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Medical Sciences

Visual Recognition Memory in Cats: Effects of Massed vs. Distributed Trials

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ABSTRACT. Two groups of normal adult mongrel cats were tested in two visual recognition tasks: 1. "Delayed matching-to-sample" (DMS) and 2. "Delayed nonmatching-to-sample" (DNMS), under two different conditions: 1. "Massed trials" – 20 consecutive trials per day, and 2. "Distributed trials" – only two trials per day. Two delays were used across the trials in these two conditions: a short delay (10 sec) and a long one (20 min). In the first condition ("massed trials"), these two delays were presented in pseudorandom order, while in the second ("distributed" trials), long delay was presented first and the short one in second position. Testing proceeded until animals reach the performance criterion – no more than 2 errors in 20 consecutive trials. Mann-Whitney Analysis of errors and trials to criterion revealed no significant difference between the two conditions of testing for both recognition tasks. This result is interpreted as indication of nonsensitivity of recognition memory tasks to interference. *© 2009 Bull. Georg. Natl. Acad. Sci.*

Key words: *visual recognition memory, cats, "massed vs. distributed" trials, interference.*

In modern cognitive neuropsychology interference is viewed as a major factor causing deficits in both the short- and long-term cognitive memories [1]. Careful analysis of the relevant literature convinces us that in the great majority of experimental works the method of "free recall" or its various modifications have been used for the assessment of the correctness of the memory task solving. But at the same time a somewhat different method for assessing cognitive memory also exists: the recognition paradigm and its various modifications [2]. In this paradigm the reproduction of information from the memory stores is assessed directly by the second presentation of the same stimulus which was presented earlier for memorizing, or of quite a new one, never presented before.

Our main objective in the present work concerns just the following topic: does the interference process exert any influence upon recognition memory? As an example of recognition memory two tasks were studied in animals – "delayed matching-to-sample" (DMS) and "delayed nonmatching-to-sample" (DNMS).; proactive interference was chosen as an example of interference. Research was performed in cats – representatives of carnivores, in which the existence of visual recognition memory had been documented by us earlier [3].

Materials and Methods

Experimental subjects

Eight experimentally naïve adult normal cats of both sexes (five males, three females) weighing 3-4.7 kg were used in this study. The animals were housed in individual cages (1.5 x 1.0 x 1.0 m) in which they had free access to water. Food was given once daily, 20 h before testing. Experimental sessions were conducted 5 days per week. The care and use of the animals complied with Georgian regulations, with Guidelines prepared by the Ethics Committee of the Institutional Animal Care and Use Committee of the Research Center for Experimental Neurology, and with the National Institutes of Health Guide for the Care and Use of Laboratory Animals.

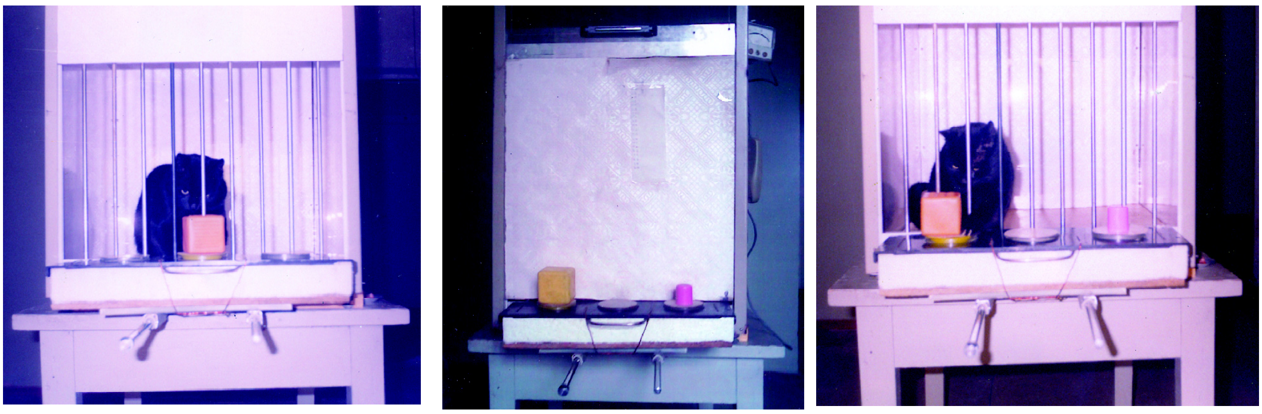
Apparatus

The Wisconsin General Testing Apparatus (WGTA) was adapted for cats so that they could use their forelimbs to displace objects and retrieve food. The apparatus, as described in detail by Okujava *et al.* [3], consisted of two main parts (Fig. 1): A cat start-cage (55cm x 65cm x 60 cm) placed on a table inside a darkened, sound-shielded room; and a test tray containing three identical food wells, each a round glass jar (25 mm deep and 73 mm in diameter), on which different objects (stimuli) may be placed. The stimuli consisted of an array of 600 junk objects, which differed from each other in size, form, texture, and color (the latter providing mainly brightness cues for cats).

Procedures

During preliminary training, cats were shaped behaviorally to displace cardboard covers placed over the three food wells to obtain rewards (each a small piece of boiled meat, 0.5 cm^3) hidden in the wells. They were then trained in the same way to displace one of three pretraining objects, which were presented singly in random order over one of the three food wells. Finally, the cats were given 20 pseudotrials to familiarize them with the structure of the task: one of the three pretraining objects was presented as the "sample" object over the baited central well; 10 s later the two other objects were presented over the lateral wells, both or neither of which were baited, in random order. The cat was allowed to displace only one of the two "test" objects. The pseudotrials were separated by 30 s intervals. During the 10 s delay intervals and the 30 s intertrial intervals, an opaque screen separated the cat from the test tray. This preliminary training was completed in 7-12 days. Formal testing was then begun, using trial-unique objects.

DMS task: each trial consisted of two parts, a sample presentation followed by a choice test. After the animal displaced the sample object from the central well and retrieved the reward (top panel of Fig.1 – "sample presentation", no other object was on the test tray), the opaque screen was lowered for delay intervals of 5 and 10 s in pseudorandom order (middle panel of Fig. 1 – "delay"). The screen was then raised revealing the sample object again together with a quite novel object, each covering one of two lateral wells, and the cat was allowed to choose (bottom panel of Fig. 1, "choice"; novel object – small cylinder). A new pair of objects was used on every trial, and the left-right positions of the sample and novel objects on the choice test varied pseudorandomly. In the choice tests of this task, the sample object was always baited, requiring an animal to learn the rule of delayed matching-to-sample. Twenty such trials, separated by 30 s intertrial intervals, were presented daily until the animal achieved the criterion score of 80 correct in 20 trials per day (across one session). The time limit for the behavioral response was set initially to 10 sec, and to 5 sec at final stages of training; withholding the response beyond that limit was scored as an error. The response of the animal toward the central food well was scored as an error. There was



"Sample presentation" phase "Delay" phase "Choice" phase

Fig. 1. Apparatus for visual recognition memory testing

no correction for errors, *e.g.* an animal after making an incorrect response to the central well was not allowed to correct it by the response to the side well in the same trial, nor in the following one.

DNMS task: the procedure was exactly the same as those used for DMS task, performed in the same apparatus, except that now the novel object was always baited on the choice test, requiring an animal to learn the rule of delayed nonmatching-to-sample.

Experimental design

To study effects of proactive interference (shortly – proaction) on recognition memory tasks we have used two groups of animals (each consisting of four normal cats). One group was tested under condition of minimal proaction, while the other – under condition of maximal proaction. Let us describe what we mean:

Minimal proaction – in this condition cats were trained in DMS task to criterion (80 correct per 40 trials across two consecutive sessions) using only two trials per experimental day, first trial with 20 minute delay duration and the second one with 10 sec delay. In fact this condition might be viewed as condition with highly distributed trials.

Maximal proaction – in this condition cats were trained in DMS task to an already specified criterion using twenty trials per experimental day; two delay intervals (5 and 10 sec) were presented randomly across 19 trials, while the last trial was presented always with 20 min delay. Learning criterion was the same as in preceding condition.

This condition might be viewed as condition with massed trials. Our first group of cats was trained under first condition, while the second group – under second condition.

Testing in these two conditions in both groups of animals began after completion of formal testing in DMS task. The first group tested under condition of distributed trials will be named “Distributed group”, while second will be named “Massed group”.

Four cats were tested in DMS task at first with massed procedure, while four other cats were tested in the same task at first with distributed procedure. Afterwards same eight cats participated in testing DNMS task, but in reverse order – first four cats were tested in DNMS at first under distributed condition, followed by massed condition, while remaining four cats were tested at first in massed condition, followed by distributed one.

Table 1

Scores obtained by individual cats during learning of the DMS task. Errors to criterion (criterion sessions were not included in the errors to criterion indices) are given for two conditions of testing - distributed trials (“Distributed”) vs. massed trials (“Massed”). Statistical significance between the two conditions was evaluated with Mann-Whitney U test

CATS	Massed		Distributed		Significance (Mann-Whitney U test)	
	10 sec	20 minute	10 sec	20 minute	Massed vs. Distributed for 10 sec	Massed vs. Distributed for 20 min
№1	25	18			m=n=4, U = 5, P = 0.243, N. S. (nonsignificant)	m=n=4, U =5, P = 0.243, N. S (nonsignificant)
№2	20	19				
№3	33	15				
№4	30	40				
№5			17	14		
№6			38	40		
№7			12	26		
№8			15	24		

Results and Discussion

The obtained results are shown in Table 1.

Same results for DNMS task learning under two conditions are shown in Table 2.

Thus, as seen from the data presented in these Tables there is no significant difference between the two conditions of testing: in both of them (the massed and the distributed trial conditions) normal cats demonstrated statistically nonsignificant difference between the scores of learning the visual recognition tasks. On the other hand, in the delayed response task (the task used to access the visuo-spatial cognitive memory in animals) the different effects of the massed and distributed trial conditions were demonstrated in cats just as in primates [4, 5].

Table 2

Scores obtained by individual cats during learning of the DNMS task. Errors to criterion (criterion sessions were not included in the errors to criterion indices) are given for two conditions of testing - distributed trials ("Distributed") vs. massed trials ("Massed"). Statistical significance between the two conditions was evaluated with Mann-Whitney U test

CATS	Massed		Distributed		Significance (Mann-Whitney U test)	
	10 sec	20 minute	10 sec	20 minute	Massed vs. Distributed for 10 sec	Massed vs. Distributed for 20 min
№1	25	15			m=n=4,	m=n=4,
№2	20	14			U = 3,	U = 4,
№3	33	27			P = 0.100.	P = 0.171,
№4	30	24			N. S.	N. S
№5			18	21	(nonsignificant)	(nonsignificant)
№6			40	20		
№7			15	17		
№8			14	50		

We speculate that this difference between the two tests of cognitive memory might be indicative of different strategies of retrieval employed in these two tests – delayed response more closely resembling "free recall" paradigm, than the ordinary recognition one.

სამედიცინო მეცნიერებანი

მხედველობითი ცნობის მეხსიერება კატებში: მასირებულ და განაწილებულ სინჯთა ეფექტები

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ნაშრომის ძირითად მიზანს წარმოადგენს იმის დადგენა, თუ რა როლს შეიძლება თამაშობდეს ინტერფერენციის ერთ-ერთი სახე – პროაქტიური ინტერფერენცია კატების მხედველობითი ცნობის მეხსიერებაში. თანამედროვე ექსპერიმენტულ ფსიქოლოგიაში პოპულარულია შეხედულება დავიწყების პროცესზე არა როგორც კვალის დროის განმავლობაში პასიურ ჩაქრობაზე, არამედ როგორც ამ კვალის "წაშლაზე" ინტერფერენციის (ხელშემშლელი პირობების) ზემოქმედების შედეგად. ასეთი დასკვნა დასტურდება მრავალი შრომით, რომელშიაც კვალის შენახვა დროში ფასდება ე.წ. "თავისუფალი გახსენების" მეთოდით. მეორეს მხრივ, არსებობს კვალის მეხსიერებაში შენახვის შეფასების მეორე მეთოდიც – ე.წ. "ცნობის შეფასება" ("recognition").

ნორმალური კატების ორ ჯგუფს შევასწავლიდით მხედველობითი ცნობის მეხსიერების ორ ცნობილ ტესტს "დაყოვნებულ შერჩევას ნიმუშის" მიხედვით და "დაყოვნებულ არშერჩევას ნიმუშის" მიხედვით. ვაწარმოებდით ამ ამოცანების დასწავლას ერთი და იგივე დასწავლის კრიტერიუმამდე (არა უმეტეს 2

შეცდომისა 20 თანმიმდევრულ სინჯში) ტესტირების ორ განსხვავებულ პირობაში: 1. ე.წ. “მასირებული” სინჯების პარადიგმაში და 2. ე.წ. “განაწილებული” სინჯების პარადიგმაში. პირველი პირობა, ჩვენი ვარაუდით, მაქსიმალურად ზრდის ინტერფერენციას, ხოლო მეორე პირობა კი, პირიქით, ამინიმიზირებს ასეთ ზეგავლენებს. ტესტირებისას ორივე პირობაში გამოიყენებოდა ორი საკმაოდ განსხვავებული ხანგრძლივობის დაყოვნება – 10 წამი და 20 წუთი; ამასთან ვიცავდით შემდეგ პირობას – “მასირებულ” პარადიგმაში 20 წთ-იანი დაყოვნება ყოველთვის იკავებდა 20 სინჯიან თანმიმდევრობაში ბოლო ადგილს, ხოლო “განაწილებულ” პარადიგმაში კი პირველს. ჩატარებულმა ექსპერიმენტმა დაგვარწმუნა, რომ კატების მხედველობითი ცნობის მეხსიერებაზე ტესტირების ამ ორი განსხვავებული პირობის გამოყენება არ იძლევა სტატისტიკურად ნიშნად განსხვავებას ამ პირობებს შორის. მხედველობითი ცნობის მეხსიერების ასეთი “მდგრადობა” ინტერფერენციული ზემოქმედების მიმართ ჩვენი აზრით მიუთითებს იმაზე, რომ ცნობის პარადიგმაში მეხსიერების საცავიდან შენახული კვალის “ამოკრეფა” არსებითად განსხვავდება კვალის “ამოკრეფისგან” ე. წ. “თავისუფალი გახსენების” პარადიგმაში.

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