DOCUMENT RESUME

ED 202 581 PS 012 183

AUTHOR	Fagen, Jeffrey W.; And Others
TITLE	Reminiscence Following Reactivation of Infant Memory: What a Difference a Day Makes.
PUB DATE	Apr 81
NOTE	13p.; Paper presented at the Biennial Meeting of the Society for Research in Child Development (Boston, MA, April 2-5, 1981).
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Conditioning; *Infants; Memory; *Motor Reactions; *Retention (Psychology); *Time Factors (Learning)
IDENTIFIERS	*Reminiscence

ABSTRACT

This paper describes a series of studies investigating the effects of memory reactivation in early infancy. Twelve-week-old infants were taught a footkick response by having one leg tied to an overhead crib mobile so that each footkick produced movement of the mobile (reinforcer). Retention of the footkick response was assessed after 6, 8, and 14 days and rates of forgetting were determined. The effects of memory reactivation in counteracting the forgetting were then examined. Reactivation consisted of placing the infants under the mobile without attaching the ribbon to their leg, so that they could be exposed for 3 minutes to the reinforcer (movement of the mobile) independent of their response (footkick). Results showed that this reactivation was sufficient to bring the level of footkicks back to its level on the original retention test immediately following initial training. Further results showed that the effects of reactivation were greatest at 24 hours after reactivation. Thereafter, forgetting was shown to occur at about the same rate as the forgetting of the initial learning. Further investigation showing that reactivation was facilitated by periods of sleep was interpreted as suggesting that infant memory is more accessible for reminiscence during periods of minimal interference. (Author/JMB)

Reminiscence Following Reactivation of Infant Memory:

What a Difference a Day Makes

Jeffrey W. Fagen, Michele Hoffman,

Carolyn K. Rovee-Collier, and Susan Thompson

Rutgers University

Paper presented at the meeting of the Society for Research in Child Development, Boston, Massachusetts, April, 1981.

Recent conditioning studies of infant memory have begun to radically alter our current thinking regarding the memorial abilities of young infants. These conditioning procedures have been modelled after designs used in animal memory research in which an organism is conditioned to perform a specific response in a distinctive setting and is then returned to that setting at some future point in time to see if the response will still be produced.

For example, a rat can be trained to avoid a shock in one side of an apparatus by hurdling into an adjacent compartment when a tone is presented. At a later time, retention is assessed by putting the rat back into the training apparatus and sounding the tone. Either the animal makes the appropriate avoidance response or he does not! As a paradigm for studying memory, what could be simpler or more straightforward? As Bruner has said, "The most important thing about memory is not storage of past experience, but rather the retrieval of what is relevant in some usable form."

In our procedure, we teach the infant a specific response, a footkick, in a distinctive setting and then return the infant to that setting at a later point in time to see if the footkick response will once more be produced at a level greater than that observed prior to training.

SLIDE 1

In our procedure, the infant's leg is attached to an overhead crib mobile by means of a ribbon. As you can see in this slide, two mobile stands are affixed to opposite sides of the infant's crib. When the mobile is suspended from the stand to which the ribbon is attached, each footkick will move the mobile. I wish to emphasize here at the outset that it is the movement of the mobile and not simply its presence that is the reinforcer here. When the mobile is suspended from the stand to which no ribbon is attached, it remains in view but nonresponsive. This nonreinforcement period is given at the outset and conclusion of each training session.

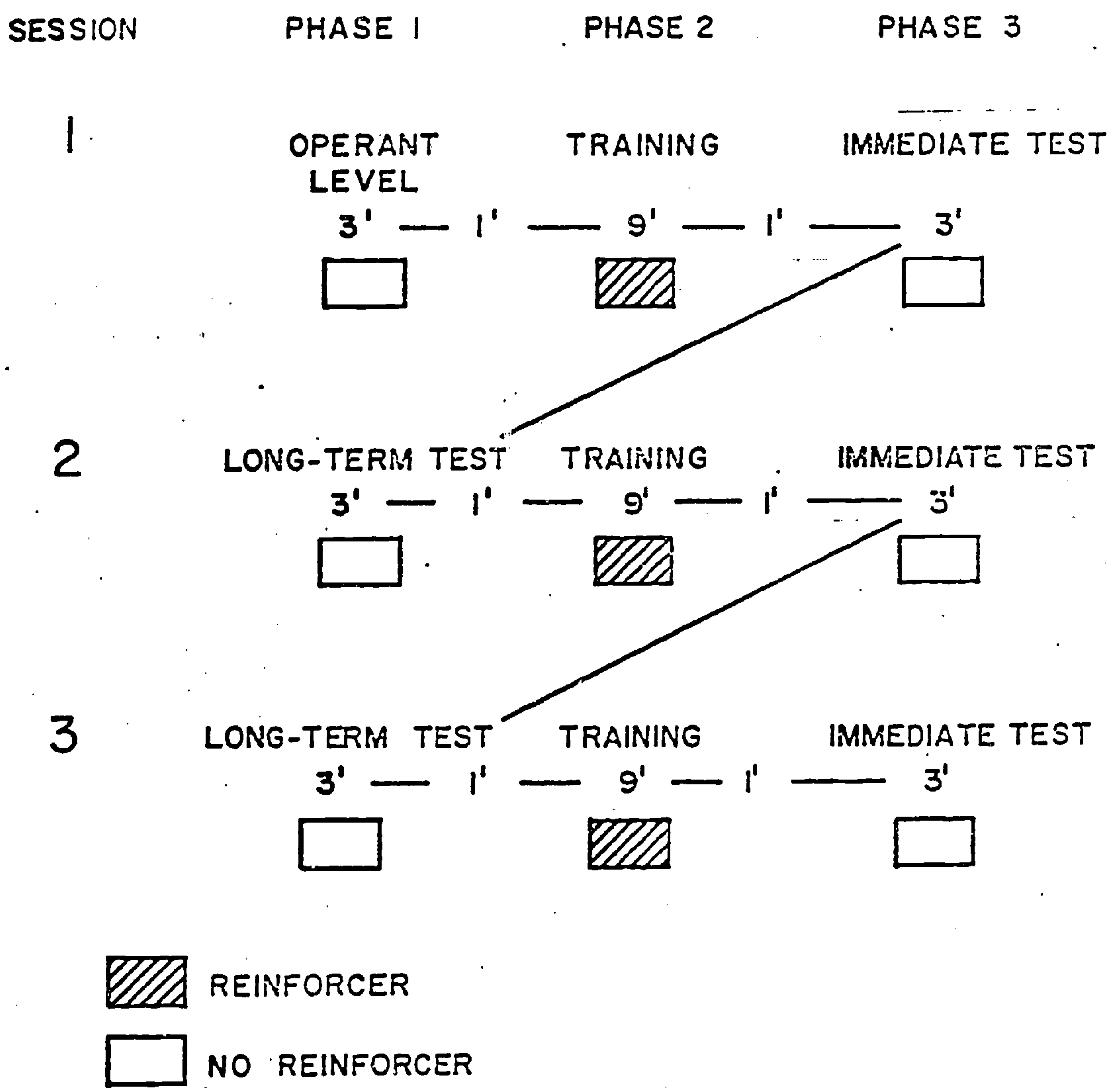
SLIDE 2

This slide is a schematic of our retention paradigm. It involves two training sessions, each separated by 24 hours, and a temporally distant third session. The interval between Sessions 2 and 3 varies and defines the retention interval. Pretraining rates of footkicking are assessed during the first three minutes of Session 1 when the mobile is nonmoving. This is labelled "operant level" on the slide. In the last three minutes of each session, the mobile is again nonmoving and we assess the immediate effects of training, hence the name "immediate test." Although this is an extinction period, complete extinction does not occur in the three available minutes.

The diagonal lines indicate the comparisons of interest. At the outset of each succeeding session, we have a procedurally identical long-term test with the nonmoving mobile. Performance here is assessed in relation to terminal performance during the immediate test of the preceeding session. Changes in performance between these two retention tests is taken as an index of forgetting. One way to do this is to compute what we call a retention ratio. In this ratio, the infant's long-term performance at the outset of Session 3 is divided by his or her immediate performance at the conclusion of Session 2. Ratios of one indicate no forgetting, in other words, the same number of footkicks were produced during the immediate and long-term retention tests. Ratios of less than one indicate fractional loss. Ratios of .3 to .4 typically reflect a footkick rate that has returned to that exhibited prior to the infant's first contingency experience (Day-1 operant level).

Using this paradigm with 12-week-old infants, we have obtained retention ratios on the order of .8-1.0 after retention intervals as long as 6 days, of .5 after 8 days, and of .4 after 14 days.

RETENTION PARADIGM



Given that infants forget, we next sought to determine if their forgetting could be alleviated. Animal memory researchers, most notably Spear and Campbell, have found that by providing animals with a portion of the original learning context, they could return long-term retention test performance to pre-forgetting levels.

Take, for example, the rat who has learned to hurdle to the "safe" side of an apparatus when a tone is sounded to avoid shock. Eventually, rats forget this, in other words, when placed in the apparatus after some time period they do nothing when the tone is sounded. If, however, the rat is given a single shock 24 hours prior to the retention test, the rat successfully makes the avoidance response upon hearing the tone the next day.

Spear has labelled the presentation of the single shock a reactivation treatment. In his view, memory is a collection of attributes each of which represents a characteristic of an event which the organism noticed. The function of the reactivation treatment is to literally prime or recyc these memory attributes making them more accessible to retrieval.

Our reactivation treatment was modelled after that used with animals. We asked whether it would be possible to alleviate forgetting in infants after forgetting had occurred but prior to the long-term retention test. Like Spear, we chose to administer a brief reexposure to the reinforcer as the reminder. Once again, in our paradigm the reinforcer is the moving mobile.

SLIDE 3

In our reactivation treatment, the infant is placed in his or her crib under the moving mobile for three minutes. The ribbon is not attached to the infant's ankle but is drawn and released by the experimenter who is hidden from view. Because of varying individual response rates, movement of the mobile is adjusted to match each infant's own response rate at the end of training. Finally,

to insure that new learning does not adventitiously occur, infants are placed in an infant seat. This redistributes their weight such that footkicks are minimized.

SLIDE 6

This slide illustrates the average retention ratios of independent groups of three-month-old infants tested for retention at various intervals following either original training or a reactivation treatment administered 13 days following training. There are three important things about these data.

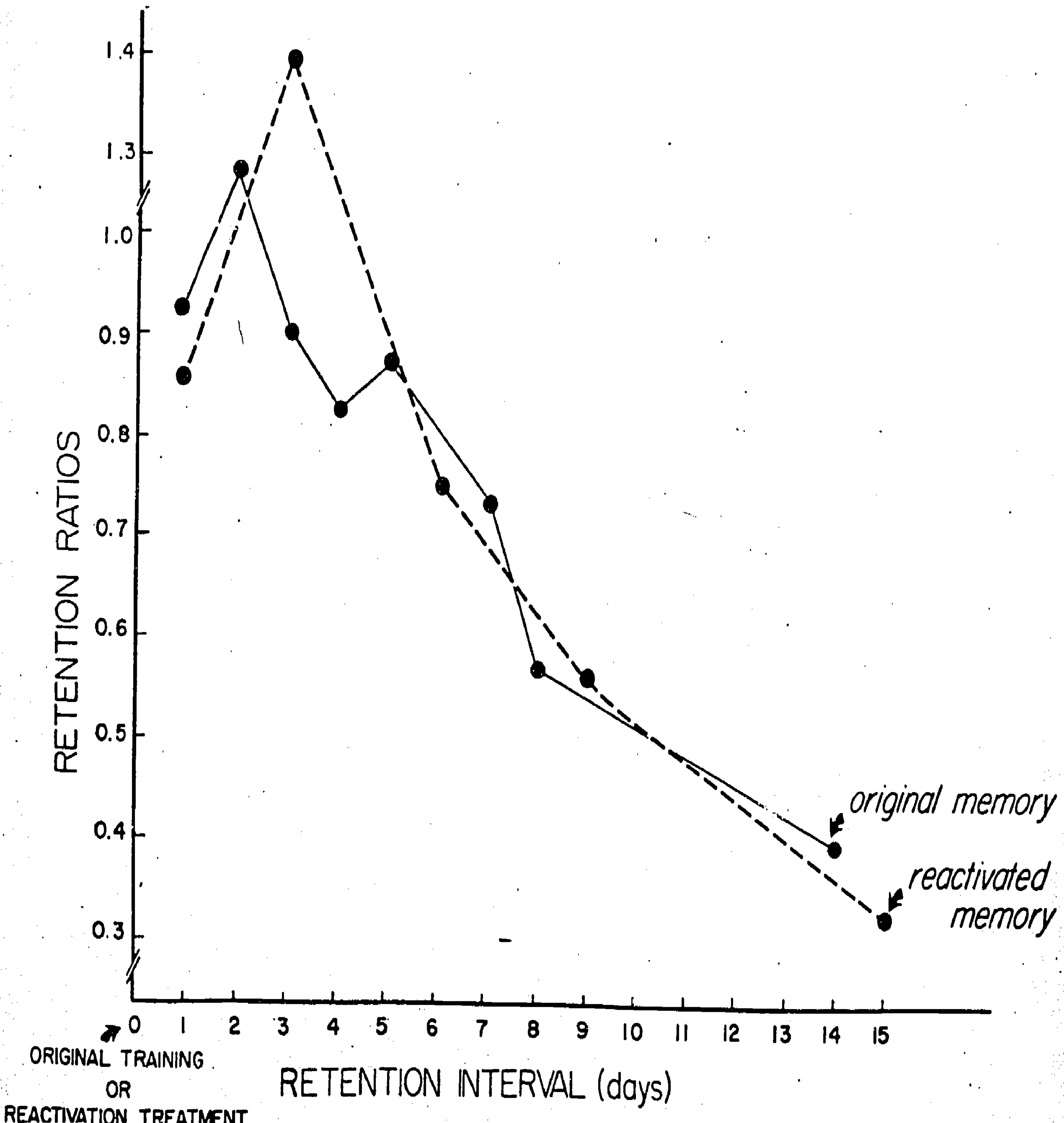
First, notice that reactivation works with infants. In other words, 24 hours after the brief reexposure to the moving mobile, performance is at a level equivalent to what it was 2 weeks earlier.

Second, the time course for the forgetting of both the original and reactivated memories is similar. Both memories show a gradual decline over days and responding eventually returns to pretraining levels.

Third, neither forgetting function is perfectly linear decreasing. Both memories show some evidence of reminiscence, that is, better performance after long than after short retention intervals. In other words, we see a retention ratio greater than one 2 days following original training and 3 days following reactivation.

The study that I will present to you today further investigated this reminiscence phenomenon of the reactivated memory by testing infants for retention of the conditioned response at intervals less than 24 hours following reactivation. Predictably, retention-test performance should be poor immediately following the reminder and should gradually improve over a 24-hour postreactivation interval.

In this study, four groups of 12-week-old infants were trained for two days and received the 3-min reactivation treatment 13 days following training. The third or retention session was administered ¼, 1, 8, or 24 hours later. For purposes of comparison, two additional groups of infants received two days of training and were tested for retention without reactivation 13 or 14 days later. I wish to reemphasize that 13 days following training is when the other groups received their reactivation treatments.


1.4
1.3
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
RETENTION RATIOS
original memory
reactivated memory
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
ORIGINAL TRAINING
OR
REACTIVATION TREATMENT
RETENTION INTERVAL (days)

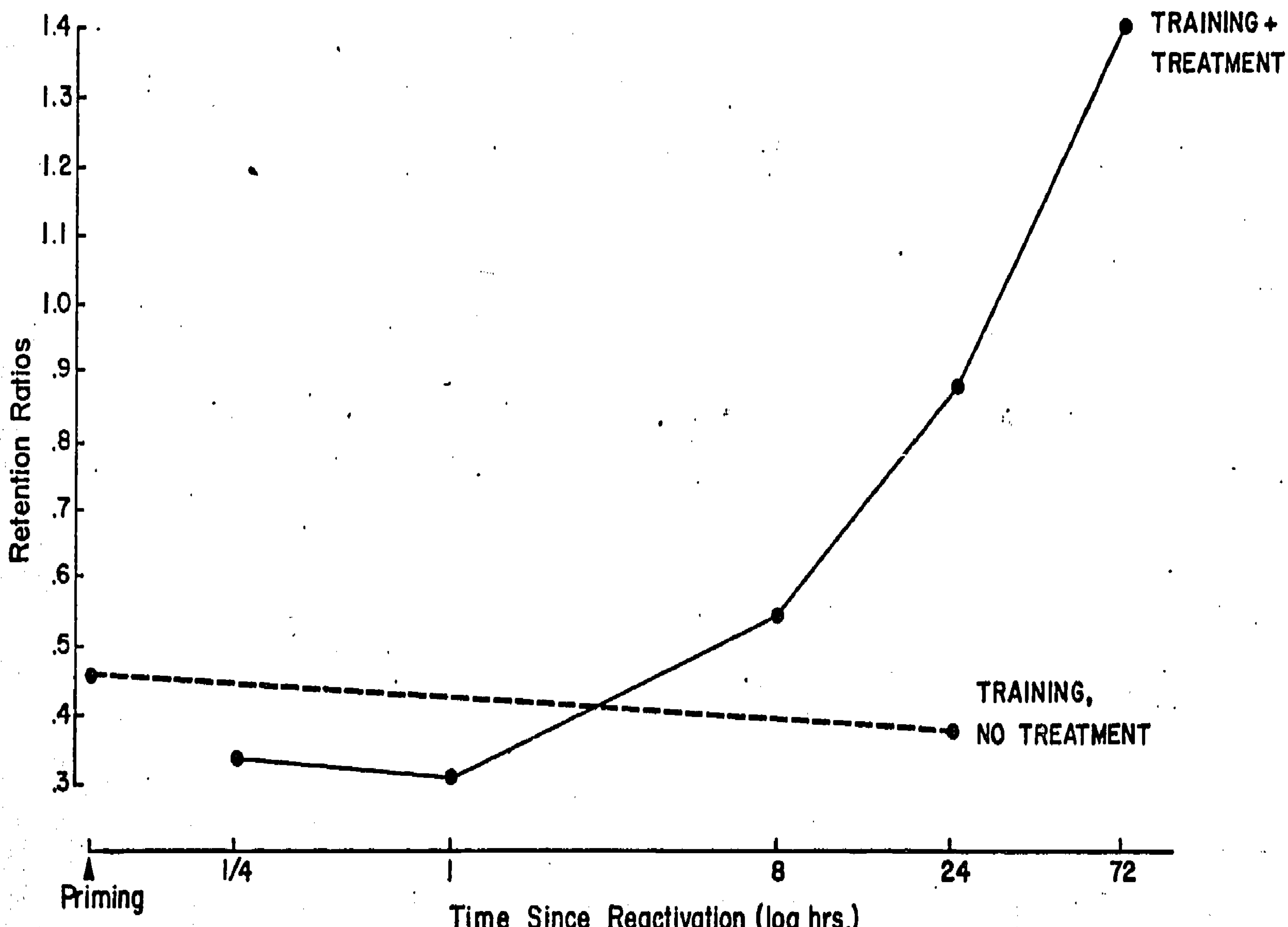
SLIDE 5

Here you see our results expressed in terms of the average retention ratio as a function of the time since reactivation. For illustrative purposes, the 72 hour point from the previous study has been included. Notice that retention following the reactivation treatment is, as predicted, a linear increasing function of the time since the reactivation treatment. Specifically, infants tested 24 hours after the reactivation treatment performed at a level equivalent to that observed during the immediate retention test two weeks earlier, while those tested just 15 minutes or 1 hour after reactivation still evidenced complete forgetting. Infants tested 8 hours after the reactivation treatment fell somewhere in between retention and forgetting. Examination of the individual data for this group revealed that some 8-hour infants were evidencing excellent retention while others were evidencing excellent forgetting.

We had asked the mothers of these 8-hour infants to keep a record of the amount of time that her infant slept between the reactivation treatment and the retention test. Remarkably, the resulting correlation between the retention ratio and the amount of sleep was .75 ($\underline{p} < .001$).

One possible explanation for the poor performance shortly after reactivation is that the reactivation treatment, though similar to training, is not identical. Specifically, we were concerned with the fact that during reactivation, infants were placed in their infant seats. Perhaps the change in context could account for the ineffectiveness of the reactivation treatment 15 minutes or an hour later. In other words, it seemed reasonable to assume that the contextual differences between training and reactivation became progressively less important.

In a second study, therefore, we trained two groups of infants for two days and administered a reactivation treatment 13 days later. Here, however, the infants were not placed in their infant seats but were supine in their cribs as they had been



1.4
1.3
1.2
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
Retention Ratios
TRAINING + TREATMENT
TRAINING, NO TREATMENT
Priming
1/4
1
8
24
72
Time Since Reactivation (log hrs.)

during training. All other aspects of the reactivation treatment were as before. These infants were then tested for retention of the contingency 1 or 24 hours later. The obtained retention ratios were equivalent to those obtained in the first study. The average retention ratio after one hour was only .38 but after 24 hours it was .78 (t (14) = 2.47, $p < .05$).

In conclusion, these data suggest that the recruitment of the sufficient number or kind of stored memory attributes necessary to reactivate the target memory attributes is a time-locked process. Even if the cues noticed during the reactivation treatment are identical to those present when the memory was originally acquired, they are insufficient for the behavioral expression of the memory. In other words, the reactivation process takes time.

We suspect that the noticed attributes continue to be active after the reactivation treatment has ended and may continue to recruit more and more attributes. Whether this phenomenon is a threshold one and discontinuous, or a progressive continuous function of the number of aroused attributes, remains to be seen. That this recruitment process is facilitated by sleep suggests that the rate at which various attributes once more become accessible increases during periods of minimal interference.