

Language processing in Portuguese children aged 4 to 10 years

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In the last decades, several studies have been conducted in order to understand how literacy and schooling affect the way language is processed. It has been found that segmentation skills and phonetic awareness are influenced by literacy and by schooling. Pre-literate children and illiterate adults have a limited awareness of speech as a sequence of phones, and the development of phonetic awareness is stimulated by reading instruction (e.g., Alegria *et al.* 1982; Liberman *et al.* 1974; Morais *et al.* 1979, 1986). However, phonetic awareness is not entirely the product of literacy and schooling. Before entering school, children have some notion of the segments of speech; indeed, their ability to perceive alliterations is predictive of success in reading acquisition (Bradley & Bryant, 1983; Rohl & Pratt, 1995). Phonetic awareness also increases with age (Bradley & Bryant, *ib.*); yet, the effect of schooling on the segmentation skills of 5- to 7-year-olds children was estimated as four times stronger than the effect of age (Bentin *et al.* 1991).

The acquisition of literacy and the degree of schooling clearly must have an effect on the awareness of the structure and elements of language. It is not always easy to separate such trivial effects of literacy from the subtle effects that literacy and schooling might have on deeper levels of language processing (e.g., which functional representations are used when recognising spoken words). Furthermore, age-related changes may contribute to differences found in the performance of linguistic tasks by pre-literate and literate children, and literate and illiterate adults.

In order to disentangle the combined effects of literacy, schooling and age on language processing, it is crucial to assess in a differentiated way the detailed structure of the language processing system. An interesting instrument to assess language processing has been recently developed in the context of neuropsychology – the test battery PALPA (Psycholinguistic Assessments of Language Processing in Aphasia). This battery consists of 60 tasks that examine auditory processing, reading and spelling, picture and word semantics, and sentence comprehension (Kay *et al.* 1992). It is based on a cognitive dual-route model of the language system consisting of different operations of mental processing; these operations are organised in partly autonomous modules, that are interconnected and communicate with each other (cf. Kay *et al.* 1992; Coltheart *et al.* 1993). The tasks of PALPA were designed to provide specific information about the functioning and the integrity of these modules.

In this study, we apply these neuropsychological tasks in order to examine changes that occur in language processing during age and schooling. Ten psycholinguistic tasks dealing with reading, sentence comprehension and auditory processing were selected and presented to groups of school and pre-school children. Here, we report the results obtained with 3 tasks (letter naming and sounding, sentence repetition, and pointing span tasks).

METHOD

Participants

Eighty kindergarten children (half with 4 years, and half with 5 years) and 160 school children participated in this study. School children belonged to 4 groups from the 1st to the 4th grade (40 per group), and were aged from 6 to 10 years; all attended their grade for the first time, excepting 10 children that were excluded from data analysis (3 from the 2nd, 1 from 3rd, and 6 from 4th Grades). The children were observed in March and April 1996; they attended kindergartens or schools located on the Northern area of Portugal.

Materials

The 3 tasks whose results are reported in this study are briefly explained below (more details in Gomes & Castro, 1996, 1997).

1. Letter naming and sounding task

Two different tasks compose this test: saying the name of the 26 letters of the alphabet, and saying how the letter is read (how it 'sounds'). Due to the characteristics of Portuguese spelling, the sounding task included 'c' with a cedilla, diacritics, a nasal diphthong and digraphs.

2. Sentence repetition task

This task provides information about the ability to repeat sentences that differ semantically and syntactically ($n = 36$). Sentences can be active, passive or comparative. They can also be reversible or non-reversible; moreover, they are built either with a verb that is directional or with a verb that is not directional, and they use either a single adjective or an additional verbal complement.

3. Pointing span for Noun-Verb sequences task

This task assesses phonological short-term storage capabilities. Twelve noun-verb and noun-verb-noun strings are used, whose grammatical structure is $S_{\text{ubject}}-V_{\text{erb}}$ and $S-V-Object$, respectively. The sentences are grammatically and semantically anomalous (e.g., "pin boil" or "hat cut shed"). Words are combined into 6 different types of strings that increase in complexity: SV, SVO, SV/SV, SVO/SV, SV/SV/SV, and SVO/SVO. Each string is presented auditorily with a sentence-like intonation. Participants have in front of them pictures representing the meaning of all words used. They are required to listen to each string, and to point to the matching pictures in exactly the same order as the corresponding words were heard.

Procedure

Participants were tested individually in a quiet room. Each task was administered to all participants, except letter naming and sounding that was not given to kindergarteners.

RESULTS

ANOVAs, with Group as between-subject factor, were computed by subject and by item on the number of correct responses; corresponding results are reported as F_1 and F_2 , respectively. Gender was also included in the analyses by subject.

1. Letter naming and sounding task

Letter naming improves from ca. 80% in Grade 1 to 100% in Grade 4 (cf. Table 1). This effect of Group was significant ($F(1(3, 68) = 9.36$, $MSE = 28.01$, $p < .001$; $F(2(3, 204) = 21.48$, $MSE = .24$, $p < .001$). Scheffé tests revealed that the only significant differences are between Grade 4 and all the other grades. This is probably due to the extremely large variability among 1st and 3rd graders. In the Sounding task, performance improved from 20% in Grade 1 to almost ceiling level in Grade 4 ($F(1(3, 68) = 106.56$, $MSE = 90.95$, $p < .001$; $F(2(3, 284) = 111.2$, $MSE = .49$, $p < .001$). Even so, only one 4th grader read correctly all stimuli. All between-group differences were significant.

Table 1 – Mean Percentage of Correct Responses (and standard deviations) in letter naming and sounding, sentence repetition and pointing span

Group	Letter		Sentence Repetition	Pointing Span	
	Naming	Sounding		Female	Male
Age 4	--	--	86(11)	40 (24)	30 (16)
Age 5	--	--	98(4)	28 (18)	29 (8)
Grade 1	82 (16)	20 (10)	96(3)	50 (18)	63 (21)
Grade 2	87 (5)	52 (11)	100(-)	42 (8)	58 (18)
Grade 3	90 (11)	71 (21)	96(4)	58 (11)	48 (12)
Grade 4	99 (2)	93 (03)	99(1)	82 (13)	70 (23)

2. Sentence repetition task

An increase in the ability to repeat sentences was observed from 4 to 5 years of age (cf. Table 1). This is indeed the main result, since post hoc comparisons of a significant Group effect ($F(1(5, 105) = 20.03$, $MSE = 3.49$, $p < .001$; $F(2(5, 210) = 28.13$, $MSE = .08$, $p < .001$) revealed that the only significant differences occurred between 4-year-olds and all the other groups.

3. Pointing span for Noun-Verb sequences task

Performance was clearly worse in both kindergarten groups, and better in 4th graders (cf. Table 1). The effect of Group was significant ($F(1(5, 101) = 14.59$, $MSE = 4.14$, $p < .001$; $F(2(5, 66) = 2.30$, $MSE = .99$, $p = .05$). Scheffé tests revealed that 4- and 5-year-olds did not differ significantly, 5-year-olds performed worse than any of the older groups, and 4th graders performed better than 3rd and 2nd graders. The interaction between Group and Gender reached significance ($F(1(5, 101) = 2.35$, $MSE = 4.14$, $p = .04$). This is probably because one gender outperforms the other in some age groups, while the reverse happens in other age groups.

DISCUSSION

A significant improvement was found in letter naming and sounding from grades 1 to 4. In the Portuguese children observed, the mastery of the alphabet appears as the outcome of

a long learning process. Knowledge of letter names is not perfectly acquired in the course of the first school year; instead learning continues until grade 4. Fourth graders performed better than third graders, but astonishingly these did not outperform first graders. Consistent with this gradual acquisition of the knowledge of letter names, the mastery of letter-to-sound correspondences follows a similar path. In the letter sounding task, each grade performs significantly better than the previous one and it is only in the fourth grade that performance comes close to the maximum. These results indicate that, at least under the learning conditions of these children, the mastery of the alphabet depends on degree of schooling and not on literacy per se.

In the sentence repetition task significant differences were found only between 4- and 5-year-olds, with no important progress over the next school years. This increase in the ability to repeat spoken sentences before entering school is clearly an age-related improvement. It indicates that aspects of spoken language processing, in particular those that involve dealing with complex sentence structures, do not depend on explicit instruction of the kind provided in school.

In the pointing span task, 4- and 5-year-olds performed roughly at the same level but then performance jumped and children aged 5 performed significantly lower than the older children. This improvement in phonological short-term storage is associated with the transition from kindergarten to school, and may be the product of both age and schooling combined. A further improvement was observed across the school years (fourth graders had a bigger span than their younger colleagues), that is presumably more related to schooling than to age.

Finally, these results show that the tasks that we adapted from the neuropsychological aphasia battery PALPA were sensitive to an increasing mastery of spoken language by kindergarteners and of written language by school age children. This shows that PALPA tasks are useful outside the context of adult aphasiology.

Three main conclusions can be drawn from these results: (1) the tasks used in this study are a sensitive instrument to monitor specific changes of the language processing system during development and schooling; (2) degree of schooling, and not literacy per se, affect low level components of the language processing system such as letter naming and letter sounding; (3) an increase in phonological short-term storage is concomitant with the start of schooling, and further increase is related to level of schooling; hence, the span of phonological short-term storage may be the joint product of age and schooling; (4) changes that were detectable in sentence repetition occurred early, between 4 and 5 years of age; they are thus a product of language development and language experience that is independent of literacy and schooling.

NOTES

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