Literacy and Cognitive Change

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The chapters in this book are about literacy. They focus on the processes of reading and spelling, their acquisition, dissolution, and biological foundations. This chapter is different: it discusses the possible effects of becoming literate on other cognitive capacities. It focuses on the specific effects of alphabetic literacy, and tries to separate these effects from more general cognitive changes that may be the product of education or schooling. We begin by considering some conceptual and methodological issues.

Literacy, Schooling, and Education

Literacy is the ensemble of representations and processes that an individual acquires as an obligatory and direct consequence of learning to read and write. In this view, literacy varies by degrees because reading and writing take several years to master. Literacy is usually acquired in school. The intricate relationship between literacy and schooling makes it difficult to disentangle their effects on cognitive development because many other abilities are acquired in school. While literacy is a competence that can be evaluated through the observation of performance, school is a setting where experiences take place and it is therefore less easy to specify its effects. Schooling is usually measured by the number of years completed at school or the academic level achieved. However, these measures do not take account of a potential confound between the number of years in school and the sociocultural or socioeconomic status of the individual.

Schooling must also be differentiated from education. First, there are many specialized forms of schooling (for visual arts, music, sports, etc.) that cannot be subsumed under the category of typical schooling. Second, there are a variety of personal ways of becoming educated. Theoretically, it would be more ambitious to ask about the impact of education than of schooling on cognitive development. However, education is an even more
elusive variable than schooling. Schooling and education themselves must be differenti­
ated from culture, which is not only a matter of knowledge but includes values and types 
of social behavior. Ishii, Reyes, and Kitayama (2003) provided an illustration of the role 
of culture on cognitive processing while controlling for the effects of schooling. All of the 
participants were undergraduates. Using emotionally relevant spoken words in a Stroop-
like test, the authors found that Americans had greater difficulty ignoring verbal content, 
while Japanese and Tagalog-English bilinguals had greater difficulty ignoring vocal tone.

Methodological issues

At first sight, a straightforward approach to questions concerning the effects of literacy 
on cognition would be to compare illiterate and literate people of the same age, sex, and 
country or region. However, illiterate and literate people differ from one another in very 
important ways. Illiterate people typically have had little or no schooling in their child­
hood and given that literacy is an instrument both for the acquisition of information and 
of social promotion, they tend to have much less sociocultural and socioeconomic status 
than literate people. As discussed eloquently by Coppens, Parente, and Lecours (1998, 
p. 184), there may be a good reason to differentiate between "unschooled, semischooled 
and schooled... individuals rather than to express the group differences in terms of li-
teracy levels" (authors' italics). In short, we need to be cautious when interpreting find­
ings concerning the cognitive effects of literacy when studies have not controlled for 
related factors.

A crucial research question is whether there are means of separating the cognitive 
effects of literacy acquisition from those of school attendance. The approach taken by 
Bertelson and Morais' group and by Cary (1988) and Verhaeghe (1999) is made possi­
ble by the fact that, in many countries where illiteracy and lack of schooling characteri­
ze a significant proportion of the population, there have been efforts to teach these people 
reading and writing in special classes. Most instructional programs are entirely or almost 
exclusively devoted to alphabetization, although some also include elements of arithmetic, 
geometry, drawing, science, and history. People who learned reading and writing in this 
way are here referred to as ex-illiterates. When ex-illiterates are contrasted with an illi-
terate group, they provide an appropriate comparison group against which to assess the 
impact of literacy per se on the development of cognition. In a series of studies using this 
paradigm, Morais and colleagues compared groups of illiterates and ex-illiterates in Por­
tugal on tasks involving the explicit, conscious analysis of speech into phonemes (Morais, 
Cary, Alegria, & Bertelson, 1979; Morais, Bertelson, Cary, & Alegria, 1986) or of visual 
figures into segments (Kolinsky, Morais, Content, & Cary, 1987b). Neither the ex-
illiterates nor the illiterates had attended school in childhood, or learned to read and write 
in traditional settings. Rather, the ex-illiterates had attended special classes organized by 
the state, the army, or the factories that employed them. These people were not fully 
literate: their literacy skills were usually quite rudimentary.

Although this approach controls as far as possible for differences in schooling, it does 
not circumvent the problem of uncontrolled differences in the knowledge acquired 
through reading. Most of the ex-illiterate people that were tested had learned to read and
José Morais and Régine Kolinsky write some years before the experiments were completed and they differed from the illiterate participants not only in terms of literacy skill, but also in terms of what they had learned from being able to read. This problem is reduced in the case of ex-illiterate people who are still attending literacy classes and who have not been favored by the wider gains associated with literacy skills.

In other studies (e.g., Kolinsky, Morais, & Verhaeghe, 1994), our research strategy has been to begin by comparing illiterate unschooled participants to literate schooled ones. The observation of group differences in such a design leaves the question of the critical factors open for further investigation. But, if no difference is observed, this finding allows the researcher to proceed immediately to another capacity or issue. Moreover, the finding of a specific effect of literacy on a given skill can be corroborated by the finding that illiterates and ex-illiterates differ on that skill but not on another related skill. For example, Morais et al. (1986) reported that although illiterates were dramatically inferior to ex-illiterates in phoneme manipulation, they were only a little worse in syllable manipulation, in line with the hypothesis that phoneme but not syllable awareness depends upon alphabetic literacy.

There remains, however, a more fundamental problem. This is the possibility that illiterates differ from ex-illiterates in some characteristic other than literacy, such as motivation or engagement with the experiment. Morais et al. (1979) interpreted their finding that illiterates were unable to delete the initial phoneme of an utterance explicitly, or to add one to it, whereas ex-illiterates could do it, as evidence that phoneme awareness does not develop spontaneously. However, the observed difference, by itself, was not necessarily due to literacy. Since the ex-illiterate participants tested had attended alphabetization classes for adults, it was possible that they had just become better at paying attention to instructions. In cases such as these, where findings are equivocal, converging data can be instructive. Read, Zhang, Nie, and Ding (1986) replicated Morais et al.’s (1979) finding in a study where they compared the phoneme awareness of Chinese readers who had been taught pin-yin (an alphabetic reading system) or who had been taught only the traditional, nonalphabetic, Chinese writing system. The alphabetized readers scored at a similar level to the ex-illiterate people and the nonalphabetized readers at a similar level to the illiterate people in Morais et al.’s (1979) earlier study. Since the two groups in Read et al.’s (1986) study were comparable in terms of number of years of schooling and professional activity, differences in attention or motivation are not a plausible explanation of these findings. Thus, Read et al.’s findings, together with the earlier study by Morais et al. demonstrate that becoming literate in an alphabetic script bootstraps the development of phoneme awareness.

The Impact of Literacy on Nonlinguistic Capacities

Does literacy affect nonlinguistic capacities such as motor behavior, music, visual cognition, mathematics, drawing, nonverbal reasoning, or executive processes? Language may intervene in many apparently nonlinguistic tasks, and the possibility that written language may affect nonverbal behaviors via inner speech must also be considered. Although
writing is a representation of oral language, some of its inherent properties, such as spatial mapping and physical permanence, might allow it to distribute processing over more representations than is presumably the case for speech. For example, writing allows recovery of information from memory to be supported not only by phonological codes but also by mentally represented orthographic codes as well as by print; that is, by external memory.

Visual cognition

A number of different aspects of visual cognition have been assessed in illiterate as compared to literate adults. Kolinsky and Morais (1999) distinguished between the early perceptual processes leading to object recognition and postperceptual processes involved in the conscious, intentional analysis of perceptual representations. A standard paradigm for examining early perceptual processes involves the observation of illusory conjunctions. These errors of recombination of correctly extracted features, which consist for example in reporting more often the presence of a red circle when green circles and red squares are presented than when green triangles and red squares are presented, indicate that the features have been unintentionally analyzed. Kolinsky et al. (1994) found no difference between illiterate and literate adults in the rate of observed illusory conjunctions for color and form, segments of geometric figures, or shape and orientation of segments. However, in a task involving intentional postperceptual processes in which the participant has to detect a part made of three segments in a figure made of six (see figure 11.1), Kolinsky et al. (1987b) found that illiterates and ex-illiterates performed at the same level and less well than children attending the second grade. Together, these findings suggest that early perceptual visual processes are universal, whereas postperceptual ones depend, not on literacy, but on schooling (or on some experience that is provided to the children usually by Grade 2 of primary school).

Brito Mendes, Kolinsky, and Morais (1988) and Brito Mendes, Morais, and Kolinsky (in press), using the same material as Kolinsky et al. (1987b), attempted to determine whether unschooled people would improve in their ability to detect highly embedded parts of a figure by providing them with analytic instructions. After each response, the subject was given feedback that consisted of placing a transparency over the figures showing the segments that should have been detected. In this way they could see whether or not each target segment was present in the figure. Correct detection of the part increased, but at the same time, the accuracy with which the participants could say when a part was not in the figure decreased. Thus, neither illiterates nor ex-illiterates benefited from the analytic feedback.

There are, however, other visual tasks in which performance does seem to be influenced by learning to read. Cooper (1976, 1980) assessed the ability of literate individuals to discriminate closed and irregular black-colored forms using a “same-different” classification paradigm designed to distinguish between holistic and analytic processing. It was argued that one group of participants used holistic matching. For them “same” responses were faster than “different” responses, and (dis)similarity did not affect the latter responses. For another group of participants who were deemed to use analytic
processing, “same” responses were not faster than “different” ones, and reaction time increased as similarity decreased. According to Cooper (1980), “perceptual development proceeds from a holistic undifferentiated mode to a more analytic or differentiated one” (pp. 338-339). Following on from this, Brito Mendes et al. (in press) examined illiterate, ex-illiterate and literate people on Cooper and Podgorny’s (1976) task, using the same materials as they did. Illiterates detected sameness as fast as difference and, unexpectedly, they were faster for “same” trials than ex-illiterate and literate people. Moreover, the effect of similarity was much smaller than the one displayed by the other groups. Thus, they apparently relied on holistic processing. By contrast, the ex-illiterate and the literate groups performed similarly: they were much faster on “different” trials than on “same” trials, and displayed a large effect of the degree of dissimilarity – evidence of analytic processing. In short, the acquisition of literacy seems to facilitate the development of analytic visual processing.

It is worth noting that literacy rather than schooling may also be responsible for a shift in perceptual processing of left–right mirror images. Verhaeghe and Kolinsky (1992)
found that ex-illiterates displayed better mirror-image discrimination skills than illiterates. This literacy effect might be related to the fact that the alphabetic system incorporates mirror-image characters like "b" versus "d" and "p" versus "q". Indeed, readers of a writing system that does not include mirror-image signs, the Tamil syllabary, were as poor as illiterates in discriminating mirror images (Danziger & Pederson, 1999). However, other activities in addition to literacy may also encourage the development of this ability. Verhaeghe and Kolinsky (1992) found that, among illiterates, lacemakers obtained better scores than nonlacemakers. Thus, it is likely that a range of activities that draw the observer's attention to the left–right orientation of stimuli promote mirror-image discrimination. In the study described above by Brito Mendes et al. (in press), the critical factor that made the ex-illiterates behave analytically is likely to have been the training of letter discrimination associated with alphabetization.

Reasoning and executive processes

There have been a small number of studies of the effects of literacy on reasoning processes. Scribner and Cole (1981) explored the resolution of logical problems by comparing illiterates, readers of Vai (based on syllabic writing) and readers of the Arabic alphabet. There were no group differences either in the number of problems solved, or in how the participants justified their responses. Likewise, in Brazil, Tsuoni (1988) found that about one third of the illiterate participants that she interviewed could understand and explain syllogisms.

However, findings regarding reasoning skills may turn on the types of task that are used. In particular, some tasks require detailed explicit visual analysis, as for some items of the Ravens Progressive Matrices. In this case, both illiterate and ex-illiterate people performed as poorly as 7-year-old European and American children (Verhaeghe, 1999). Arguably, difficulties with explicit visual analysis might not be the sole factor affecting unschooled people's performance in reasoning tasks. Another reason might be that these tasks demand a high level of executive control, for example, the inhibition of a first response, shifting between dimensions of a stimulus, or planning a response.

One task that has been used widely to assess executive processes is the classic Stroop task in which participants are required to focus on one stimulus dimension while ignoring another. In the classic paradigm, they are required to name the color of the ink (e.g., green) in which a color-word (e.g., red) is presented. In a digit Stroop test in which subjects had to count the number of presented symbols rather than to report their identity, both illiterate and ex-illiterate participants were slower overall than literate participants, even in the control, baseline condition (requiring to respond "3" to **), but neither the interference effect in the incongruent condition (e.g., respond "3" to 2 2 2) nor the facilitation effect in the congruent condition (requiring e.g. to respond "3" to 3 3 3) varied between the groups. Moreover, reaction time did not vary between illiterates and ex-illiterates. Thus, the presence and efficiency of the processes underlying these effects seem to be independent of both literacy and schooling (see, however, Kolinsky, 1988, and Verhaeghe, 1999, who found that both illiterate and ex-illiterate people had some difficulties on a task involving selective attention).
Shifting between alternative criteria is a basic requirement of the California Card Sorting Test. In an adaptation of this test, in which six cards could be classified according to two semantic and three perceptual criteria, Kolinsky, Penido, and Morais (in preparation) found that illiterates and ex-illiterates could shift from one dimension to another, including across domains. When compared with a literate group there was a schooling effect, with literate people finding more criteria, but there was no difference between illiterates and ex-illiterates. Finally, planning was evaluated with the Tower of London test (Shallice, 1982). The results showed no significant difference between illiterate and ex-illiterate participants in either number of movements or time needed to reach the goal configuration.

The findings on nonlinguistic capacities presented in this section can be summarized as follows. As regards visual abilities, perceptual processes are influenced neither by schooling nor by literacy, while postperceptual processes involving explicit visual segmentation are influenced by schooling but not by literacy. Nevertheless, literacy contributes both to the development of an analytic approach in same-different comparisons and to the ability to discriminate mirror images efficiently. As regards reasoning and executive processes, illiteracy per se does not seem to affect performance. Illiterates are able to reason correctly on syllogisms and other logical problems, although they do not do so spontaneously. They also use executive processes such as inhibition of irrelevant information and shifting between stimulus dimensions as well as ex-illiterates, although schooling favors these control processes.

The Impact of Literacy on Linguistic Capacities

The impact of literacy on linguistic and, especially, on metalinguistic capacities has been examined more systematically than the impact of literacy on nonlinguistic capacities. Four domains of linguistic processing will be addressed: speech processing, verbal short-term memory, lexical and semantic knowledge, and metalinguistic abilities. Finally, we will briefly discuss the effects of orthographic skills on spoken word recognition.

Speech processing tasks

Since learning to read in an alphabetic system involves making connections between letters and phonemes, a viable hypothesis is that acquiring literacy will affect the development of phonological representations through reciprocal interaction (e.g. Harm & Seidenberg, 1999; Snowling & Hulme, 1994a). In principle, such changes might be seen in speech recognition or speech production tasks. However, the empirical evidence shows that, at least on early processes involved in speech perception, there is no influence of literacy. The relevant studies are not considered in detail here because they have been reviewed elsewhere (Morais & Kolinsky, 2002a, 2002b). In brief, illiterate people have been found not to differ from literate people in the identification of consonants spanning an acoustic continuum from voiced to unvoiced, or from one place of articulation...
to another (Castro, 1993), or in the McGurk phenomenon in which visual information from the speaker’s mouth movements has an effect on phonetic identification (Morais & Mousty, 1992). In a similar vein, illiterates are no less sensitive than their literate counterparts to the feature blending error (Morais, Castro, Scliar-Cabral, Kolinsky, & Content, 1987b) or to the blends of other speech units like consonantal phonemes in dichotic listening tasks. The last finding deserves special attention. The logic of such blends is the same as the logic of illusory conjunctions: if the units can be wrongly combined, they must have been separately registered at some processing stage. Testing Portuguese literate people, we found that the initial consonant of CVCV utterances is the unit that leads to the higher blending error rate, compared to the syllable and vowel (Kolinsky & Morais, 1993). Subsequent testing of Portuguese illiterate adults and preliterate children yielded the same pattern of results (Morais & Kolinsky, 1994, and Castro, Vicente, Morais, Kolinsky, & Cluytens, 1995, respectively). This demonstrates sensitivity to consonants in speech perception in a population that is unable to represent them consciously. Unconscious perceptual representations of phonemes develop prior to the onset of literacy.

Similarly no special difficulties have been reported among illiterate people at higher levels of spoken word recognition. For instance, Adrian, Alegria, and Morais (1995) found that illiterates have no difficulty in perceiving or discriminating isolated syllables or words (see also Scliar-Cabral, Morais, Nepomuceno, & Kolinsky, 1997) and they perform with a high degree of accuracy in lexical decision tasks (Morais & Kolinsky, 2002a).

The ability of illiterate and ex-illiterate people to repeat words of three, four and five syllables has been reported to be unimpaired (Morais & Kolinsky, 2002b) at least in terms of accuracy. However, there were differences between unschooled (both illiterates and ex-illiterates) and schooled people in the repetition errors they made. While 57% of the errors made by literate people were limited to a single consonant, only 24% and 26% of the errors made by illiterates and ex-illiterates, respectively, were of this type. If consonant errors reflect the possession of segmental phonological representations (as is usually assumed), then this difference suggests that, although they are sensitive to consonants in perception, unschooled people have limited access to phonemic units of speech and rely instead on representations of larger speech segments (such as syllables). If this is the case, we should predict that both illiterates and ex-illiterates may do poorly on verbal short-term memory tasks because these depend on having access to precise phonological codes.

The difference observed in global versus segmental errors in the repetition task echoes a similar difference observed in a word recognition task using dichotic presentation between highly literate people and “semiliterate” adults who were alphabetized in childhood but do not read frequently (Morais et al., 1987b). In interpreting this result, we suggested that it may reflect the availability in the highly literate people of an attentional mechanism focusing on the phonemic structure of speech. This interpretation is supported by the fact that the proportion of segmental errors can be increased in university students by asking them to pay attention to the phonemic structure of the items (Castro, 1993). A further possibility is that the phonological representations involved in speech recognition are more segmentally structured in literate people, but there is no empirical evidence supporting this view. Whatever the interpretation of the difference in segmental errors, it does not seem to depend on the mere acquisition of the alphabetic code but rather on intensive reading practice for at least some years.
Verbal short-term memory

A number of different paradigms have been used to assess the verbal memory skills of illiterate people, with somewhat inconsistent findings. Ardila, Rosselli, and Rossa (1989) reported no effect of literacy on immediate recall of simple sentences presented sequentially, although an educational effect was observed for delayed recall of the same sentences. In a similar vein, Ostrosky-Solis, Ardila, Rosselli, Lopez-Arango, and Uriel-Mendoza (1998), using repeated presentation of six common nouns belonging to three different semantic categories, found no difference in recall between illiterates and people with 3–4 years of schooling. In contrast, Reis and Castro-Caldas (1997) used a variant of the word pair association test of the Wechsler Memory Scale (Wechsler, 1945) with illiterate adults and literate schooled adults. An important finding of this study was that when the relation between associated items was phonological, for example “lua”–“rua” (moon–street), the illiterates did relatively more poorly than when the relationship was semantic (e.g., fork–spoon). Castro-Caldas and Reis (2003, p. 84) concluded that illiterates “use preferentially semantic strategies to deal with language problems rather than strategies based on formal attributes of the words.” It is important to note, however, that literacy and schooling were confounded in this study and therefore this may also be the case for unschooled people.

Moreover, although illiterate unschooled people appear to pay less attention to formal aspects of words than literate schooled people do, there is evidence that they nevertheless code nameable visual images into phonological representations spontaneously. Morais et al. (1986) presented pictures of objects successively to participants, while saying their names orally. Each picture was placed face down, and after the last one had been presented, participants were given a card displaying these together with other pictures. The task was to match the cards, without turning them up, with the pictures on the card. In this situation, performance is typically poorer in children and adults when the names of the pictures rhyme with each other (Conrad, 1971). Morais et al. observed that this rhyme effect was equivalent in illiterates and ex-illiterates. However, the overall memory performance of the participants was rather low, more so for illiterates than for ex-illiterates. A similar effect was found in a digit span task (Morais & Kolinsky, 2002a; see also Petersson, Reis, & Ingvar, 2001) and by Scribner and Cole (1981) in a comparison of illiterates and Qur’anic literate people in a task involving the ordered recall of a list of words.

In summary, there is reasonable evidence that short-term memory span is impaired in illiterate and/or unschooled populations (reduced to about three or four words or digits and certainly much inferior to that of literate adults). These findings are broadly consistent with the view that phonological representations in these people are insufficiently segmentalized to support effective maintenance of verbal information in short-term memory. However, there are other possible explanations for these findings. First, illiterate people cannot use orthographic mental representations as cues for supplementing degraded phonological information, and ex-illiterate people are unlikely to be able to activate such representations automatically. Second, unschooled participants may not use rehearsal procedures, or use them to a lesser extent than schooled ones. Consistent with this idea, the unschooled people we tested did not show any difference in span for mono-syllabic display. Maugha have diff order.

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syllabic and trisyllabic items, although, in the same experimental conditions, they did display the usual effect of lexicality (larger span for words than for pseudowords; Hulme, Maughan, & Brown, 1991). Third, unschooled participants, especially illiterate ones, may have difficulties attending to a sequence of unrelated phonological events to encode their order.

Taken together, findings from studies of speech processing, repetition, and verbal short-term memory (STM) in illiterate and ex-illiterate populations suggest that differences in phonological processing that would be an immediate consequence of acquisition of the alphabetic code are small and concern only verbal memory span. More importantly, there are differences between unschooled and schooled people arising at the level of segmental phonological information as well as at the level of listening strategies. These differences manifest themselves in difficult recognition tasks (e.g., under dichotic presentation) and in tasks involving memory demands (recognition of sequences, repetition, memory span).

Castro-Caldas, Petersson, Reis, Stone-Elander, and Ingvar (1998) reported a pioneering brain imaging study of illiterates while they were completing word and pseudoword repetition tasks. Using the subtraction methodology, brain activation differences between the literate (schooled) and illiterate groups were small when repeating words, but were observed for several areas when repeating pseudowords. The functional significance of these brain differences is still unclear, although Castro-Caldas and Reis (2003) suggest that they concern the phonological loop. It is possible that phonological differences between illiterates and people with relatively advanced literacy skills occur for both word and pseudoword processing, but that these differences only appear clearly, using this kind of brain imaging methodology, when there is no simultaneous activation of, or even interaction with, semantic representations, which are most probably involved in word but not pseudoword repetition.

**Lexical and semantic knowledge**

It is almost a truism to state that lexical knowledge is increased by reading. Indeed, reading accounts for most of the new words that both schoolchildren and adults learn. Arguably, through reading people also become aware of associated word meanings, synonyms, and antonyms. Morais, Macedo, Grimm-Cabral, Larochelle, and Kolinsky (in preparation) used a free word association task to compare the performance of illiterates and ex-illiterates, who all attended an alphabetization class but were classified according to their word and pseudoword reading skills. Many of their responses consisted of a complete sentence or a phrase rather than a word, but such responses were considered acceptable (see Entwisle, 1966, for use of the same procedure with children). The ex-illiterates made more paradigmatic responses (including synonyms and antonyms) (51.9%) than the illiterates (36.5%). Though rare, functional responses (e.g., “to work” in response to “man”) were more frequent in the illiterates (9.5%, compared with 4.9%). Many responses involved a personal reference and can be classified as syntagmatic (e.g., “I know how to clean the house” in response to “to know”); these were more frequent in the illiterate (27.5%) than in the ex-illiterate (34.9%) group.
These findings are consistent with the observation of a developmental shift from syntagmatic to paradigmatic responding in this task (Brown & Berko, 1960; Entwisle, 1966; Ervin, 1961), and with the idea that this shift is related to reading acquisition (Cronin, 2002; Cronin et al., 1986). However, given that the responses in the free word association task are strongly influenced by word association frequency, the differences observed between illiterates and literates could reflect changes in word association frequency as reading was acquired rather than a shift from syntagmatic to paradigmatic responding. To control for this possibility, Morais et al. (in preparation, b) compared knowledge of paradigmatic and syntagmatic relations in a forced-choice task. Here participants were presented with a target word and a choice of two test words: one related to the target, the other not. They considered three types of paradigmatic relation (synonymy, antonymy, and category sharing), and two types of syntagmatic relation (noun-adjective and verb-noun). Overall, after controlling for vocabulary knowledge, ex-illiterates were better at selecting the related word than the illiterates, and there was a trend for the syntagmatic relations to be more accessible (due primarily to the illiterates' problems with antonyms).

Morais, Macedo, Grimm-Cabral, and Kolinsky (in preparation, a) used the phenomenon of release from proactive interference (Wickens, Dalezman, & Eggemeier, 1976) to assess automatic access to lexical knowledge in adults varying in literacy skills and children. Proactive interference (PI) refers to the fact that, if people are asked to remember sets of items in lists, and each list consists of lists from the same semantic category, memory performance declines over trials. Release from PI occurs if the category is changed and there is a consequent upturn in memory performance. Thus, if illiterate people are sensitive to categorical relations, they should show both PI and release from PI under the appropriate conditions. In this study, names of animals were presented in all four trials of the control condition, while in the experimental condition, participants were presented with names of fruits on the first three trials and animal names in the fourth trial. Seven- to 11-year-old children outperformed unschooled adults, but both groups showed an effect of proactive interference. Importantly, there was no group difference in the release from proactive interference observed in the fourth list of the experimental condition. The analysis of intrusion errors in the different lists confirmed the idea that both proactive interference and release from it are independent of schooling and literacy. They also show that illiterates can use categorical information as a cue for retrieval, in line with the findings of Cole, Gay, Glick, and Sharp (1971) and Scriber (1974).

In a further study, Kolinsky et al. (in preparation) used a task devised by Nation and Snowling (1999) to assess implicit semantic processing skills in children with normal and poor reading comprehension. The task required children to make lexical decisions about items in a mixed list of auditorily presented words and pseudowords. While good comprehenders showed semantic priming from category-related items regardless of their degree of association with the target words, poor comprehenders only showed semantic priming between category coordinates when the words shared high association strength (e.g., doctor–nurse), not when they shared low association strength (e.g., sheep–cat). In Kolinsky et al.'s study, both illiterate and ex-illiterate adults showed a significant effect of semantic priming, and there was no convincing evidence of a literacy effect. Thus, unschooled people are sensitive to semantic relations, including abstract ones.
Turning to more explicit tasks, Luria (1976, p. 18) proposed that illiterates are “unable to group objects according to abstract semantic features.” However, this idea, that categorical classification emerges with literacy and/or schooling is inconsistent with evidence that the capacity for categorization appears early in development, before the onset of literacy (e.g., Blewitt & Toppino, 1991; Mansfield, 1977; Markman, 1984; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). Luria’s observations on illiterate adults may reflect preference for practical schemes rather than lack of categorical organization.

Scliar-Cabral and Monteiro, Morais, and Kolinsky (2002a) asked people varying in literacy skill to complete a task that required them to match a target word, for example “duck,” with either a taxonomically related word (“sparrow”) or an unrelated word (“sheep”). In this task, the illiterates made as large a number of taxonomic choices as literate adults who had completed four school grades in childhood. Thus, they were able to group drawings into categories and provide justifications of a taxonomic kind for their groupings. They were also able to provide a superordinate term for sets of three items (e.g., “fruit” for apple, peach, and pineapple). However, when the proportion of justifications and responses consisting of the nearest superordinate or subordinate term was compared to those made by more highly educated people, an effect of schooling, but not of literacy, emerged. Thus, while categorical organization does not depend on either literacy or schooling, it seems, as might be expected, that education contributes to increases in the richness of the structure of an individual’s semantic knowledge. Similar findings have been reported from category fluency tasks in which there is no convincing evidence of a literacy effect: illiterates use hierarchically organized categories as do more highly educated people but at the same time they produce fewer words (Ratcliff et al., 1998; Reis & Castro-Caldas, 1997).

**Metalinguistic abilities**

Metalinguistic awareness refers to the ability to reflect on language at its many different levels. However, most research relevant to literacy has been directed at awareness of the sound structure of words. According to Morais, Kolinsky, Alegria, and Scliar-Cabral (1998), phonological awareness is the capacity to represent phonological information consciously. It is assessed by requiring intentional, explicit judgments or operations on phonology. Thus, it goes beyond the mere activation of phonological representations in the recognition and production of speech.

One may distinguish between word and subword awareness. Awareness of words has been examined by Cary (1988) who first asked illiterates and ex-illiterates to segment orally presented sentence into words. While ex-illiterates were able to complete this task, illiterates segmented the sentences into syntactic clauses. However, when asked to repeat the last “bit” of an interrupted sentence, a task that is less sensitive to meaning bias, the illiterates produced single words a majority of the time, suggesting that they have some conscious access to the word unit (Cary & Verhaeghe, 1991).

At the level of subword awareness, Morais et al. (1998) (Morais, 1991a) distinguished between holistic and analytic forms of phonological awareness. These forms roughly...
correspond to Gombert's (1992) concepts of epiphonological and metaphonological knowledge. Holistic phonological awareness is involved, for instance, in judging phonological length, and in some speech sound classification and detection tasks. To assess sensitivity to phonological length, Kolinsky, Cary, and Morais (1987a) presented participants (silently) with a series of drawings. On neutral trials, drawings represented objects of the same physical size with names varying in phonological length (e.g., "pé-pedga," meaning "foot" and "sock," respectively). The participants' task was to choose the object with the longest name. Sixty percent of the illiterates obtained scores of at least 75% correct responses, demonstrating holistic phonological awareness. However, all but one subject was better in these trials than in incongruent trials, in which the longer word denoted the smallest object (e.g., "gato-borboleta," meaning "cat" and "butterfly," respectively). Thus, most illiterates experienced an attentional conflict between semantics and phonology.

The appreciation of rhyming relationships between words may also be accomplished on the basis of holistic phonological awareness even though, from a literate point of view, it involves subsyllabic analysis. Morais et al. (1986) found that about half of the illiterate participants they tested could choose among four drawings the one whose name rhymed with a target. Similarly, Bertelson, de Gelder, Touni, and Morais (1989) reported that 75% of the illiterates they tested reached a criterion of six consecutive correct responses when judging whether pairs of words rhymed. Moreover, illiterate poets provide a striking illustration of the dissociation between holistic and analytic phonological awareness (Cary, Morais, & Bertelson, 1989; Morais, 1991b). The illiterate poet F.C. performed at chance level in three out of four tests requiring the classification of either consonants or vowels; while he succeeded in classifying the vowels of triads of CV syllables, he was not able to do this with triads of VC syllables, suggesting that attention to vowels was only observed in a rhyming context (Morais et al., 1998). Although illiterate poets only display holistic phonological awareness, they have probably acquired a large rhyming lexicon that enables them, by analogy, both to identify and produce rhymes.

To assess phoneme classification, Cary (1988) used triads of CV or VC syllables in which two items had a common vowel. Illiterates were able to classify matching pairs correctly when they were perceptually close (like /pe/ and /be/ in the triad /pe, be, si/) but they had much more difficulty when within triads (e.g., /se, be, pi/) where vowel sharing (/sei - /be/) conflicted with overall perceptual similarity (in this case, between /be/ and /pi/). The large difference in performance between the two situations suggests that illiterates rely on holistic phonological awareness or holistic acoustic similarity rather than on phonological identity. The capacity of illiterates to rely on global phonological similarity as well as their sensitivity to acoustically salient information may also explain the variability of their performance in phoneme detection tasks. As a matter of fact, Morais et al. (1986) found that the performance of illiterates in a phoneme detection task was much better when the target was an acoustically salient /R/ than when it was a stop. Phoneme detection performance was also facilitated when the detection of a target phoneme, for example /pi/, remained constant throughout the testing session; this may be because from a global phonological similarity match between the target pronunciation (/psa/ and the very short stimuli (e.g., /p|/ , /p|a/ vs. /|/ , /|a/; unpublished data by Fiadeiro, Cary, & Morais).
Intentional (explicit) segmentation of verbal items into syllables should, at first sight, be considered a simple case of analytic phonological awareness. Bertelson and de Gelder (1989) showed that ex-illiterates performed better than illiterates in syllable as well as rhyming and phoneme tasks (see also Morais et al., 1986). However, given that co-articulation effects are relatively weak between syllables, it seems more reasonable to admit that only conscious subsyllabic segmentation deserves to be called analytic phonological awareness. Indeed, both preliterate children and illiterate adults can succeed on syllable segmentation tasks (Liberman, Shankweiler, Fischer, & Carter, 1974), but they find segmenting words into phonemes very difficult (e.g., Liberman et al., 1974, and Morais et al., 1979, 1986, respectively).

Evidence from the now large body of literature on learning to read in alphabetic systems is consistent with the view that phoneme awareness is fostered by literacy instruction. We would argue that it begins to develop when one starts to learn the letters of the alphabet and to discover what they represent. Lukatela, Carello, Shankweiler, and Liberman (1995), testing adult unschooled speakers of Serbo-Croatian, found that all the participants who had poor letter recognition ability (less than 50% correct identification) scored 0% in phoneme deletion, and all the participants who identified all the letters scored between 70 and 100% correct in the same deletion test. On the other hand, given that the process of learning to read is a long one, the ability to represent phonemes mentally and to operate on them also plays a very important role in the acquisition both of the alphabetic code and of efficient grapheme-phoneme and phoneme-grapheme transcoding and assembly procedures. For this reason, it is now accepted that the relation between phoneme awareness and learning to read and write is an interactive one (Morais, Alegria, & Content, 1987a).

Whether or not the developmental course of the relations between learning to read and write and acquiring phoneme awareness is the same in children and in adults engaged in late alphabetization is an interesting question, but comparative studies are difficult to design given the multiple differences between the two populations. Using identical materials and procedure, we found a similar learning effect for phoneme segmentation through successive training blocks with preliterate children (Content, Kolinsky, Morais, & Bertelson, 1986) and illiterate adults (Morais, Content, Bertelson, Cary, & Kolinsky, 1988). On the basis of these results, it can be argued that there is no critical period for the acquisition of phoneme awareness, and furthermore, that illiterate adults can discover the alphabetic principle with the aid of instruction. But it cannot be concluded that the alphabetic principle is accessed through the same processes, and therefore that instructional methods should be the same for adults and children.

Knowledge of orthographic codes and intensive practice with them may eventually influence phonological judgments. In a classic experiment, Seidenberg and Tanenhaus (1979) found that auditory rhyme decisions were faster when words were orthographically similar (e.g., rose-nose) than when they were not (e.g., rose-goes), and the opposite effect held for nonrhyming decisions. Intentional subsyllabic segmentation is also influenced by orthographic knowledge. Testing literate people in a task requiring to blend two spoken CVC Portuguese words into a (new) CVC pseudoword, Ventura, Kolinsky, Brito-Mendes, and Morais (2001) observed a preference for CVC blends (e.g., responding /ful/ to the word pair /fur/ -- /pet/) for words for which the final C is followed in the
orthographic representation by a mute letter ("cure," "pele"), but preference for C/VC blends (e.g., responding /be/ for the word pair /bei/ /mei/) for words for which there is no such final mute letter ("bar," "mel"). This was observed even when instructions emphasized the importance of focusing on sound, and when possible acoustic-phonetic differences were controlled. Both Seidenberg and Tanenhaus' and Ventura et al.'s findings are instances of the impact of literacy on metaphonological representation.

Finally, before concluding it is important to note that orthographic knowledge may influence not only metaphonological judgments but also the recognition of spoken words. The evidence, by definition, comes from literate people. Thus, Ziegler and Ferrand (1998) found that French words with rimes that can be spelled in multiple ways (e.g., /ɔ / as in "nom," "tronc," "long," "don," "bond," "plomb") produced longer latencies and more errors in auditory lexical decision tasks than words with rimes that are spelled only one way (e.g., /ɔ/ as in "biche," "riche"), and Ventura, Morais, Pattamadluk, and Kolinsky (2004) replicated this pattern of results in Portuguese, a shallower orthographic code. Extending these findings, Ziegler, Muneaux, and Grainger (2003) found that orthographic neighborhood had a facilitatory effect in auditory lexical decision: spoken words with many orthographic neighbors yielded faster and more accurate response latencies than those with few orthographic neighbors.

Conclusions

This chapter has reviewed evidence suggesting that learning to read and spell in alphabetic languages may bring about changes in a variety of linguistic and nonlinguistic cognitive capacities. We have focused primarily on data obtained by comparing groups of illiterates and ex-illiterates whose origin and present sociocultural status is as close as possible to each other. We are aware, however, that to distinguish the availability of literacy from the extended use of this skill is difficult. Practising any skill is likely to increase it. In the case of literacy, its use contributes both to the acquisition of knowledge and to improvements in the skill itself, leading to a "Matthew effect" (cf. Stanovich, 1986). Thus the interpretation of studies such as those described here comparing literate with ex-illiterate people, must be done cautiously.

Nevertheless the studies reviewed here suggest that learning to read an alphabetic script has only a limited impact on visual cognition. Indeed, activities other than reading and writing may also elicit change in abilities such as mirror-image discrimination. Likewise, the studies of linguistic capacities revealed relatively small or absent effects of literacy on lexical or semantic skills, though unsurprisingly, education does have an impact on accumulated lexical knowledge. In similar vein, while literacy has only a small effect on memory span, much larger effects of schooling were observed on both memory span and pseudoword repetition.

In contrast metaphonological knowledge appears to be strongly and directly influenced by learning to read an alphabetic script. We have argued that the most important effect is on the development of phoneme awareness. Phoneme awareness arises at the beginning of learning to read and write in alphabetic systems. Its analytic power allows people
to deal with other phonological units or relations like syllables and rhyme, at a higher level of efficiency than that based purely on holistic phonological representations.

Phoneme awareness may also be a remote cause of the superiority of highly literate over both illiterate and ex-illiterate people in short-term memory span and in word and pseudoword repetition. Indeed, highly literate people may have capitalized on phoneme awareness to develop better specified, phonemically structured, phonological representations and/or phoneme-oriented strategies of listening, in addition to having become able to activate orthographic codes. In fact knowledge of word orthography influences phonological judgments and intuitions, and the effect of orthographic knowledge goes much farther since it extends to spoken word recognition.