INTERNATIONAL JOURNAL OF BEHAVIORAL DEVELOPMENT, 1988, *11* (4) 467–474

Rate of Forgetting in Early Childhood

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The relation between age and rate of forgetting was investigated with a task that eliminated differences in level of initial learning. Three-, four-, and six-year-olds were shown 40 pictures, then were tested for their recognition of 20 pictures immediately, followed by a recognition test of all pictures 24 hours later. Rate of forgetting was nearly identical in every age group. The results are discussed in terms of the interference theory of forgetting and hypotheses about the relation of forgetting to neurological maturation.

INTRODUCTION

Although there has been considerable research concerning memory development in early childhood (Baker-Ward, Ornstein, & Holden, 1984; DeLoache, 1984; Perlmutter, 1984), the question of whether rate of forgetting changes during this period has been largely ignored. Although three-year-olds typically remember less than five- or six-year-olds, this may not reflect differences in rate of forgetting. The three-year-olds' deficit could be entirely attributable to deficits in acquisition and/or retrieval.

The question of whether rate of forgetting changes during early childhood is important. First, the various components of memory performance

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This research was supported by grants from the National Science Foundation (NSF-77-22075) and the National Institute for Child Health and Human Development (5-T32-HD-07151 and HD-01136). The authors thank Sonya Hernandez for help in testing subjects, and Gary Gillund, Dave Riccio, and Jim Jenkins for helpful suggestions about analyses and arguments in the paper.

may have different developmental profiles and may be responsive to different factors (Brainerd, Kingma, & Howe, 1985). Second, the phenomenon of childhood amnesia—the inability to remember events from early childhood—may be a consequence of an extremely rapid rate of forgetting in young children (Campbell, 1984). Third, comparative research suggests that rate of forgetting slows as the central nervous system matures. For example, a developmental slowing in rate of forgetting has been observed in rats, a species whose young have very immature central nervous systems, but not in guinea pigs, a species whose central nervous systems are relatively mature at birth (Campbell, Misanin, White, & Lytle, 1974). Considerable maturation of the central nervous system occurs during early human childhood. Finally, the interference theory of forgetting actually predicts *slower* rates of forgetting in younger than in older children. According to the theory, forgetting results from the gradual recovery of pre-experimental associations which compete with associations learned in the memory experiment. Younger children should experience less of this interference because they have both fewer and weaker pre-experimental associations (Keppel, 1964; Hasher & Thomas, 1973). However, this explanation assumes that there are no age differences in the retroactive interference that results from learning during the retention interval.

In contrast to the many developmental studies of rate of forgetting after early childhood (see Dempster, 1984; Fajnsztejn-Pollack, 1973), there have only been three such studies in early childhood. All have found no age differences. However, all have methodological problems. Koppenaal, Krull, and Katz (1964), who compared four-, five-, and eight-year-olds, used a measure of rate of forgetting that does not eliminate the contribution of learning that occurs during the initial memory test (Underwood, 1964). The results were also contaminated by ceiling effects. Hasher and Thomas (1973), who compared three-, six-, and nine-year-olds, obtained a nonsignificant trend toward faster forgetting in older children—the nine-year-olds' performance declined by 82% more than did the three-year-olds'. With only ten subjects per test condition, the experiment had insufficient power. Rogoff, Newcombe, and Kagan (1974), who compared four-, six-, and eight-year-olds, informed children of how long their retention interval would be, but only the older children inspected pictures longer when they expected a longer retention interval. Thus rate of forgetting was not validly calculated in the reported comparison of the performance of groups receiving long versus short retention intervals.

The present study was designed to avoid an additional problem—namely, the tendency for older children's initial level of learning to exceed that of younger children. The claim that initial level of learning affects rate of forgetting has been accepted for a long time (Spear, 1978; Underwood, 1972), although Slamecka and McElree (1983) have recently challenged it. The solution adopted by Hasher and Thomas (1973) and Koppenaal et al. (1964) of giving the younger children additional learning trials so as to equate initial levels of learning is problematic. Additional learning trials by themselves may alter rate of forgetting (Wickelgren, 1975). They may result in distributed practice or the overlearning of a few items, both of which slow forgetting.

The solution adopted in the present study was to design a task in which many sources of age differences in initial learning were absent. First, picture recognition, rather than recall, was used so as to reduce the contribution of age differences in strategic encoding and retrieval. Second, in order to eliminate the contribution of age differences in distractibility, children were shown a blank slide every eight acquisition slides so they would not have to maintain attention over a long period. Moreover, while the blank slide was presented, the children were congratulated for having watched every slide, were warned that more pictures were coming, and were reminded to watch every one. Third, test distractors had the same names as targets so as to eliminate the contribution of age differences in the use of name information during acquisition or test. Finally, acquisition slides were presented very rapidly so as to eliminate the contribution of age differences in elaborative encoding. Children had only enough time to identify acquisition slides.

Three-, four-, and six-year-olds were given a two alternative forced-choice recognition test for half the acquisition slides immediately after presentation and for all of them 24 hours later. Rate of forgetting was measured by comparing immediate recognition to delayed recognition of items tested for the first time.

A secondary goal of the study was to compare each age group's ability to learn from a recognition test. Brown and Scott (1971) demonstrated that preschoolers are capable of such learning. This learning was measured by comparing the delayed recognition of re-tested items to that of items tested for the first time.

METHOD

Subjects

Twenty-four three-year-olds (mean age = 3.5 years), 24 four-year-olds (mean age = 4.7 years), and 24 six-year-olds (mean age = 6.10 years) participated. There were equal numbers of males and females in each group. The preschool children were located through published birth records. They were tested in a lab room at the university. The six-year-olds were tested in a private room in a parochial school. Most children were from middle class homes.

Stimuli

One hundred and twenty colour slides depicting individual people, animals, or common objects were constructed. There were three exemplars from each of 40 categories, e.g. balls, strollers, boys. Exemplars differed in colour and detail, but not appreciably in size or shape.

Three series (A, B, C) were constructed by randomly assigning exemplars of the same category to different series. Subjects received either series A or B as acquisition slides. Acquisition series was counterbalanced with age and sex. Three test series (AB, BC, and AC) were constructed by pairing exemplars from different acquisition series. Subjects received either AB and AC or AB and BC as their test slides depending on whether A or B had been their acquisition series. Test series was counterbalanced with time of test, age, and sex. The order of slides in each test series was random, except that the correct exemplar appeared equally often on the right and left and appeared on the same side never more than three times consecutively.

A training set of three acquisition and three test slides was created for use on the first day of testing. These slides were not exemplars of any category represented in the experimental slides. An additional set of three test slides was constructed for reacquainting the subject with the test procedure on the second day. The targets in these slides were the same as the first three training slides of the previous day.

Apparatus

Subjects sat 35 to 70cm away from a 30 × 60cm rear projection screen. All slides were presented from a Kodak carousel projector. Beneath the screen was a control panel hidden from the subject. The experimenter used a button during acquisition to initiate presentation of slides, alternating 470msec exposure with 720msec dark inter-slide intervals.

Procedure

Half of the subjects in each age X sex group were tested by a man and half by a woman. For some of the youngest children it was necessary for a parent to sit with the child during testing.

After establishing rapport with a child, the experimenter presented the training slides. For each slide, the experimenter encouraged the child to look at the item closely, indicating that he or she would have to point to it later. The experimenter then presented the training test slides. For each slide, the experimenter asked the child to point to the picture he or she had seen before.

After training, the experimenter told the child "I am going to show you some pictures. They are going to come on very fast. I want you to look at every picture because you will have to point to them later." The experimenter then presented the first eight acquisition slides. A blank slide was then presented for ten seconds. The child was congratulated for watching every picture, was told that more pictures were coming, and was reminded to watch every one. A second blank slide was presented, then followed 1190msec later by the next eight acquisition slides. Presentation continued in this fashion for all 40 acquisition slides.

After the last acquisition slide, the experimenter presented each of 20 test pairs and told the child to point to the one that he or she had seen before. No corrective feedback was given.

When the child returned 24 hours later, the experimenter presented the three training test pairs. All children correctly pointed to the targets. The children then were tested on all 40 test pairs. Half of the targets had been targets in the immediate test. No distractor appeared in both tests.

RESULTS

To determine rate of forgetting, immediate test performance was compared to delayed test performance on items tested for the first time. A 3(age) × 2(sex) × 2(test) mixed analysis of variance of per cent correct responses yielded only a significant test effect, $F(1,66) = 69.64$, $P < 0.01$. Recognition scores dropped an average of 14 percentage points over the 24 hour retention interval (see Table 1). The age effect, $F(2,66) = 1.69$, and age *X* test interaction, $F(2,66) = 0.49$, did not even approach significance.

To assess the learning that took place during the immediate test, delayed recognition of retested items was compared to delayed recognition of items tested for the first time. A 3(age) × 2(sex) × 2(item type) mixed analysis of variance of these scores yielded only a significant item type effect, $F(1,66) = 106.51$, $P < 0.01$. Substantial learning took place during the immediate test. This learning was age-invariant.

DISCUSSION

The experiment succeeded in equating the three-, four-, and six-year-olds for initial level of learning without having to give the younger children more learning trials. The age groups showed nearly identical rates of forgetting over 24 hours.

Although there are dangers in arguing for the null hypothesis, the study is defensible against foreseeable methodological criticisms. First, the experiment had sufficient power to detect *moderate* age differences in rate of forgetting. For example, if there were a difference of one standard error between the rates of three- and six-year-olds in the populations, the present study had a 95% chance of detecting it (cf. Cohen, 1977, for the

TABLE 1
Mean (and Standard Deviation) of Percent Correct Recognition for Four Age Groups on Immediate and Delayed Tests

		Delayed	
Age	*Immediate*	*First-tested*	*Re-tested*
3-year-olds	77.7	63.5	78.1
	(12.4)	(15.4)	(15.9)
4-year-olds	83.1	66.7	85.6
	(11.3)	(12.6)	(9.7)
6-year-olds	82.1	69.8	86.9
	(11.2)	(12.2)	(10.8)

details of power analysis). Because the study did not have sufficient power to detect small differences, it is only safe to conclude that there are not substantial changes in forgetting rates during the preschool period. This conclusion is further supported by the fact that the rates obtained were nearly identical, not merely nonsignificantly different, and the rates showed no monotonic trend—the rates were 14.2, 16.4, and 12.3, for the three-, four-, and six-year-olds, respectively. Second, it might be argued that the three year age range studied is not broad enough to reveal age differences. However, large differences in this age range are typically obtained in memory experiments (Baker-Ward et al., 1984; DeLoache, 1984; Perlmutter, 1984) and the goal of the study was to explore whether these large differences might be attributable to differences in rate of forgetting. Third, it might be argued that not enough forgetting took place for age differences to emerge. However, given that floor level is 50% correct, the most that scores could decline from initial levels near 80% is 30 points. The obtained declines of 14 ± 2 points actually represent nearly 50% losses. Also, if scores had declined further, floor effects would have become a problem.

The findings indicate that acquisition and/or retrieval differences are more likely the sources of memory development in early childhood than are differences in rate of forgetting. Additional support for this claim can be derived from the fact that equivalent initial levels of performance were obtained in a task that was designed to eliminate the contribution of differences in acquisition and retrieval processes. Compare the present results to those of Hoffman and Dick (1976) who found a 25 percentage point age difference in immediate recognition of 600 pictures. The latter task clearly taxes acquisition processes.

The interference theory of forgetting could be interpreted as predicting slower rates of forgetting in younger than in older children (Keppel, 1964).

However, the opposite prediction could be derived from evidence of the maturation of retention-relevant neurological structures (Campbell, 1984). Perhaps both explanations are correct—countervailing forces could have produced the age-invariant forgetting rates of the present study. This assumes that the forces are of equal strength.

More likely, both explanations are incorrect. Extensions of interference theory to normal forgetting—forgetting that occurs when neither retroactive nor proactive learning is manipulated within the laboratory—have been consistently disconfirming. Contrary to the theory, rate of forgetting is usually found to be invariant with respect to encoding process, rate of learning, item meaningfulness, and item similarity (Underwood, 1972). Also, as Campbell and Spear (1972) noted, developmental differences in the strength and number of pre-experimental associates are unlikely to matter since proactive interference is greatly reduced when prior learning has been spaced and the experimental material is easily differentiated from prior material. But if the predictions of interference theory are to be dismissed, then the results of the present study disconfirm the view that neurological immaturity causes faster forgetting in three- than in six-year-olds. Rate of forgetting does not appear to change substantially during the preschool years.

All children showed substantial learning during the immediate test, consistent with Brown and Scott's (1971) results. In fact, this learning completely offset the forgetting that took place during the retention interval. No age differences were found in this learning.

Manuscript received 24 October 1986

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