BRAZILIAN CHILDREN PERFORMANCE ON REY'S AUDITORY VERBAL LEARNING PARADIGM

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Abstract – The Rey Auditory Verbal Learning paradigm is worldwide used in clinical and research settings. There is consensus about its psychometric robustessness and that its various scores provide relevant information about different aspects of memory and learning. However, there are only a few studies in Brazil employing this paradigm and none of them with children. This paper describes the performance of 119 Brazilian children in a version of Rey´s paradigm. The correlations between scores showed the internal consistency of this version. Also, the pattern of results observed was very similar to that observed in foreign studies with adults and children. There was correlation between age in months and recall scores, showing that age affects the rhythm of learning. These results were discussed based on the information processing theory.

KEY WORDS: memory, child, Rey auditory verbal learning, cognitive science, neuropsychology.

Desempenho de crianças brasileiras no paradigma de aprendizagem auditivo-verbal de Rey

Resumo – O paradigma de aprendizagem auditivo-verbal de Rey é utilizado em todo o mundo, tanto em pesquisa quanto na clínica. Há consenso sobre sua robustez psicométrica e de que seus vários escores fornecem informações relevantes sobre diferentes aspectos da memória e da aprendizagem. No entanto, existem apenas alguns poucos estudos no Brasil envolvendo este paradigma e nenhum deles com crianças. Este artigo descreve o desempenho de 119 crianças brasileiras em uma versão do paradigma de Rey. As correlações entre escores mostraram a consistência interna desta versão. Além disso, o padrão de resultados encontrado foi muito similar àquele observado em estudos estrangeiros com adultos e crianças. Verificou-se correlação entre idade em meses e os escores de evocação, mostrando que a idade afeta o ritmo de aprendizagem. Estes resultados foram discutidos a partir da teoria do processamento da informação.

PALAVRAS-CHAVE: memória, criança, aprendizagem auditivo-verbal de Rey, ciência cognitiva, neuropsicologia.

The use of auditory verbal learning paradigms for assessment of memory was first proposed by Claparède in 1919[1,2]. However, their popularization is due to the Rey Auditory Verbal Learning Test (RAVLT), originally developed for children[3,4] and, subsequently, extended for young and old adults[5]. There are many variations of the paradigm proposed and made popular by Rey[3,4]. The general composition consists of 4 or 5 learning trials of a 15 words list, presented always in the same order, with immediate recall tested following each presentation. After this part, in some variations, an interference list is presented and its immediate recall is tested. The interference list attends the objective of assessing the effect of a new set of stimuli on the consolidation and recall of previously learned information. To attain this objective, the interference list, whenever used, is followed by a new recall of the first list. Next, after a 20 to 30 minutes delay and with no further stimuli presentation, there is a free recall test of the first list. Finally, in many versions, there is a recognition trial, where the subject has to discriminate the words of each one of the lists among a set of words, or imbedded in a story[6]. In its different versions, the auditory verbal learning paradigm, is one of the most widely used learning and memory assessment procedures. With its help, memory deficits have been detected in a great variety of disorders[7-13], including during infanthood[12-16]. Also, it has been showing extremely robust in terms of its psychometric qualities[6] and of the internal consistency of the results pattern, despite of variations in the procedure[17,18]. It is agreed that a great advantage of this paradigm is that

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many aspects of the performance may provide clinically relevant information[6]. Not only it is possible to compute the number of words recalled correctly at each trial, but also one may estimate the learning curve, compare the recall scores before and after a 20-30 minutes delay (thus assessing forgetfulness), compare the scores of free recall and recognition after a time delay (thus assessing the quality of codification attained by the subject) or evaluate the susceptibility of memory processes to interference, comparing performance before and after the interference list (an attentional measure), among other possibilities[12].

There is extense literature on the performance of normal adults in this paradigm[6,12,13]. However, studies about the performance of children are extremely rare, despite the fact that this kind of paradigm was originaly developped for healthy children[3,4,19]. A search of the international literature on this subject, showed only two papers on normal children. Forrester and Geffen[20], using the American adaptation of Rey's test, collected representative data for 7 to 15 years old Australian children. Van den Burg and Kingma[17], using a shorter version, without an interference list or a recognition trial, published data on German children. A search of the Brazilian literature showed that this paradigm has not been used in this country as it has been worldwide. Only two studies were found, one of them about the effects of aging on memory[11] and the other one about the performance of healthy brazilian adults, by Malloy-Diniz and colleagues[21]. However, there is no study about the performance of normal Brazilian children on this paradigm.

Taking into account the usefulness of this paradigm in the clinic and for research and the reduced number of studies about children response to that, it was developed a version for children, in Portuguese. In this paper we characterize the performance of 119 children 7 to 10 years old and compare our results with the data from children in other countries.

METHOD

Subjects

Participated in this study 119 subjects, 59 boys and 60 girls, aged from 7 to 10 years, students of private schools in Rio de Janeiro (Table 1). The subjects were from classes C and D, as estimated from parents professions and incoming, reported. Were included as subjects all children in the age band of interest, except those with diagnosed neurological or neuropsychiatric disturbances. These information were collected from a questionnaire filled in by parents. For all subjects the informed consent was obtained from parents after approved by institutional ethics comitee.

Procedure

The subjects were tested individually in appropriate conditions in a separate room inside the schools. The material used was paper, pencil and a tape recorded to register the word evocated by the subjects.

It was used a modified version of the Rey's auditory verbal learning paradigm. This version includes: 1) 4 presentations of a 12 words list (list A), followed by free recall attempts (A1, A2, A3 e A4); 2) presentation of another 12 words list - list B - and free recall test of this list (B); 3) a fifth recall, without further presentation, of list A (A5); 4) a delayed recall of list A, after 20 minutes (A6) and 5) recognition of lists A and B (recA e recB) (a record sheet is available writing to hcharchat@uol.com.br). In the recognition trial of lists A e B it was required that the subjects judged whether each of a 54 words set belonged to list A or to list B or to none of those. The stimuli words in this part included all words from lists A and B, and 30 distractor words similar to those on the lists in terms of fonology or semantics. The reduced number of words per list and the reduction of number of learning trials of list A, compared with Rey's and other versions, aimed to shorten the duration of testing, making it more suitable for limitations in sustaining attention expected especially for younger children. To compose the lists, were selected concrete noums, with 2 or 3 syllables, not belonging to the same semantic category, as described in the original paradigm[3,5].

Table 1. Demographic characteristics.

	7 years	8 years	9 years	10 years	P
N	37	28	34	20	
Sex					
Female	20	10	19	11	>0.05[a]
Male	17	18	15	9	
Education					
1st grade	4	0	0	0	
2nd grade	23	13	0	0	
3rd grade	1	10	10	1	<0.05[b]
4th grade	0	0	22	5	
5th grade	0	0	2	14	

[a]chi-square analyze comparing sex frequencies between different ages; [b]chi-square analyze comparing education grade frequencies between different ages.

Table 2. Correct word recall means (SD) according to age and trials comparing to Forrester and Geffen (1991) data.

Ages	SA1		SA2		SA3		SA4	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
7–8	5.06	(1.5)	6.6	(2.2)	7.6	(2.5)	8.7	(2.0)
7–8[a]	4.5	(1.3)	6.7	(1.8)	8.1	(2.2)	9.4	(2.3)
9–10	5.7	(1.3)	7.5	(1.9)	8.6	(1.7)	9.2	(1.6)
9–10[a]	5.8	(1.2)	8.9	(1.6)	9.9	(1.8)	10.9	(1.5)

[a]Forrester and Geffen (1991).

Table 3. Correct word recall means (SD) according to age and trials comparing to van den Burg and Kingma (1999) data.

Ages	SA1		SA2		SA3		SA4	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
7 years	4.9	(1.5)	6.2	(1.9)	7.2	(2.7)	8.4	(2.1)
7 years[a]	4.5	(1.6)	6.7	(1.8)	7.9	(2.3)	8.4	(2.1)
8 years	5.2	(1.6)	7.0	(2.5)	8.0	(2.2)	9.0	(1.8)
8 years[a]	4.9	(1.4)	7.6	(2.0)	8.5	(2.2)	9.6	(2.2)
9 years	5.7	(1.5)	7.3	(1.8)	8.4	(1.9)	9.0	(1.6)
9 years[a]	5.6	(1.4)	8.2	(1.9)	9.7	(2.2)	10.5	(2.0)
10 years	5.3	(1.4)	7.9	(2.0)	8.8	(1.2)	9.6	(1.4)
10 years[a]	5.9	(1.6)	8.6	(1.6)	10.1	(1.9)	10.7	(2.1)

[a]van den Burg and Kingma (1999).

For each subject, were computed simple and composed scores. The simple scores were: (i) number of words recalled in each of the 6 recall attempts of list A, designated as SA1, SA2, SA3, SA4, SA5 e SA6, (ii) number of words recalled in the immediate recall test of list B (SB), (iii) number of words recognized from lists A e B (SrecA e SrecB), The composed scores were: (i) learning (∑SA1-SA4), (ii) learning rate (SA4-SA1), (iii) retroactive interference (SA5/SA4), (iv) forgetfulness (SA6/SA5), (v) access to codified list A (SA6/SrecA) and (vi) access to codified list B (SB/SrecB)

Statistical analysis

Initially, the internal consistency of the all set of results was tested using Pearson´s correlation. The consistency between the pattern of results observed and those presented in the literature was studied through examination of the means and standard deviation, as well as through the execution of *t* tests for repeated measures. Finally, the age effect was tested with Pearson´s analysis of correlation between age in months and the different scores measured. Also, an ANOVA was runned and followed by a LSD (Least Significant Difference) post hoc test.

RESULTS

Internal consistency

Taking together the all set of data, it was observed a significant correlation (r=0.20, p=0.02) between the scores related to short-term memory (SA1 e SB1). Also, there were significant correlations (r between 0.18 and 0.71, p<0.05) between the scores related to long term memory (SA3, SA4, SA5, SA6, SrecA, SrecB). The SA2 was correlated (r between 0.27 and 0.60, p<0.05) both with measures of short term memory (SA1 e SB1) and those of long term memory (SA3, SA4, SA5, SA6, SrecA).

Consistency between the patern of results observed and those presented in the auditory verbal learning litterature

Tables 2 e 3 present the results for the learning trials from the present study, side by side with the finds of Forrester and Geffen[20] and those of Van den Burg and Kingma[17]. The means and standard deviations are very similar in the three studies, except for a tendency for slightly smaller scores SA2 to SA4 for the brasilien sample compared to the literature.

Tables 4 and 5 summarize the results for the Brazilian children in terms of simple and composed scores. Repeated measures *t* tests showed that there was learning of list A (SA1<SA2<SA3<SA4), reduction of the number of list A words recalled after introduction of list B (SA4>SA5), recall of more words in the first presentation of list A, compared to the recall performance for list B (SA1>SB1), number of words recognized larger than recalled, both from list A and list B (SrecA>SA6), and recognition of list A better than that of list B (SrecA>SrecB). There was no

Table 4. Correct word recall means (SD) according to age and trials.

Ages	SA1	SA2	SA3	SA4	SB1	SA5	SA6	SrecA	SrecB
7	4.9 (1.5)	6.2 (1.9)	7.2 (2.7)	8.4 (2.1)	4.6 (1.2)	6.7 (2.4)	7.1 (2.0)	10.3 (2.0)	6.5 (2.6)
8	5.2 (1.6)	7.0 (2.5)	8.0 (2.2)	9.0 (1.8)	4.5 (1.4)	7.5 (1.5)	7.9 (1.8)	10.3 (1.7)	6.7 (2.0)
9	5.7 (1.5)	7.3 (1.8)	8.4 (1.9)	9.0 (1.6)	4.7 (1.2)	7.8 (1.7)	7.7 (1.9)	10.7 (1.7)	7.6 (2.7)
10	5.3 (1.4)	7.9 (2.0)	8.8 (1.2)	9.6 (1.4)	5.2 (1.3)	7.6 (1.7)	8.1 (1.7)	11.5 (0.7)	7.2 (2.4)

Table 5. Mean (SD) of composed scores according to age.

Ages	∑SA1SA4	SA4-SA1	SA5/SA4	SB1/SA1	SrecA/A6	SrecB/B1
7	26.84 (5.8)	3.5 (2.5)	0.96 (0.1)	1.04 (0.5)	1.56 (0.5)	1.47 (0.6)
8	29.32 (6.1)	3.8 (2.0)	0.86 (0.2)	0.96 (0.5)	1.34 (0.3)	1.57 (0.6)
9	30.47 (4.3)	3.3 (2.1)	0.89 (0.2)	0.86 (0.3)	1.44 (0.3)	1.68 (0.7)
10	32.15 (3.5)	3.9 (2.5)	1.08 (0.2)	0.97 (0.4)	1.5 (0.4)	1.41 (0.5)

∑ SA1SA4 – Sum of trials 1, 2, 3 e 4.

lost of information after the 20 minutes delay for list A (SA5=SA6). For the comparisons where the mean scores showed different, *t* values have been between 8.64 and 17.41 and $p<0.001$.

Age effects

It was observed statistically significant positive correlation between age in months and: (a) the number of words recalled in the learning trials (SA1, SA2, SA3 and SA4), (b) the learning score (∑SA1-SA4) and (c) the number of words recognized from list B (SrecB). The correlation coefficients were between 0.18 and 0.29 and $p<0.05$.

An ANOVA was runned to investigate the age effect on the simple and composed scores. It was observed significative age effect on the number of words recalled on the learning trials SA1, SA2 and SA3 and also on the learning score (∑SA1-SA4) (F between 2.31 and 5.39, $p<0.05$). The LSD post hoc analysis has shown that 7 years old recall less words, compared to 9 to 10 years old, on each of the learning trial (SA1, SA2, SA3 and SA4) and show smaller learning scores (∑SA1-SA4). The 10 years old recognized more words from list A (SrecA) than 7 and 8 years old.

DISCUSSION

The auditory verbal learning paradigm is a very usefull tool for the assessement of several aspects of memory and learning in the clinical setting as well as in research[6]. There is only one pair of studies on this paradigm in portuguese speakers and none of them with children[11,21]. Thus, this study aimed to describe the performance of 119 children 7–10 years old on a shortened version of this paradigm, and also to compare these data with other studies with children from other countries[17,20].

The data from the Brazilian sample showed strong internal consistency, as demonstrated by significant correlations between short-term scores on one side, and between long-term scores on the other. It was interesting the finding that the scores for the second learning trial SA2 correlated both with short and long-term memory scores. It is possible that, along the learning trials, one will recruit progressively more the long-term stores than the working memory, because the amount of information gradually exceeds the capacity of this temporary store[22].

The means and stardard deviations for this Brazilian sample, both for simple and composed scores, were very similar to those from the two existing normative studies for German[17] and Australian[20] children. There was only a tendency for slightly smaller scores SA2 to SA4 for the Brazilian children compared to the others. This might be an effect of the reduced number of words in the shortened version of the paradigm used in this study. It is conceivable that, since less nodes (words) were activated in memory (by the hearing of the list), the number of words available to recall was smaller and so was the chance of recalling.

The pattern of results found in this study was also consistent with the immense literature on this paradigm on healthy and not healthy adults and children[6]. There was learning of list A along the four first trials as well as a small reduction of words recalled from that list, after list B was introduced. Also, after the 20 minutes delay, there was no significant lost of information from list A and the recognition score was larger than the recall score for list A. Finally, recognition of list A was better than for list B. Only one result differed from the pattern regularly found with this paradigm: the recall scores for the first presentation of list A and for list B were different, suggesting that list B was more difficult to store on working memory than list A. It would be expected no difference

between those scores. However, the mean span of working memory found for each one of the lists fit perfectly in the expected capacity for this system (7±2 items for adults and slightly smaller for children)[22,23].

There was an age effect on the learning rate of list A: 7 years olds were slower to learn the list along the 4 trials, compared to 9 and 10 years olds. The 8 years old group did not differ from the younger or older groups, suggesting that this is probably an age where the change is occurring in a more evident way or in most children, or both. The change in rate of learning at this time of life might be, at least in part, effect of the central executive development, and so of a progressively more strategic encoding of new information[24,25]. Also, it is possible to conceive that the enlargement of vocabulary as the child gets older, makes easier to encode and recall the lists: the memory nodes for the words being already in long-term memory, encoding is much more a matter of elevation of activation level, than that of formation of new nodes of memory[24].

In synthesis, the results from this Brazilian sample showed consistent internally and similar to the data from the two normative studies for children published to this day[17,20]. The pattern of simple and composed scores found was the classical pattern found in the immense adult literature. Taken together, these results corroborate the strength of the paradigm, despite the variations in its several existing versions. In view of these results and of usefulness of this paradigm to measure different aspects of learning and memory, it would be recommended to collect norms with this version of the auditory verbal learning to 7 to 14 years old children.

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