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LANGUAGE NON-SPECIFIC SELECTION IN HIGHLY PROFICIENT BILINGUALS

Farzaneh DERA VI

ABSTRACT

Three psycholinguistic experiments within a word/picture interference paradigm have been conducted with early, balanced and highly proficient Persian-French bilinguals, in order to determine the processes underlying their lexical access (activation and selection). The results support the predictions of a cascade activation model and a language non-specific model of lexical access.

Keywords: bilingualism, lexical access, bilingual speech production, Persian, French, lexical selection, lexical activation.

1. Introduction

How do bilinguals prevent interference between their languages? How does lexical selection function in highly proficient bilingual speakers? These questions remain central in psycholinguistic research on bilingualism.

The majority of researchers (Levelt, 1989; Levelt *et al.*, 1999; Costa *et al.*, 2000, 2006; Colomé, 2001) are in agreement that speech production necessitates at least three different levels of representation: a conceptual level, where the speaker decides which information he/she would like to communicate; a lexical level, where words are accompanied by their grammatical properties; and a phonological level, where the phonological words are represented.

Two mechanisms are distinguished during speech production: activation and selection.

Attempts to explain the activation process have been made through two different models: serial and cascade models. In the serial model of activation (Levelt, 1989; Schriefers *et al.* 1990; Levelt *et al.* 1999), only the node selected during the first stage of speech production sends activation to the phonological level. This model predicts phonological activation only in the further stages of speech production. On the other hand, the cascade activation model (Dell & O'Seaghdha, 1992; Peterson & Savoy, 1998) suggests that the activation goes continuously from the lexical to the phonological level, and therefore is not limited to the lexical node selected. This model predicts phonological activation at every stage (initial and subsequent) of speech production.

Furthermore, two different models have been put forward to describe the bilingual lexical selection process. There is a debate concerning whether lexical competition is restricted to the nodes of the response language or whether all the nodes enter into competition, regardless of their source language. The advocates of a language specific lexical selection (Costa *et al.*, 1999; Costa & Caramazza, 1999) predict that the selection mechanism considers only nodes belonging to the response language, even if the two languages are activated. Those supporting a language non-specific model of lexical selection (Green, 1986, 1998 a, 1998 b; De Bot & Shreuder, 1993; Poulisse & Bongaerts, 1994; Hermans *et al.*, 1998) suggest, on the contrary, that all activated nodes enter into competition.

The majority of the empirical results, especially those obtained recently (Costa *et al.*, 2000; Colomé, 2001), support a cascade activation model. The activation seems to pass continuously from the lexical to the phonological level. The lexical and phonological representations of the non-response language are activated.

As for the lexical selection mechanism, the empirical results as well as their interpretations differ, and there is a persisting debate between the different research communities. A number of paradigms have been used to check the validity of activation and lexical selection models and several have produced converging results: the semantic competitor priming paradigm (Lee and Williams, 2001) and the phoneme monitoring paradigm (Colomé, 2001) concluded in favour of a language non-specific model of lexical selection. The picture/word interference paradigm is the one which has been most used, but it has led to contradictory results (Hermans *et al.*, 1998; Costa & Caramazza 1999; Costa *et al.*, 1999 and 2003), as further explained below.

Recent attempts to reconcile these contradictory results (Finkbeiner *et al.*, 2006; Costa *et al.*, 2006; Kroll *et al.*, 2006) have highlighted the main divergences between the two models of lexical selection.

The authors who defend a model of language-specific lexical selection insist that even if the two languages are activated, only the lexical nodes of the response language are competing for selection. They refer to empirical results obtained with highly proficient bilinguals to underline that as bilingual competence increases, the speakers abandon an inhibitory mechanism, designed to prevent interference from their two languages, and rely on a language-specific selection mechanism. However, these authors recognize that their models do not provide any explanations for bilingual code switching.

The advocates of a model of language non-specific lexical selection underline that the two languages are competing in a real communication context (for example: simultaneous translation, code switching). They rely on empirical results showing that speech planning is an interactive and non-selective process, with lexical candidates competing within and between the two languages. In their view, the serial activation mechanism and the selective lexical selection mechanism represent special cases, observed only under certain conditions. Empirical evidence confirming their predictions is provided by several paradigms: picture/word interference, inhibition effect by semantic competitor priming, phoneme monitoring and translation.

2. Objectives of the study

My study aimed at replicating the experiments conducted by Hermans *et al.* (1998), Costa and Caramazza (1999) and Costa *et al.* (1999 and 2003), in order to determine which model of lexical selection is more adapted to bilingual speech production of early, balanced and highly proficient Persian-French bilinguals.

As the experiments conducted within the picture/word interference paradigm had led to contradictory results and because the level of proficiency had been identified as one of the main factor underlying the observed differences, I chose this paradigm to design three psycholinguistic experiments conducted with these highly proficient bilinguals. In the same way as the authors mentioned above, I used phono-translation distractors (distractors phonologically related to the target word's translation) to investigate the validity of the two models of lexical selection. The language non-specific model of lexical selection predicts longer response times when phono-translation distractors are used, while the

language-specific model expects response times similar to those obtained with unrelated distractors.

The first experiment used visual distractors, following Costa's studies in 1999. Peterson and Savoy (1998) underlined that the use of visual distractors allows for a better monitoring of the lexicalization process, as the delay between the distractor's display and the participants' response is minimized. Auditory distractors add several milliseconds for the word to be read, and this can complicate the detection of the start of the lexicalization process.

The majority of the experiments conducted within the picture/word interference paradigm had been conducted with languages sharing the same alphabet. As Persian and French have distinct alphabets and belong to a different typology, in addition to allowing me to replicate the previous investigations for another pair of languages, I could investigate the impact of the differences between the two languages on the studied effects.

Auditory distractors were used in the second and third experiments, following Hermans *et al.* (1998) and Costa *et al.* (2003). The response language was inverted in the third experiment, in order to observe the impact on the various effects.

The definition of the competency level of bilinguals varies among these authors. Hermans *et al.* (1998) considered their Dutch-English bilingual participants as highly proficient: they had a minimum of five years of education in their second language and obtained good scores in linguistic tests. Costa *et al.* (1999) tested highly competent Catalan-Spanish bilinguals who had at least thirteen years of bilingual education. Costa and Caramazza (1999) tested highly competent Spanish-English bilinguals who had been practicing their second language for at least six years. Costa *et al.* (2003) considered their Spanish-Catalan participants highly competent as they were exposed to their second language before the age of six and were university students at the time of the experiments.

The highly proficient Persian-French bilinguals who took part in my experiments started their second language during their early childhood, when they were four-five years old. On average, they had benefited from a bilingual education of 11 years and had 39 years of bilingual practice when the experiments took place. The stability of their languages derives from the length of their bilingual education and practice. They were older (43 years old, on average) than the bilinguals tested by the authors mentioned above. They had all pursued their academic studies in France before settling down. As the majority of the previous studies (among them Costa *et al.*, 2003; Costa & Santesteban,

2004; Kroll *et al.*, 2006) has underlined the importance of proficiency level in bilingual lexical access, the experiments were conducted with this fairly homogeneous sample of participants who had an early start and a much longer bilingual practice than those studied previously.

The participants filled a biographic questionnaire based on the one proposed by Grosjean (2000). Their responses included the scores they had attributed to themselves to judge their level in four linguistic competences (oral production, oral comprehension, reading and writing) in French and in Persian. Their average score, on a 1 to 7 scale, was higher than 6 for French and around 6 for Persian.

An earlier study (Deravi, 2007) analyzing the code-switching patterns of this same population had underlined that these bilinguals switch frequently and without difficulties between their languages. Many of them often undertake simultaneous interpreting tasks to facilitate communication between monolingual communities which surround them. Therefore, their linguistic performances might be closer to interpreters than to second language learners and non balanced bilinguals. Therefore, I assumed that lexical access for these early, balanced and highly proficient bilinguals is language non-specific. My investigation aimed at determining whether the lexical candidates compete within and between these participants' two languages, in a speech planning process that is interactive and non-selective, as Kroll *et al.* (2006) suggest.

As mentioned before, evidence from experimental studies converges towards the validity of a cascade activation model. My experiments also aimed at investigating whether the predictions of this model apply to the speech production of these highly proficient bilinguals.

3. First experiment: visual distractors in Persian (L1 = first language), response in French (L2 = second language)

3.1. Conditions of the first experiment

The participants were 23 early, highly proficient and balanced Persian-French bilinguals (16 women and 7 men). They were all selected among former students of bilingual (French-Iranian) schools. On average, they had benefited from a bilingual parallel education (in Persian and in French) during eleven years, which had started during childhood (around the age of four), before coming to France to continue their studies and settling down. When the experiment was conducted, their ages ranged from 38 to 52. Their average age was 43 and they had 39 years of bilingual practice. Some of the participants were

simultaneous bilinguals (according to Sebastián-Gallès *et al.* 2005); they were born into a family of mixed couples (Iranian father, French mother) and had been exposed to both languages since birth.

For this experiment, 32 pictures were selected, using the standardized drawings of Alario and Ferrand (1999), who were inspired by those proposed by Cicowicz *et al.* (1997). These pictures represented common objects, animals and fruits; they were drawn in black on a white background. Twelve other pictures dedicated to the training session (warm-up trials) were added in order to prepare the participants for the experiment.

The participants had to name each picture in their second language (French). Persian was considered the first language of all participants, including simultaneous bilinguals.

Four visual distractor words (in Persian) were associated with each picture. These distractors represented the four tested conditions: the first was semantically related to the target word; the second was phonologically related to the translation (in L1) of the target word; the third was phonologically related to the target word (in L2); and the fourth was unrelated.

An extract of the list of the pictures and their related distractors is provided in Table A. For each of the Persian distractors and picture names in Persian, an IPA transcription is indicated along with French and English translations. For a full list of the distractors used for this experiment, please refer to Appendix A.

Picture	Translation	Distractors			
		Semantic	Phono-translation	Phonological	Unrelated
Mouse	موش	پنیر	موشک	سور	خبر
IPA transcription	muʃ	panir	muʃak	sur	xabar
Translation FR	souris	fromage	fusée	fête	nouvelle
Translation EN	mouse	cheese	jet	feast	news
Table	میز	صندلی	میخک	طبل	دامن
	miz	sandali	mixak	tabl	daman
	table	chaise	oeillet	tambour	jupe
	table	chair	carnation	drum	skirt

Table A – Extract of the list of Persian visual distractors used in the first experiment (Response language: French)

All the pictures had non-cognate names in both languages. The number of phonemes, letters and syllables of the distractors were matched, as much as possible. The semantic distractors were chosen to avoid any phonological relationship between the names of the picture in Persian and in French.

Hermans *et al.* (1998) used auditory distractors, while Costa *et al.* (1999) adopted visual distractors for their experiments. I chose visual distractors for this first experiment to replicate their experimental conditions with another pair of languages belonging to a different typology and using different alphabets.

Each of the 23 participants was tested in four SOA (*Stimulus Onset Asynchrony*) conditions. The 32 pictures were divided into four lists of eight pictures and completed by 12 pictures used for the training sessions (warm-up trials). Each list of 11 pictures (eight for the experiment and three for the warm-up trials) was tested in one of the four SOA conditions. The order of appearance of the lists was changed for each participant. In the lists related to the conditions SOA - 300 and - 150, the distractor was displayed respectively 300 and 150 ms before the target picture. In the list related to SOA + 150, the distractor was displayed 150 ms after the target picture. In the list related to SOA 0, the distractor appeared at the same time as the target picture.

Each participant saw each picture displayed four times on a Compaq Armada laptop screen with distractors in four conditions: semantically related, phono-translation, phonologically related, and unrelated. For instance, when the picture displayed was a mouse (/muʃ/ in Persian), four distractors were used. In the semantic condition, the distractor was /panir/ ('cheese'). This Persian word is semantically related to the target word *mouse*. In the phono-translation condition, the distractor was /muʃak/ ('jet'), as it shares the first syllable with /muʃ/ which is the translation of *mouse* in Persian. Thus, this Persian word is phonologically related to the translation in Persian of the target word, that should be named in French. In the phonological condition, the distractor was /sur/ ('feast'). This Persian word shares the first syllable with the French target word *souris* /suri/, as it is phonologically related to it. In the unrelated condition, the distractor was /xabar/ ('news'), since this Persian word is not related to the target word in French.

The pictures used for the training sessions were only seen once and they were associated with only one distractor. The training sessions always ended with a picture associated to an unrelated distractor. The 32 pictures were divided into four lists of eight pictures. For each list, the order of appearance of the distractors in the four conditions was different. Sub-lists were elaborated to manage

the order of appearance of each item. There were at least 4 trials between two presentations of the same picture within a list.

The participants were tested individually. The experimental session took place in two stages and in French (considered their second language). The instructions were given orally to the participants.

During the first stage, a booklet containing 44 pictures including 32 pictures for the experiment and 12 pictures for the training sessions was presented to the participants. For each picture, the name was printed in French at the bottom of the page. The participants were instructed to use only the name indicated in the booklet during the experiment. When the participants acknowledged having seen all the pictures, another booklet containing only the pictures was presented to them. They were asked to name the pictures again.

The second stage was dedicated to the training session followed by the experiment. At the beginning of each experiment, a block of three trials was displayed to train the participants. They could ask questions before starting the experiment itself. During the experimental session, the participants were instructed to name the pictures, as soon as possible, in their second language (French), without taking note of the visual distractors appearing on the screen in their first language (Persian).

The participants were sitting at a distance of approximately 60 cm from the computer screen and had a Plantronics headset including a microphone to record their responses. The distance to the screen could vary between participants but it was considered as comfortable by them. The pictures and the distractors were displayed in the middle of the screen. Sometimes, based on the SOA conditions, the picture and the distractor were displayed on top of each other.

The experiment was controlled by DMDX software (Forster and Forster, 2003) used in the experiments conducted by the authors mentioned previously. The StatView¹ software was chosen for the statistical analysis.

For each list, the following procedure has been respected. The participants were invited to press the space bar to begin the session. After a 500 ms pause, a fixation point was displayed during 700 ms where the picture was going to appear. The training session started with the warm-up trials: three pictures were displayed for 2000 ms. Based on the SOA conditions, a distractor could appear before, during or after the picture's display. Each training session ended with an unrelated distractor. The participants were invited to press the space bar to begin the experiment. They could make a pause or ask questions before starting the experiment. The visual distractors were displayed according to the

1. StatView version 5.0. SAS Institute Inc. Copyright 1992-1998.

SOA conditions. For negative SOA, they were displayed 300 or 150 ms before the picture. For positive SOA, they were displayed 150 ms after the picture. At SOA 0, the picture and the distractor were displayed simultaneously. After each trial, a pause of one second was inserted. Each trial lasted three seconds. At the end of each list (containing 32 trials with the exception of the warm-up trials), a message was displayed to thank the participants and inform them that they had reached the end of the list. Each participant was tested with four lists, following the above procedure. Each list was associated with one of the four SOA conditions and the order of the lists was randomly defined.

The other authors had tested different groups of participants for each SOA condition. They tested their participants on their linguistic competences in order to check the existence of a correlation between their degree of competence and the results obtained. As I tested all the Persian-French bilinguals in the four SOA conditions, each participant acted as his/her own control.

3.2. Results of the first experiment

The trials where the participants had hesitated, stuttered or provided wrong or late (superior to 2000 ms) answers were discarded. The trials where the response time was greater than two standard deviations from the participant's average response time were also discarded. The latter were replaced by the mean response time of the participant, in the corresponding distractor condition. The global error rate was 11%. The table of mean response times and error/replacement percentages per SOA condition is provided in Appendix A. Figure 1 provides the details and distinguishes between the various SOA conditions.

On the basis of these results, the following main points can be highlighted. Compared to the unrelated condition, all the other distractors facilitated picture naming, even those in phono-translation and semantic conditions. At SOA 0 ms, the participants took longer to name pictures than in other SOA conditions. The participants needed more time to name pictures when the distractors were displayed simultaneously with the pictures. A phonological facilitation effect was observed for all SOA conditions, except for SOA - 300 ms where the response times were almost identical for the various types of distractors. Phono-translation distractors facilitated the response times under all SOA conditions and did not inhibit picture naming.

Two analyses of variance were conducted for each SOA condition, to examine the interactions and their degree of significance between the two variables Type of distractor and Participant on one hand, and between the two variables Type of distractor and Picture on the other hand. At SOA - 300 ms,

both the within-participant analysis ($F(3,22)=1,237$ with $p>0,1$) and the within-picture analysis ($F(3,7)=1,537$ with $p>0,1$) reached the same conclusion: no significant effect was found. At SOA - 150 ms, the within-participant analysis ($F(3,22)=2,612$ with $p>0,1$) indicated no effect while the within-picture analysis ($F(3,7)=3,36$ with $p<0,05$) showed significant effects. The same pattern was observed at SOA 0 ms where the within-participant analysis ($F(3,22)=2,595$ with $p>0,1$) indicated no effect, contrary to the within-picture analysis ($F(3,7)=3,143$ with $p<0,05$). Finally, at SOA + 150 ms, both analyses reached the same conclusion ($F(3,22)=8,778$ with $p<0,001$ and $F(3,7)=11,102$ with $p<0,001$): significant effects of distractor type were obtained.

Therefore, the conclusions of the within-participant and within-picture analyses are similar at SOA - 300 ms (no effects) and SOA + 150 ms (important effects). For the other SOA conditions, only the within-picture analysis highlights significant effects.

The results of the within-participant analysis were confirmed by PLSD (Protected Least Significant Difference) Fisher tests conducted to compare the degree of significance of the observed effects, taken two by two, for each SOA condition. No significant effect was observed at SOA - 300 ms. There was only one significant effect, phonological compared to unrelated distractors, at SOA -150 ms. Two significant effects were observed at SOA 0 ms (phonological distractor compared to unrelated and semantic distractors). At SOA + 150 ms, all effects were significant, which explained the strong global effect obtained under this condition.

Figure 1 – Mean response times obtained for the 23 participants of the first experiment (visual distractors) for different distractor types and SOA conditions

This experiment shows a **phonological facilitation at SOA + 150 ms** replicating the results obtained by Hermans *et al.* (1998) and Costa *et al.* (2003). These authors concluded on the validity of the predictions of a language non-specific lexical selection model. However, in my experiment, contrary to the predictions of such a model, no interference effect was caused by phono-translation distractors and instead a facilitation effect was observed. Therefore, it is not possible at this stage to determine which lexical selection model is more suitable to account for these results.

Furthermore, the choice between the two activation models is difficult because of contradictory results. The facilitation effect observed at SOA + 150 ms is similar to the one observed by Hermans *et al.* (1998), who supported a serial model of activation. However, the results of this first experiment showed no interference effects regarding semantic distractors at early SOA conditions (SOA - 300 and - 150 ms), contrary to the predictions of such a model of activation.

Costa and Caramazza (1999), Costa *et al.* (1999) and the authors mentioned above observed semantic interference effects, while the results obtained with my participants suggest semantic facilitation effects that did not reach significance. Costa *et al.* (2003) also observed a weak semantic facilitation effect, at SOA 0, during their second experiment. Costa *et al.* (2005) obtained semantic facilitation effects in experiments conducted with monolinguals, when the semantic distractors were not categorically related to the name of the picture. Their findings can be used to explain the observed effects of the first experiment. In fact, most of the semantic distractors that I have used did not hold a categorical relationship with the pictures associated with them. Recently, Costa *et al.* (2008) also obtained a facilitation effect induced by phono-translation distractors in a naming task. Their bilingual participants were asked to name the colour of words written in one of their languages.

At SOA 0 ms, when Persian distractors appeared on the screen at the same time as pictures, the participants took more time to name them. One possible explanation may lie in the failure of any strategy developed by the participants to ignore these visual distractors. Therefore, the simultaneity of the word-picture appearance required a longer time to process the visual distractors and this situation entailed higher response times.

As mentioned earlier, my investigation aimed at verifying the impact of different alphabets on the observed effects. Kroll *et al.* (2006) referred to previous experiments conducted with Japanese-English bilinguals to examine the impact of cognates on phonological facilitation effects, which concluded that, despite the difference in alphabet, sharing the same phonology was enough

to produce facilitation effects. Globally, the use of visual distractors in Persian facilitated picture naming at all SOA conditions, regardless of the type of distractors used. At SOA + 150 ms, where the most significant effects were observed, these distractors facilitated the naming process: the facilitation effect was - 88 ms for phonological distractors, - 44 ms for phono-translation and - 33 ms for semantic distractors. These results highlight the role of **truly phonological representation** in reading and extend the conclusions obtained by previous studies to a new pair of languages.

3.3. Design of new experiments

The results of the first experiment were different from those obtained by other researchers. Several factors could have caused these differences: the degree of proficiency of my participants, who had a longer bilingual practice than those who participated in the other experiments; the difference between French and Persian, which are more different from each other than the pairs of languages tested by the authors mentioned above; and the choice of visual distractors.

In order to replicate as closely as possible the experiments conducted by Hermans *et al.* (1998) and Costa *et al.* (2003), who had used auditory distractors, I designed two new experiments with this type of distractors. I also wanted to check whether the inversion between the first and second language of these bilinguals would lead to different results. For this reason, in the last experiment with auditory distractors, the response language was Persian (their first language) while the distractors were in French (their second language).

Given the constraints related to the availability of my participants, I conducted the two auditory experiments the same day with each participant. Each experimental session was divided into two sub-sessions and their order alternated for each participant. During one of the sub-sessions, the participants were tested for the second or the third experiment. If they were tested for the second experiment, the language of the experimental session was French (response language and their second language); if they were tested for the third experiment, the language of the experimental session was Persian (response language and their first language).

The 23 bilinguals (6 men and 17 women) who took part in the second and third experiments belonged to the same bilingual population as those described in the first experiment. When the experiments were conducted, their ages ranged from 36 to 53. Their average age was 43 and they had 39 years of bilingual practice. They had started learning their second language around the age of 5.

Some of these bilinguals (14 of them) had taken part in the first experiment. The others were being tested for the first time.

4. Second experiment: auditory distractors in Persian (L1 = first language), response in French (L2 = second language)

4.1. Conditions of the second experiment

For the purpose of this experiment, 28 pictures were selected using the standardized drawings of Alario and Ferrand (1999). Three other pictures dedicated to the training session (warm-up trials) were added in order to prepare the participants for the experiment.

The participants had to name each picture in their second language (French). Persian was considered the first language of all the participants, including the simultaneous bilinguals.

Four auditory distractors (in Persian) were associated with each picture. These distractors represented the four tested conditions (semantic, phono-translation, phonological and unrelated).

An extract of the list of pictures and their related distractors is provided in Table B. For each of the Persian distractors and picture names in Persian, an IPA transcription is indicated along with French and English translations. For a full list of the distractors used for this experiment, please refer to Appendix B.

The picture names in the two languages and the words used as distractors were chosen according to the same rules as those applied in the first experiment. The auditory distractors were read by an Iranian female speaker who did not speak French.

Each of the 23 participants was tested in four SOA conditions. The 28 pictures were divided into four lists of seven pictures and completed by three pictures used for the training sessions (warm-up trials). Each list of 10 pictures (7 for the experiment and 3 for the warm-up trials) was tested in one of the four SOA conditions. The order of appearance of the lists was changed for each of the participants. In the lists related to the SOA conditions - 300 ms and - 150 ms, the distractor was heard respectively 300 and 150 ms before the target picture was displayed on the screen. In the list related to SOA + 150 ms, the distractor was heard 150 ms after the target picture was displayed. In the list related to SOA 0 ms, the distractor was heard at the same time as the target picture was displayed.

Picture	Translation	Distractors			
		Semantic	Phono-translation	Phonological	Unrelated
Bee IPA transcription Translation FR Translation EN	زَنَبُور zanbur abeille bee	نیش niš dard sting	زَن zan femme woman	ابر abr nuage cloud	خیار xiar concombre cucumber
Bread	نان nan pain bread	کره kare beurre butter	نازک nazok fine thin	پند pand conseil advice	چکش tjakkol marteau hammer

Table B – Extract of the list of Persian auditory distractors used in the second experiment (Response language: French)

The other conditions of this experiment were similar to those described for the first experiment with one difference: the use of auditory distractors which were heard in the headset according to the various SOA conditions. As in the first experiment, the participants were not divided per SOA group. Each participant acted as his/her own control.

4.2. Results of the second experiment

The same procedure as the one used for the first experiment was applied to detect errors. The global error rate was 8 %. The table of mean response times and error/replacement percentages per SOA condition is provided in Appendix B. Figure 2 provides the details and distinguishes between the various SOA conditions.

On the basis of these results, the following main points can be highlighted. Higher response times were obtained at SOA + 150 ms compared to other SOA conditions. The participants needed longer times to name pictures when they heard the distractors 150 ms after the pictures' appearance. At this SOA, all distractors generated inhibition effects. Semantic distractors generated response times close to those generated by unrelated distractors. Phono-translation distractors increased response times for all SOA conditions except at SOA 0 ms. Phonological distractors facilitated naming only at SOA - 300 ms and 0 ms and they slightly increased response times at SOA - 150 and + 150 ms.

Similarly to the first experiment, two analyses of variance (within-participant and within-picture) were conducted for each SOA condition.

Figure 2 – Mean response times obtained for the 23 participants of the second experiment (auditory distractors) for different distractor types and SOA conditions

At SOA - 300 ms, both the within-participant analysis ($F(3,22) = 5,770$ with $p < 0,001$) and the within-picture analysis ($F(3,6) = 6,514$ with $p < 0,001$) reached the same conclusion: significant effects of the distractors were obtained. At SOA 150 ms, both analyses ($F(3,22) = 1,799$ with $p > 0,1$ and $F(3,6) = 2,200$ with $p > 0,1$) show the absence of significant effects. The same conclusions were reached at SOA 0 ms ($F(3,22) = 0,473$ with $p > 0,1$ ms and $F(3,6) = 0,699$ with $p < 0,1$) and at SOA + 150 ms ($F(3,22) = 0,879$ with $p > 0,01$ and $F(3,6) = 1,134$ with $p > 0,01$). Therefore, the conclusions of both within-participant and within-picture analyses are similar under all SOA conditions.

PLSD Fisher tests allowed a more refined analysis of the within-participant effects. Three significant effects were observed at SOA - 300 ms for the phono-translation distractors as compared to the other distractors. A significant effect of the phono-translation distractor was also detected at SOA - 150 ms. No significant effect was observed at SOA 0 nor at + 150 ms.

These effects are **different** from those obtained during the first experiment with visual distractors. The phonological and semantic auditory distractors facilitated picture naming at SOA - 300 ms while visual distractors did not show different response times compared to the unrelated distractors. At SOA - 300 ms, the phono-translation auditory distractors increased response times while they did not show any effect in the visual experiment. These results indicate

that **lexical representations of the first language** are at work during the initial stages of speech production in their second language.

The phonological facilitation effects and the phono-translation interference effects, which were observed for early SOA conditions, tend to support the predictions of cascade activation models. However, as the phonological and semantic facilitation effects did not reach significance, it is difficult to reach a conclusion concerning the activation process. A slight phonological facilitation at SOA 0 ms and a slight phonological inhibition at SOA - 150 and + 150 ms were also detected. These results do not match the predictions of a serial model of activation and they support, albeit weakly, the cascade model.

Although the effects did not reach significance at SOA + 150 ms, they did accompany an increase in response time. This could indicate that, when auditory distractors are heard after the appearance of pictures, they all interfere with the naming process, without significant differences between them.

5. Third experiment: auditory distractors in French (L2 = second language), response in Persian (L1 = first language)

5.1. Conditions of the third experiment

The third experiment was designed to investigate the impact of the inversion of the participants' languages on the observed effects.

The 23 participants tested during this experiment were the same as those who took part in the second experiment. The conditions of this experiment were identical to those applied in the second experiment except for the following differences: the lists contained auditory distractors in French, associated with picture names in Persian; the auditory distractors were read by a French female speaker who did not speak Persian, the experimental session was conducted in Persian and the participants were instructed to reply in this language.

Picture	Translation	Distractors			
		Semantic	Phono-translation	Phonological	Unrelated
Potato	سیب زمینی	plat	pommade	cire	vache
IPA transcription	sibzamini				
Translation FR	pomme de terre				
Translation EN	potato	meal	ointment	wax	cow
Saddle	زین	cheval	céleri	zigzag	bague
	zin				
	selle				
	saddle	horse	celeri	zigzag	ring

Table C – Extract of the list of French auditory distractors used in the third experiment (Response language: Persian)

An extract of the list of the pictures and their related distractors is provided in Table C. For the picture names in Persian, an IPA transcription is indicated along with French and English translations. For a full list of the distractors used for this experiment, please refer to Appendix C.

The picture names in the two languages and the words used as distractors were chosen according to the same rules as those applied in the two previous experiments.

5.2. Results of the third experiment

The same procedure as the one used for the two previous experiments was applied to detect errors. The global error rate was 9 %. The table of mean response times and error/replacement percentages per SOA condition is provided in Appendix C. Figure 3 provides the details and distinguishes between the various SOA conditions.

On the basis of these results, the following main points can be highlighted. Phonological distractors facilitated picture naming. Semantic distractors also facilitated picture naming (except at SOA + 150 ms) but to a lesser extent than the phonological distractors. Phono-translation distractors facilitated picture naming at early SOA conditions but increased response times at SOA 0 and at SOA + 150 ms. Similarly to the previous auditory experiment, response times were higher at SOA + 150 ms compared to other SOA conditions. The participants named pictures more slowly when they heard the auditory distractors after the pictures' appearance. All distractors facilitated picture naming at early SOA conditions (- 300 and - 150 ms). Phono-translation distractors slightly inhibited

picture naming at SOA 0 ms as compared to unrelated distractors, while the other distractors facilitated naming. Only phonological distractors facilitated picture naming at SOA + 150 ms, while other distractors increased response times compared to unrelated distractors.

Figure 3 – Mean response times obtained for the 23 participants of the third experiment (auditory distractors) for different distractor types and SOA conditions

Following the same procedure as the one adopted for the previous experiments, two analyses of variance (within-participant and within-picture) were conducted for each SOA condition.

All effects observed under all SOA conditions reached significance in both analyses. At SOA - 300 ms, the within-participant analysis produced $F(3,22)=7,533$ with $p<0,001$ and the within-picture analysis displayed $F(3,6)=8,424$ with $p<0,001$. At SOA -150 ms, $F(3,22)=3,468$ with $p<0,05$ and $F(3,6)=4,799$ with $p<0,005$ were obtained. At SOA 0 ms the analyses produced $F(3,22)=3,534$ with $p<0,05$ ms and $F(3,6)=4,095$ with $p<0,01$. At SOA + 150 ms, the analyses displayed $F(3,22)=9,675$ with $p>0,0001$ and $F(3,6)=12,993$ with $p>0,0001$. Therefore, the conclusions of within-participant and within within-picture analyses were similar under all SOA conditions (as in the second experiment).

PLSD Fisher tests allowed a more refined analysis of the within-participant effects and confirmed their significance. The auditory distractors increased response times at SOA + 150 ms, as compared to other SOA conditions, as in

the second experiment. The phonological distractors facilitated picture naming, as compared to the other distractors. The semantic facilitation effect was observed at all SOA conditions, except at SOA + 150 ms and it reached significance contrary to the two previous experiments. Phono-translation distractors generated significant effects at SOA - 150 ms and SOA + 150 ms. At SOA - 150 ms they facilitated picture naming while they increased response times at SOA + 150 ms.

Four main results are derived from this third experiment.

First, the increased response times obtained at SOA + 150 (similar to observations during the second experiment) underline the fact that when auditory distractors are heard after the appearance of the pictures, they perturb the picture naming process regardless of the language of the distractor. Any strategy developed by the participants to ignore these distractors seems to have failed at this later stage of speech production. At such late SOA, French distractors increased response times for phono-translation and semantic distractors while they facilitated picture naming for phonological distractors. Therefore, during the **last stages** of speech production, the **two languages** of the bilingual are present and compete for lexical selection.

Second, the phonological facilitation effects observed at early SOA conditions (- 300 ms and - 150 ms) are consistent with the predictions of cascade activation models, which assume that activation flows between conceptual, lexical and phonological levels throughout the speech production process. These results do **not** replicate the predictions of serial models of activation, which assume a phonological activation only after the lemma selection process.

Third, the semantic facilitation effect observed at all SOA conditions, except for SOA + 150 ms, is similar to the findings of Costa *et al.* (2005), who obtained the same effect with monolinguals, when the semantic distractors were not categorically related to the names of the pictures.

Finally, the participants' second language (French) seems to have become their dominant language. The results obtained by Hermans *et al.* (1998) with Dutch-English bilinguals at SOA - 300 ms, tested in their second language (English) with distractors in their first language (Dutch) are very similar to those obtained with Persian-French bilinguals tested in their dominant language (French) with distractors in their less dominant language (Persian): a phonological facilitation was observed for all distractors. Similarly, the results obtained by Costa *et al.* (2003) at SOA + 150 ms with Spanish-English bilinguals tested in their second language (English) are identical to those observed with Persian-French bilinguals tested in their less dominant language (Persian):

6. General Discussion

The results obtained within the word/picture interference paradigm with Persian-French early proficient bilinguals are globally **different** from those obtained for other bilinguals, such as the participants of Hermans *et al.* (1998) and Costa *et al.* (2003). Only the third experiment showed similar results to those obtained by these authors.

The origin of this difference could lie in the fact that the Persian-French bilinguals were older, more balanced and had benefited from a longer bilingual practice of their languages. As mentioned earlier, their performances might be closer to those of interpreters rather than language learners or unbalanced bilinguals. Another explanation for this difference is the fact that French and Persian are languages with different alphabets and typology. These differences are more important than the ones between the language pairs tested by the authors mentioned above, who tested Dutch-English and Spanish-Catalan bilinguals.

In the first experiment, a phonological facilitation was observed at SOA + 150 ms, replicating the results obtained by Hermans *et al.* (1998) and Costa *et al.* (2003). Despite the difference in alphabet, the visual distractors facilitated the naming process. This result highlights the role of phonological representation in reading for a new pair of languages.

The inhibition effect observed at SOA - 300 ms for phono-translation distractors during the second experiment indicates the impact of the non-response language during the early stages of speech production. As the facilitation effects generated by phonological and semantic distractors did not reach significance at such early SOA, it is difficult to reach a conclusion concerning the activation process. Although the effects observed at SOA + 150 ms did not reach significance, they showed an increase in response times, while no significant difference was observed between the various types of distractors.

The results of the third experiment showed significant effects at all SOA conditions. These effects support the assumptions of a language non-specific lexical selection model, as the distractors interact with picture naming at all stages of speech production. The early facilitation effects are compatible with the assumptions of cascade models, and contradict the predictions formulated by serial models of activation. The semantic facilitation effect observed at all SOA conditions, except at SOA + 150 ms, could be explained by the use of

semantic distractors which were not categorically related to the names of the pictures. The increase in response times observed in the second experiment was observed again in this last experiment at SOA + 150 ms, and this time reached significance. When auditory distractors are heard after the appearance of pictures, they seem to perturb more the naming process.

The response language of the third experiment was Persian and the distractors were heard in French. As already indicated in the interpretation of these results, if we accept that French has become the dominant language of these participants, part of the results replicate those obtained by the experiments conducted by other researchers. Given their linguistic history, the fact that they settled in France many years ago, and that French remains the language most practiced, it seems reasonable to suggest that French has become their dominant language instead of Persian.

Globally, if only significant effects are taken into consideration, the results converge towards facilitation effects generated by all distractors, except phono-translation ones that increased response times at SOA - 300 ms (second experiment) and SOA + 150 ms (third experiment) with the same magnitude (+ 36 ms for both experiments). These early, balanced and highly proficient bilinguals seem to benefit from the distractors related to pictures-names (compared to unrelated distractors), regardless of the language which has been set for the distractor and for their response, especially at early (- 300 ms) and late (+ 150 ms) SOA. **Speech planning in one of their language remains open to the representations of their other language, during initial and later stages of speech production.**

In conclusion, the results of these three experiments lean in favour of the predictions of a **cascade model of activation** and a **language non-specific model of lexical selection**. Such a selection model is also compatible with the practice of code switching. These experiments have replicated the methods used previously within the picture/word interference paradigm for a different population of bilinguals and also for a different and new pair of languages.

Of course, other experiments are needed before we can definitively choose between the various activation and lexical selection models, and determine those which are better adapted to understand bilingual speech production. As the results provided by the picture/word interference paradigm make it difficult to conclude in an absolute and categorical fashion, it may be helpful to use other frameworks to conduct experiments investigating the validity of these models.

Kroll *et al.* (2006) mentioned several factors that play a role in bilinguals' access to their two languages and their respective relationships: the level of proficiency in a language and the context of its acquisition, the tasks initiating the speech production, the nature of the concepts to convey, the situations in which the bilingual speakers are placed and cognitive resources available to them.

The level of proficiency in a language and the context of its acquisition and use are critical elements that can determine the relationships between the languages and the ease of selecting one instead of the other. Costa and Santesteban (2004) underlined that early bilinguals (compared to less balanced bilinguals) acquire not only the languages, but also the attentional competences allowing them to select more effectively the desired language. Our results confirm these assumptions. Favourable and early contexts of acquisition, a long practice of both languages and years of bilingual education have allowed my participants to establish solid links between their languages. The observed effects support the existence of these relationships.

The tasks initiating speech production can also influence the results. In naming tasks, little information is language- or culture-specific, while in translation, the word initiating speech production provides information not only about the response language, but also about the language that should not be used. It would therefore be interesting to test these highly proficient Persian-French bilinguals with translating tasks, to investigate the existence or the absence of interferences between their languages.

The nature of the concepts to convey can also account for some results. Kroll *et al.* (2006) mentioned that the majority of naming experiments used pictures of concrete nouns which often reflect only concepts completely shared between languages. Their naming as isolated words eliminates the specific syntactic features of the languages. Once more, translation tasks that are not limited to concrete nouns, could allow less biased effects. It would be fruitful to conduct new translation experiments with my participants in order to compare their performance with those observed during picture naming.

The activation of both languages can be modulated by the context of the bilinguals' interactions and the cognitive resources available to them. It would be interesting to replicate the measures concerning translation and cognitive capacity undertaken by Christoffels *et al.* (2006) to investigate whether these Persian-French bilinguals, who are used to alternate between their languages, and who can translate simultaneously, replicate the cognitive facilitation effects observed with other participants.

The results of these new experiments should contribute to a better understanding of lexical selection in bilingual speakers and of the mechanisms preventing interference between their languages.

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RÉSUMÉ

Trois expériences psycholinguistiques ont été menées dans le cadre du paradigme image/mot sur des bilingues persan-français précoces, équilibrés et très compétents pour déterminer les mécanismes d'activation et de sélection qui sous-tendent leur accès au lexique. Les résultats plaident en faveur des prédictions d'un modèle d'activation en cascade et d'un modèle de sélection lexicale non spécifique à la langue.

Appendix A – Experiment 1: list of distractors, table of mean response times and error percentages

N°	Picture	Translation	Distractors			
			Semantic	Phono-translation	Phonological	Unrelated
1	Souris IPA transcription French translation	موش mul souris	پنیر panir fromage	موشک muljak fusée	سور sur fête	خبر xabar nouvelle
2	Poule	مَرغ morq poule	خروس xorus coq	مورد mored à propos de	پول pul l'argent	نام nam nom
3	Table	میز miz table	صندلی sandali chaise	میخک mixak oëillet	طبل tabl tambour	دامن daman jupe
4	Pomme	سیب sib pomme	الو alu prune	سینی sini plateau	پشت poft derrière	هواپیما havapeima avion
5	Bouton	دکمه dokme bouton	پیراهن pirahan chemise	دکان dokkan boutique, échoppe	بوته boute arbuste	نفت naft pétrole
6	Chat	گربه gorbe chat	سگ sag chien	گرگ gorg loup	شاه jah roi	سیخ six broche
7	Marteau	چکش tjakko/ marteau	میخ mix clou	چتر t'atr parapluie	مردم mardom gens	زمین zamin terre
8	Peigne	شانه /ane peigne	مو mu cheveu	شاخه /axe branche	پندار pendar pensée	داس das faux, faucille
9	Chapeau	کلاه kolah chapeau	سر sar tête	کدام kodam lequel	شب /ab nuit	خیار xiar concombre
10	Vache	گاو gav vache	گوسفند gusfand mouton	گاری gari charrette	وشم valm vapeur	نبات nabat sucre candi
11	Livre	کتاب ketab livre	درس dars leçon	کتری ketri bouilloire	لیف lif gant de bain	هویج havid3 carotte
12	Gant	دستکش dastke/ gant	انگشت angoft doigt	دستور dastur ordre	گام gam pas	پرنده parande oiseau
13	Porte	در dar porte	پنجره pandzare fenêtre	دره dare vallée	پرِئقال porteqal orange	روز ruz jour
14	Lit	تخت taxt trône	بالش bale/ oreiller	تشت tal/ cuvette	لیز liz glissant	متن matn texte
15	Bague	انگشتر angoftar bague	دستبند dastband bracelet	انگور angur raisin	باغ baq jardin	توت tut mûre
16	Main	دست dast main	بال bal aile	درد dard douleur	من man moi	پلو polo riz

N°	Picture	Translation	Distractors			
			Semantic	Phono-translation	Phonological	Unrelated
17	Corde IPA transcription French translation	طناب tanab corde	گره gere noeud	تنور tanur four	کرد kord Kurde	برف barf neige
18	Cheval	اسب asb cheval	زین zin selle	اصل asl principe, original	شوید ševīd aneth	لباس lebas vêtement
19	Pastèque	هندوانه hendevane pastèque	طالبی talebi melon	هندوستان hendustan Inde (pays)	پست past vil	دبیر dabir professeur (lycée)
20	Elephant	فیل fil éléphant	فنجون fendžun tasse	فیس fis orgueil	الهام elham inspiration	کره kare beurre
21	Chameau	شتر šotor chameau	صحرا sahra sahara	شجاع šodza' hardi, brave	شمع šam' bougie	خنده xande rire
22	Bouteille	بطری botri bouteille	شیشه šile vitre, bouteille	بته botte buisson	بوران buran bourrasque	مادر madar mère
23	Fourchette	چنگال tʃangal fourchette	قاشق qaʃoq assiette	چنگک tʃangak crochet	فولاد fulad plomb	هشتصد haštsad 800 (huit cents)
24	Serpent	مار mar serpent	نیش niš morsure (croc)	مال mal bien	سرکه serke vinaigre	پرده parde rideau
25	Verre	لیوان ver verre	آب ab eau	لیمو limu citron	ورد verd incantation	بخت baxt chance
26	Banane	موز moz banane	میوه mive fruit	موضوع mozu' sujet	بنا banna maçon	ستاره setare étoile
27	Montre	ساعت sa'at montre	زمان zaman temps	صاحب saheb propriétaire	منفرد monfared seul, singulier	اش aš soupe
28	Mouche	مگس magas mouche	پشه paše moustique	مگر magar sauf si	موسیر murt'e fourmi	نقل noql dragée
29	Pêche	هلو holu pêche	گلابی golabi poire	هما homa phénix	پشکل peškel crotte	گونه gune joue
30	Montagne	کوه kuh montagne	دشت dašt vallée	کوچه kut'e rue	منتشر montašer publié	همیشه bini nez
31	Balai	جارو dzaru balai	خاک xak poussière	جان dzan âme	بلی bale oui	دفعه daf'e fois
32	Cafard	سوسک susk cafard	حشره hašare insecte	سوسن susan lys (fleur)	کف kaf mousse, écume	بیست bist vingt (20)

EXPERIMENT NB 1	MEAN	RESPONSE TIME	FOR DISTRACTOR	CONDITION	Error/replacement percentage
SOA CONDITION	Unrelated	Phonological	Phono-translation	Semantic	
SOA -300 ms <i>Standard deviation</i> Difference with unrelated condition	891 165	892 203 1	890 162 -1	868 160 -23	10%
SOA -150 ms <i>Standard deviation</i> Difference with unrelated condition	953 170	913 163 -40	932 176 -21	926 157 -27	13%
SOA 0 <i>Standard deviation</i> Difference with unrelated condition	1057 194	1012 186 -45	1029 210 -28	1052 185 -5	12%
SOA +150 <i>Standard deviation</i> Difference with unrelated condition	955 212	867 170 -88	911 205 -44	922 196 -33	9%
Total error/replacement rate for experiment					11%

AppendixB – Experiment 2: list of distractors, table of mean response times and error percentages

EXPERIMENT NB 2	MEAN	RESPONSE TIME	FOR DISTRACTOR	CONDITION	Error/replacement percentage
SOA CONDITION	Unrelated	Phonological	Phono-translation	Semantic	
SOA -300 ms <i>Standard deviation</i> Difference with unrelated condition	771 182	749 181 -22	807 201 36	756 194 -15	7%
SOA -150 ms <i>Standard deviation</i> Difference with unrelated condition	753 154	769 168 16	784 194 31	766 180 13	9%
SOA 0 <i>Standard deviation</i> Difference with unrelated condition	814 204	799 198 -15	799 192 -15	810 197 -4	6%
SOA +150 <i>Standard deviation</i> Difference with unrelated condition	875 206	889 255 14	902 257 27	886 246 11	11%
Total error/replacement rate for experiment					8%

N°	Picture	Translation	Distractors			
			Semantic	Phono-translation	Phonological	Unrelated
1	Panier IPA transcription French translation	سَبَد sabad Panier	سُفَرِه sofre nappe	سَبْزِی sabzi herbes vertes	پَنیر panir fromage	خودکار xodkar stylo
2	Abeille	زَنبُور zanbur Abeille	نِش niš dard	زَن zan femme	اَبَر abr nuage	خِيار xiar concombre
3	Pain	نَان nan Pain	کَرِه kare beurre	نَاژِک nazok fine	پَنَد pand conseil	چَکَش čakkoš marteau
4	Bougie	شَمْع šam' Bougie	نُور nur lumière	شَدِيد šadid fort, intense	بُوسِه buse baiser	کُچِه kut'e rue
5	Chaîne	زَنجیر zandžir Chaîne	قُفْل qofl serrure	زَنگ zang cloche	شِکار šekar chasse	مُورَغ morq poule
6	Tasse	فَنجَان fendžan Tasse	نَعْلَبِکِ na'lbeki soucoupe	فِلْفِل felfel poivre	تَصْمِيم tasmim décision	نَفْت naft pétrole
7	Poupée	عُرُوسْک arusak Poupée	بَاژِی bazi jeu	أَرَبَاب arbab maître	پُوشْک pušak couche	پَرَنج berendž riz
8	Canard	مُرْغَابِی morqabi Canard	شِنَا šena natation	مُرْدَاب mordab mare	کَنْدَن kandan creuser	صَحْرَا sahra sahara
9	Citron	لِیْمُو Limu Citron	پُرْتَقَال porteqal orange	لِیْوَان livan verre	سِیر sir ail	چِرَاغ čeraq lampe
10	Nez	دَمَاق damaq Nez	صُورَت surat visage	دَمَاوَنَد damavand Damavand (montagne)	نِغْرَان negaran inquiet	مِیخ mix clou
11	Citrouille	کَدُو kadu Citrouille	کُوزِه kuze cruche, pot	کَلَام kalam parole	سِیْم sim fil (électrique)	لِبَاس lebas vêtement
12	Bouche	دَهَان dahan Bouche	لَب lab lèvre	دَوَا dava médicament	بُوشَهْر buš'her Bouchehr (ville)	قَبْض qabz reçu
13	Pyramide	هَرَم heram Pyramide	مُرَبَّع moraba' carré	هَزَار hezar mille	پِیر pir vieux	دَسْت dast main
14	Chien	سَگ sag Chien	گُورِه gorbe chat	سَد sad digue	شِیر šir lion/lait	کُود komod placard

N°	Picture	Translation	Distractors			
			Semantic	Phono-translation	Phonological	Unrelated
15	Chaise IPA transcription French translation	صَدَلِي sandali Chaise	نِشِستِه ne aste assis	سَدَد sanad document, preuve	شَن ʃen sable	پَشِه pale moustique
16	Cerveau	مَغَز maqz Cerveau	فِکَر fekr pensée	مَقَام maqam statut	سِرْکِه serke vinaigre	شیرینی ʃirini sucrierie
17	Bol	کاسِه kase Bol	مَاسْت mast yaourt	کَاسِب kaseb commerçant	بُلْبُل bolbol rossignol	سَرُخ sorx rouge
18	Canon	توپ tup Canon	تَفَنگ tofang pistolet	توشِه tule provision	کَنَدو kandu ruche d'abeille	مَرَبَّا morabba confiture
19	Carotte	هَوِیج havidʒ Carotte	کَاهو kahu laitue	حَوَاس havas sens	کَر kar sourd	شَهْر ʃahr ville
20	Tambour	طَبْل tabl Tambour	تار tar terne	طَبِیب tabib médecin	تَاب tab balancoire	کِشْمِش ke me ʃ raisin sec
21	Barrière	مَانَع mane' Barrière	حِفَازَت hefazat protection	مَالِک malek propriétaire	بَرَابَر barabar égal	پِیْمَان peiman promesse
22	Chèvre	بُز boz Chèvre	کوه kuh montagne	بُزاق bozaq salive	شَوید ʃevıd aneth	دَاسْتَان dastan histoire
23	Pistolet	هَفْت تیر haft tir Pistolet	گُلُولِه golule balle (pistolet)	هَفْتَاد haftad soixante-dix	پِیش pi devant	طَوُطِی tuti perroquet
24	Maison	خَانِه xane Maison	حَیَاط haiat cour	خَوَاب xab sommeil	مِزَاج mezaj tempérament	پَخْش pax distribution
25	Couteau	چاقو tʃaqu Couteau	چَنگَال tʃangal fourchette	چَادَر tʃador tente	کُوسِه kuse requin	بَالِش bale oreiller
26	Echelle	نَرْدَبَان nardebān Echelle	پَلِه pelle marche	نَرگِس narges narcisse (fleur)	عِشْرَت e rat joie	قَهْوِه qahve café
27	Lanterne	فَانُوس fanus Lanterne	نُورَانِی nurani lumineux	فَاسِد fased pourri	لَالِه lale tulipe (fleur)	بَسْتِه baste paquet
28	Poumon	شَشْ ʃo Poumon	نَفَسْ nafas soupir, respiration	شُسْتَن ʃostan laver	پُول pul argent	کَبَاب kabab brochette

Appendix C – Experiment 3: list of distractors, table of mean response times and error percentages

N°	Picture	Translation	Distractors			
			Semantic	Phono-translation	Phonological	Unrelated
1	Pomme de terre IPA transcription French translation	سیب زمینی sibzamini Pomme de terre	plat	pommade	cire	vache
2	Souris	موش mul Souris	chat	soutane	mouchoir	cahier
3	Selle	زین zin Selle	cheval	céleri	zigzag	bague
4	Balance	ترازو tarazu Balance	poids	balcon	table	fleur
5	Vis	پیچ pitl Vis	marteau	vieux	pilier	banane
6	Chaussure	کفش kafš Chaussure	pied	chauve	café	Poire
7	Arbre	درخت deraxt Arbre	branche	argent	derrière	cartable
8	Fouet	شلاق šalloq Fouet	douleur	four	château	nuage
9	Sifflet	سوت sut Sifflet	bruit	Cime	Sourd	Bateau
10	Fenêtre	پنجره pandžare Fenêtre	rideau	feu	panache	poussin
11	Loup	گرگ gorg Loup	chien	Loupe	gorge	tomate
12	Ver	کرم kerm Ver	fruit	vélo	quête	jus
13	Fourmi	مورچه murtše Fourmi	insecte	fou	mouton	pantalon
14	Ballon	توپ tup Ballon	jeu	ballet	tour	viande

N°	Picture	Translation	Distractors			
			Semantic	Phono-translation	Phonological	Unrelated
15	Coffre IPA transcription French translation	صندوق sandoq Coffre	valise	colis	sable	casserole
16	Banquette	نیمکت nimkat Banquette	chaise	banlieue	Nice	pêche
17	Avion	هواپیما havapeima Avion	vol	avancer	havre	écureuil
18	Fromage	پنیر panir Fromage	beurre	froment	pané	chameau
19	Cerise	گیلاس gilas Cerise	gâteau	serein	guirlande	pipe
20	Eglise	کلیسا kelisa Eglise	prière	aiguille	quai	sommet
21	Clown	دلقک dalqak Clown	cirque	clôture	dame	journée
22	Cerf	گوزن gavazn Cerf	forêt	serpent	gare	Terrible
23	Bureau	دفتر daftar Bureau	travail	bulle	dalle	farce
24	Oreille	گوش guš Oreille	tête	or	gourmand	tapis
25	Plume	پر par Plume	oiseau	plusieurs	parole	tabouret
26	Fleur	گل gol Fleur	jardin	flamme	gomme	Oncle
27	Clé	کلید kelid Clé	porte	clair	quelle	soupe
28	Louche	ملاقه malaqe Louche	cuillère	lourd	malade	ami