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INTERFERENCE BETWEEN SURFACE FORM AND ABSTRACT REPRESENTATION IN SPOKEN WORD PERCEPTION

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ABSTRACT

The aim of this study was to examine the influence of an abstract code (orthographic and/or morphophonemic) on the perception of the sounds in French spoken words. For this purpose, we used words whose surface phonology was not congruent either with both orthographic and morphophonemic codes or with orthographic code alone. Experiment 1 showed that the processing of spoken word is affected by an underlying abstract code, which is presumably orthographic and/or morphophonemic. Experiment 2 examined the role of orthography alone, and showed that the sole orthographic code influenced spoken word processing. However, the effect obtained in Experiment 2 was smaller than that obtained Experiment 1. These data are interpreted in the framework of an interactive model of speech perception, where the written/abstract code and the phonetic code interact in both directions.

1. INTRODUCTION

The present study examined the interactions between surface phonology code and an abstract linguistic code (written and/or morphophonemic) in the perception of spoken words.

Many studies have found that phonology influenced the processing of written word (see for example [1]; [3]; [5]). By contrast, this study is concerned with the symmetrical influence of e.g. script on phonological representations, which has been demonstrated in a few published studies (for example [2]; [4]).

More specifically, we examined the influence of an abstract code, orthographic and/or morphophonemic, on the perception of the sounds in French spoken words. For this purpose, we used words whose surface phonology was not congruent either with both orthographic and morphophonemic codes (Experiment 1), or with the orthographic code alone (Experiment 2). Experiment 1 used spoken words such as "absurde," in which the letter 'b' is pronounced /p/. Experiment 2 used words such as "asile," where 's' is pronounced in a non-canonical way, /z/. In both cases, script and surface phonology are thus conflictual. In words such as "absurde", however, there is also a conflict with a morphophonemic representation (comprising the {ab-} prefix), which is congruent with the spelling.

2. EXPERIMENT 1

2.1. Experiment 1a: phoneme monitoring task.

This experiment used a generalized phoneme monitoring task: subjects had to detect as quickly as possible /p/ or /b/ in words such as "absurde" and "capsule." If their responses were based on an abstract code, they should have more difficulty to detect /p/ in "absurde" than in "capsule." Moreover, they should detect /b/ in "absurde" more often than in "capsule." Differences in reaction times also could appear: accessing an abstract representation could be slower than accessing a surface phonology representation.

2.1.1. Method

Stimuli and design: Thirty-two French test words containing /p/ followed by /s/ or /t/ were used. In half of them, /p/ corresponded to the letter 'b', (such as "absurde" or "obtus"). In the other half, /p/ corresponded to the letter 'p' (such as "capsule" or "opticien"). Sixty-four fillers contained /p/ or /b/, corresponding to the letters 'p' or 'b', respectively. In addition, 192 fillers did not contain /p/ nor /b/.

Each word was presented only once for the detection of /b/ or of /p/. For example, "absurde" was presented to half of the participants for the detection of /p/, and to the other half for the detection of /b/. The reaction times were measured in milliseconds from the release burst of the target labial-stop /b/ or /p/.

Participants: Sixty students native speakers of French, participated in this experiment.

2.1.2. Detection rates.

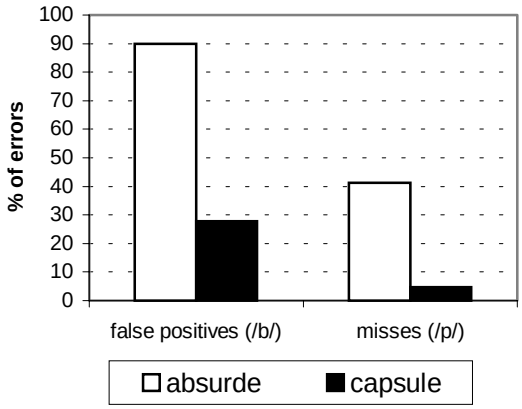

Fig.1: % of false positive detections for /b/ and misses for /p/ in "absurde" and "capsule."

The results were very clear. Figure 1 shows the rate of misses and false positive detections in "absurde" and "capsule." The rate of misses of /p/ was significantly higher in "absurde" than in "capsule." Moreover, /b/ was more often detected than /p/ in "absurde" (although detections of /p/ reached 58%).

These results suggest that subject's responses were determined by abstract representations rather than by surface representations.

2.1.3. Reaction times

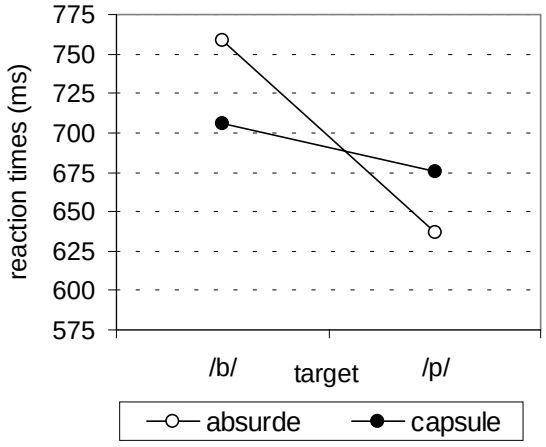

Fig. 2: mean reaction times for the detections of /p/ or /p/ in "absurde" and "capsule."

The reaction times (Figure 3) showed than false positive detections of /b/ in "absurde" were longer than correct detections of /p/ in "absurde," as well as in "capsule," by about 100 ms.

2.1.4. Discussion

Experiment 1a showed that an underlying abstract code influenced the processing of spoken words. Moreover, the reaction times suggested that accessing this abstract code was slower than accessing the surface code.

The following experiment examined the time course of the building up of abstract and surface codes.

2.2. Experiment 1b: phonemic gating task.

This experiment examined how the abstract and surface codes built up over time. Of particular interest was the "point" in time at which the abstract code emerged and conceivably began to influence the surface code.

2.2.1. Method

Stimuli and design: Twenty spoken words were used: eight test words such as "absurde" (/a**p**syrd/), and 12 control words (eight such as "abdiquer," (/a**b**dike/) and four such as "capsule" (/ka**p**syl/)) were presented. Each word was presented incrementally. The initial fragment (gate) ended in the vowel preceding the labial stop, at the point of highest spectral stability. The other 7 fragments were made increasingly longer using a 40 milliseconds increment. In order to avoid any perseveration in the responses, the gated items were presented blocked by duration.

Procedure: Participants had to transcribe the stimuli they heard in lieu of guessing a word as in the classic gating paradigm.

Participants: Fifteen students, native speakers of French, participated in this experiment.

2.2.2. Results

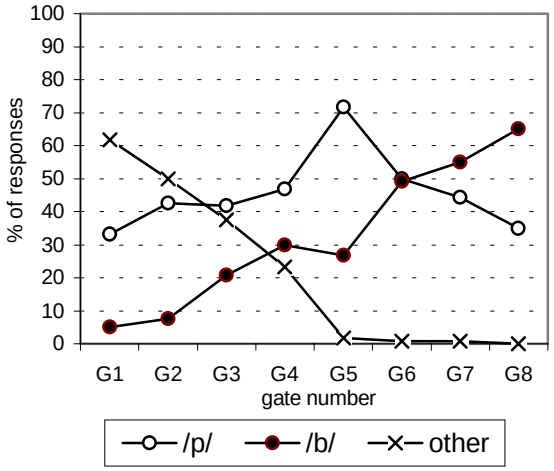

Fig. 3: % of transcriptions of /b/ and /p/ for test words such as "absurde" as a function of gate number

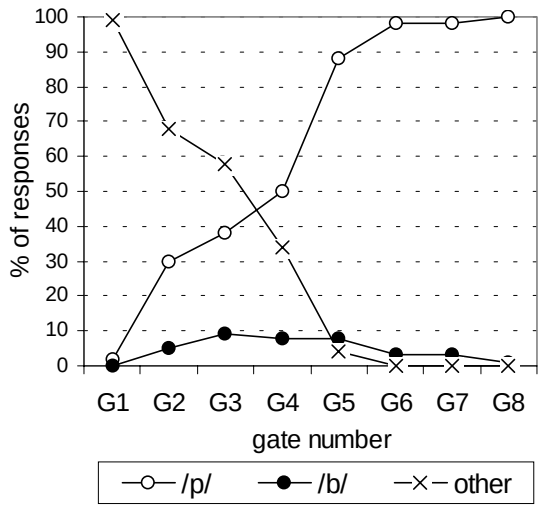

Fig.4: % of transcriptions of /b/ and /p/ for control words such as "capsule" as a function of gate number.

Figure 3 shows a reversal of the transcriptions from /p/ to /b/ for words such as "absurde" between Gates 5 and 8. The pattern of results for control words such as "capsule" showed in Figure 4 was different: the percentage of /p/ responses steadily increased until gate 5-6, where it reached 90%, then remained above the 96% level.

2.2.3. Discussion

The data suggest that the transcriptions were based on a phonetic code until Gate 5. Then, when more linguistic information became available, transcriptions were based on a more abstract code. This code could be an orthographic code, because /apsyrd/ is written with the letter 'b'. But it could also be a morphophonemic code because all the test words such as "absurde" contained a prefix ({ab}, {ob}, {sub}) compatible with an underlying /b/.

3. EXPERIMENT 2

This experiment aimed at exploring the role of orthography alone. For this purpose, we used the case of the letter 's' which, in French, has a canonical pronunciation /s/ and an alternative pronunciation /z/ (when 's' appears between two oral vowels). These two pronunciations are determined by regular grapheme-phoneme correspondences that are explicitly taught to French-learning children. They do not reflect different morphophonemic codes. For example, "asile" is not morphologically related to a word in which 's' would be pronounced /s/. Thus, only the orthographic code could be responsible of possible interferences with surface phonology.

3.1. Method

3.1.1. Stimuli and design

Forty words contained /s/ or /z/: twenty-four items such as "asile," "azur" and "aisselle" were used as test-items, and 16 words such as "zombi" and "songeur" were used as fillers. In addition, 60 other fillers did not contain /s/ or /z/.

Each word was presented only once, for the detection of /s/ or /z/. For example, "asile" was presented to the half of the subjects for the detection of /s/, and to the other half for the detection of /z/. Reaction times were measured in milliseconds from the acoustic onset of /s/ or /z/, estimated from spectrograms.

3.1.2. Procedure

In a generalized phoneme monitoring task, participants had to detect the phonemes /s/ or /z/ as quickly as possible.

3.1.3. Participants

Forty-eight students, all native speakers of French, participated in this experiment.

3.2. Results

The relevant comparison was that between words such as "asile" and "azur," because both types of words contained /z/, but spelled differently: canonical spelling in "azur", non-canonical in "asile".

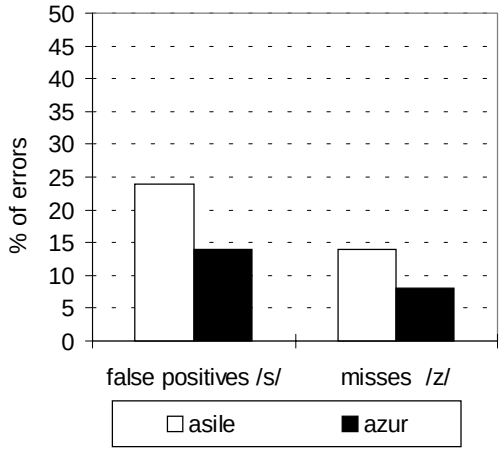

Fig. 5: % of false positive detections for /s/ and misses for /z/ in "asile" and "azur."

As shown in Figure 5, subjects tended to detect /s/ in "asile" more often than in "azur." Moreover, /z/ was omitted more often in "asile" than in "azur."

3.3. Discussion

These results revealed that the orthographic code alone can automatically influence spoken word processing. The effect was however rather modest (about 10%) perhaps because the sound-to-spelling correspondence rule that was exploited here is deeply implemented in the listener's mind.

4. GENERAL DISCUSSION

Experiment 1 showed that an abstract linguistic code influences the processing of spoken French words: subjects tended to detect /b/ and to miss /p/ in "absurde" more often than in "capsule." The results of a phonemic gating task provided an indication of activation of these two codes. Subjects used 'p' to transcribe /p/ in words such as "absurde," until Gate 5. Then, they gradually switched to b'.

Experiment 2 provided evidence for the influence of the orthographic code alone. In words such as "asile," subjects tended to detect /s/ and to miss /z/ more often than in "azur." The orthographic code only, caused such a bias, because "asile" does not possess any underlying morphophonemic representation containing /s/, such as /asil/. We thus can conclude that the orthographic code interferes with the processing of spoken words. The effect found in Experiment 2 was weaker than that found in Experiment 1a. It is difficult, however, to directly compare these two experiments. The /p/-/b/ contrast could be less salient perceptually than the /s/-/z/ contrast. Also, the sound-to-spelling correspondences are different in nature in the two situations. Given these differences, it would be highly speculative to propose that the morphophonemic code is more influent than the orthographic code alone.

Overall, these data are compatible with the view that orthography interacts with phonetic perception in spoken words. Given the literature showing that phonology interacts with word reading, it is tempting to propose that both the visual and auditory processing of words engage orthographic and phonetic representations that interact in both directions.

REFERENCES

[1] Coltheart, V., Patterson, K. & Leahy, J. (1994). When a ROWS is a ROSE: phonological effects in written word comprehension. *The Quaterly Journal of Experimental Psychology*, **47A(4)**, 917-955.

[2] Dijkstra, T., Fieuws, S. & Roelofs, A. (1995). Orthographic effects on phoneme monitoring. *Canadian Journal of Experimental Psychology*, **49**, 264-271.

[3]Lukatela, G., Lukatela, K. & Turvey, M. T. (1993). Further evidence for phonological constraints on visual access: Towed primes frog. *Perception and Psychophysics*, **53**, 461-466.

[4] Seidenberg, M. S. & Tanenhaus, M. K.(1979). Orthographic effects on rhyme monitoring. *Journal of Experimental Psychology: Human Learning and Memory*, **5**, 546-554.

[5] Ziegler, J. C., Van Orden, G. C. & Jacobs, A. M. (1997). Phonology can help or hurt the perception of print. *Journal of Experimental Psychology: Human Perception and Performance*, **23**, 845-860.