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Are phonological processes the same or different in low literacy adults and children with or without reading disabilities?

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Abstract The primary purpose of the study reported here was to examine whether phonological processes are the same or different in low literacy adults and children with or without reading disabilities in a consistent orthography. A sample of 150 subjects was selected and organized into four different groups: 53 low literacy adults, 29 reading disabled children, 27 younger normal readers at the same reading level as those with reading disabilities and low literacy adults, and 41 normal readers matched in age with the reading disabled group. We administered phonological awareness tasks which included items with different complexity of syllable structure. The results showed that the complexity of syllable structure had not a particularly marked effect on low literacy adults. Rather, the deletion task revealed the phonological deficit in low literacy adults across all syllable structures.

Keywords Low literacy adults · Dyslexia · Transparent orthography · Phonological awareness tasks · Complexity of syllable structure · Reading level match design

There has been increasing interest in determining whether or not phonological processes such as phonological awareness (PA) are crucial for effective literacy acquisition in adults as is the case in children, or, on the other hand, if adults follow

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a different path to literacy acquisition. Overall, the researchers have not investigated the learning processes of adults nearly as extensively as those of children and adolescents and, consequently, very little is known about the word reading processes of low-literate adults (LLA) (Greenberg, Ehri, & Perin, 2002). Therefore, there has been much less investigation where low literacy adults are compared with younger disabled readers to achieve a more complete picture of similarities and differences distinguishing LLA from other populations of readers (Greenberg, Ehri, & Perin, 1997). This was the purpose of the present study. Using a reading level match design we selected LLA and elementary school students with or without reading disabilities who read at the same grade equivalent level on the Word reading subtest of the Batería de Evaluación de los Procesos Lectores de los Niños de Educación Primaria (PROLEC [Standardized Reading Skills Test]; Cuetos, Rodríguez, & Ruano, 1996) and then compared their performances on different PA tasks (i.e., blending, isolation, segmentation, and deletion) which includes items with different complexity of syllable structure: CV and CCV.

Defining phonological awareness

One of the critical issues in this field of research has been the operationalization and measure of the PA construct. There are several major determinants of the difficulty of PA tests (Jiménez & Venegas, 2004). These determinants include: (a) The complexity of the units on which the operations are performed, (b) The cognitive requirements of the task, and (c) The complexity of syllable structure of items which are presented in each task (e.g., consonant-vowel (CV), consonant-vowel-consonant (CVC), consonant-consonant-vowel (CCV), etc.).

The main focus of this study is focused on the second and third determinant, i.e., the task differences and complexity of syllable structure. This latter is an important source of variability not controlled for in the PA tasks. Investigators have used various tasks in order to tap aspects of PA; however, there has been little standardization within individual PA tasks (McBride-Chang, 1995; Stahl & Murray, 1994). The performance on PA tasks could be affected when syllables with CV structure are shown as items, or when syllables are shown as CVC or CCV structures. Treiman (1992) suggested that syllables seem to break most readily between the onset (any beginning consonants) and the rime (the vowel and any final consonants). The rime may be further divisible into the vowel nucleus and the coda, or any final consonants. She demonstrated that is more difficult to delete the initial phoneme in syllables with CCV structure than it is in syllables with CV structure. In the case of CV structure the operation that is required is the analysis of syllables into onset and rime. Finally, when CCV structure is presented the operation involved is the analysis of phonemes composing cluster onset. Thus, the access to phonological units of speech can be mediated by the linguistic complexity of the items on which the operations are performed, as has been demonstrated in a number of studies carried out across languages in children (Arnqvist, 1992; Jiménez & Haro, 1995; Schreuder & van Bon, 1989; Stahl & Murray, 1994; Treiman & Weatherston, 1992) and adults (Jiménez & Venegas, 2004; Treiman, Bowey, & Bourassa, 2002).

Treiman and Weatherston (1992), for example, found that children had more difficulty isolating the initial consonant when it belonged to a syllable-initial consonant cluster. Similar results have been found by Jiménez and Haro (1995) in Spanish children. These children could segment initial phonemes from a CVC word more easily than they could break up a consonant blend in a CCVC word. In the Stahl and Murray's (1994) study the easiest linguistic level for children was analyzing onsets and rimes and not analyzing vowels and codas. However, Jiménez and Venegas (2004) found in LLA that the easiest linguistic level was analyzing vowels and codas, followed by analyzing onsets and rimes, followed by analyzing cluster onsets. They suggested that this finding is probably due to the fact that segmenting a word between onset and rime is more natural in the English language (Treiman, 1985). In addition, onset-rime segmentation has proved more helpful than post-vowel segmentation in short-term learning of the words (Wise, Olson, & Treiman, 1990).

Phonological awareness and literacy acquisition across languages

Another issue in relation to literacy acquisition is that the findings of studies of the relationship between PA and reading skills may be influenced by the characteristics of the language concerned. It would seem obvious that results obtained in orthographically non-transparent languages cannot be generalized to transparent languages such as Spanish. The consideration of other languages is important because orthographies vary considerably in the demands that they make on the readers. Spanish has a regular orthography because it has the highest degree of regularity of the correspondences between graphemes and phonemes.

English previous studies using reading-matched controls have shown that LLA have more difficulty in solving PA tasks and the reading of non-words than do non-disabled children reading at grade level (Greenberg et al., 1997; Read & Ruyter, 1985; Thompkins & Binder, 2003). For instance, Greenberg et al. (1997) examined whether word reading processes operate similarly in English adult literacy (AL) students and elementary school students matched for reading level. They found severe phonological processing deficits in English-speaking adult literacy students compared to typically developing children at the same reading level. More recently, Thompkins and Binder (2003) found continuing phonological deficits in LLA in comparison with reading-matched children.

In Spanish, Jiménez and Venegas (2004) carried out a replication of a study with children conducted by Stahl and Murray (1994), and the results indicated that there were some differences in the pattern of literacy acquisition for their Spanish adults in comparison with child literacy acquisition in English. Stahl and Murray (1994) found that the ability to manipulate onsets and rimes within syllables was related more strongly to reading once an adequate level of letter recognition had been achieved. They also provided empirical evidence that the ability to isolate a phoneme from either the beginning or the end of a word was also crucial to reading because nearly all children who could not adequately perform this task also had not achieved a pre-primer instructional level. Therefore, they suggested that knowledge

of letter names may provide children with a foundation for learning to manipulate onsets and rimes and that this ability seems to aid children with word recognition. However, Jiménez and Venegas (2004) found that knowledge of the names of Spanish letters in adults does not appear to be particularly relevant in learning to manipulate onset and rimes and that this ability does not contribute greatly to word recognition. They concluded that awareness of onsets and rimes may be necessary for English children to read words but not for Spanish adults.

However, many of the studies reviewed here, although they examine a number of different languages, do not analyze the relative importance of complexity of syllable structure and task differences in assessing the link between PA skills and reading in LLA and reading disabled children (RD).

Overall, following the findings obtained by Stahl and Murray (1994), we consider that this issue may be relevant to better understand and to assess PA deficits in individuals with reading disabilities and LLA. For another study, Jiménez et al. (2005) investigated the effects of the complexity of syllable structure (i.e., CV vs. CCV) and the effects of task differences in the explanation of deficit in PA in Spanish dyslexic children. They found that the access to phonological units of speech was not mediated by the complexity of syllable structure of the items. That means that the performance of RD children on phonological awareness task was affected when syllables with structure CV were shown as items, but also when syllables were shown as CCV.

Many of the studies reviewed across languages did not analyze the relative importance of complexity of syllable structure and task differences in assessing the assumption that difficulties in accessing the constituent phonemes of the speech stream are responsible for specific reading difficulties. Therefore, the aim of the present study is two-fold: firstly, to examine whether phonological processes are the same or different in LLA and children with or without reading disabilities when different sources of variability, such as tasks, position of the phoneme, syllable structure of the items, familiarity of the items, are controlled; Secondly, to determine which factor, task differences versus complexity of syllable structure, contributes to the explanation of individual differences in reading. We addressed these questions by comparing the performance of LLA with children with or without reading disabilities (age-matched and matched on reading level) on different PA tasks (i.e., blending, isolation, segmentation, and deletion) which includes items with different complexity of syllable structure: CV and CCV. Our prediction was that if LLA students and RD children perform similarly to younger normal children on the various phonological tasks, this indicates that LLA and RD children follow a typical course of development but just do it slowly. However, a deficit in PA would be found if LLA and RD children perform worse in a PA test than children despite being matched for reading level, this suggests that they are atypical and deficient in the reading processes tapped by the tasks and that these deficits may explain their great difficulty in learning to read. Confirmation of this hypothesis would lead us, in turn, to investigate whether the PA deficit in LLA is better understood in terms of task differences or effects of syllable structure.

Method

Participants and design

A sample of 150 subjects was selected with an age range of 7–77 years ($M = 294.1$; $SD = 271.2$). The subjects were classified into four groups according to reading level: (1) a group of 53 low literacy adults (LLA) (age, $M = 631.2$; $SD = 176.7$) (53 female); (2) a group of 29 fourth grade reading disabled children (RD) (age, $M = 117.6$; $SD = 5.6$) (19 male, 10 female); (3) a group of 41 fourth grade normal readers matched in age (CA) with the reading disabled (age, $M = 116.4$; $SD = 5.4$) (20 male, 21 female); and (4) a group of 27 younger normal readers of second grade (age, $M = 91.6$; $SD = 4.2$) (13 male 14 female) at the same reading level (RL) as the RD and LLA. Children with reading difficulties were defined as those who had a percentile score of <25 on the pseudoword test, and read at the same grade equivalent level of second grade on the word reading test. Both subtests are included in the Spanish Standardized Reading Skills Test (PROLEC, Cuetos et al., 1996). There were significant differences between all groups in word naming accuracy Welch F (3, 68.954) = 5.81, $p < .001$; $\eta^2 = .10$. Post hoc comparisons with Bonferroni showed that the reading disabled group performed similarly to the RL and LLA on word reading, t (54) = 2.39, $p = 1.00$, t (79) = 1.49, $p = .82$, respectively. Consequently, reading disabled, younger normal readers, and LLA were matched on word reading using the Spanish standardized reading test Prolec. Furthermore, CA group performed significantly better than the RD and LLA groups on word reading, t (68) = 3.84, $p < .001$, t (91) = 2.80, $p < .05$, respectively. There were not significant differences between CA and RL groups on word reading t (66) = 1.17, $p = 1.00$. The group of low-literate adults was selected from those admitted to the ECCA Radio, Centro de Educación de Adultos (Center for Adult Education), in the Canary Islands (Spain). All participants have attended literacy courses but have not attained the level of proficiency required to earn a certificate. None of the participants had attended school in childhood. In interviews with low literacy adults in the present study, 90% reported not having sensory, acquired neurological, motor, and other problems traditionally used as exclusionary criteria for learning disabilities. Also, 39% reported that they had additional difficulties with mathematics, 48% with language, and 13% with both areas. As to the difficulties in reading or spelling, 20% reported that learning to read is difficult, 72% reported difficulty with spelling, and 7% reported difficulty with both areas. No intelligence measure was used because it has been demonstrated that adults may remain poor readers despite general cognitive maturity, experience with written language, and adequate general intelligence (e.g., Read & Ruyter, 1985).

The means and standard deviations for age and reading measures by group are presented in Table 1.

A reading level match design was used in this study. All groups carried out four PA tasks (i.e., isolation, deletion, segmentation, and blending), which came from the Prueba de Conciencia Fonológica (PCF) (Test of Phonological Awareness) (Jiménez, 1995). Two of the tasks (isolation and deletion) can be defined unambiguously in terms of complexity of syllable structure. Stahl and Murray

Table 1 Means and Standard Deviations on the Age, PCF test, Word and Pseudoword reading

	Groups							
	RD		RL		CA		LLA	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Age	117.6	5.63	91.6	4.23	116.4	5.42	631.3	176.7
Word reading	29.1	1.05	29.6	.62	29.8	.52	29.4	.79
Pseudoword reading	24.9	2.62	29.2	.65	29.7	.46	24.9	3.78

RD = Reading disabled; RL = Reading age; CA = Chronological age; LLA = Low-literate adults

(1994) varied the position of the sound that should be isolated or deleted. This introduces an extra source of variability. So, comparisons are confounded by position and by length. Consequently, in the present study we only selected stimuli CV and CCV because they are mostly comparable. Therefore, a first analysis included a between-participants factor (reading level) and two orthogonal dimensions within participant factors: task differences (isolating vs. deletion) and complexity of syllable structure (CV, CCV). On the other hand, the blending and segmentation tasks were comparable in terms of cognitive demand and therefore, we carried out a second analysis which included a between participant's factor (reading level) and two orthogonal dimensions within participant factors: task differences (blending vs. segmentation) and complexity of syllable structure (CV, CCV).

Materials

Standardized reading skills test (PROLEC, Cuetos et al., 1996)

This test includes several reading subtests. We administered only the Word Reading and Pseudoword Reading subtests. These subtests require the correct identification of 30 ordinary words and 30 pseudo words with different linguistic structures (CCV, CVV, CVC, CCVC, CVVC, and VC). Both subtests measure the accuracy of the responses. The authors reported an alpha coefficient of .92, and used as validity criteria the teacher's ratings of reading ability. Teachers were asked to rate reading ability on a 10-point scale, ranging from low ability (1) to high ability (10). All correlations between reading measures and teacher's ratings were significant statistically ($p < .001$).

Test of phonological awareness

We administered the PCF (Jiménez, 1995) that includes four tasks: blending, isolation, segmentation, and deletion. In the Blending task all the phonemes of each word were presented orally and sequentially by the examiner. This task required the

child to synthesize segmented phonemes to recognize a word. Phoneme isolation required the child to say the first or last sound of a spoken word. Deletion required the child to remove sounds from the beginning or end of one word and to form another word. Segmentation required pronouncing all phonemes of a word. The tasks are shown in the Appendix. Real-word items were selected for each task. High-frequency words used in the PCF test were selected on the basis of ratings generated from a normative study conducted by Guzmán and Jiménez (2001). They employed a sample of 3,000 words obtained from texts drawn from children's literature. Word familiarity was measured using these authors' procedure of frequency estimation, which involved the separation of the 3,000 words into different sets which were printed. For each set, different groups of 30 children were asked to rate each word on a 5-point scale, ranging from least frequent (1) to most frequent (5). The estimated frequency was calculated for each word by averaging the rating across all 30 judges. On the basis of these ratings, high-frequency words were selected. Stahl and Murray (1994) recognized some limitations with regard to the instrument and conceptualizations that they used. One of the goals of their study was to describe PA as a function of linguistic complexity units, namely vowel-coda, onset-rime, cluster-onset, and cluster-coda. To achieve this purpose, the materials across the four PA tasks (blending, segmenting, isolation, deletion) were regrouped. However, in the segmentation task, for example, the item m-o-v-e was grouped under onset-rime and vowel-coda linguistic units, c-r-e-a-m was grouped under cluster-onset unit, and s-e-n-d was grouped under the cluster-coda unit. All of these stimuli involved phoneme manipulations in different parts of the syllable. If the segmentation tasks were created to only manipulate the unit of interest (e.g., s-ight for onset-rime unit, fl-at for cluster-onset unit) then the classification would have more sense. The same issue is a problem for the blending task. So, for instance, they did not use an onset-rime blending task, because their pilot testing indicated that this was at ceiling for participants. The CVC blending task was used to assess both onset-rime blending and rime-coda blending on the basis of the assumption that to blend three phonemes of a word together requires both abilities. For isolation and deletion tasks the target segments were the focus of analysis but it did not seem that this was necessarily the case for segmentation and blending. Taking into account some of these considerations, we redid the linguistic complexity analysis by including only the materials from the two tasks (deletion and isolation) which can be defined unambiguously in terms of linguistic complexity. In each task eight words with different syllable structure were presented. In four of these words, the operation required involved the CV structure. In another four words the syllable structure was CCV. Thus, syllable structure was controlled for each task. In sum, two levels of syllable complexity are represented in each task: analyzing onsets and rimes (CV structure), and analyzing phonemes composing cluster-onsets (CCV). The PCF test included 32 items which represented the four tasks—phoneme, blending, isolation, and deletion—at two syllable structures (CV, CCV). Similarly to the procedure used by Stahl and Murray, the same set of scores was used once to generate a set of averages across tasks and once to generate a set of averages across syllable structures.

Procedure

Six experienced psychologists administered the reading tests and the PA assessment. The assessment was carried out individually over four sessions per subject in a school room which had the appropriate conditions. The administration of the tasks included in the PCF test was randomly ordered, each being preceded by four practice items to ensure that the children and adults understood the instructions.

Results

An analysis of variance (ANOVA) for one factor (reading disabled vs. normal readers matched in age vs. younger normal readers vs. low literacy adults) was conducted and the total number of correct responses of PCF test was calculated separately across participants and items. The analysis of variance on total number of correct responses showed that there were significant differences between all groups $F1\ (3, 146) = 58.6$, $p < .001$, $MSE = 1.02$, $\eta^2 = .54$; $F2\ (3, 29) = 45.0$, $p < .001$. Subsequent tests of simple main effects confirmed that LLA had significantly lower scores on the PCF test ($M = .51$; $SD = .16$) than RD groups ($M = .61$, $SD = .15$), $F\ (1,146) = 10.6$, $p < .001$, RL group ($M = .77$, $SD = .10$), $F\ (1,146) = 68.1$, $p < .001$, and CA group ($M = .85$, $SD = .06$), $F\ (1,146) = 154.4$, $p < .001$. Also, RD children had significantly lower scores than RL group $F\ (1,146) = 20.0$, $p < .01$. Overall, this means that LLA and RD children are characterized by a deficit in PA (see Fig. 1).

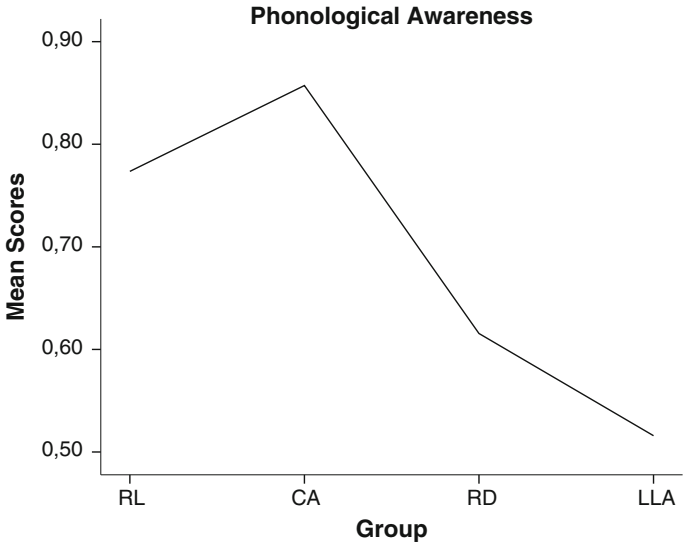

Fig. 1 Mean scores of correct responses in phonological awareness as a function of group (*Note*: RD = Reading disabled; RL = Reading age; CA = Chronological age; LLA = Low-literate adults)

Isolation versus deletion

The CA group was at ceiling on the CV deletion and CV isolation tasks. Accordingly, the CA group has not been included in this analysis. Therefore, a (3 × 2 × 2) Group (low literacy adults vs. reading disabled vs. younger normal readers) × Task Differences (isolation vs. deletion) × Complexity of Syllable Structure (CV vs. CCV) mixed analysis of variance was performed on the number of correct responses as a dependent variable and it was calculated separately across participants and items. Table 2 contains means and standard deviations for the four groups in each of the PA tasks, and complexity of syllable structure.

This analysis yielded a main effect of Group $F1\ (2,\ 98) = 9.58,\ p < .001,\ MSE = .81,\ \eta^2 = .16,\ F2\ (2,\ 11) = 121.9,\ p < .001$. Subsequent tests of simple main effects confirmed that LLA had significantly lower scores than RD group $F\ (1,\ 98) = -2.64,\ p < .001$, and RL group $F\ (1,\ 98) = -\ 4.12,\ p < .05$. Also, there was a main effect of Complexity of Syllable Structure $F1\ (1,\ 98) = 314.6,\ p < .001,\ MSE = 17.1,\ \eta^2 = .76,\ F2\ (1,\ 12) = 13.2,\ p < .01$ demonstrated that individuals had mean scores greater in analyzing onsets and rimes than analyzing cluster onsets.

Finally, there was a significant interaction Group × Task Differences × Complexity of Syllable Structure $F1\ (2,\ 98) = 6.18,\ p < .01$, MSE = .37, $\eta^2 = .11$, $F2\ (2,\ 11) = 41.3,\ p < .001$. Tests of simple main effect confirmed that in the isolation task LLA had significantly lower scores in analyzing onset and rimes than RD children $F\ (1,\ 98) = 5.48,\ p < .05$, but not with RL group $F\ (1,\ 98) = .12,\ p = .72$. Also, the performance of LLA was more affected when syllables were shown as CCV than RD children $F\ (1,\ 98) = 8.04,\ p < .01$. Nevertheless, there were no significant differences between LLA and RL group $F\ (1,\ 98) = 3.06,\ p = .08$, when syllables with structure CCV were shown as items.

Table 2 Mean proportions correct and Standard Deviations for Task and Complexity of Syllable Structure by Group

	Groups							
	RD		RL		CA		LLA	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Isolation								
CV	.81	.23	.95	.10	1.00	.00	.92	.17
CCV	.33	.15	.43	.11	.46	.08	.50	.31
Deletion								
CV	.93	.13	.97	.08	1.00	.00	.75	.34
CCV	.61	.37	.64	.36	.91	.18	.16	.28

Note: CV = Consonant-vowel; CCV: Consonant-consonant-vowel; CVC: Consonant-vowel-consonant; RD = Reading disabled; RL = Reading age; CA = Chronological age; LLA = Low-literate adults

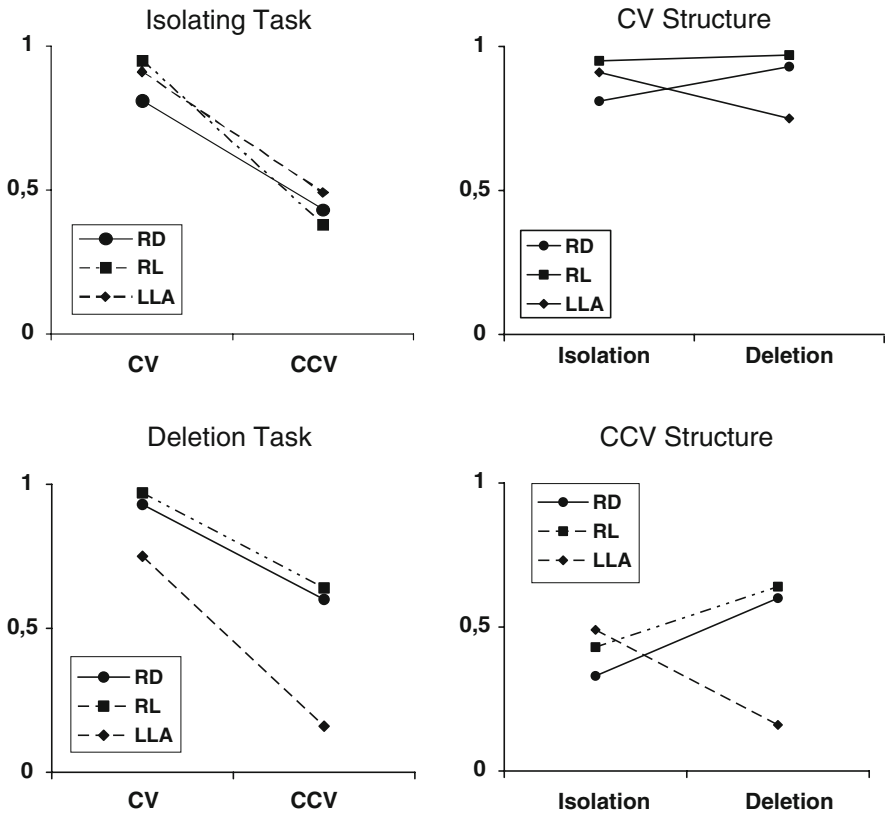

Fig. 2 Interaction between Group × Task differences × Complexity of Syllable structure on correct responses (*Note*: RD = Reading disabled; RL = Reading age; LLA = Low-literate adults)

In the deletion task, however, LLA had significantly lower scores when syllables were shown as CV and CCV than RD children F (1, 98) = 10.7, $p < .001$, F (1, 98) = 38.6, $p < .001$, respectively, and RL group F (1, 98) = 12.3, $p < .001$, F (1, 98) = 4.60, $p < .001$, respectively.

Overall, these findings suggest that the performance of LLA on deletion task was affected when syllables with structure CV were shown as items, but also when syllables were shown as CCV. That is, the access to phonological units of speech was not mediated by the linguistic complexity of the items in the deletion task (see Fig. 2).

Segmentation versus blending

A (4 × 2 × 2) Group (low literacy adults vs. reading disabled vs. normal readers matched in age vs. younger normal readers) × Task Differences (segmentation vs. blending) × Complexity of Syllable Structure (CV vs. CCV) mixed analysis of

Table 3 Mean proportions correct and Standard Deviations for Task and Complexity of Syllable Structure by Group

	Groups							
	RD		RL		CA		LLA	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Blending								
CV	.59	.25	.71	.25	.88	.17	.41	.31
CCV	.57	.40	.70	.20	.79	.23	.25	.39
Segmentation								
CV	.63	.29	.91	.15	.93	.14	.62	.29
CCV	.46	.38	.83	.26	.90	.18	.52	.34

Note: CV = Consonant-vowel; CCV: Consonant-consonant-vowel; CVC: Consonant-vowel-consonant; RD = Reading disabled; RL = Reading age; CA = Chronological age; LLA = Low-literate adults

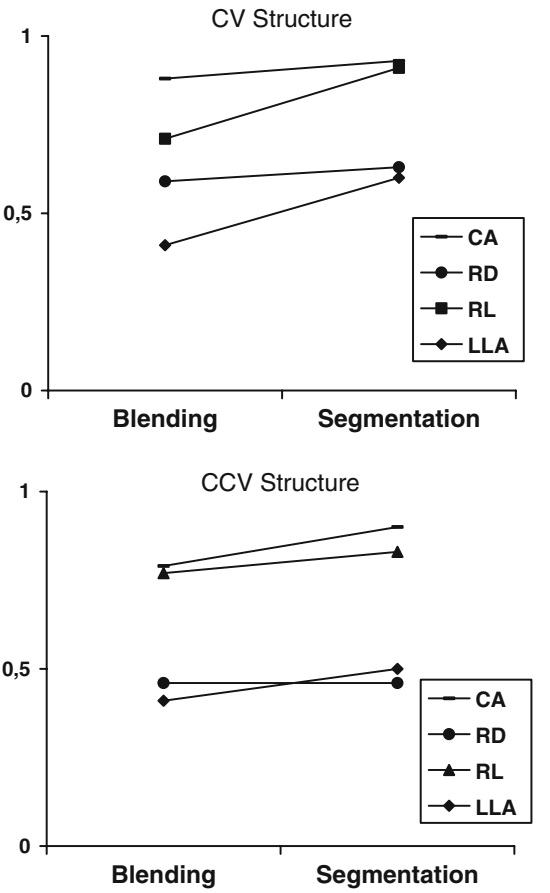

Fig. 3 Mean scores of correct responses in blending and segmentation tasks across syllable structures in each group (*Note*: RD = Reading disabled; RL = Reading age; CA = Chronological age; LLA = Low-literate adults)

variance (ANOVA) was performed on the number of correct responses as a dependent variable and it was calculated separately across participants and items. Table 3 contains means and standard deviations for the four groups in each of the PA tasks, and complexity of syllable structure.

This analysis yielded a main effect of Group $F1$ (3,144) = 45.1, $p < .001$, MSE = 6.47, $\eta^2 = .48$, $F2$ (3, 10) = 45.3, $p < .001$. Subsequent tests of simple main effects confirmed that LLA had significantly lower scores than RD group F (1, 144) = 6.58, $p < .05$, RL group F (1,144) = 57.6, $p < .001$, and CA F (1,144) = 45.5, $p < .001$. The main effect of Task Differences was also reliable, but only when subjects were treated as a random factor $F1$ (1,144) = 22.8, $p < .001$, $MSE = 1.72$, $\eta^2 = .13$; $F2$ (1, 12) = 2.61, $p = .13$. Likewise, a main effect of Complexity of Syllable Structure was also reliable $F1$ (1, 144) = 23.1, $p < .001$, $MSE = .96$, $\eta^2 = .13$, $F2$ (1, 12) = 18.9, $p = <.001$ demonstrated that individuals had mean scores greater in analyzing onsets and rimes than analyzing cluster onsets. The interaction between all variables was not reliable when subjects were treated as a random factor ($p < 1$) (see Fig. 3).

Finally, the range age was skewed in the LLA group. We wondered if it might led to a confound effect between low literacy and aging. In order to test whether these specific features of the LLA group might have affected the results, we assigned ranges to age variable within the LLA group (i.e., percentiles 25, 50, and 75). Results of ANOVAs showed that age had not an influence on phonological awareness F (2, 50) = .77, $p = .46$, $\eta^2 = .03$. For isolation vs. deletion tasks, the interaction Group × Task Differences × Complexity of Syllable Structure was not significant F (2, 50) = .08, $p = .92$, $\eta^2 = .003$. And, for segmentation vs. blending tasks neither the interaction was significant F (2, 50) = .36, $p = .69$, $\eta^2 = .01$.

Discussion

The primary purpose of the study reported here was to examine if adults perform worse than children with or without reading disabilities on some PA tasks despite being matched for reading level in a consistent orthography. If empirical support for a deficit were found, then a second issue was to explore the effects of the complexity of syllable structure and the effects of task differences in the explanation of deficit in PA. The current study demonstrated that the scores obtained by LLA and RD children in the PCF test were inferior to the scores obtained by the RL group when different sources of variability (i.e., task, the position of the phoneme, syllable structure of items, and familiarity of items) were controlled. This means that LLA and RD children did indeed show a deficit in PA, and this suggests that they are atypical and deficient in the reading processes tapped by the tasks and that these deficits may explain their great difficulty in learning to read.

Previous studies of English LLA using a reading level match design have revealed phonemic deficits irrespective of the task used to assess phonemic awareness (Greenberg et al., 1997; Read & Ruyter, 1985; Thompkins & Binder,

2003). Our finding is particularly significant, as it indicates that LLA learning to read consistent orthographies also exhibit the same difficulties in PA displayed by English-speaking LLA.

The second issue in the present study was to determine which of the two factors, task differences or complexity of syllable structure, might better reveal the deficit in PA. We found that LLA perform worse than children on PA tasks despite being matched for reading level. Previous research has arrived at a means of conceptualizing PA for the purpose of examining the relation with reading skills (Stahl & Murray, 1994). We considered, therefore, that this would prove to be a fruitful way of looking at the relations between PA and adult literacy.

In the isolation task LLA performed equally well as RL group across syllable structures, but RD children had higher scores than LLA across syllable structures. For the deletion task, however, a deficit was found for LLA irrespective of syllable structure. The performance of LLA on deletion task was affected when syllables with structure CV were shown as items, but also when syllables were shown as CCV. That means that the access to phonological units of speech was not mediated by the linguistic complexity of the items in the deletion task. Finally, for segmentation and blending tasks, the different reading groups were not differentially affected by syllable structure.

Some English studies provided empirical evidence that complexity of syllable structure has an influence in learning to read, and the controversy has been centered over the role of large versus small phonological units as predictors of children's reading skills (e.g., Bryant, 2002; Goswami, 2002; Goswami, Ziegler, & Richardson, 2005; Hulme et al., 2002; McMillan, 2002). For instance, Stahl and Murray (1994) found that the ability to manipulate onsets and rimes within syllables was related more strongly to reading, once an adequate level of letter recognition is achieved. Goswami et al. (2005) demonstrated that English readers, more so than German ones, attend to phonological units that are larger than single phonemes. Studies with Spanish children, however, have demonstrated that in the Spanish language onset and rime units are not involved in the translation of printed letter strings into phonological forms (Jiménez, Alvarez, Estévez, & Hernández-Valle, 2000). In addition, there is evidence in Spanish-speaking children that they are able to classify words on the basis of the rhyme unit in oddity tasks (e.g., bucal-moral-vejez), and also they performed well on oddity tasks which require them to identify the medial vowel phoneme and the same coda (e.g., dosel-senil-viril) (Jiménez & Ortiz, 1993). Nevertheless, Jiménez and Ortiz (2000) designed a longitudinal study on a sample of preliterate Spanish children and using path analysis demonstrated that the role of manipulating vowel-coda was not as great as they had assumed in the hypothesized model tested. Also, this result was consistent with those studies in Spanish which revealed evidence that at 6 years of age, the relationship between rhyme and reading is low (Carrillo, 1994).

Complexity of syllable structure would then play a less important role since Spanish is an orthographically transparent language. Jiménez and Venegas (2004) examined the relationship between PA and reading skills in a sample of Spanish illiterate adults analyzing the contribution of complexity of syllable structure and

task differences separately. They reasoned that if adult literacy acquisition is affected by the same factors that govern the acquisition of literacy skills in Spanish children, complexity of syllable structure would play a less important role since Spanish is an orthographically transparent language. They found that phonemes isolating appeared to distinguish adults who could read from adults who could not read words at the primary level. Also, the performance on all PA tasks was related to reading measures, a finding that was not coincident with Stahl and Murray's (1994) study. One possible interpretation offered by Jiménez and Venegas is that performance across tasks, when the linguistic complexity is controlled, is facilitated by the transparency of orthography because all tasks require phoneme manipulation.

The present study has some limitations, and the recognition of these should contribute to the refinement of future research efforts. It is important to recognize the importance of the analysis of developmental changes in the manifestation of a phonological deficit in LLA learning to read a regular orthography. When dyslexic children learning to read consistent orthographies are studied during the later phases of learning to read, evidence for a phonemic deficit in terms of accuracy of performance is difficult to find (Wimmer, Mayringer, & Landerl, 2000). de Jong and van der Leij (2003) studied the development of phonological processing abilities in dyslexics learning to read in Dutch. They also demonstrated that impairments in PA at the level of phonemes became manifest in 1st grade and tended to disappear at the end of primary school. Nevertheless, in a second cross-sectional study, it was found that dyslexic children's awareness of phonemes was hampered when task demands increased. Durgunoğlu and Öney (2002), for example, assessed the progress of adults participating in an intensive adult literacy program developed for a consistent orthography language, namely Turkish. They concluded that the results were consistent with studies of children's literacy acquisition, which show the critical nature of PA in literacy acquisition.

Our findings have educational implications for the field of adult literacy education. Adult literacy education requires a foundation of research based knowledge on how adults read. In order to effectively teach reading to adults with low literacy skills, educators need to be knowledgeable about reading theory and practice (Campbell & Malicky, 2002). Teaching reading to adults could be more effective if educators include the stimulation of PA. At the same time, counselors should be taking into account that in a consistent orthography the task performance is more relevant than complexity of syllable structure in the assessment of deficit in PA in LLA.

In sum, despite the cited above limitations, the research findings demonstrate that the deficit in PA in low-literate adults who learn in a consistent orthography is better revealed by the deletion task across all syllable structures. This means that low-literate adults experienced more difficulty in deleting phonemes irrespective of complexity of syllable structure.

Appendix: Tasks of phonological awareness

I. Isolating

Instructions: This time I want you to listen for just one sound in a word. Tell me the sound you hear at the beginning of each word I say. For example, if I say *fila*, you say /f/.

Practice words: pila, foto, roto, brazo

1. CV

sopa [soup] (/s/)	tela [cloth] (/t/)	mono [monkey] (/m/)	pita [agave] (/p/)
3.75	3.87	3.80	3.73

2. CCV

blusa [blouse] (/b/)	frito [fried] (/f/)	crema [cream](/k/)	frase [sentence] (/f/)
3.84	3.79	3.51	3.75

II. Deletion

Instructions: I wonder if you could take a sound away from a word and make a whole new word. For example, say *rata*. Now say it again, but don't say /r/ (For each item, use this form: Say [word]. Now say it again, but don't say [phoneme].)

Practice words: lino, pasa, grito, fama

1. CV

toro [bull] (oro)	faro [lighthouse](aro)	mojo [garlic sauce](ojo)	pupa [pain] (upa)
3.35	3.50	3.74	3.37

2. CCV

flaco [thin](laco)	crema [cream](rema)	frito [fried](rito)	claro [clear](laro)
3.54	3.51	3.79	3.37

III. Segmentation

Instructions: Do you remember when I said the words in secret code and you guessed what word I was saying? This time I want you to say the word in a secret code. I'll say a word, and you spread out all the sounds in the word. For example, if I say *rana*, you say /r-a-n-a/.

Practice words: pollo, grano, peso, porra.

1.CV

s a c o [bag]	t i z a [chalk]	m e s a [table]	p o l o [iced lolly]/
3.77	3.65	3.66	3.81

2.CCV

f r e s a [strawberry]	c r o m o [chromo]	c l a s e [classroom]	f r í o [cold]
3.98	3.86	3.37	3.64

IV. Blending

Instructions: I'm going to say some words in a secret code, spreading out the sounds until they come out one at a time. Guess what word I'm saying. For example, if I say *s-o-f-a*, you say *sofa* (For each item, pronounce the segments with as little additional vowel as possible).

Practice words: queso, broma, puma, niño

1. CV

b-e-s-o [kiss]	s-e-t-a [mushroom]	n-i-d-o [nest]	v-i-n-o [wine]
3.78	3.64	3.74	3.77

2.CCV

p-l-a-n-o [plane]	b-r-u-j-a [witch]	f-r-a-s-e [sentence]	p-l-a-t-o [dish]
3.22	3.71	3.68	3.75

References

Arnqvist, A. (1992). The impact of consonant clusters on preschool children's phonemic awareness: A comparison between readers and nonreaders. *Scandinavian Journal of Psychology, 33*, 29–35.

Bryant, P. (2002). It doesn't matter whether onset and rime predicts reading better than phoneme awareness does or vice versa. *Journal of Experimental Child Psychology, 82*, 41–46.

Campbell, P., & Malicky, G. (2002). The reading strategies of adult basic education students. *Adult Basic Education, 12*, 3–19.

Carrillo, M. S. (1994). Development of phonological awareness and reading acquisition. A study in Spanish language. *Reading and Writing: An Interdisciplinary Journal, 6*, 279–298.

Cuetos, F., Rodríguez, B., & Ruano, E. (1996). *Batería de Evaluación de los procesos lectores de los niños de Educación Primaria (PROLEC) [Battery for assessment of reading processes in children]*. Madrid, Spain: T.E.A. Ediciones.

de Jong, P. F., & van der Leij, A. (2003). Developmental changes in the manifestation of a phonological deficit in dyslexic children learning to read a regular orthography. *Journal of Educational Psychology, 95*, 22–40.

Durgunoğlu, A. Y., & Öney, B. (2002). Phonological awareness in literacy acquisition: Its not only for children. *Scientific Studies of Reading, 6*, 245–266.

Goswami, U. (2002). In the beginning was the rhyme? A reflection on Hulme, Hatcher, Nation, Brown, Adams, & Stuart (2002). *Journal of Experimental Child Psychology, 82*, 47–57.

Goswami, U., Ziegler, J. C., & Richardson, U. (2005). The effects of spelling consistency on phonological awareness: A comparison of English and German. *Journal of Experimental Child Psychology, 92*, 345–365.

Greenberg, D., Ehri, L. C., & Perin, D. (1997). Are word-reading processes the same or different in adult literacy students and third-fifth graders matched for reading level? *Journal of Educational Psychology, 89*, 262–275.

Greenberg, D., Ehri, L. C., & Perin, D. (2002). Do adults literacy students make the same word-reading and spelling errors as children matched for word-reading age? *Scientific Studies of Reading, 6*, 221–243.

Guzmán, R., & Jiménez, J. E. (2001). Estudio normativo sobre parámetros psicolingüísticos en niños de 6 a 8 años: la familiaridad subjetiva [Normative study about psycholinguistic parameters in children from 6 to 8 years old: The subjective familiarity]. *Cognitiva, 13*, 153–191.

Hulme, C., Hatcher, P., Nation, K., Brown, A., Adams, J., & Stuart, G. (2002). Phoneme awareness is a better predictor of early reading skill than onset-rime awareness. *Journal of Experimental Child Psychology, 82*, 2–28.

Jiménez, J. E. (1995). Evaluación de la conciencia fonológica [Assessment of phonological awareness]. In J. E. Jiménez & M. R. Ortiz (Eds.), *Conciencia fonológica y aprendizaje de la lectura* (pp. 74–78). Madrid: Síntesis. (Phonological awareness and learning to read).

Jiménez, J. E., Alvarez, C., Estévez, A., & Hernández-Valle, I. (2000). Onset-rimes units in visual word recognition in Spanish normal readers and reading disabled children. *Learning Disabilities Research & Practice, 15*, 135–141.

Jiménez, J. E., García, E., Ortiz, M. R., Hernández-Valle, I., Guzmán, R., Rodrigo, M., et al. (2005). Is the deficit in phonological awareness better explained in terms of task differences or effects of syllable structure? *Applied Psycholinguistics, 26*, 267–283.

Jiménez, J. E., & Haro, C. (1995). Effects of word linguistic properties on phonological awareness in Spanish children. *Journal of Educational Psychology, 87*, 193–201.

Jiménez, J. E., & Ortiz, M. R. (1993). Phonological awareness in learning literacy. *Cognitiva, 5*, 153–170.

Jiménez, J. E., & Ortiz, M. R. (2000). Metalinguistic awareness and reading acquisition in the Spanish language. *The Spanish Journal of Psychology, 3*, 37–46.

Jiménez, J. E., & Venegas, E. (2004). Defining phonological awareness and its relationship to reading skills in low literacy adults. *Journal of Educational Psychology, 96*, 798–810.

McBride-Chang, C. (1995). What is phonological awareness? *Journal of Educational Psychology, 2*, 179–192.

McMillan, B. M. (2002). Rhyme and reading: a critical review of the research methodology. *Journal of Research in Reading, 25*, 4–42.

Read, C., & Ruyter, L. (1985). Reading and spelling skills in adults of low literacy. *Remedial and Special Education, 6*, 43–52.

Schreuder, R., & van Bon, W. (1989). Phonemic analysis: Effects of word properties. *Journal of Research in Reading, 12*, 59–78.

Stahl, S. A., & Murray, B. A. (1994). Defining phonological awareness and its relationship to early reading. *Journal of Educational Psychology, 86*, 221–234.

Thompkins, A. C., & Binder, K. S. (2003). A comparison of the factors affecting reading performance of functionally illiterate adults and children matched by reading level. *Reading Research Quarterly, 38*, 236–258.

Treiman, R. (1985). Onsets and rimes as unit of spoken syllables: Evidence from children. *Journal of Experimental Child Psychology, 39*, 161–181.

Treiman, R. (1992). The role of intrasyllabic units in learning to read and spell. In P. B. Gough, L. C. Ehri, & R. Treiman (Eds.), *Reading acquisition* (pp. 65–106). Hillsdale, NJ: Erlbaum.

Treiman, R., Bowey, J. A., & Bourassa, D. (2002). Segmentation of spoken words into syllables by English-speaking children as compared to adults. *Journal of Experimental Child Psychology, 83*, 213–238.

Treiman, R., & Weatherston, S. (1992). Effects of linguistic structure on children's ability to isolate initial consonants. *Journal of Educational Psychology, 84*, 174–181.

Wimmer, H., Mayringer, H., & Landerl, K. (2000). The double-deficit hypothesis and difficulties in learning to read a regular orthography. *Journal of Educational Psychology, 92*, 668–680.

Wise, B. W., Olson, R. K., & Treiman, R. (1990). Subsyllabic units in computerized reading instruction: Onset-rime vs post-vowel segmentation. *Journal of Experimental Child Psychology, 49*, 1–19.