CROSS-LANGUAGE EFFECTS OF LEXICAL STRESS IN WORD RECOGNITION: THE CASE OF ARABIC ENGLISH BILINGUALS

Sami BOUDELAA & Mehdi MEFTAH

Université Paris 7, Laboratoire de Phonétique, 10 Rue Charles V, 75004, Paris, France.
(both authors are also at Université Paris V, Laboratoire de Psychologie Expérimentale)

ABSTRACT

Two lexical decison experiments examined the effects of lexical stress on word processing in Arabic-English bilinguals. In Experiment 1, Arabic and English minimal stress pairs sreved as primes either to semantically related targets, to targets related to the second member of the pair, or to control targets. English minimal stress pairs were processed like homophones, but Arabic ones were not. In experiment 2, the effects of mis-stressing Strong-Weak (SW) and Weak-Strong (WS) common words (ie., words that are not members of a minimal stress pair) was investigated. Only realizing a /SW/ word in a /WS/ stress pattern was adverse in English. In Arabic, however, mis-stressing had an adverse effect both in the case of SW and WS words. Taken together, the results suggest (a) that the time course of lexical stress effects are language dependent and (b) that Arabic-English bilinguals function monolingually with respect to lexical stress information. These resuslts are explained in terms of the asymmetry underlying the phonological structures of the two languages.

1. INTRODUCTION

Psycholinguistic research on the use of lexical stress information during on-line word recognition has yielded rather non-coinciding results. In English, it seems that prior information relative to the number of syllables and lexical stress pattern of a word does not affect lexical decision latencies. Also, mis-stressing (ie., realizing a word with an inapproporiate stress pattern) inhibits word recognition only if a canonically Strong-Weak word is realized in a Weak-Strong stress pattern (Cutler & Clifton, 1984). More important still, minimal stress pairs, which are identical segment sequences that are lexically different only by virtue of a difference in stress position, behave like homophones suggesting that lexical stress information is not used to constrain lexical access (Cutler, 1986).In Dutch, gating results show that the words suggested on the basis of gated information are different depending on whether the stimulus word is SW or WS (Van Heuven, 1988). More recently however, cross-modal priming results with Dutch material indicate that lexical stress information is used late in the process of word recognition (Jongenburger & Van Heuven, 1995). In Arabic, intramodal priming (auditory-auditory) results indicate that lexical stress information may be actively used to constrain the selection phase of the word recognition process (Boudelaa, 1995).

Given the disparity between the experimental results relative to the effect of lexical stress during word recognition, the question of determining the nature of the representation that is projected onto the lexical level remains as yet a moot point.

Of major interest in this respect is to define whether the mapping between the perceptive input and the mental representation of lexical forms is made in terms of *phonemes* (Marslen-Wilson, 1987, McClelland & Elman, 1986), in terms of *disticntive features* (Marslen-Wilson & Warren, 1994) or in terms of a parallel matching between *segmental plus prosodic information* and l*exical representation* (McQueen, Norris & Cutler, 1994, Banel & Bacri, 1994). One way of shedding light on this issue can be achieved by studying bilingual speakers, who can draw on more than one linguistic repertoire in case of need. The processing of more than one language by bilinguals is interesting in that it helps clarify first the *interactions between two linguistic systems* and second it provides a means of uncovering the structure of the human language processor itself by *distinguishing what is language dependent from what is not* (Cutler, Mehler, Norris & Segui, 1992). The present study focuses on the *exact locus* of lexical stress effects in word recognition by investigating the performances of Arabic-English bilinguals in a semantic priming paradigm.

2. EXPERIMENT 1

Arabic and English are two stress accent languages in which minimal stress pairs occur. For example, with stress on the first syllable, which is underlined, the Strong-Weak Arabic string /wasˤafaa/ means "they described", while the Weak-Strong /wasˤafaa/ means "and it celared up". Likewise in English the word "forbear" means "ancestor" or "tolerate" depending on whether it is realized Strong-Weak as "forbear" or Weak-Strong as "forbear". Being semantically distinct, members of such pairs are supposed to be related to different words at the representational level: By hypothesis, the Arabic Strong-Weak /wasˤafaa/ (ie. they described) is related to /ʃarah aa/ (ie., they explained), while the Weak-Strong /wasˤafaa/ is related to /raaqa/ (i.e. it became brighter). If the information relative to the stressed syllable is used during the mapping between the acoustic input and the representation of lexical forms, then in a semantic priming paradigm a member of a minimal stress pair will facilitate only the recognition of the target related to it: The Arabic Strong-Weak /wasˤafaa/ will facilitate the target /ʃarah aa/, but not the target /raqaa/ which is related to the Weak-Strong /wasˤafaa/. Alternatively, if lexical stress information does not constrain the early stages of the recognition process, then a members of a minimal stress pair should faciltate both the target related to it and that related to its stress partner. In other words, the targets /ʃarah aa/, and /raqaa/ should be facilitated to the same extent by the Strong-Weak /wasˤafaa/ as well as by the Weak-Strong /wasˤafaa/.

2.1. Method

Subjects: 15 Arabic-English bilinguals took part in the experiment. Control subjects were 24 Arabic monolinguals and 24 English monolinguals. The mean age of all subjects was 29 years old and none of them had any known history of hearing loss or speech disorder.

Material and procedure: The material consisted of 32 quadruplets 16 of which were Arabic and 16 English. The first item of every quadruplet was a member of minimal stress pair which served as a prime to:

- A semantically related target (R1). For example, /wasʕafaa/-/ʃarahaa/, /wasʕafaa/-/raaqa/ in Arabic, and "forbear"-"ancestor", "forbear"-"tolerate" in English.

- A target related to the second member of the pair (R2). For example, /wasʕafaa/-/raaqa/, /wasʕafaa/-/ʃarahaa/ in Arabic and "forbear"-"tolerate", "forbear"-"ancestor" in English.

- A non-related target (NR). For example, /wasʕafaa/-/xaraʒaa/ (ie. they went out), /wasʕafaa/-/naamaa/ (ie., they slept) in Arabic and "forbear"-"arrival","forbear"-"vibrate" in English.

The associative relationship between prime and target was determined beforehand on the basis of a lexical association test. A further 96 items (48 Arabic and 48 English) controlled with respect to syllable structure, stress pattren and frequency of usage was selected to be used as primes to legal Arabic and English non-words formed by changing one to two phonemes across all possible positions in the original 96 words. Six lexical decision lists were constructed 3 for Arabic and 3 for English. Each list comprised 32 items half of which were non-word targets. Each bilingual heard an Arabic list and an English one. As for the Arabic and English monolinguals, they heard a single list in the appropriate language. The subjects had to respond "word" or "non-word" as quickly and as accurately as possible by pressing one of the two appropriately labelled reponse keys. The presentation of stimuli and data collection were controlled on-line by a Toshiba T-5200 using a da_tr program (Hallé, 1991). Response times were measured from the acoustic offset of the target word.

2.2. Results

Subjects' responses included a low error rate (4%) which did not yield any statistically significant results in all conditions. Table (1) displays subjects' mean reponse times (and standard deviation) across all experimental conditions.

ACCENT	R1	R2	NR	NR-R1	NR-R2
SW/Bar	341 (37)	356 (44,5)	401,5 (42,5)	60	45
SW/Bang	363,5 (35,2)	365,9 (44)	406 (43)	43	41
SW/Mar	342 (45,5)	355,1 (42,5)	393 (39)	51	38
SW/Mang	353 (34)	359 (44,5)	398 (44,98)	45	39
WS/Bar	353 (43,2)	399,5 (38,6)	408 (38,5)	55	9
WS/Bang	369,1 (45)	347 (43)	403 (40)	34	56
WS/Mar	350 (59)	390 (44)	395 (47,5)	45	5
WS/Mang	350 (43)	363,5 (43,5)	396,5 (39,5)	46	33

Table 1: Mean response times (and standard deviations) as a function of the stress pattern of the prime and target type. "SW" and "WS" indicate a Strong-Weak and a Weak-Strong prime respectively. "Bar" and "Mar" stand respectively for bilinguals and Arabic monolingulas processing Arabic data. "Bang" and "Mang" stand respectively for bilinguals and English monolingulas processing English material. "R1" denotes a related target, "R2" a target related to the second member of the minimal stress pair and "NR" reperesents a non related target. "NR-R1" and "NR-R2" refer to the priming effect accross the different experimental conditions.

Statisical analysis of bilinguals' RTs with the English material using a two-way ANOVA *(Stress-relation)* indicated that there was no effect of *Stress* pattern ($F<1$): An English prime word member of a minimal stress pair facilitated not only the target related to it, but also the target related to its stress partner. Thus, R1 and R2 targets like "ancestor" and "tolerate" were facilitated to the same extent both by the SW "forbear" and the WS "forbear". The main effect of *Relation* was significant ($p < 0,05$) in the sense that R1 and R2 targets were more quickly recognized than Non-related targets: There was a significant priming effect for R1 and R2 targets as opposed to NR targets. The interaction between the two factors was not significant. The analysis of English monolinguals' performances yielded the same pattern of results with a member of a minimal stress pair facilitating both R1 and R2 targets. These results suggest that lexical stress information is not used to constrain the early stages of the word recognition process in English.

As for Arabic data, statistical analyses of bilingulas' responses indicated that there was no effect of *Stress* ($F<1$). There was however, a siginificant main effect of *Relation* ($p <0,05$) with R1 and R2 targets having a significant priming effect compared to NR targets. The interaction between *Stress* pattern and *Relation* was significant: When the prime is SW both R1 and R2 target were facilitated, but when the priming word is WS only R1 type of targets were facilitated. For example, the prime /wasʕafaa/ facilitated both the target /ʃarahaa/, and the target /raaqa/ which is related to its stress partner /wasʕafaa/. By contrast, the WS /wasʕafaa/ facilitated

only the target related to it /raaqa/. An identical pattern of results emerged out of the analysis of the Arabic monolingulas' performances.

2.3. Discussion

Two interesting aspects evolve out of these results. First, the processing system seems to take into account only the information relative to the segmental specification during the mapping between the input and target representation. The *stress pattern of the priming word does not weigh on the early stages of processing provided that the segmental* (perhaps featural) information has a good *match* with the lexical representation (Marseln-Wilson, 1987). However, the finding that /WS/ Arabic primes like /waʕafaa/ faicilitate only the target related to them, suggests that in this language at least, *stress information may influence the word recognition process during the selection phase*. The asymmetry underlying the processing of minimal stress pairs in Arabic and English may be attributed to the fact that in Arabic minimal stress members do not have the same morphological structure: A WS Arabic word member of a minimal stress pair like /waʕafaa/ consists in a prefix plus a root, which is the case neither of the SW Arabic words nor of the English pairs. The presence of a prefix in the Arabic WS word type might have contributed to the crosslanguage differences in the proceessing of minimal stress pairs. The second important aspect of the results is that Arabic-English bilinguals behave like Arab monolinguals when processing Arabic material and like English monolinguals when processing English material. This suggests that a bilingual subject can function monolingually depending on the nature of the linguistic input that he processes. In order to further clarify these two aspects of the results -the exact role of lexical stress in word processing and the monolingual nature of bilinguals- the effect of mis-stressing will be examined.

3. EXPERIMENT 2

In this experiment the effects of wrong lexical stress assignment are investigated by using common words (ie., words that are not members of a minimal stress pair). If lexical stress is used late in the word recognition process, mis-stressing common Arabic and English words should not have an adverse effect on lexical access so far as the segmental specification of the word is not altered.

3.1. METHOD

Subjects: The subjects were the same as in Experiment 1, except that a further bilingual speaker was selected in order to have an equal number of bilinguals per experimental condition.

Matrial and procedures: The material consisted of 32 words (16 Arabic and 16 English). Half of the words in each in language was SW and half was WS. Each of the 32 words was realized in a correctly stressed version (CS) and mis-stressed one (MS). Mis-stressing resulted when stress was shifted either to the right in the case of a SW word (eg. /kataba/ "he wrote" realized */kataba/ and "colleague" realized "colleague") or to the left in the case of a WS word (eg. /ʃaahadnaa/ "we watched" realized */ʃaahadnaa/). The CS and the MS versions of such words were used to prime semantically related targets (R) and control targets (C). Another 128 words (64 Arabic and 64 English) were selected to serve as primes to non-word targets. Eight lexical decision lists (4 Arabic and 4 English) were prepared each containing 64 items half of which were non-word targets. The procedure used to run the test was the same as in Experiment 1.

3.2 Results

Subjects responses included a low error rate (5%) which was not statistically significant. Bilinguals' and English monolinguals' performances with the English data showed that a target related to a WS word had mean priming effect of 66 ms irrespective of the prime was realized with a correct or a wrong stress pattern. However, a target related to a SW word had a priming effect (89 ms) only if the priming word is realized with an orthdox stress pattern. In Arabic, related targets reflect a mean priming effect (86 ms and 89 ms for SW and WS respectively) only if the priming word is correctly stressed.

A Three-way Anova was conducted on the performances of bilinguals with English material with *Stress* pattern, (SW vs. WS) *Correction* of stress (Correctly stressed vs. Mis-stressed) and *Relation* (Related target vs. control target) as main factors. The results revealed that the effects of *Stress* pattern and *Correction* were not significant ($F<1$). The effect of *Relation* was significant ($p < 0,05$) with related targets having a significant priming effect compared to control targets. The interactions between these factors were significant ($p < 0,05$): When Arabic-English bilinguals processed an incorrectly stressed English input only leftward stress movements impeded recognition. In other words, a WS English word like "minute" facilitated a related target "small" irrespective of whether it was correctly stressed or not, but an originally SW English word "touchy" failed to prime a related target like "weak" unless its stress pattern was correctly realized. These results were the same as those found with English monolinguals.

Turning to bilingulas' performances with Arabic material, the results showed that the effect of *Stress* was not significant ($F<1$). As for the other two factors (*Correction and Relation*), they both had significant effects ($p < 0,05$). None of the possible interactions between the three factors reached significance ($F < 1$). A SW word like /kataba/ (he wrote) failed to prime a related target like /qrara?a/ (he read) when it was realized with an unorthodox WS stress pattern as */kataba/. Similarly, a canonically WS word like /ʃaahadnaa/ (we watched) was of no facilitatory effect on the related target /ra?ajnaa/ (we saw) when mis-stressed as */ʃaahadnaa/. Analogous results were obtained with Arabic monolinguals' data.

3.3. Discussion

Mis-stressing impedes the recognition process in Arabic irrespective of the direction of the stress movement. In English, only rightward stress movements retard the recognition process. These results suggest that in Arabic, but not in English a full specification of the stress pattern of a

word is necessary for the language processor to successfully fulfill the recognition process. In Arabic lexical stress information seems to be actively used during the recognition process probably during the selection phase of lexical candidates. By contrast, in English lexical stress information are more likely to be used later in the recognition process perhaps during the verification phase of words already accessed on the basis of segmental information alone.

4. CONCLUSION

Arabic-English bilinguals can function monolingually with respect to the use of lexical stress information during word recognition. When bilinguals are processing Arabic material the mapping of the auditory input onto lexical representations is sensitive both to segmental and prosodic information. While processing English material however, Arabic-English bilinguals seem to draw solely on segmental information to map auditory input onto internal representations of lexical forms. The asymmetry underlying the use of lexical stress in Arabic-Englih bilinguals may be resultant from (a) the difference between the information vehicled by the stressed syllable in Arabic and English and (b) the difference underlying the status of lexical stress in the two languages. In Arabic, the stressed syllable provides the processing system with information about the structure of the word and the structure of the syllables it comprises. If provided with a stressed "CV" syllable in a given word, the system can infer that the word in question does not contain any other syllable which has a more complex structure like "CVC", "CVV", "CVCC" or "CVVCC". Also, in Arabic stress position in a word is a lot less unpredictible than in English, and it seems that stress information is more likely to be used in languages where it is completely predictible like French (Banel & Bacri, 1994). As for English, it appears that the stressed syllable is not important as such. It is only by contrast to to an unstressed syllable with a reduced vowel (McQueen et al., 1994). Taken together, the present results suggest that the auditory input is projected onto lexical form representation by taking into account *both segmental and prosodic information. But while segmental information seems to be invariably used during the early stages of processing, the temporal locus of the use of prosodic information seems to be language dependant.*

5. REFRENCES

Banel, M.-H. & Bacri, N. (1994). On metrical patterns and lexical parsing in French: *Speech Communication, 15*, 115-126.

Boudelaa, S. (1995). The use of prosodic information in word recognition in modern standard Arabic: *Proceedings of ICPHS, Vol IV*, 340-343. Stockholm Sweden.

Cutler, A. & Clifton, C. (1984). The use of prosodic information in word recognition. in H, Bouma & D, Bouwhis (eds), Attention and performance: X. Control of language processes, 183-196. Hillsdale, NJ.

Cutler, A. (1986). Forbear is a homophone: Lexical prosody does not constrain lexical access, *Language & Speech, 3*: 201-219.

Cutler, A., Mehler, J. Norris, D. & Segui, J. (1992). The monolingual nature of speech segmentation by bilinguals, *Cognitive Psychology, 24*, 381-410.

Grosjean, F. (1994). Going in and out of languages: An example of bilingual flexibility: *Psychological Sciences 4*, 201-206.

Jongenburger, W. & Van Heuven, V. (1995). The role of linguistic stress in the time course of word recognition in stress-accent languages: *Proceedings of Eurospeech, Vol III*, 1695-1698. Spain.

Marslen-Wilson, W. D. & Warren, P. (1994). Levels of perceptual representation and process in lexical access: *Psychological Review, 4*, 653-675.

Marslen-Wilson, W. D. (1987). Functional parallelism in spoken word recognition. (in) U. H. Frauenfelder & L. K. Tyler (eds) *Spoken word recognition. A cognition special issue*. MIT. Press.

McClelland, J. L. & Elman. J. L. (1986). The TRACE model of speech perception *Cognitive Psychology, 18,* 1-86.

McQueen, J., Norris, D. & Cutler, A. (1994). Competition in spoken word recognition: Spotting words in other words, *J. Experimental Psychology: Learning, Memory and Cognition, 20*, 621-638.

Van Heuven, V. (1988). Effects of stress and accent on the human recognition of word fragments in spoken context: Gating & shadowing, *FASE Symposium*, 811-818, Edingburgh.