

行政院國家科學委員會專題研究計畫成果報告

新連結的記憶

Memory of New Associations

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一、中文摘要

本研究以六個實驗探討新連結的內隱記憶，另以四個實驗探討新連結的外顯記憶。就內隱記憶的研究系列而言，核心議題為內隱記憶的本質是以激發量的增加或修正為基礎，或以情節痕跡為基礎。就外顯記憶研究系列而言，核心議題為新連結記憶的累積速度。本報告著重在內隱記憶的研究系列。六個實驗針對先前圖字新連結無法產生內隱記憶的結果，探索可能的解釋模式。實驗結果分別排除知覺處理太過容易、反應偏差、圖字干擾、以及概念成份過高的其他解釋；實驗結果顯示新連結的內隱記憶究竟以激發或情節為基礎主要取決於新連結是否在一次情節痕跡內就可產生足夠的激發量；當一次情節無法產生足夠的激發量時，新連結必須經過多次學習才能產生內隱記憶的促發效果。因此，激發或情節的二分野理論模式可能是不必要的。

關鍵詞：新連結、內隱記憶、促發效果

Abstract

The nature of implicit memory was examined in six experiments in which repetition priming for new associations after a single episode was explored. In another

four experiments, explicit memory for new associations was examined. The present report focuses on the first series of studies. Through six experiments, I ruled out alternative accounts for the absence of association-specific repetition priming in previous studies that used picture-word pairs. These alternative accounts include: ease of perceptual processing, response bias, interference between pictures and words, and the use of a speeded task that taps heavily on conceptual components. Moreover, the results showed that whether implicit memory is activation or episode based may primarily depend on the strength of new associations built in one episode. When connection links between new associations have sufficient strength after one trial of learning, repetition priming is episode-based. In contrast, when connection links do not have sufficient strength, gradual modification of activation is required through multiple trials of episodes. Thus, the dichotomy between episode- and activation-based models may be overstated.

Keywords: New associations, implicit memory, repetition priming

二、緣由與目的

Repetition priming is often defined as performance enhancement after a single trial. But can priming occur after a single exposure to novel information that has no stable representation? If repetition priming for novel information can occur after only a single episode, priming must be episode-based, rather than activation-based that require preexisting representations.

Using pairs of new associations, researchers have found only ambiguous evidence supporting episode-based repetition priming. The strength of newly established associations may be the key element in the manifestation of association-specific repetition priming after a single episode.

When no links exist in a word-picture pair, association strength is quite weak such that only explicit retrieval can gain access to contextual information. Indirect tests of memory through speeded matching tasks have failed to show significant association-specific repetition priming after one episode of learning. Moreover, neither perceptual contiguity nor unitization through sentence generation, copy, interactive imagery, or physical integration has overturned the results. These null results, however, cannot refute the episodic view of repetition priming unless alternative explanations are ruled out.

The purpose of this study is threefold: (1) to rule out alternative explanations for the failure to observe association-specific repetition priming between unrelated pictures and words, (2) to demonstrate that

multiple trials of learning are necessary to support repetition priming when integration of unrelated pictures and words is difficult, and (3) to support the hypothesis that activation strength in newly established associations is crucial to manifestation of association-specific repetition priming after a single trial.

If empirical evidence substantiates the contrast in priming between weak and strong associations, the emphasis on one episode in the definition of repetition priming is overstated. Repetition priming should simply be defined as performance change in an indirect test after one or multiple episodes that render sufficient activation in the stimulus representation. Repetition priming would thus be a co-product of a learning episode that modifies or renders sufficient activation strength.

三、結果與討論

Experiment 1: Is the null result due to easy perceptual processing?

According to Ostergaard's (1998) information availability model, three sources of information exist for processing a memory task: perceptual sources, the study episode, and all other prior encounters with the item. If the task can be performed easily by the amount of perceptual and other information, priming measures may be insensitive to variations in the amount of episodic information. By degrading the stimuli in the test phase to reduce the information available from the perceptual sources, baseline performance is reduced, and participants are induced to retrieve episodic information from the prior study

encounter. When baseline performance is deteriorated, priming effects should become larger and more sensitive to the episodic information available from prior study.

In previous studies of picture-word pairs, perceptual information was readily available to participants. Participants were thus less likely to use information from a prior episode, and hence did not benefit from the prior experience. The objective of this experiment is to examine whether repetition priming for new associations can manifest when perceptual information in the test phase is much degraded. If visual difficulty in perceiving information increases retrieval of episodic information, repetition priming for new associations should manifest.

Two priming effects are viable in pairs of unrelated stimuli: item-specific repetition priming (ISRP) and association-specific repetition priming (ASRP). ISRP occurs when response to test pairs in which each of the members of the pairs was studied in two separate episodic trials (i.e. *recombined* pairs) is better than response to test pairs of two unstudied items (i.e. *unprimed* pairs). ASRP is obtained when response to test items with pairings identical to those encountered in the previous study phase (i.e. *intact* pairs) is superior to response to recombined pairs. With an intact pair, the exact episode is reinstated such that the individual items and their new association are preserved in their whole configuration.

Thirty-two participants performed a speeded matching task in which they judged whether the picture and word in each pair referred to the same object in both the study

and test phases. In the test phase, a random-dot mask was superimposed on the stimuli with a dot density pre-tested for each individual participant for a 75% accuracy rate.

Results

ISRP was significant, whereas ASRP was not.

Pair Type		
Unprimed	Recombined	Intact
2031.15* (6.20)	1621.77 (4.70)	1666.77 (3.40)

*RT in ms, Error in %

Experiment 2: Is the null result due to response bias?

Response bias is evident in repetition priming as response in lexical decision was slower to a repeated non-word. The two sources of information are likely in opposition, abolishing the benefit of repeating a newly established association. The first source is perceptual fluency in re-processing a prior episode, with fluency enhancing performance. The second source is response selection in re-processing a prior episode. When an unrelated word-picture pair reoccurred the second time, familiarity biases response selection toward a *yes* response. The bias is in direct conflict with the current response selection, which requires a *different* response to the unrelated picture-word pair. Thus, ASRP cannot manifest.

To rule out the role of response bias in previous studies, I used a categorization task in this experiment. Only performance in the *same* response was analyzed. If repetition priming can be obtained after a single trial,

ASRP should be observed when response bias is eliminated.

Thirty-six participants performed a speeded categorization task in which they judged whether the picture and the word in each pair belonged to the same category (natural or man-made) or to different categories.

Results

A significant ISRP was observed, whereas ASRP was not significant.

Pair Type		
Unprimed	Recombined	Intact
1175.85 (6.60)	1044.06 (5.00)	1059.79 (4.40)

Experiment 3: Is the null result due to interference between unrelated pictures and words?

Because judging a pair of unrelated pictures and words may require intervening processes that produce interference, elaborative processes are perhaps necessary to complete the processes such that the memory of a prior experience can only be tapped by explicit tests of memory. The purpose of this experiment is to examine repetition priming for newly learned associations within the same domain of representation.

In Experiment 3A, associations were established in the domain of object representations. Thirty-six participants were presented with pairs of object contours and instructed to judge which of the two objects was larger in size. In a size judgment task, participants must make an elaborative comparison of perceptual representations between the two members of each pair.

In Experiment 3B, another 36 participants performed the same speeded categorization task as participants in Experiment 2. The only change was the replacement of object contours with object names. If the failure to obtain ASRP in previous studies resulted from interference between two separate domains of representations, an indirect test of new associations within the same representation system should benefit performance.

Results

ISRP was significant, whereas ASRP was not.

Size Judgment

Pair Type		
Unprimed	Recombined	Intact
1595.44 (9.20)	1144.27 (9.70)	1139.23 (6.20)

Categorization

Pair Type		
Unprimed	Recombined	Intact
1298.82 (5.00)	1140.94 (5.30)	1156.82 (5.00)

Experiment 4: Is the null result due to specificity in the use of a speeded task?

It is likely that the failure to obtain ASRP in previous studies resulted from the heavy involvement of semantic analysis. To rule out this alternative explanation, participants in this experiment were asked to perform a matching task in the study phase, and name a picture in the test phase in which pairs were sequentially presented. Although participants also needed to recognize semantic identity, picture naming in brief presentation is similar to word identification,

and can be classified as a nonverbal task requiring perceptual analysis.

Fifty-six participants performed a speeded matching task in the study phase. During the rest period, participants were told that the second phase of the experiment was to explore how people identify pictures under difficult conditions. They were told that the pairs would be sequentially presented, and that the word was presented to add task difficulty. The sequence of presentation was as follows: a word, a pattern mask for one frame, a picture, a pattern mask until participants responded.



Participants were given 60 practice trials to allow them to become familiar with the task difficulty and to determine the threshold for correctly identifying a picture at 40% for each individual participant.

Five types of pair combinations were generated for the test phase: (1) two new members, (2) a new word with an old picture, (3) a new picture with an old word, (4) two old members from separate episodes, and (5) two old members from the same episode. With *same* (picture and word refer to the same object) and *different* (the two members refer to different objects) pairs used in the study phase, 10 possible conditions were generated for the test phase.

Results

Data from 16 participants were excluded from analysis because they did not show a stable psychophysics function to determine threshold. Results showed

priming of the picture from its verbal label because of a preexisting link when both referred to the same object. When pairs involved two unrelated objects with no preexisting link, ISRP was significant, whereas ASRP was not.

Study	Test Phase				
	Intact	Recombined	New Word	New Picture	Both new
Same	0.87	0.55	0.55	0.30	0.74
Different	0.53	0.55	0.54	0.37	0.34

Note: picture and word refer to different objects in the recombined, new word, and new picture conditions.

Experiment 5: Is it impossible to show ASRP between unrelated pictures and words?

It is plausible that an indirect test is not well adapted for learning new associations when the associations tap representations in two separate domains no matter how many exposures participants experience in the study phase. To rule out this alternative explanation, this experiment demonstrates that the same indirect test that fails to show significant ASRP can indeed support priming of new associations after multiple trials of learning. It is assumed that multiple trials of learning strengthen the connection weight between unrelated picture and words such that an indirect test can show ASRP. Thirty-two participants performed the speeded matching task in both the study and test phases with three repetitions in the study phase.

Results

ISRP significant as usual, ASRP was also significant.

Pair Type		
Unprimed	Recombined	Intact
794.31 (3.10)	673.52 (2.50)	706.05 (2.50)

Experiment 6: Is implicit memory adapted only for gradual learning?

It is plausible that implicit memory is not adapted for one-trial, rapid learning of new associations. Thus, an indirect test of memory can only support significant ASRP after multiple trials of extracting invariance in the acquisition of novel information. However, evidence has shown implicit memory for new associations after a single trial of learning. The context for the manifestation of ASRP includes double lexical decision of word pairs, easy unitization between color and a stimulus item, and distinctive embedding of an incongruous object in a visual scene.

The purpose of this experiment is to replicate a previous study that used a double lexical decision task in testing repetition priming for new associations in word pairs. To eliminate a possible confounding variable in the previous study, word-nonword pairs were included in the study phase. In addition, incidental learning was used such that the thirty-two participants were not aware of the memory nature of the experiment. Because lexical decision is a fluent process in the everyday use of language, one episode may be sufficient to create a connection link between unrelated word pairs with sufficient strength. In contrast, one episode should not be enough to establish a link between a word

and a non-word. Thus, ASRP should manifest only for word-word pairs but not for word-nonword pairs.

Results

Supporting the prediction, one episode produced significant ASRP for word-word pairs but not for word-nonword pairs. The failure to observe ASRP for word-nonword pairs cannot be accounted for by response bias because bias was item-based and showed in both intact and recombined conditions.

	Pair Type		
	Unprimed	Recombined	Intact
Word-Word	1032.08 (8.60)	894.31 (3.60)	865.78 (4.20)
Word-Nonword	1059.59 (8.60)	1017.61 (11.50)	996.63 (12.80)

Conclusion

Although the results from each experiment can be accounted for with alternative explanations, the data converge to support the hypothesis that the activation strength in the connection link between unrelated members in a newly established association is the key to repetition priming. When unrelated pictures and words have no preexisting links in their representations, one episode of learning is simply not enough to support repetition priming. Only multiple exposures permit an indirect test to show repetition priming for new associations. In contrast, when a new link can be easily established with sufficient strength by fluent processing of unrelated words, one episode is enough.

If activation strength plays an important role, the distinction between the activation view and the episodic view may not be as stark as previously conceptualized. An episode can be operationally defined as activation of pre-existing units and creation of new units in representation. Depending on the processes involved in accomplishing a task and the fluency of these processes, the level of analysis can be completed on an abstract level or in the original form. Repetition priming simply reflects the fluency of re-processing elements with sufficient strength.

四、計畫成果自評

本研究的原始計畫書提出記錄生理指標，以觀察針對圖字新連結的反應偏差。但在先前作業中發現，要將執行實驗的軟體搭配生心實驗室的生理記錄儀器是一件非常困難的事。權宜之下，改以其他方式驗證反應偏差的角色。

筆者認為，此系列研究的資料提供了有關促發效果所展現的內隱記憶方面重要的實徵結果。在此文獻裡，激發或情節基礎的理論一向將之二分化。研究者多半認為新訊息在一次學習後可以產生促發效果是情節為基礎的最好證據。然而，文獻裡的資料並不一致地支持其中之一的理論模式。本研究系列的結果顯示，決定新連結是否在一次學習就可產生促發效果的關鍵因素在於一次經驗裡的新連結是否有足夠的強度；若強度夠就可以情節為基礎，若強度不夠，就需要多次激發才能展現新連結的促發效果。至於外顯記憶系列的研究則顯示：相對於項目記憶的累積，新連結

記憶的累積比較緩慢。但是，刻意提取的確比較適合展現強度較弱的記憶痕跡。

五、參考文獻

Ostergaard, A. L. (1998). The effects on priming of word frequency, number of repetitions, and delay depend on the magnitude of priming. *Memory & Cognition*, 26(1), 40-60.

(其餘部份，請見全文)