# Alphabetic literacy and psychological structure

José Morais*
Régine Kolinsky*
Jesus Alegria*
Leonor Scliar-Cabral**

RESUMO*** – Nesta contribuição examinamos as consequências da aquisição de um sistema alfabético de representação da linguagem sobre as estruturas psicológicas. Em primeiro lugar, descrevemos os dados empíricos que demonstram que a literacia alfabética suscita a emergência da consciência fonémica. Muitos destes estudos foram realizados em populações de iletrados de Portugal, Espanha e Brasil. Distinguimos entre a sensibilidade fonológica, a consciência fonológica e a consciência fonémica. Em seguida, apresentamos as consequências da consciência fonémica sobre a maneira como as pessoas conceptualizam a fonologia da sua língua e fazem atenção a ela. Por fim, mostramos que a literacia alfabética influencia os estádios tardios do reconhecimento das palavras faladas mas não os processos mais precoces, entre os quais em especial a extração automática da informação fonética.

RÉSUMÉ – Les conséquences de l'acquisition d'un système alphabétique de représentation du langage sur les structures psychologiques sont examinées. Les données empiriques démontrant que la litéracie alphabétique suscite l'émergence de la conscience phonémique sont d'abord passées en revue. Beaucoup de ces études ont porté sur des populations d'illettrés au Portugal, en Espagne et au Brésil. Nous distinguons la sensibilité phonologique de la conscience phonologique et de la conscience phonémique. Ensuite, nous présentons les conséquences de la conscience phonémique sur la manière dont les personnes conceptualisent la phonologie de leur langue et y font attention. Enfin, nous montrons que la litéracie alphabétique influence les stades tardifs de la reconnaissance des mots parlés mais pas les processus les plus précoces, dont notamment l'extraction automatique de l'information phonétique.

* Université Libre de Bruxelles, Belgique.
** Universidade Federal de Santa Catarina – UFSC.
*** Português de Portugal.

ABSTRACT – The consequences for psychological structure of acquiring an alphabetic system of language representation are examined. First, empirical evidence demonstrating that alphabetic literacy promotes the acquisition of phonemic awareness is reviewed. Most of these studies involved the testing of illiterate populations in Portugal, Spain and Brazil. Phonological sensitivity, phonological awareness and phonemic awareness are distinguished. Then, the consequences of phonemic awareness on the way people conceptualize and attend to the phonology of their language are presented. Finally, it is shown that alphabetic literacy influences late stages of spoken word recognition although not the earlier processes, namely the automatic extraction of phonetic information.

## Introduction

It is widely accepted that the discovery or invention of the alphabetic writing represents one of the major technological advances of the history of mankind (cf., among many others, the classic book by McLuhan, 1962). The question that is addressed here concerns the effects of acquiring the usage of this tool on psychological structure.

The idea that technological evolution influences mental activity and representation is fascinating. It is likely that technology does modify our mind as it modifies our way of living. Yet, the changes might be rather superficial. Biologists and anthropologists tell us that, at a philogenetical scale, the human brain and the use of tools have evolved together in an interactive way: any increase of tools complexity which is more demanding at brain level makes selective pressure on it, and more powerful brain capacities produce more complex tools. Does this model that looks reasonable apply to changes at the individual life span scale? The particular question we wish to explore in this contribution concerns the possibility that speech processing and representation change as a consequence of being exposed to alphabetic writing. The alphabetic script is a cultural product of our society, derived from a natural one -language-, and children have to become integrated in the society. The question is whether the children's mind changes as a consequence of the acquisition of alphabetic literacy, and if it does, at what level do the changes take place. The first stages of this acquisition are emphasized, because it is at this time that the specific effects of the alphabetically written representation of language can be appreciated in a relatively pure way.

The alphabet is a code that represents language roughly at the level of units called phonemes. In order to be able to read and write alphabetic material, it seems tremendously advantageous, if not necessary, to acquire conscious knowledge both of the alphabetic principle, i.e. that letters stand for phonemes, and of the particular alphabetic code, i.e. which letters stand for which phonemes. In the first section of the present contribution, we will argue that learning to read and write alphabetically promotes the acquisition of conscious representations of phonemes as well as the development of the ability to analyze spoken language into phonemes. These latter capacities are usually called phonemic awareness and conscious or intentional phonemic segmentation ability, respectively. In the second section, we will argue that alphabetic literacy, probably through its phonemic awareness component, influences the processes of spoken language recognition.

## 1 Alphabetic literacy promotes the acquisition of phonemic awareness

### 1.1 Phonemic awareness

Children studies have generally shown a dramatic increase of performance on tasks supposed to reflect phonemic awareness, from kindergarten to first-grade. In one of those studies (Zhurova, 1973), children were shown dolls with colored jackets and were told, for instance, that "the boy with the green jacket is Gan, the boy with the white jacket is Whan", etc. Then, they were tested for the retention of names and questioned about dolls with other (pink, etc.) colored jackets. The rule for new jackets was used successfully by 12%, 39% and 100% of the children in the 4 to 5, 5 to 6 (kindergartners), and 6 to 7 (first-graders) years age groups, respectively. In another famous study (Liberman, Shankweiler, Fischer & Carter, 1974), children were asked to play a game in which segments (either syllables or phonemes) of a word spoken by the experimenter had to be indicated by the number of taps. The authors found that none of nursery school children (mean age: 4.10) could segment by phoneme (i.e. reach a criterion of 6 consecutive errorless trials) while 46% could segment by syllable. The percentage of children who were able to segment by phoneme increased up to 17% in kindergartners (5.10 years), and especially in first-graders (6.11 years), who reached 70%.

As Shankweiler and Liberman (1976) pointed out, the dramatic progress in intentional phonemic segmentation between ages 5 and 6 "might result from the reading instruction that typically begins between ages five and six. Alternatively it might be a manifestation of cognitive growth not specifically dependent on training". Some children studies yielded results that support the instructional hypothesis. In Denmark, where children begin literacy instruction one year later than in other industrialized countries, the improvement in intentional phonemic segmentation also tends to occur one year later (Skjelfjord, 1976). Testing children differing by some months of age at the beginning of the school year compared with testing at the same age but at two different periods in the school year showed that amount of instruction, rather than chronological age, is relevant (Alegria & Morais, 1979). Finally, type of instruction provokes very important differences, with the phonic method leading to much faster acquisition of phonemic awareness than the whole-word method (Alegria, Pignot & Morais, 1982).

Clear-cut evidence could be obtained by comparing illiterate adults, who had never been in school and never learned to read or write, and ex-illiterate adults, i.e. people of comparable age and background who had attended literacy classes as adults. Morais, Cary, Alegria and Bertelson (1979) run such a study in Portugal. The task was either to add a prespecified consonant at the beginning of a spoken utterance or to delete the initial consonant. The illiterates performed as poorly as first-grade Belgian beginning readers (less than 20% correct responses), whereas ex-illiterates reached the level of second-graders (more than 70% correct) (children data from Morais, Cluytens & Alegria, 1984). Morais, Bertelson, Cary and Alegria (1986) replicated these results and showed moreover that illiterates' inability to analyze language is not general, since most of them performed well in a task involving the deletion of the initial syllable. Conscious access to syllables does not depend crucially on alphabetic literacy, although this form of literacy probably provides useful cues for conscious syllabification. What alphabetic literacy specifically promotes is awareness of phonemes.

The Portuguese illiterate data were later replicated on similar populations from other countries, namely Spain (Adrian, Alegria & Morais, 1995) and Brazil (Scliar-Cabral, Morais, Nepomuceno & Kolinsky, 1997), at least as regards phonemic awareness tasks. In the Spanish study, the syllable tests yielded surprisingly poor scores, although somewhat higher than the corresponding phonemic tests. The authors attributed their illiterates' low performance on the syllabic tests to the fact that their subjects were given only 4 training trials versus 15 in Morais et al. (1986). However, this may not be the real source of the discrepancy, since in the Brazilian study, with only one training trial, the illiterates performed relatively well on syllable deletion while displaying almost null performance on phoneme deletion. The Spanish and the Brazilian studies differed also by the fact that the syllable to be deleted was a CV and a V, respectively; since the remaining syllable to be produced was a CV in both cases, the initial V might have been easier to disregard. Anyway, even if syllabic tasks can elicit a large (inter-subjects and inter-experiments) variability in illiterates' performance, all the studies mentioned above converge to show that tasks involving conscious access to the phoneme are out of the reach of illiterate people.

The literature on metaphonological abilities has often confounded the notions of phonemic awareness and phonological awareness. In order to make clear what are the specific contributions of alphabetic literacy to those abilities, it is necessary to first unpack the notion of phonological awareness.

## 1.2 Phonological sensitivity

Phonological awareness must first be distinguished from phonological sensitivity: people can be sensitive to phonological properties without being aware of them. Phonological sensitivity is a component of spoken language comprehension, and is demonstrated by appropriate behavior. It allows the listener, for instance, to recognize correctly the Portuguese words "mapa" and "capa", even when these utterances are presented in isolation.

## 1.3 Phonological awareness

Phonological awareness becomes necessary when one must decide, for instance, which of two evoked names is longer, or whether or not two nonsense utterances are identical. These tasks imply intentional judgments on phonology rather than the mere activation of phonological structures. In the same vein, most people are aware of some phonological properties when they appreci-

ate or use rhyme and other phonological resemblances in poetry, slogans, and puns. Phonological awareness is thus the capacity to represent phonological properties consciously. As such it is a general, not very useful, concept, unless one specifies the phonological properties which an individual is aware of.

In particular, one should distinguish between analytic and holistic forms of phonological awareness. The latter, which do not imply segmentation, may be present before the onset of alphabetic literacy.

1.3.1 Some of these holistic forms of phonological awareness are certainly necessary to language development, like for example the self-corrections exhibited by children in the course of language acquisition. They provide a testimony of awareness of incorrect pronunciation: the child most probably realizes the difference between incorrect and correct pronunciations.

1.3.2 Also, comparing the phonological length of a pair of evoked object names yielded high scores in some of the illiterate adults tested by Kolinsky, Cary and Morais (1987). In this task, participants were silently presented with a pair of standardized drawings. On neutral trials, drawings represented objects of the same physical size, which names varied however in phonological length. Sixty percent of illiterates obtained scores of at least 75% correct responses. The incongruent trials, where the longer word denotes the smallest object, were intended to indicate whether phonological awareness in illiterate people can resist semantic interference. Among the subjects who might be credited with this capacity, 83% obtained lower scores in the incongruent than in the neutral trials, though always above chance level. It thus seems that most of the subjects, rather than simply falling in the semantic trap, experienced an attentional conflict between semantics and phonology.

1.3.3 Holistic phonological awareness may also afford the possibility to accomplish some speech sound classification or detection tasks. Cary (1988) tested illiterate adults in the classification of triads of CV or VC spoken syllables. When two of the items not only shared a vowel, but were also perceptually close to each other (like in the triad /pe, be, si/), they were classified together most of the time. The proportion of correct classifications largely fell, however, when vowel sharing conflicted with the perceptual similarity

of another pair, like in the triad /se, be, pi/. The large difference in performance observed between the two situations suggests that illiterates may use some form of holistic phonological awareness to appreciate phonological similarity.

Most of the phoneme detection situations have yielded low scores in illiterates (e.g., Morais et al., 1986). However, unpublished data obtained by Fiadeiro, Cary and Morais suggest that illiterates may perform quite well when placed in very easy detection conditions, namely when a phoneme target which remains constant through the testing has to be found among very short stimuli. Most probably, illiterates were not using phonemic representations in this situation. The detection of /p/ in /pi/ or /pa/ but not in /vi/ or /va/ may actually result from a phonological similarity judgment between the pronounced target /pə/ and each of these stimuli.

1.3.4 Rhyme appreciation and production have been largely debated in the effort to distinguish between phonological and phonemic awareness. According to Bradley and Bryant (1985), rhyming abilities depend on "breaking words and syllables into phonological segments", or at least into onset (initial consonant or consonantal cluster) and rime (initiated by the vocalic nucleus of the syllable). Thus, for these authors, rhyming abilities imply phonemic awareness or at least analytical phonological awareness. However, most illiterates are able to appreciate rhyme, and some are even able to produce it spontaneously. Morais et al. (1986) used a rhyme detection task in which subjects listened to 5 objects names while being presented with drawings. The first, target name, rhymed with one of the other names. Fourty eight percent of the illiterates obtained at least 75% correct choices of the rhyming name. In Bertelson, De Gelder, Tfouni and Morais (1989), Brazilian illiterates were presented with examples of word pairs that either rhymed or not. Then, they had to judge whether or not new pairs rhymed, erroneous responses being corrected. Seventy five percent of the illiterates reached the criterion of 6 consecutive correct responses. Illiterates can thus appreciate rhyme. If this ability implies subsyllabic awareness, then a contradiction appears, since illiterates usually fail subsyllabic segmentation tests (Morais et al., 1979; 1986; Bertelson et al., 1989).

The best way to overcome this contradiction is to consider that rhyme can be appreciated on the basis of holistic phonological awareness. However, one should note that, in most rhyming situations, syllabic segmentation must precede rhyme apprecia-

tion. Indeed, "constituição" and "não" do rhyme, whereas "constituição" and "constituído", despite being phonologically closer, do not rhyme. Informal observations of the first author suggest that illiterates are sensitive to rhyme in the first case (which is frequent in popular songs and poems) while they do not take the last case of phonological resemblance as being rhyme. We thus have to admit that the kind of phonological awareness involved in rhyme appreciation is not only wholistic, but also involves analysis, namely syllabic awareness. However, given that co-articulation effects are weak between syllables, it may be rather uninteresting to emphasize the analytic nature of syllabic segmentation, and the notion of analytic phonological awareness should perhaps be reserved for the conscious representations of subsyllabic units.

The idea that rhyming ability does not necessary imply phonemic awareness is clearly supported by the observations made on illiterate poets (Cary, Morais & Bertelson, 1989; Morais, 1991). Despite their capacity to produce rhyme in their poems, illiterate poets are unable to perform tasks which, like consonant deletion or reversal, require phonemic awareness. The study of these people may be very helpful to determine those metaphonological capacities which do not strictly depend on alphabetic literacy. Illiterate poets are not only superior to non-poets in rhyme production; they also show higher rhyming discrimination than the best illiterate non-poets, as it was the case in a classification task requiring to distinguish rhyme from assonance (e.g., /bulǝ, gumǝ, lumǝ/).

Poets were also superior in a classification task requiring conscious knowledge of alliteration (initial consonant sharing). However, like for rhyme, responses apparently based on alliteration may not result from a subsyllabic or even phonemic analysis, but from a very fine attentional capacity to phonological similarities or discrepancies between utterances. As mentioned before, illiterates' phonological sensitivity is powerful enough to allow them to discriminate words that differ in one single phoneme. However, in order to make intentional judgments about phonology, some voluntary form of attention to speech sounds is necessary. Most of the illiterates possess this capacity to some extent, as shown by their rhyming and classification performances. Their attentional capacity suffers, however, from severe limitations. As already mentioned, they become unable to attend to vowel sharing when a conflicting, perceptually closer pair, is also available (Cary, 1988; see also Scliar-Cabral et al., 1997). Moreover, as observed by Cary and Morais (unpublished data reported by Morais, 1991), illiterates

are quite unable to appreciate similarity based on consonant sharing, even when no other conflicting response is available, as in the triad /lar, lǝv, foʃ/. By contrast, illiterate poets, who scored highly in those tests, have developed some of these capacities.

Illiterate poets also suffer, however, from some limitations in phonological awareness. Fzor instance, like non-poets, they are unable to classify together two items sharing the final consonant, like in /sol, mal, lid(ǝ)/. In a similar vein, FJC, the most studied illiterate poet (Cary & Morais, unpublished data; see also Morais, 1994), did not perform above chance level in three out of four classification tests in which phonemic identity conflicted with greater similarity of another pair. He only succeeded in vocalic classification of CV triads. This cannot be attributed to a general enhanced attention to vowels, given that FJC failed vocalic classification of VC triads. Selective attention to vowels was thus only displayed in a rhyming context. This is puzzling, since it appears to support a tautology: rhyming ability is due to rhyming ability! One possible interpretation of illiterate poets' rhyming and classification abilities is that confrontation with rhyming patterns of a popular poetry has led them to elaborate a rhyming lexicon (and/or suffixes and respective derivational rules) which helps them to increase, at the same time, the discriminability power of their phonological awareness. So, while their phonological awareness remains rather wholistic, searching in their rhyming lexicon for convenient analogies allows to put /si/ and /pi/ together from among /si, pi, be/, and helps them to distinguish true rhymes from assonances or alliterations.

In any case, the whole pattern of illiterate poets' results shows that the kind of phonological awareness that can be reached in the absence of alphabetic learning presents important limitations. Phonological awareness in nonalphabetic people is holistic, probably syllabic, and does not include selective attention to constituent phonemes. Even if one could distinguish a priori this capacity of phonemic selective attention from the capacity to both represent in isolation and manipulate phonemes intentionally, the empirical evidence suggests that the main tour de force is the acquisition of phonemic attention. Once this is acquired, under the influence of alphabetic literacy, the elaboration of conscious representations of phonemes may follow rather easily.

## 1.4 Consequences of phonemic awareness

Promotion of phonemic awareness by alphabetic literacy has important consequences on the way people conceptualize and attend to the phonology of their language.

1.4.1 Phonemic awareness gives people a mental code for manipulating efficiently the constituents of language in the whole set of metaphonological functions. Thus, it becomes easier to verify rhyme and to make spoonerisms and acronyms intentionally. However, in most of these situations, phonemic awareness probably does not operate alone. Alphabetic knowledge also gives people the possibility to use the corresponding imaged written codes. Although rhyme verification may, in some languages like English, be better verified without the interference of written codes, spoonerisms and acronyms involve a working memory capacity that may be largely insured by the use of visual imagery. Indeed, the occasional occurrence of visual errors (i.e. manipulating letters rather than phonemes) suggests that alphabetic people tend to use written codes in these tasks. It is possible that most of the work is done on the basis of written codes, phonemic codes intervening whenever corrections are necessary.

1.4.2 We noticed above that illiterate people dispose not only of phonological sensitivity, enabling them to discriminate between phonological neighbors, but also of some phonological awareness allowing them for instance to evaluate phonological length and phonological similarity. Phonological awareness supports, in addition, the verification of word incorrect pronunciation in children as well as in adults. However, phonemic awareness may be very helpful in this task, compared to wholistic phonological awareness. Cary and Morais (unpublished data; cf. Cary, 1988) tested illiterate and ex-illiterate adults in the task of word mispronunciation detection. Subjects listened to a spoken story and had to tap on a table whenever they heard a mispronunciation. Even when dialectal variety was controlled, illiterates missed about 75% of the mispronunciations, whereas ex-illiterates missed only 25%. The possibility that ex-illiterates used written codes can plausibly be discarded, since they were writing at a rudimentary, slow level, and should be unable to transcode the spoken story on-line. Another possibility may be that illiterates would be much more distracted by semantics than ex-illiterates. This idea is supported by the already mentioned fact that illiterates' evalua-

tions of phonological length is interfered by semantic incongruity (Kolinsky et al., 1987). In the same vein, Scliar-Cabral et al. (1997) observed that in vowel (syllable) and consonant deletion tests, both unschooled illiterate subjects and quasi-unschooled subjects (who completed at most the second grade in childhood and did not attend school any more) showed a strong tendency to transform the pseudowords stimuli into real words belonging to their lexicon (for instance, [asa] → /a'sado/, "roosted"). To examine the possibility that semantic interference intervenes in illiterates' mispronunciation detection score, Cary and Morais (unpublished data; cf. Cary, 1988) ran a further experiment in which, in one version, the sentences of the story were presented in scrambled order, with long pauses between them and without normal intonation. Illiterates' mispronunciation detections increased in this situation compared to normal presentation. But the effect was small, and so semantic interference may only be part of the explanation of the group difference. A plausible explanation is that phonemic awareness gives ex-illiterates a much more precise attentional focusing on phonology than the one illiterates can dispose of. While listening to the story, and having noticed that mispronunciations take place at the phonemic level, ex-illiterates would tend to focus their attention at this level. They are then able to detect local inconsistencies with the lexicon to a greater extent.

1.4.3 The last idea might be complemented by a much stronger hypothesis which is that, by focusing their attention at the phonemic level in current communication, people who are aware of phonemes may also have developed more precise lexical representations. In other words, phonemic awareness would help also in acquiring the correct phonological form of new words. The present authors have been stroken many times, during their exchanges with illiterates, by the amount of errors they produce when using foreign proper names, even when they have a reasonable knowledge of the foreign language. When being introduced to a new person, many illiterates tend to confound his or her name with another one, perhaps more familiar to them, which is phonologically similar and shares at least the end or rhyming part. Thus, the French names "Eliane" and "Régine" become "Diane" and "Christine", respectively. Curiously, the attributed names survive repeated opportunities to correct the error. These anecdotal observations illustrate the difficulty of learning new words in the absence of conscious representations of phonemes. A reasonable hypothesis is that phonemic awareness prevents many errors by al-

lowing both a precise perception and the retention of precise phonological representations. To what extent, and at what level, phonemic awareness contributes to speech perception processes is the object of the next section.

## 2 Alphabetic literacy influences spoken word recognition

The recognition of spoken language includes the unconscious, mandatory and automatic operation of perceptual mechanisms which are biologically determined. The development of these mechanisms presumably requires critical experiences that take place in the usual conditions of early childhood. But recognition includes also processes which, while possibly being unconscious, mandatory and automatic, are acquired under the influence of explicit instruction and training. For instance, recognition of written words in the alphabetic system by beginning readers is based, at least partially, on a phonological assembling mechanism that is usually acquired through both alphabetic explicit instruction and progressive phonemic awareness. Phonological assembling is at the beginning an effortful, conscious activity, but later on it becomes unconscious: readers are not aware of using it in pseudoword reading. There is thus no reason to discard a priori the idea that phonemic awareness may be at the origin of processes that intervene in the recognition of spoken words, or at least that it may influence the operation of some recognition processes. These processes may then become automatized, effortless, and unconscious.

The number of experimental studies of spoken word recognition in young preliterate children has greatly increased in the last years. The processes used by preliterates seem to be somewhat less directional and less oriented to the extraction of segmental information than the processes used by older, literate people. For example, adults generally display a higher rate of mispronunciation detection of the initial syllable than of the following ones. This effect is not observed in children (Cole & Perfetti, 1980). In a similar vein, in adults more than in children, words where some phonemes have been degraded or suppressed are judged less identifiable when those phonemes are initial than when they are not (Walley, 1988).

Studdert-Kennedy (1987) sustains that the rapid lexical growing that occurs around three years of age is contemporaneous with a passage from relatively wholistic lexical representations to representations structured in terms of phonemes. This may be necessary, given the rapid increase of the proportion of words with many neighbors (Charles-Luce & Luce, 1990). The acquisition of alphabetic literacy may accelerate this developmental course, since literacy contributes to expanding the lexicon and therefore puts an additional pressure on the need for phonemically structured representations. A related question is whether alphabetic literacy can have similar effects on the processes of spoken word recognition, i.e., whether alphabetic people use more phonemically-based processes than nonalphabetic people. However, given the importance in speech recognition of mechanisms that are constrained both by universal properties of the speech production device and by very early linguistic experience, a large part of processing should be unaffected by alphabetic literacy. This part should, in principle, be the most peripheral and include at least the extraction of phonetic information from the speech input. In the remaining section of the present chapter, some empirical evidence of both alphabetic literacy-independent and -dependent processes is reviewed.

### 2.1 Automatic extraction of phonetic information

Three types of phenomena have been investigated in illiterate Portuguese adults and compared to literate controls.

2.1.1 Categorical perception. Identification responses to sets of stimuli spanning the acoustic continuum that links two opposite values of a phonetic feature do not change in a smooth but rather abrupt manner (Liberman, Cooper, Shankweiler & Studdert-Kennedy, 1967). Castro and Morais (unpublished data; see Morais & Mousty, 1992) ran an experiment of word identification in which words differed in voicing (/balU/-/palU/ and /kOlU/-/gOlU/). Identification responses showed the usual curves of categorical perception, and there was no difference on the average between literates and illiterates.

2.1.2 McGurk effect. It has been shown that visual information about the movements of the speaker's mouth can affect the perception of auditory information: adult (literate) listeners presented with a slightly ambiguous acoustic /ba/ and looking at a

face that articulates /da/ silently may have the impression of hearing /da/ or even /bda/ (McGurk & McDonald, 1976). Morais, De Gelder and Verhaeghe (unpublished data; cf. Morais & Mousty, 1992) presented the continuum /ba-da/ either auditorily, or simultaneously with the speaker's face on a video screen. In this last case, the two sensory informations were either congruent or incongruent. In the pure auditory situation, there was no difference between literates and illiterates as far as the slope of the identification curve is concerned. This result converges with the previous one to indicate that phonetic categorization, in terms of either place of articulation or voicing, is literacy-independent. In the auditory-visual situation, the literates' results confirmed once again the optical influence. Moreover, the shift in the identification curve was roughly the same in illiterates as in literates. The fact that there is no influence of literacy on the McGurk effect is consistent with the claim that the auditory-visual integration of phonetic information is carried out by a modular, biologically-programmed device (Liberman & Mattingly, 1985).

2.1.3    Feature blending. The extraction of phonetic features may be inferred from the occurrence of some perceptual errors. For instance, when people receive the dichotic pair /ba-ta/ and erroneously recognize /pa-da/ above chance, one may interpret this error as the combination of the place of articulation value of the stimulus delivered to one ear with the voicing value of the stimulus delivered to the other ear (Day, 1968; Cutting, 1976). Morais, Castro, Scliar-Cabral, Kolinsky and Content (1987) examined this effect using dichotic presentations of CVCV Portuguese words in which the initial C was always a stop. In one third of the trials the initial consonants of the dichotic pair differed in both place of articulation and voicing. The task was to recognize the word presented in one, previously specified, ear. A significant proportion of phonetic feature blendings was observed, which did not differ significantly between literates, semiliterates (with normal but short schooling in childhood) and illiterates. Thus, alphabetic literacy has no effect at the level where phonetic feature blendings take place.

## 2.2    Alphabetic literacy effects

Alphabetic literacy affected other levels of processing in the task used by Morais et al. (1987).

2.2.1    Segmental versus global errors. Since all the phonemes of the dichotic words used in a trial were different, with the exception of the last vowel, it was possible to calculate the proportion of errors on one segment only, for instance on the initial consonant (segmental errors), and the proportion of errors on at least both segments of a syllable (global errors). The results showed that the proportion of segmental errors was higher in literates than in illiterates, whereas the proportion of global errors showed the opposite trend. This effect remained significant even when subgroups of same overall performance were compared. It was also observed in a further experiment (Castro & Morais, unpublished data) which used single-word but noisy presentations. This effect may reflect the availability in literates, who are aware of phonemes, of an attentional mechanism focusing on the phonemic structure of speech.

Models of spoken language processing generally admit that listeners may focus their attention on the level of information that is more appropriate to the task. The Morais et al.'s (1987) results suggest a more specific claim, namely that listeners can focus their attention on phonemic constituents even when they have to recognize whole words. This hypothetical attentional mechanism might be automatic or, instead, strategic and optional. In order to gather evidence on this issue, Castro and Morais (unpublished data; cf. Morais, Castro & Kolinsky, 1991) have compared two groups of literates tested in the noisy situation. The control group was simply required to recognize stimuli. Subjects of the experimental group were, in addition, informed about word structure and invited to pay attention to individual phonemes as a mean of improving performance. Despite the fact that the two groups obtained the same mean performance, segmental errors were proportionally more frequent in the experimental group. Thus, attention on the phonemic constituents of words is not automatic but, instead, constitutes a strategy.

2.2.2    Phonological fusions. Phonemic attention in spoken word recognition is presumably a consequence of phonemic awareness. The alphabetic literacy effect which will be described below would stem, rather, from orthographic knowledge. Orthographic influences on metaphonology have been observed on rhyme judgments (Seidenberg & Tanenhaus, 1979) and phonemic detection (Taft & Hambly, 1985). In the present case, it takes place during lexical recognition and affects the occurrence of errors called phonological fusions. These are observed in dichotic listen-

ing when, for example, the stimuli "banket" and "lanket" yield the perception of "blanket"; they are barely affected by acoustic variables but largely by linguistic factors like the lexical status of illusory outputs (Cutting, 1975). Castro and Morais (unpublished data; see Morais et al., 1991) replicated this phenomenon with literate and illiterate Portuguese, using both pairs of words whose fusion would be consistent with orthography (e.g., "cara-lara" yielding the word "clara") and pairs whose fusion would not be consistent with orthography (e.g., "liz-fiz" yielding the word "feliz", which contains a mute /ə/ and is pronounced /fliʃ/). In the consistent case, the illusion was observed as frequently in literates as in illiterates. In the inconsistent case, while illiterates displayed the same illusory rate as in the consistent case, literates' orthographic knowledge inhibits the occurrence of phonological fusions, which they experienced at a much lower rate. This suggests that upper levels of processing in lexical access are not only morphophonemic, but are also permeable to orthographic representations.

To sum up, it appears that alphabetic literacy does not affect phonetic processing, but may have an effect on phonemic processing, either by contributing to a phonemic attentional strategy, or by allowing orthographic knowledge to influence the integration of phonemic sequences.

## 3   The exercise of literacy contributes to the development of short-term memory

The recognition of words is only part, though an important one, of spoken language comprehension. This includes also memory mechanisms that allow word representations to be retained for a time long enough as to be used in sentence processing. Phonological representations in short-term memory seem particularly apt for this task. Their use in illiterates was investigated by Morais et al. (1986). The experimenter presented pictures of objects, in succession, while saying their names orally. Each picture was placed face down, and after the last one had been presented subjects were given a cardboard displaying these and other pictures. The task was to match the cards, without turning them up, with the pictures of the cardboard. In this situation, it is usual to obtain a rhyme effect, i.e. lower performance when the series of pictures contains rhyming names (Conrad, 1971; Alegria & Pignot, 1979). This effect was also observed in illiterates, and was as im-

portant as in ex-illiterates. Thus, illiterates dispose of phonological representations in short-term memory, and the contribution of these representations to immediate recall does not increase with the acquisition of phonemic awareness.

On the other hand, the mean number of items used in each trial in order to yield about 50% correct matches was rather low: 4.3 for illiterates, and 4.8 for ex-illiterates. This is much inferior to the usual short-term memory span obtained with literate adults. Further, unpublished data, by Verhaeghe, Byrne, Kolinsky and Morais, indicate that the forward and backward digit spans as estimated by the WISC are very low in illiterates: around 4 and 2 items, respectively. Ex-illiterates are only slightly better. Thus, rudimentary reading and writing, knowledge of the alphabetic code, and phonemic awareness are insufficient to allow an efficient use of short-term verbal memory. The capacity shown by normal literates shall be explained by other factors, which may be more closely linked to experience, knowledge and organizational processes obtained through literacy activities than to the literacy abilities by themselves.

## 4   A final general comment on literacy and alphabetic literacy

If one puts the specific issue of phonemic awareness apart, the precise effects of alphabetic literacy, and a fortiori of literacy in general, on language processes and representations remain poorly understood. The main problem is that literacy, as a scientific concept, is difficult to circumscribe. For at least two reasons: most contemporaneous illiterate people live in a literate milieu; and literacy is a continuous rather than a dichotomous variable (cf. discussion by Scliar-Cabral, 1998).

Literacy is indeed not limited to the capacity to read and write, but it includes this capacity. As a transcoding capacity, from spoken to written language and vice-versa, it implies the acquisition of some mechanisms that have direct effects on mental structures. We attempted, in the present contribution, to summarize the main available data that are relevant to understand such effects.

## References

Adrian, J. A., Alegría, J., & Morais, J. (1995). Metaphonological abilities of Spanish illiterate adults. *International Journal of Psychology, 30*, 329-353.

Alegria, J., & Morais, J. (1979). Le développement de l'habileté d'analyse phonétique consciente de la parole et l'apprentissage de la lecture. *Archives de Psychologie, 183*, 251-270.

Alegria, J., & Pignot, L. (1979). Genetic aspects of verbal mediation in memory. *Child Development, 50*, 235-238.

Alegria, J., Pignot, L., & Morais, J. (1982). Phonetic analysis of speech and memory codes in beginning readers. *Memory and Cognition, 10*, 451-456.

Bertelson, P., De Gelder, B., Tfouni, L. V., & Morais, J. (1989). Metaphonological abilities of adult illiterates: New evidence of heterogeneity. *European Journal of Cognitive Psychology, 3*, 239-250.

Bradley, L., & Bryant, P. E. (1985). *Rhyme and reason in reading and spelling*. Ann Arbor: University of Michigan Press.

Cary, L. (1988). *A análise explícita das unidades da fala nos adultos não-alphabetizados*. Unpublished doctoral dissertation, University of Lisbon.

Cary, L., Morais, J., & Bertelson, P. (1989). A consciência fonológica dos poetas analfabetos. *Anais do Simpósio Latino-Americano de Psicologia do Desenvolvimento*, Ed. Universitária da EFPE, Recife, Brasil, 160-166.

Charles-Luce, J., & Luce, P. A. (1990). Similarity neighbourhoods of words in young children's lexicons. *Journal of Child Language, 17*, 205-215.

Cole, R. A., & Perfetti, C. A. (1980). Listening for mispronounciations in a children's story: The use of context by children and adults. *Journal of Verbal Learning and Verbal Behavior, 19*, 297-315.

Conrad, R. (1971). The chronology of the development of covert speech in children. *Developmental Psychology, 5*, 398-405.

Cutting, J. E. (1975). Aspects of phonological fusion. *Journal of Experimental Psychology: Human Perception and Performance, 1*, 105-120.

Cutting, J. E. (1976). Auditory and linguistic processes in speech perception: Inferences from six fusions in dichotic listening. *Psychological Review, 83*, 114-140.

Day, R. S. (1968). Fusion in dichotic listening. *Dissertation Abstracts International, 29*, 2649B.

Kolinsky, R., Cary, L., & Morais, J. (1987). Awareness of words as phonological entities: The role of literacy. *Applied Psycholinguistics, 8*, 223-232.

Liberman, A. M., Cooper, F. S., Shankweiler, D., & Studdert-Kennedy, M. (1967). Perception of the speech code. *Psychological Review, 74*, 431-461.

Liberman, A. M., & Mattingly, I. G. (1985). The motor theory of speech perception revised. *Cognition, 21*, 1-36.

Liberman, I. Y., Shankweiler, D. P., Fischer, F. W., & Carter, B. (1974). Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology, 18*, 201-212.

McGurk, H., & McDonald, J. (1976). Hearing lips and seeing voices. *Nature, 264*, 746-748.

McLuhan, M. (1962). *The Gutenberg galaxy*. Toronto: University of Toronto Press.

Morais, J. (1991). Phonological awareness: A bridge between language and literacy. In d. J. Sawyer & B. J. Fox (Eds.), *Phonological awareness in reading: the evolution of current perspectives*, Berlin: Springer-Verlag.

Morais, J. (1994). *L'Art de Lire*. Paris: Éditions Odile Jacob (Brazilian translation: A Arte de Ler; São Paulo: FUNESP, 1996).

Morais, J., Bertelson, P., Cary, L., & Alegria, J. (1986). Literacy training and speech Segmentation. *Cognition, 24*, 45-64.

Morais, J., Cary, L., Alegria, J., & Bertelson, P. (1979). Does awareness of speech as a sequence of phones arise spontaneously? *Cognition, 7*, 323-331.

Morais, J., Castro, S. L., & Kolinsky, R. (1991). La reconnaissance des mots chez les adultes illettrés. In R. Kolinsky, J. Morais & J. Segui (Eds.), *La reconnaissance des mots dans les différentes modalités sensorielles. Études de psycholinguistique cognitive*. Paris: Presses Universitaires de France (pp. 59-80).

Morais, J., Castro, S. L., Scliar-Cabral, L., Kolinsky, R., & Content, A. (1987). The effects of literacy on the recognition of dichotic words. *The Quarterly Journal of Experimental Psychology, 39A*, 451-465.

Morais, J., Cluytens, M., & Alegria, J. (1984). Segmentation abilities of dyslexics and normal readers. *Perceptual and Motor Skills, 58*, 221-222.

Morais, J., & Mousty, P. (1992). The causes of phonemic awareness. In J. Alegria, D. Holender, J. Morais & M. Radeau (Eds.), *Analytic approaches to human cognition*, Amsterdam: North-Holland (pp. 93-212).

Scliar-Cabral, L. (1998). Letramento e as perspectivas para o proximo milénio. In L. Grimm-Cabral & E. Gorski (Eds.), *Linguística e ensino. Reflexoes para a pratica pedagogica da lingua materna*. Florianopolis: Editora Insular (pp. 17-30).

Scliar-Cabral, L., Morais, J., Nepomuceno, L., & Kolinsky, R. (1997). The awareness of phonemes: So close - so far away. *International Journal of Psycholinguistics, 13*, 211-240.

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

Shankweiler, D., & Liberman, I. Y. (1976). Exploring the relations between reading and speech. In R. M. Knights & D. J. Bakker (Eds.), *Neuropsychology of learning disorders: Theoretical approaches*. Baltimore: University Park Press.

Skjelfjord, V. J. (1976). Teaching children to segment spoken words as an aid in learning to read. *Journal of Learning Disabilities, 9*, 297-306.

Studdert-Kennedy, M. (1987). The phoneme as a perceptuo-motor structure. *Haskins Laboratories: Status Report on Speech Research, 91*, 45-57.

Taft, M., & Hambly, G. (1985). The influence of orthography on phonological representations in the lexicon. *Journal of Memory and Language, 24*, 320-335.

Walley, A. C. (1988). Spoken word recognition by young children and adults. *Cognitive Development, 3*, 137-165.

Zhurova, L. Y. (1973). The development of analysis of words into their sounds by preschool children. In C. A. Ferguson & D. I. Slobin (Eds.), *Studies of child language development*. New York: Holt, Rinehart and Winston.