphic 2. Average reaction times for words and pseudo-words.

Errors

There was an acceptable margin of error. 95.1% correct answers for words, 96% for pseudo-words. This shows an inverse trend effect in which, even if the percentage difference is not important since it represents the 0.9%, there were more errors for words than for pseudo-words.

Familiarity

Based on the results on phonological density and lexicality, and by observing the error analyses, the involvement of the word familiarity factor was inferred. In order to verify this, it was decided to carry out a post-experimental test. The test was estimated to last about 5 minutes and consisted of completing a questionnaire in which the degree of familiarity of each word was rated on a scale of 1 to 5: ‘not familiar at all’, ‘rather familiar’, "moderately familiar", ‘quite familiar’ and ‘very familiar’. Only 13 of the 30 subjects in the original experiment participated. The number of responses obtained per level of the scale is shown: all words, high density words, low density words (see graphic 3).



Graphic 3. Number of responses per level of the familiarity scale. All words, high-density words, low density words.

Errors

At every level of the familiarity scale, the responses for words and pseudo-words were balanced, and the differences were not large. In general, responses for low-density words predominated slightly more than those for high-density words, with the exception of the 'quite familiar' level, where there were more responses for high-density words.

According to the calculation of the averages of the responses, we identified the words that were unknown for the participants. They had averages below 3.7 (see appendix 6). Among these words, six belonged to the list of low phonological density words: ‘feinte’ [to feint], ‘meule’ [grindstone], ‘zinc’ [zinc], ‘ronce’ [bramble], ‘songe’ [dream], veuve [widow], and only one of them belonged to the list of high density words: ‘rate’ [spleen], which created an imbalance. Pie charts are shown for each of the six words, revealing the percentages of familiarity by level in the scale (appendix 7).

Phonological neighbourhood density reanalysis

The results of the familiarity test showed that some words are less well recognised than others. We therefore decided to remove from the analysis the seven low familiarity words. By doing this, we obtained a trending effect ($\beta = 0.016$, std.err 0.010, $t = 1.66$, $p=0.09$).

Discussion

The first results regarding the phonological neighbourhood density variable did not show a significant effect, which differ from our hypotheses and the rest of the literature. Therefore, it was decided to do an additional analysis and check the lexicality effect to test the well-functioning of the lexical decision task. The obtained lexicality effect was significant, however, it was found that when analysing the errors, and despite of having an overall assertiveness rate of 95.1%; there was an inverse trend effect where pseudo-words were slightly better recognised than words (96% vs 95%). Although this was not a significant difference in percentage of errors, it did raise questions about the words used in the experiment. Luce and Pisoni (1998) suggest that a 'word' response would be executed by means of the activation of a stored schema in the mental lexicon, whereas a 'non-word' response would be executed after having exhausted all the possibilities of corresponding schemas in the mental lexicon. In view of these results, other variables were implied to play a role in the recognition process. We observed that there were particular words that elicited more errors than others. The fact that some words were better recognized made us think about the involvement of the word-familiarity variable, which represents how well a word is known by an individual (Leroy & Kauchak., 2014). An additional survey involving the total number of words used in the experiment was conducted. Looking at the results of the familiarity survey, we found an imbalance regarding the familiarity of words in the high and low density groups; where there were six that belonged to the low density word group and only one that belonged to the high density word group. By removing these seven items from the analysis, a phonological density trend effect was obtained this time. This is congruent with the rest of the literature. It is then inferred that participants had difficulty knowing certain words because they were not familiar with them. An issue is then raised in regard to the role of word familiarity. It has been previously suggested that word familiarity, a subjective measure based on ratings, may be a more accurate measure of word recognition than word frequency, even though word frequency effects have had an important impact on theories of lexical access and many word recognition models have incorporated this factor in their architecture (Connine, Mullennix, Shernoff & Yelen, 1990). Little attention has been given to word familiarity despite of its strong effect on spoken word recognition. An explanation of this could be the unavailability of familiarity data for most words (Amano, Kondo, Sakamoto & Suzuki, 2006); as word familiarity is inherent to the listener's characteristics and not to the words as such (Grosjean, 1985). Therefore, for this particular experiment, we induced that there could be a generational effect in which all the participants are young enough to recognise a vocabulary which may no longer be used in a daily basis, and which may have eventually fallen into disuse, as vocabularies evolve on a time-scale to fit the population's expectations (Smith, 2004). According to Bochkarev, Solovyev and Wichmann (2014), the rate of evolution of the lexicon has to do with social interaction and with the frequency with which we use different words. New lexical items appear while others cease to be used. Frequently used words evolve at a slower rate and infrequently used words at a more rapid rate (Pagel, Mark, Atkinson, Quentin, Meade & Andrew, 2007). However, it is difficult to know about the dynamics of lexical evolution, because spoken language tents to be less conservative than written language, and it is harder to have a proper register such as for written language. Therefore, more research is needed regarding the inherent characteristics of subjects that propitiate word familiarity, as well as the role of lexical evolution in material development for word recognition tasks.

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Appendix

	Low density										
	PHON	GRAPH	NPHONS	FRECUM	NSYLL	PU	COPTY2	HFCOPTY2	VOTY	VOHTY	V
1	bºb	bombe	3	26	1	4	53	2	14	2	
2	f5t	feinte	3	5	1	4	13	1	19	11	
3	z5g	zinc	3	11	1	4	7	0	5	0	
4	Z9n	jeune	3	417	1	4	5	0	6	0	
5	dºk	donc	3	524	1	4	17	1	10	1	
6	d5d	dinde	3	1	1	4	9	2	6	3	
7	k9R	coeur	3	308	1	4	18	0	14	5	
8	mºd	monde	3	611	1	4	93	1	17	1	
9	m2l	meule	3	5	1	4	15	0	11	6	
10	m5s	mince	3	51	1	4	31	2	15	2	
11	n9v	neuve	3	28	1	4	5	1	6	2	
12	nyk	nuque	3	26	1	4	66	4	7	2	
13	sºZ	songe	3	40	1	4	51	2	12	1	
14	f9j	feuille	3	99	1	4	32	0	15	2	
15	k5z	quinze	3	69	1	4	35	0	6	1	
16	lºg	longue	3	186	1	4	45	2	8	1	
17	v9v	veuve	3	24	1	4	5	0	6	3	
18	Z@b	jambe	3	131	1	4	34	2	7	2	
19	Z@R	genre	3	135	1	4	34	1	9	2	
20	b@k	banque	3	47	1	4	57	1	18	2	
21	l5Z	linge	3	27	1	4	38	0	11	0	
22	gEp	guêpe	3	4	1	4	39	5	12	3	
23	kEs	caisse	3	65	1	4	42	3	18	4	
24	pºp	pompe	3	25	1	4	97	1	18	1	
25	Rºs	ronce	3	6	1	4	91	5	18	6	
	MEAN		3	**115**	1	4	37	1	12	3	

Note. the most frequent or most used definition of phonological density is the one adopted for this work: VOTY; because it best fits Luce and Pisoni's model and the sequentiality of the spoken word recognition process. However, two other measures were also tested: COPTY2, for words that share the onset, which has been shown to be important for word recognition; VOSTY3, for lexical comprehension

Appendix II

	High density										
	PHON	GRAPH	NPHONS	FRECUM	NSYLL	PU	COPTY2	HFCOPTY2	VOTY	VOHTY	VOSTY3
1	kaR	car	3	472	1	4	1387	0	56	2	17
2	bij	bille	3	14	1	4	323	6	31	2	16
3	RaZ	rage	3	24	1	4	1017	17	35	8	15
4	kOR	corps	3	393	1	4	1225	1	40	5	14
5	kOl	col	3	47	1	4	1225	22	48	10	14
6	gaz	gaz	3	56	1	4	419	4	32	1	14
7	gaR	gare	3	52	1	4	419	5	46	9	14
8	bOl	bol	3	13	1	4	253	12	39	19	14
9	bOt	botte	3	25	1	4	253	7	41	10	14
10	bav	bave	3	3	1	4	743	74	30	14	14
11	bas	basse	3	75	1	4	743	2	35	5	14
12	sEk	sec	3	55	1	4	301	12	30	8	13
13	sEl	sel	3	760	1	4	301	2	41	4	13
14	fas	face	3	255	1	4	400	2	36	2	13
15	faR	phare	3	23	1	4	400	21	43	16	13
16	pat	patte	3	87	1	4	1176	23	49	4	12
17	pan	panne	3	9	1	4	1176	111	32	12	12
18	tas	tasse	3	19	1	4	453	12	38	13	11
19	taR	tard	3	247	1	4	453	0	46	3	11
20	kas	casse	3	23	1	4	1387	44	44	16	17
21	kap	cape	3	26	1	4	1387	37	39	5	17
22	biS	biche	3	7	1	4	323	11	36	6	16
23	biz	bise	3	5	1	4	323	16	38	11	16
24	Rat	rate	3	3	1	4	1017	88	43	23	15
25	Ram	rame	3	11	1	4	1017	37	44	13	15
	MEAN		3	**108**	1	4	725	23	40	9	14

Appendix III

	Pseudo-words	base
1	louffe	louche
2	mibe	mine
3	nague	nappe
4	puve	puce
5	soube	soude
6	jube	jupe
7	douffe	douce
8	fude	fugue
9	manve	manche
10	mube	mur
11	nèppe	nerf
12	nobbe	nord
13	rangue	rampe
14	rouche	rousse
15	ruffe	ruche
16	chabe	chasse
17	chaide	chaise
18	chime	chine
19	tembe	tempe
20	toube	tour
21	gèke	gel
22	buffe	bulle
23	fème	fer
24	quive	quiche
25	ponne	poche
26	dave	dame
27	dappe	dalle
28	daze	dard
29	fike	fille
30	fide	figue
31	fime	fine
32	laze	lac
33	laffe	lame
34	lague	lard
35	loppe	lobe
36	lode	lotte
37	tibe	tique
38	tile	tir
39	vate	vague
40	vaffe	vache
41	bème	bec
42	beppe	belle
43	dille	digue
44	dibbe	dire
45	coume	coupe
46	couffe	coude
47	lippe	lime
48	line	ligue
49	meppe	mer
50	mèbbe	messe

Appendix IV

Pseudo-word	laigne	laine
Pseudo-word	jale	jars
Pseudo-word	niffe	niche
Pseudo-word	phode	phoque
Pseudo-word	buppe	butte
Word	choc	
Word	date	
Word	tonne	
Word	terre	
Word	soupe	

Appendix V

Code sujet :

Date de passation de l'expérience : Heure de passation de l'expérience :

Nom :	Prénom :
Profession :	
Sexe : **F** / **M**	
Date de naissance :	
Lieu de résidence :	
Niveau d'études :	
Domaine d'études :	
Langue native :	
Autres langues parlées :	
Déficit auditif : **oui** / **non**	
Main dominante : **droite** / **gauche** / **ambidextre** → **VOIR DERRIERE TEST**	

QUELLE MAIN UTILISEZ-VOUS POUR	Toujours la gauche **-2**	Souvent la gauche **-2**	Sans préférence **0**	Souvent la droite **1**	Toujours la droite **2**
1. lancer une balle ?					
2. vous brosser les dents ?					
3. couper avec des ciseaux ?					
4. tenir un marteau ?					
5. vous peigner ?					
6. tenir un couteau ?					
7. tenir une allumette pour l'allumer ?					
8. tenir une raquette ?					
9. tenir un rasoir ou un tube de rouge à lèvres ?					
10. tenir une cuillère ?					
TOTAL*					
ACTIONS COMPLÉMENTAIRES:					
11. écrire ?					
12. dessiner ?					
13. tâter un tissu ?					
14.vérifier la température de l'eau ?					
15. vérifier la rugosité d'une surface ?					
	*Résultats	total entre -20 et -14= gaucher total entre -13 et +13= ambidextre total entre +14 et +20= droitier			

(adapted from Oldfield et al., 1996)

Appendix VI

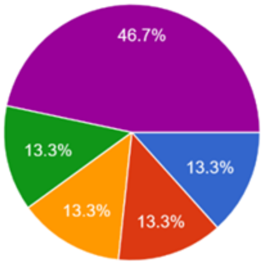
Banque	Basse	Bave	Biche	Bille	Bise	Bol	Bombe	Botte	Caisse	Cape	Car	Casse	Coeur	Col	Corps	Dinde
5	5	5	5	5	5	5	5	5	5	4	5	5	5	4	5	5
5	4	2	5	2	4	2	3	4	5	1	1	2	5	2	2	3
5	5	4	4	4	4	5	5	5	5	4	3	3	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
5	5	2	4	4	4	4	4	3	5	4	4	3	5	3	4	3
5	4	4	3	4	5	5	4	4	5	4	5	5	5	5	5	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
3	3	5	4	1	4	1	3	1	4	3	1	1	1	1	1	3
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
5	5	4	5	5	5	5	5	5	5	5	4	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
4.84615385	4.69230769	4.30769231	4.61538462	4.23076923	4.69230769	4.38461538	4.53846154	4.38461538	4.92307692	4.23076923	4.07692308	4.15384615	4.69230769	4.23076923	4.38461538	4.46153846

Donc	Face	Feinte	Feuille	Gare	Gaz	Genre	GuÊpe	Jambe	Jeune	Linge	Longue	Meule	Mince	Monde	Neuve	Nuque
5	5	4	5	5	5	5	5	5	5	5	5	3	5	5	5	5
4	2	1	2	1	3	4	3	4	4	2	5	1	2	2	3	3
5	4	2	4	4	5	5	4	5	5	5	4	3	4	5	3	4
5	5	4	5	5	5	4	5	5	5	5	5	4	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5
4	3	3	4	5	4	5	4	4	4	3	3	2	3	5	4	3
5	5	2	5	5	5	5	3	5	5	5	5	1	5	5	5	4
5	5	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5
2	3	5	1	1	1	5	1	1	1	4	1	3	4	1	3	1
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5
5	5	5	5	5	5	5	5	5	5	5	5	1	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	1	5	5	5	5
4.61538462	4.38461538	**3.76923077**	4.30769231	4.30769231	4.46153846	4.84615385	4.23076923	4.53846154	4.53846154	4.53846154	4.46153846	**2.92307692**	4.46153846	4.46153846	4.38461538	4.23076923

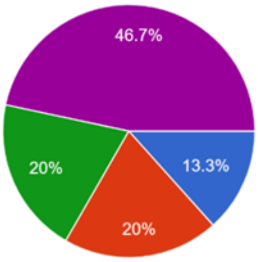
Panne	Patte	Phare	Pompe	Quinze	Rage	Rame	Rate	Ronce	Sec	Sel	Songe	Tard	Tasse	Veuve	Zinc
5	5	4	5	5	4	4	3	4	5	5	4	5	5	4	4
2	2	3	2	1	2	2	1	1	3	4	2	4	4	3	1
4	4	5	5	4	4	4	3	3	3	5	4	5	4	3	5
5	5	5	5	5	5	5	4	4	5	5	4	5	5	5	4
5	5	4	4	5	5	4	5	5	5	5	5	5	5	5	2
3	3	3	3	3	3	2	2	2	3	4	2	4	3	2	1
5	3	2	1	5	5	3	1	1	5	5	1	5	3	2	1
5	5	5	5	5	5	5	3	5	5	5	5	5	5	5	4
3	1	1	1	1	4	3	4	1	3	1	1	1	3	1	3
5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	4	5	5	5	5	5	5	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
4.38461538	4.07692308	4	3.92307692	4.15384615	4.38461538	4	**3.38461538**	**3.53846154**	4.38461538	4.53846154	**3.69230769**	4.53846154	4.38461538	3.76923077	**3.38461538**

Appendix VII

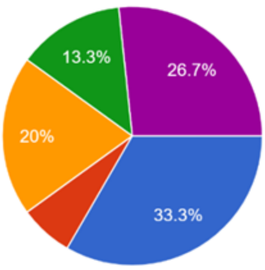
Feint



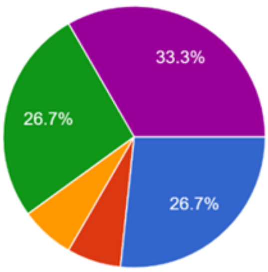
Songe



Meule



Zinc



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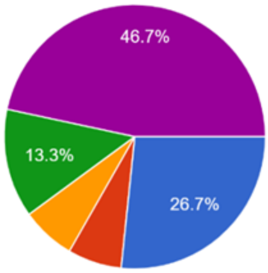

Rate